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BYTE

MAY 1989

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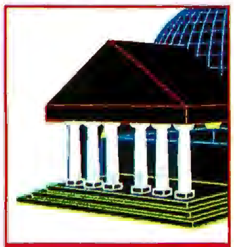

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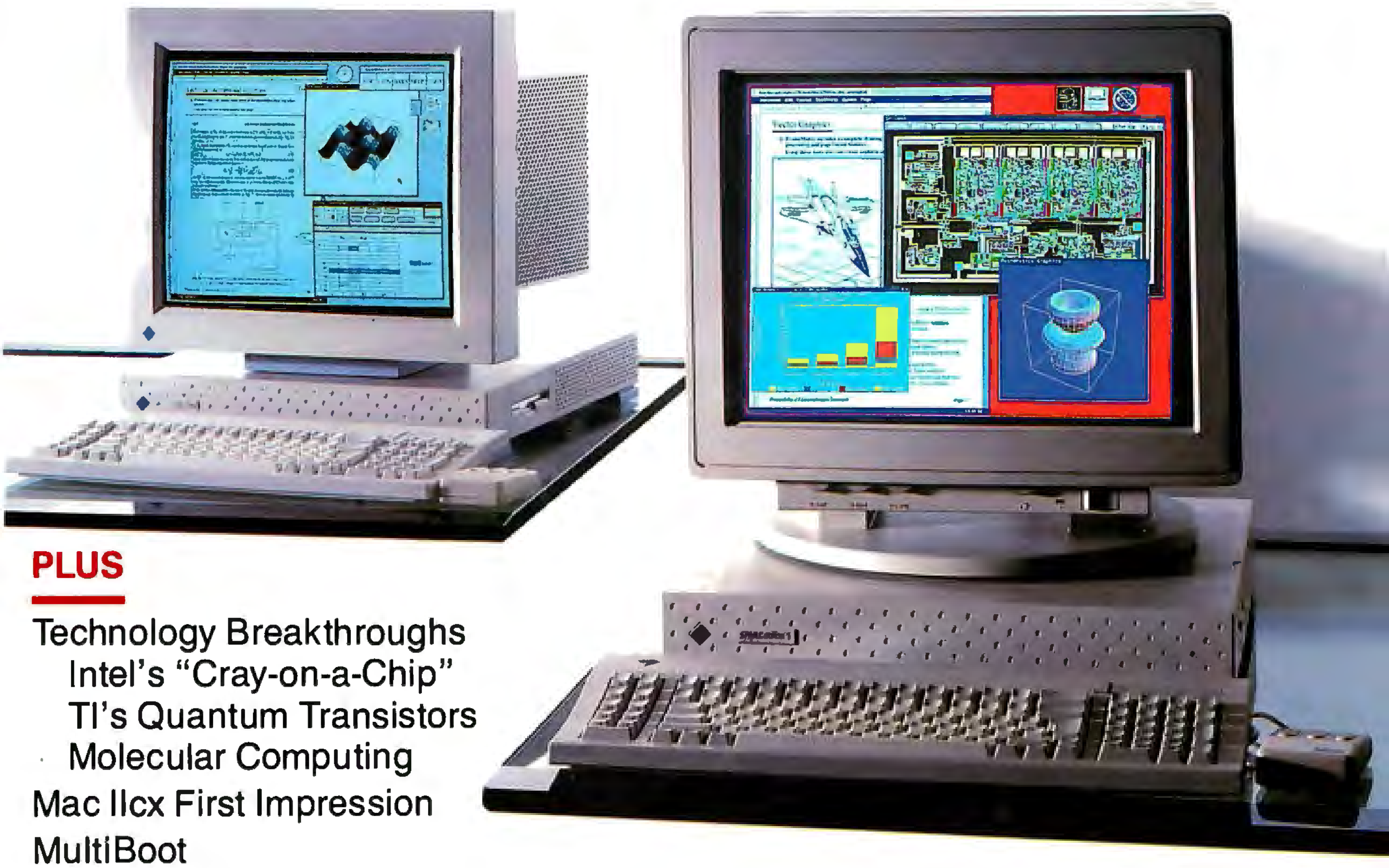

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THE DELL 386 SYSTEM 325 HAS A 25 MHz CLOCK RATE, CACHE MEMORY CONTROLLER, 90 MB 18ms ESDI DRIVE, PAGE MODE INTERLEAVED MEMORY, AND 100% COMPATIBILITY WITH MS-DOS, OS/2 AND UNIX SYSTEM V.

Technically speaking, the 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 Dell System 325 25 MHz ran circles around a field of 386-based systems. 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.

A PERSONAL COMPUTER THAT'S REALLY PERSONAL.

Of the more than 150,000 personal computers we've sold to date, each one's 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®, 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 90 MB ESDI disk drive. Or we can configure it with a 150 or 322 MB unit.

As you might expect, the output is just as intense. You can choose between VGA mono with paperwhite screen, or VGA Color

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Printer System 800: $699.95
Our highest resolution text and graphics, 24-pin dot matrix printer. Draft quality at 200 cps. Letter quality at 66 cps. Parallel and serial interfaces. Wide carriage.

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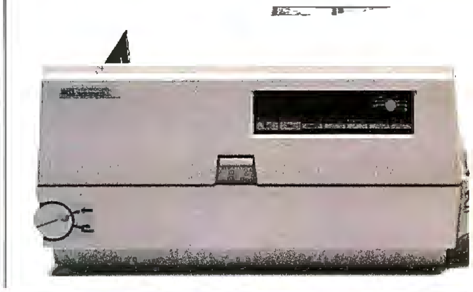


SO HOW COME YOU NEVER CALL?

THE DELL SYSTEM 325 25 MHz 386

PC MAGAZINE EDITOR'S CHOICE

"The new top-of-the-line Dell System 325 is a flagship worth putting out in front of the fleet."
February 14, 1989

STANDARD FEATURES:

- Intel 80386 microprocessor running at 25 MHz.
- Choice of 1 MB or 4 MB of RAM** expandable to 16 MB using a dedicated high speed 32-bit memory slot.
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
- VGA systems include a high performance 16-bit video adapter.
- Socket for 25 MHz Intel 80387 or 25 MHz WEITEK 3167 math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200-watt power supply.
- 8 industry standard expansion slots.

OPTIONS:

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

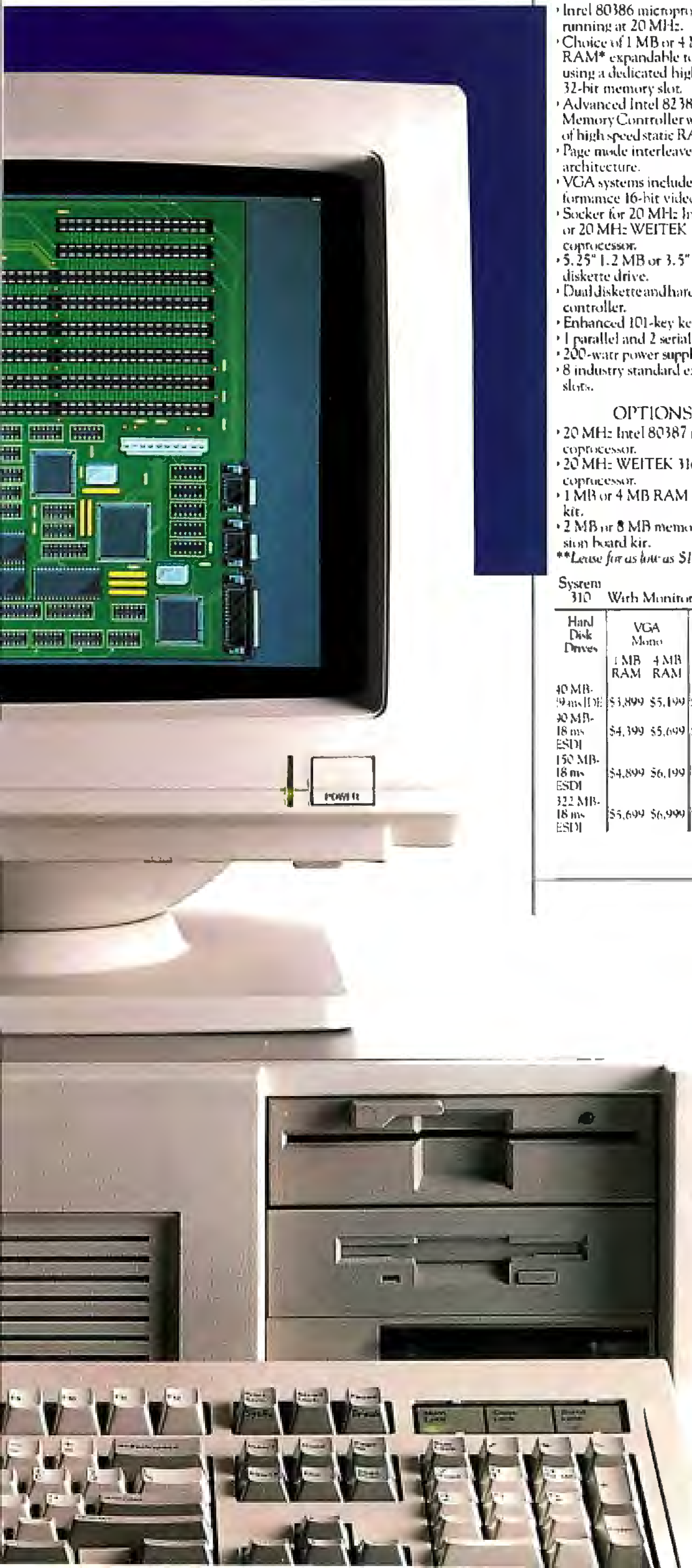
***Lease for as low as $216/Month.*

System 325	With Monitor & Adapter			
	VGA Mono		VGA Color Plus	
Hard Disk Drives	1 MB RAM	4 MB RAM	1 MB RAM	4 MB RAM
90 MB-18 ms ESDI	$5,999	$7,299	$6,299	$7,599
150 MB-18 ms ESDI	$6,499	$7,799	$6,799	$8,099
322 MB-18 ms ESDI	$7,299	$8,599	$7,599	$8,899

Disclaimer: All systems are photographed with optional extras, which some computer retail won't even recogn

Laser System 150, 15 pages per minute: $5,995.
Laser System 80, 8 pages per minute: $3,295.
Laser System 60, 6 pages per minute: $2,195.

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



THE DELL SYSTEM 310
20 MHz 386.

The best combination of performance and value available.

STANDARD FEATURES:

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

OPTIONS:

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

***Lease for as low as $141/Month.*

System 310	With Monitor & Adapter			
Hard Disk Drives	VGA Mono		VGA Color Plus	
	1 MB RAM	4 MB RAM	1 MB RAM	4 MB RAM
40 MB-19 ms IDE	$3,899	$5,199	$4,199	$5,499
90 MB-18 ms ESDI	$4,399	$5,699	$4,699	$5,999
150 MB-18 ms ESDI	$4,899	$6,199	$5,199	$6,499
322 MB-18 ms ESDI	$5,699	$6,999	$5,999	$7,299

THE DELL SYSTEM 220
20 MHz 286.

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

STANDARD FEATURES:

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

OPTIONS:

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

***Lease for as low as $86/Month.*

System 220	With Monitor	
Hard Disk Drives	VGA Mono	VGA Color Plus
One Diskette Drive	$2,299	$2,599
40 MB-29 ms Hard Disk	$2,999	$3,299
100 MB-25 ms Hard Disk	$3,599	$3,899

THE DELL SYSTEM 200
12.5 MHz 286.

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

STANDARD FEATURES:

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

OPTIONS:

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

***Lease for as low as $93/Month.*

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

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

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Dell Enhanced Microsoft® MS-DOS® 3.3: $99.95.
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Dell UNIX® System V/386, Release 3.2:
Now Available. Call for details.

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Plus, 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.

In all probability, the average computer retailer won't have any understanding what makes the System 325 go.

He will, however, be quite aware of the fact that he could add a 35% markup if he could sell it in his store.

Which he can't.

Because we sell direct.

Meaning you now have the unique opportunity to talk directly with a computer expert. And ask things like, "What's the difference between IDE and ESDI?" Or, "How much SIMM RAM should I add?"

In other words, the kinds of questions you should be able to ask a retailer, but usually can't.

So as you might suspect, dealing direct not only saves you the 35% markup, but 100% of the aggravation.

WE COME WHEN WE'RE CALLED.

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

Overkill was one description used in a PC Week article.

Perhaps.

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

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 office full, a leasing plan is 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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BYTE

MAY 1989 VOL. 14/NO. 5

COVER STORY

FIRST IMPRESSIONS

Two Powerful Systems from Sun

by Nick Baran

page 108

The SPARCStation 1 and the Sun-3/80 offer workstation performance at PC prices.

REVIEWS

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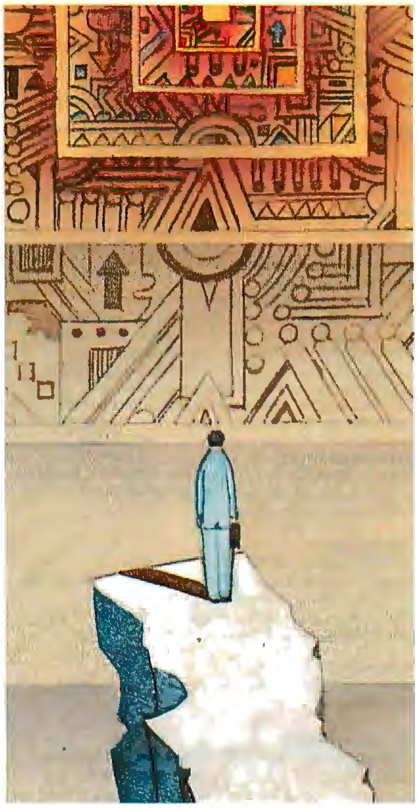

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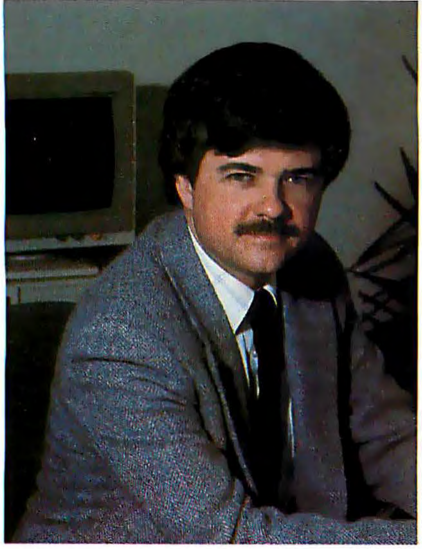


EDITORIAL ■ Fred Langa

A LOT OF COMPANY

A report from West Germany shows worldwide links you might not know about

Hannover, West Germany—CeBIT, the world's largest computer and telecommunications exhibition, opened here in March, and, as always, BYTE was on the scene.

BYTE has a large and growing circulation in Europe. In fact, BYTE is the largest Pan-European computer magazine, with wide circulation in every country on the Continent, including the USSR. BYTE also goes to Asia, Africa, Australia, and South America. BYTE's English-language edition alone reaches over 1.5 million readers worldwide. And this isn't the only edition. BYTE's content is also licensed to other independent publications across the globe, appearing in numerous languages. You have a lot of company as you read this issue.

And it's a two-way street. By sending our editors around the globe and by working with people in other countries, BYTE can give you thorough coverage of not only the products available in your local computer store, but also significant desktop computer technologies and products from the increasingly important global market.

Witness our recent coverage of Japan's TRON project, Scotland's Rekursiv object-oriented chip, Soviet software, and so on. Our Microbytes service on BIX regularly carries news and product information from Europe and our friends at *Nikkei BYTE* in Japan. No other computer magazine brings you coverage like this.

Here's a sampling of what we saw at CeBIT, as reported by Senior Technical Editor Nick Baran:

CeBIT (which is a German acronym for Center for Office and Information Technology) draws about 3000 exhibitors and half a million visitors from all over the world.

This year's CeBIT kicked off West Germany's major commitment to ISDN telecommunications. ISDN allows the integration of text, graphics, video images, and voice communications on a single digital line. In an event that aired on West German television, the Post Office Minister, Dr. Schwarz-Schilling, introduced the first ISDN network in West Germany, with about 8000 nodes in eight major cities. Prime Minister Helmut Kohl participated in a multimedia conversation via ISDN with the mayor of Frankfurt. West Germany hopes to have a nationwide ISDN network by 1993.

One of the most popular exhibitors at CeBIT was Atari, which displayed its hand-held PC Folio "pocket computer." PC Folio runs MS-DOS and uses the 80C88 microprocessor. The device is about 8 inches long, 4 inches wide, and an inch thick. It has a 63-key keyboard and an 8-line, 40-character LCD.

One of the more interesting exhibits was Toshiba's prototype 14-inch color LCD. Based on active matrix technology, the display supports the VGA standard and displays 16 colors, with a resolution of 720 by 550 pixels. Toshiba also showed an 11-inch version of the display in a prototype laptop computer.

Almost 200 U.S. companies exhibited at CeBIT this year. Among them were Microsoft, Apple, IBM, Commodore, Novell, and Compaq.

Commodore is a major player in the West German microcomputer market. Sporting an enormous exhibition booth in the main hall at CeBIT, Commodore announced a Unix-based version of its Amiga 2500, which it is calling the Amiga 2500 UX, and a new version of its PC40 AT system, called the PC40-III.

The Amiga 2500 UX is virtually identical to the Motorola 68020-based Amiga 2500, except that it uses a separate 68851 processor for memory management. The clock speed of the 2500 UX is 14.2 MHz, and the machine comes standard with a 68881 math coprocessor and 3 megabytes of main memory. As is customary at West German product announcements, pricing for the 2500 UX was not discussed.

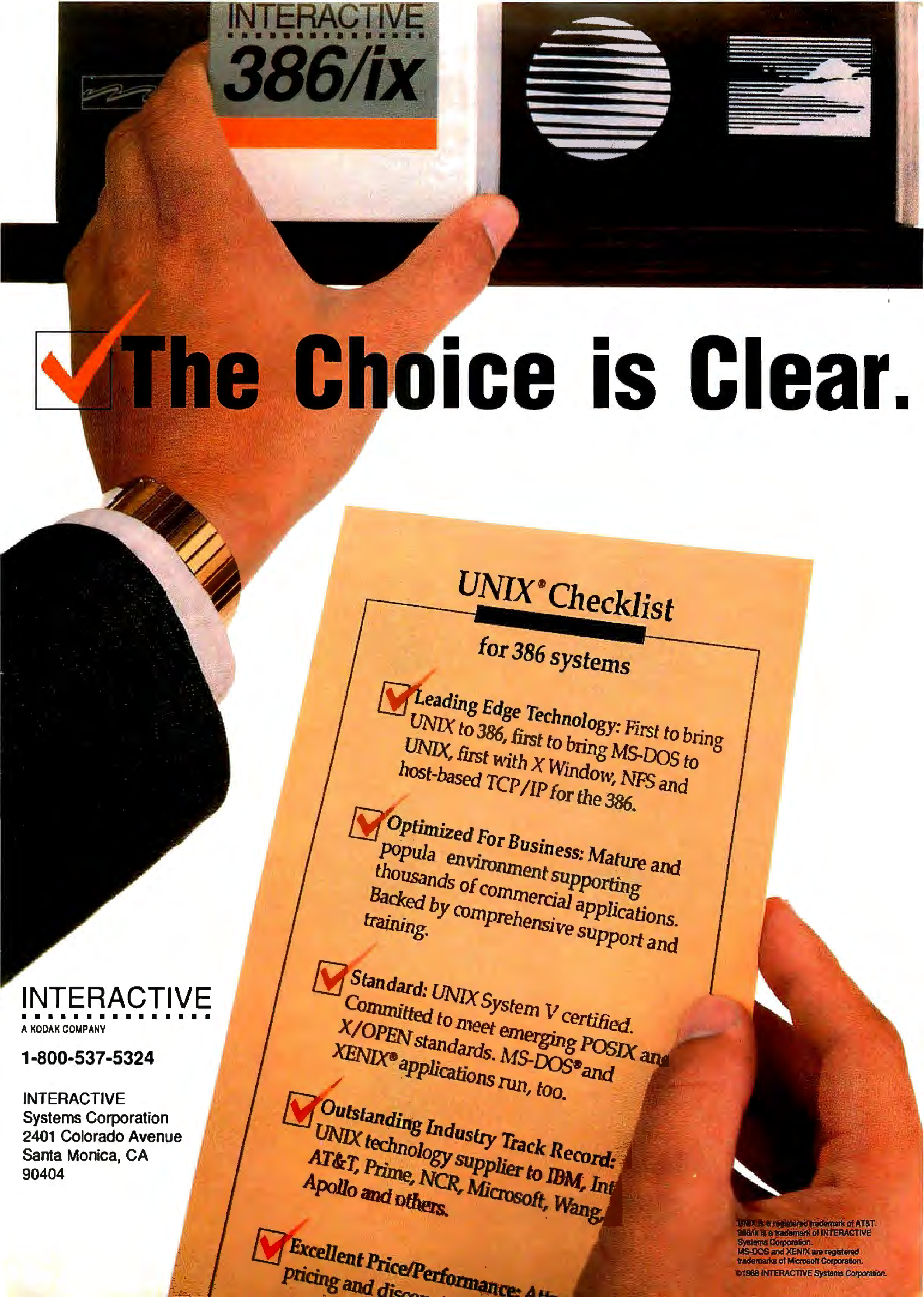
Big Blue looks as dominant as ever in West Germany. With over 7000 square meters of exhibition space in seven different locations at CeBIT, IBM's presence was felt in every technical category, from telecommunications to scientific and engineering applications.

IBM has major research and development projects under way in Stuttgart. Some of these projects were displayed at CeBIT. One of the most interesting was a language-comprehension project using an IBM PS/2. The objective is to make the computer understand the linguistic and logical relationships of German text so that the machine can answer questions about a given document stored in the computer.

A prototype using a 200-word description of a hiking trail was demonstrated. The program takes the text and breaks it down into its grammatical components (i.e., nouns, verbs, objects, and so forth) and then represents each sentence of the text in a logical form that is conceptually similar to an organizational chart. In the demonstration, the system was asked, "Where does the trail end?" The system answered, "The answer to your above question is: In Stuttgart." The language-comprehension project is a joint effort of IBM and several German universities and is planned for completion in 1991.

If it—or any other worldwide development—holds promise to make your use of your computer more productive and worthwhile, you can count on BYTE to bring you the news.

—Fred Langa
Editor in Chief
(BIX name "flanga")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"We are very happy that our system is at the top of the stack in both price and performance, but it is your courteous service that is uncontested by the competition."
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"Overall, I feel that your product is outstanding and your service has been excellent."
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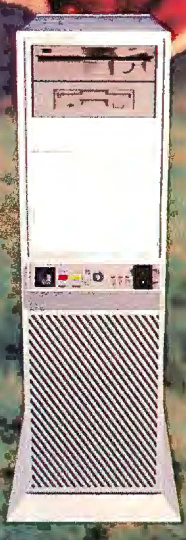

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1.2 Meg 5¼" Drive
1.44 Meg 3.5" Drive
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16 Bit VGA Board
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1 Parallel/2 Serial Ports
101 Key Keyboard
MS DOS 4.01

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Due to the Volatility in the DRAM Market all prices subject to change.

CUSTOMER SATISFACTION
marketer of micro computers in the nation. In order to attain this lofty goal it, to achieve "complete customer satisfaction" we had to supply the best to feel that he or she received most value for their hard earned money. In completely unheard of in the mail-order business. At this point we can the largest company in the market we strongly feel that we are the best. We same. We want you to feel entirely confident of your decision to purchase a do everything in our power to keep you satisfied after you receive your are saying about us. In addition to this we were the only "clone" company chosen out of the hundreds of products they reviewed for it's overall value.
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Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEweek *reports*

Diamond Film Has Promise for Tough Hard Disks

If it's true that diamonds are forever, the hard disk of the future might last "forever" if current research in diamond films proves successful. Researchers are working on synthetically producing thin carbon films that have the diamond crystalline structure; they're using a chemical process involving methane and hydrogen, two abundantly available raw materials.

Diamond, the hardest known raw material, also has a very low coefficient of friction and very high heat resistance, making it an excellent material for coating hard disk platters. While current oxide and metal-plated hard disk media suffer from "head crashes" and other problems due to wear and corrosion, diamond-film-coated hard disks would be much more reliable.

Several computer companies, including IBM, Seagate, and Hewlett-Packard, are interested in diamond-film technology, according to professor Stig Hagstrom of Stanford University's Department of Materials Science and Engineering. (Japanese companies actively involved in diamond-film studies are "ahead" of research developments in the U.S., he said.) Hard disks with diamond-film coatings are only "one to three years away," Hagstrom said.

The tricky part in all this is consistently producing diamond film. "If you're unlucky," Hagstrom said, "you end up with graphite." Another considerable challenge is developing improved techniques for depositing the diamond film on a substrate. It's currently necessary to deposit the film at a temperature of 600 °C, making the process impractical with plastics used in floppy disks. However, the high processing temperature does not present a problem for metal hard disk platters.

In the longer term, diamond film offers great potential as a semiconductor. Diamond is in the same family of elements as silicon and germanium and could conduct current at three times the speed of silicon (diamond has three times the "hole mobility" of silicon). Diamond film has much higher heat resistance than silicon and could operate as a transistor at temperatures from 6°C to 700°C, allowing much higher power than can be achieved from silicon. But before they can manufacture diamond transistors, chip makers will have to come up with effective "doping" techniques, which introduce impurities into the pure film material for controlling the electronic properties of the semiconductor. The Japanese have successfully doped diamond film. However, diamond semiconductors are probably five to ten years away, said Hagstrom.

For more information, contact Dr. Stig Hagstrom at the Stanford University Department of Materials Science and Engineering, Stanford, CA, (415) 723-2558.

Backplane Bus up Against the Wall; Designers Looking to New Architectures

The backplane bus architecture used on computers today will hit its peak performance levels in the next few years, several experts in the field predict. "We've hit the brick wall," said bus designer David Gustavson at the recent Buscon '89 conference. The most promising backplane-bus concept currently in the works is the Futurebus project (IEEE standard 896.1), which designers hope will offer transfer rates of 200 to 300 megabytes per second (the fastest buses in use today offer transfer rates well under 20 megabytes per second). Futurebus represents the "end of the road" for conventional backplane bus architecture, said Paul Borrill of National Semiconductor. "Futurebus will be the last great bus."

The problem with backplane tech-

continued

NANOBYTES

Any doubts about **Intel's 80860 RISC processor** showing up in personal computers were dispensed with at the 80860's official debut. The major demo at the rollout pitted a Sun-4/110 (using a SPARC chip) against a Silicon Graphics Personal IRIS (with a MIPS chip) against an IBM PS/2 Model 80 that had a prototype 33-MHz 80860 bus-master card in it. The PS/2 was running OS/2 and used its 80386 for nothing but flashing up the dots generated by the 80860. Each system was running the same Mandelbrot fractal program; the PS/2 was the fastest. IBM executive James Cannavino confirmed that IBM and Intel are working on developing the bus-master card as a possible commercial product. Big Blue watchers still don't know how to interpret Cannavino code, but we think he was saying it's a product we'll be able to buy in a year or so.

Portable OS/2: "Making OS/2 popular is priority 1, 2, 3, 4, 5, and 6," says Microsoft's vice president of systems software, Steve Ballmer. The company is intent on making OS/2 widely used and plans to port it to non-IBM-type systems. Microsoft won't produce such an operating system for at least two years, but when it does, portable OS/2 will be going head to head with Unix, an established portable operating system that's been getting more ink than a candidate for Secretary of Defense.

Motorola wants to make its 88000 RISC processor a big hit in the Unix workstation market, but right now the chip is going through the stage of no commercial software. The **88open Consortium**, an independent group of companies whose biggest financial backer is Motorola, is trying to persuade developers to write for the 88000

continued

NANOBYTES

processor. The group's new Software Initiative Organization consists of 30 software vendors committed to providing programs for the 88000 RISC architecture. The organization will also certify software that's fully compatible with the 88000 Binary Compatibility Standard, which is based on AT&T Unix version 5.3 but will be compatible with Unix 5.4 when it's released later this year or early next year.

Initial backers of the SIO include some **major Unix software vendors**, such as ABSOFT (FORTRAN compilers), Frame Technology (desktop publishing), Informix (database management software), and Insignia Solutions and Phoenix Technologies (MS-DOS emulation software). So far, Sanyo/Icon, Data General, and Opus/Everex have introduced 88000-based systems.

Bernardo Huberman, a research fellow at Xerox PARC who spoke at the Clearpoint-sponsored chaos conference, eloquently described the world as being surrounded by a vast "**computational membrane**." As new generations of computers are linked into the world grid, Huberman said, chaos will inevitably become a major problem. Thinking about the effects of chaos on large networks of the future can be both sobering and frightening. The world banking system already relies on large networks, as do international companies like Hewlett-Packard, and spawning networks—giant multitasking environments wherein computing tasks roam in search of free computing resources—are expected to be a component in the theoretical "Star Wars" strategic defense system.

The **Extended Industry Standard Architecture** bus will overtake the Micro Channel in about a year, says a man who sells bus connectors. Fernando Ramirez, a sales engineer at Burndy Corp.—which makes EISA and Micro Channel connectors—says his company already has big commitments to buy EISA connectors

continued

nology is that it's inherently a "broadcast only" mechanism. "Only one guy can talk at a time," explained Gustavson. Current handshake protocols are limited by the time required for the signal to propagate from the sender to the receiver and then for a response to return to the sender. While the Futurebus project greatly improves (theoretically) the performance of current bus technology, the only way to make significant gains is to introduce a new architecture, according to Gustavson. Current technologies might reach maximum data transfer rates of 200 megabytes to 300 megabytes per second, but new bus designs will be needed to reach transfer rates of 1 gigabyte per second or more.

Gustavson, an engineer at the Stanford Linear Accelerator; David James and Paul Sweazey of Apple Computer; and John Moussouris of MIPS Computer have been working on a new architecture, called the Scalable Coherent Interface (SCI), that employs the concept of parallel "point-to-point interconnects." In the SCI model, bursts of data are transmitted at one time, similar to the packet concept used on LANs. The packets of data are sent along "unidirectional links" from the CPU to a cache controller and finally to a SCSI interface that ties together incoming and outgoing links. Gustavson showed a prototype model of the concept using a modified Micro Channel board that had what Gustavson called a "transmitter" soldered on to it.

According to Gustavson, the initial target transfer rate is 1 gigabyte per second per processor, with a maximum of 65,000 processors. In the ultimate SCI configuration, the 20 terabytes (that's 20,000 gigabytes) of data stored in the Library of Congress could be moved three times per second, according to Gustavson. While current bus technology will peak out at transfer rates of about 300 megabytes per second, the gigabyte-per-second transfer rate of SCI may very well be needed in the next 10 years. The proposed Super Collider project in Texas, for example, will handle 400,000 gigabytes of raw data every year. The 100-MFLOPS processors of the future will require 1-gigabyte-per-second transfer rates to achieve full utilization.

There are, of course, some major technological hurdles to jump before the SCI project becomes a reality. First, there are currently no VLSI chips capable of handling the proposed transfer rates of 1 gigabyte per second or more. Second, the cache coherency mechanism, designed to make sure that a system never allows one processor to change a piece of data without all the other processors knowing about it, has not been fully worked out.

However, the SCI project is no pie in the sky. Gustavson said the technology for the VLSI chips will be available in the next year or two. The project now has an IEEE project number (IEEE 1596) and a sizable commitment of resources from Apple, Hewlett-Packard, and Norsk Data, Gustavson said.

For further information, contact David Gustavson at the Stanford Linear Accelerator, P.O. Box 4349, Stanford, CA 94309, (415) 926-2863.

New FORTRAN Standard at Least a Year Away

You can talk about C, you can talk about C++, you can talk about Ada, and you can talk Smalltalk. But when it comes to science and engineering applications, FORTRAN is still the world's standard programming language. And it's in dire need of an upgrade. FORTRAN 77, established in 1977, is the most recent standard; the last time FORTRAN was updated, Jimmy Carter was president, Eddie Murray and Andre Dawson were baseball's rookies of the year, and Radio Shack was selling the TRS-80 Model I for $599.95. The forthcoming standard has been known as FORTRAN 8X, which optimistically indicates that it will be ready sometime in this decade.

However, it looks like a new FORTRAN standard won't be ready until some time in 1990, according to Jerrold Wagener, vice chairman of the ANSI X3J3 subcommittee, which is working out the technical specifications of the new standard. At a recent meeting in Palo Alto, California, about 50 members of X3J3 hashed out details such as whether to have an INCLUDE statement in FORTRAN

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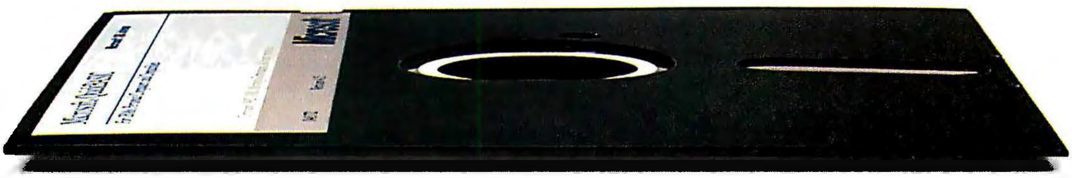

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from several makers of IBM PC AT compatibles, including **Hewlett-Packard, Olivetti, and Everex**. The EISA connector features a bilevel slot that can accommodate boards made for ATs as well as the 32-bit EISA boards when they arrive.

Not everyone foresees Easy Street for EISA-based computer systems. At Buscon '89, several bus watchers said **EISA is just a ploy** by PC clone makers to get IBM to lower its licensing fees for Micro Channel patents. EISA has the backing of Compaq, Zenith, Hewlett-Packard, Tandy, and other major makers of PC-compatible hardware.

Is it a revolution? Or just a minor rebellion? The **Gartner Group** claims in its latest study of computers in America that the majority of businesses in the U.S. **do not use personal computers** to get their business done. And it doesn't look like they'll be working with them any time soon. According to a Gartner study of 45,000 executives at 8000 business places around the country, 70 percent of all "nonfarm, nonresidential businesses do not possess a PC." Of those questioned, 9 percent said they planned to buy one this year.

The **National Institute of Standards and Technology** (formerly the National Bureau of Standards) is setting up a research program to study **security and management** issues relating to networks that use Open Systems Interconnection architecture or ISDN communications. NIST seeks joint participants who will provide funding, equipment, or staff. Contact NIST, B151 Technology Building, Gaithersburg, MD 20899.

As everybody in this industry knows, Apple is pushing hard to get its **Macs into corporate America**. Whether or not it's succeeding is a matter of conjecture and how much you believe the league of analysts. But one Mac watcher says **HyperCard's scripting language** is helping push

continued

(similar to the `#include` command in the C language) or whether "percent" and "dot" are equivalent notations. Among many other changes, the new FORTRAN will feature enhanced array operations, dynamic data structures, user-defined data types, pointers, and new regulations for numeric precision.

Agreeing on a new standard is an incredibly complex task. Many proposals have been contributed from FORTRAN programmers around the world. The committee must vote on each of these proposals.

The International Organization for Standards (ISO) is also working on a new FORTRAN standard, and that group's effort must be coordinated with the ANSI work so that a single standard emerges.

"It's very critical to have a new standard," Wagener said. "It would be of tremendous benefit to scientific programming and would make the programming process much more efficient."

The X3J3 committee hopes to have its final proposal ready for public comment this fall. The document is nearly 400 pages long.

Anyone interested in reviewing or commenting on the FORTRAN 8X standard can obtain further information from J. L. Wagener, X3J3 Vice Chairman, Amoco Production Research, P.O. Box 3385, Tulsa, OK 74102.

Chaos Study Could Affect Computers, Networks

Will computers unlock the secrets of chaos? Will the science of chaos lead to drastically new types of computers? Chaos, or what the scientists more accurately call nonlinear dynamic systems, integrates the disciplines of physics, math, computer science, and biology. At a recent conference sponsored by Clearpoint Research, experts from those fields discussed the implications of using computers to study chaos and chaos's effect on the future of computer design. (By way of parenthetical and grossly simplified background, chaos is the tendency for systems to exhibit unpredictable, seemingly random behavior. Consider water flowing over a waterfall: All the supercomputers in the world couldn't predict the path an individual drop of water might take.)

Norman Packard, one of the innovators of chaos science and the director of the Center for Complex System Research, said the most immediate use of computers in the chaos field is in attempting to model chaos, doing what he termed "capturing real-world dynamics within the artificial world of the computer." But while computer simulation and modeling isn't exactly a new field, Packard said chaos modeling will eventually result in radical new computer designs that will change computers "from dumb brutes into innovative creatures."

Packard holds out little hope that existing studies of artificial intelligence and expert systems will make any dramatic change in computers, saying that research is resulting in "brittle" systems that "don't have the ability to explore on their own." Current neural net research is a step in the right direction, he said, but researchers need to work harder to design models that "press up against the limits of predictability."

But while Packard sounded optimistic that chaos research will result in a "sharp transition" to a new breed of computers, he declined to speculate on details, saying it's a "science that's just being born." He did predict that computers of the future will consist of a "combination of randomness and structure" and said it might well be 10 to 20 years before we'll see commercial applications of these new systems.

While chaos studies might some day result in a new breed of computers, a more immediate problem is being studied by Bernardo Huberman, a research fellow at Xerox's Palo Alto Research Center (PARC). Huberman's research is pointing to potential problems caused by chaos factors in computer networks. As networks get larger, some begin to exhibit what Huberman terms "wildly unpredictable behavior." While this isn't a problem in a typical local-area (or even wide-area) network, PARC is developing next-generation "spawning networks" in which unpredictable behavior could be a problem.

A spawning network is a multitasking environment in which comput-

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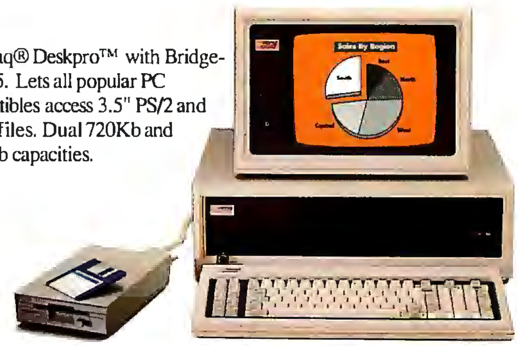

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Macs into corporate offices. At the recent Software Development '89 conference, consultant, author, and HyperTalk expert **Dan Shafer** said HyperTalk has specifically fueled Mac purchases because it lets users design their own front ends to applications. There's been "a surge in interest over the last six months because folks want to use Macs as front ends to databases nobody can understand," said Shafer. "Put a cartoon in front of a database, and people think they understand it better."

In a move to give the Sun-driven Scalable Processor Architecture (SPARC) complete vendor independence and, in particular, independence from Sun Microsystems, the **SPARC Vendor Council** has formed a "not for profit" organization to oversee the development and binary compatibility of

continued

ing tasks automatically migrate to machines that have free computing resources. In a spawning network, the database sort and report process that you start in one window before jumping to another application can actually be performed as a "spawned process" on some other machine in the network in a process completely transparent to the user.

According to Huberman, processes in spawning networks essentially "bid" for free computing resources. The lack of a central control in a spawning network is both its biggest advantage and the cause of unpredictable chaotic problems, he said. Individual processes don't always "know" the state of the network and can sometimes cause situations that either lock up the network or cause it to act strangely. Huberman calls the whole thing a "computational ecosystem," and he said that his group is studying the ecology of biological systems in an effort to draw a parallel with what's happening in a spawning network.

Chaos scientists aren't ones to make glib predictions. They like to point out that despite millions of dollars spent on computers, weather services haven't become more accurate in their forecasts.

Unix Is One-Half of IBM's System Strategy

IBM is stepping up its investments in its Unix-based systems and software and is "dead serious about this market," IBM's U.S. general manager told a crowd of Unix users, developers, and vendors. Delivering the keynote address at UniForum in San Francisco in March, Terry Lautenbach told the audience that IBM has "a long way to go to establish a leadership position" but that the company is committed to the Unix market. Lautenbach said IBM is "very pleased"

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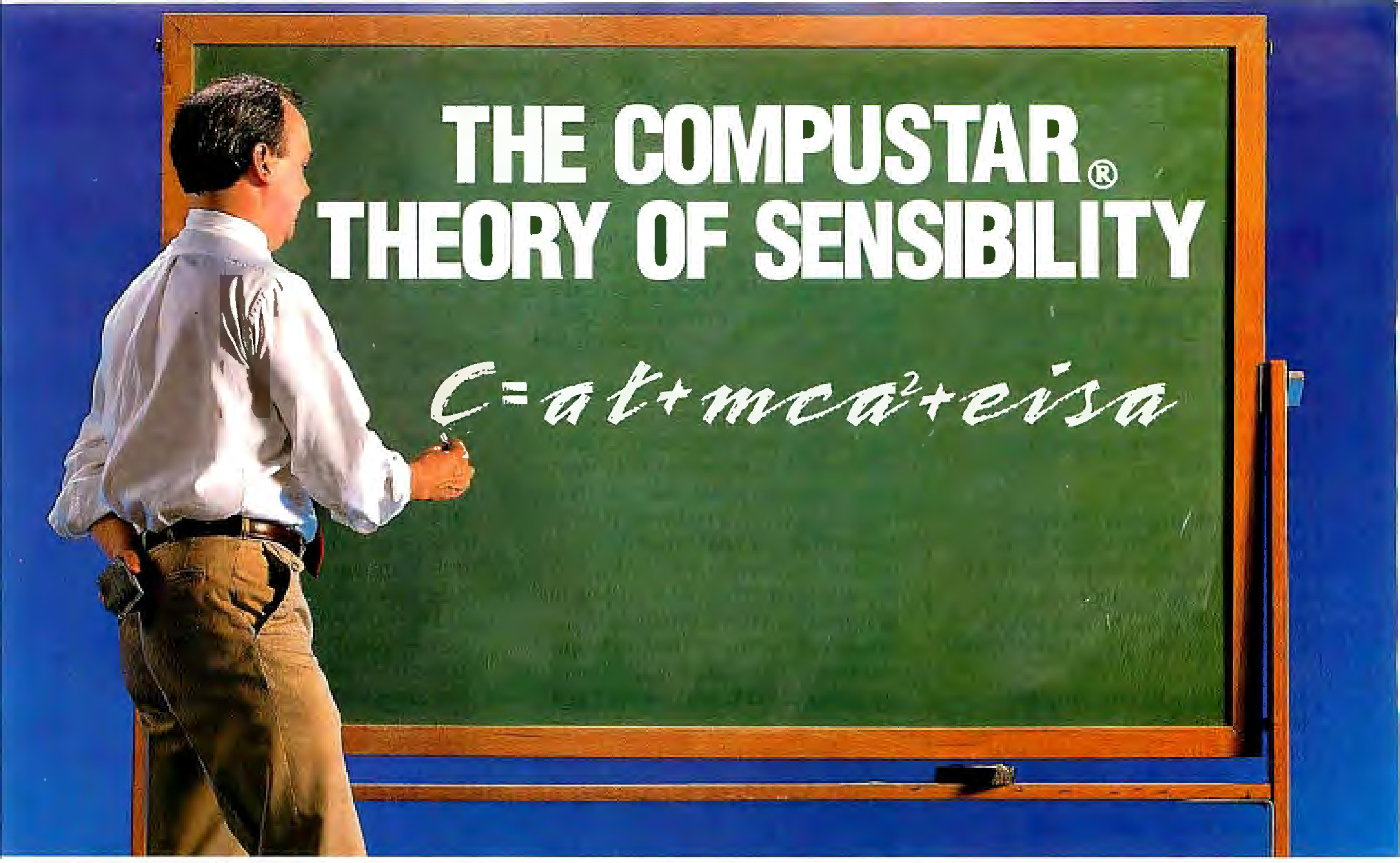

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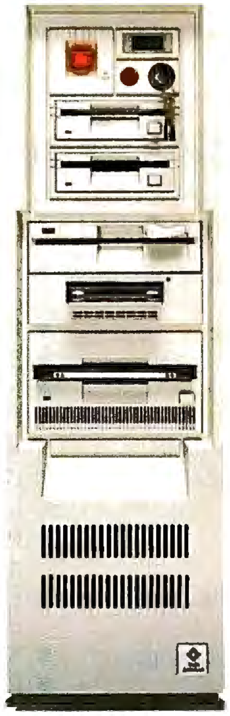

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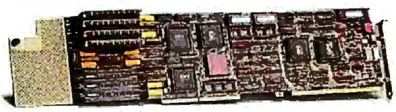

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SPARC processors from multiple vendors. Founding members of SPARC International include the manufacturers of the SPARC processor: Bipolar Integrated Technology, Fujitsu Microelectronics, LSI Logic, Cypress, and Texas Instruments.

Texas Instruments (Houston) has cranked up the speed of its **TMS34010** graphics processor to **60 MHz**. The original has a clock rate of 40 MHz. The new chips are $76 each when you buy 10,000.

Intel said it will buy **Sun386i** systems for its circuit designers to use in developing "new generations" of ICs. Sun's 386i is a Unix system (with a DOS compatibility box) based on Intel's 80386 chip.

In what the company called "an incitement of guerrilla warfare,"

continued

with the progress of the Open Software Foundation (OSF) and will support the OSF/Motif graphical user interface being developed for Unix by Microsoft, Hewlett-Packard, and DEC.

Lautenbach emphasized that IBM views its Unix inplementation, AIX, and its Systems Application Architecture (SAA) as two equally important "strategic platforms" for its customers. SAA will be the standard framework for IBM's proprietary operating systems, VM, MVS, AS/400, and OS/2. AIX will be the platform for IBM's products in the open architecture of the Unix environment. IBM will provide connectivity between AIX workstations and SAA hosts and, if customers demand them, applications that run under both SAA and AIX.

IBM's enthusiasm for the Motif graphical interface raises the question of how IBM will use the NextStep user interface it has licensed from NeXT. It's unlikely that IBM will support two different and incompatible user interfaces on its Unix platform. It's reasonable, however, that IBM will use some of the NextStep technology, such as its development toolkit and object-oriented programming features. Many analysts have said that IBM hedged its bets when it licensed NextStep, just in case OSF fell apart and there was no other pictorial user interface that IBM could adopt.

Chip Makers Preview Memory Technologies

Fatter and faster memory technologies dominated this year's International Solid-State Circuits Conference in New York, where chip makers described advances in memory technology that will affect future personal computers and workstations.

Three Japanese companies revealed laboratory prototypes of the

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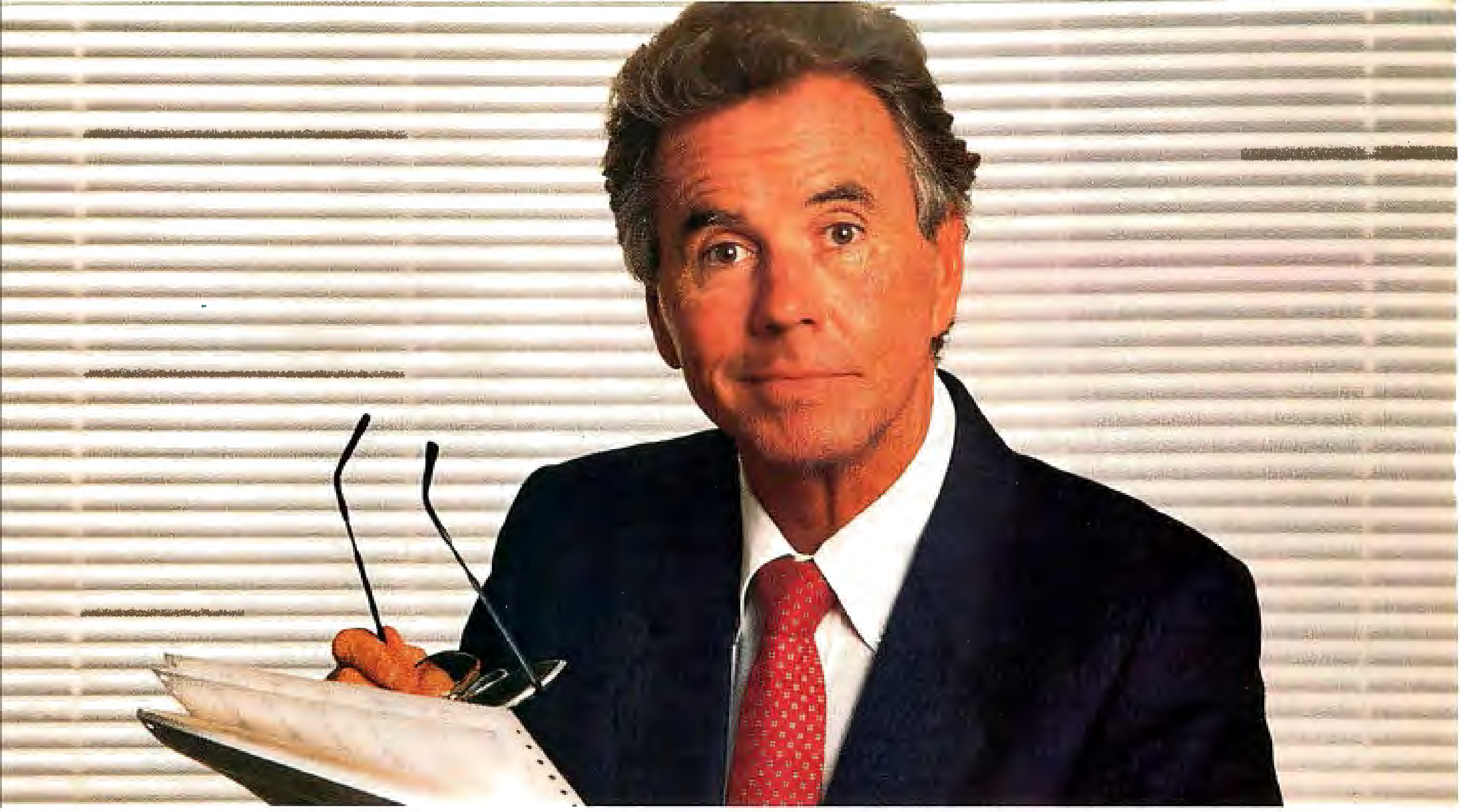

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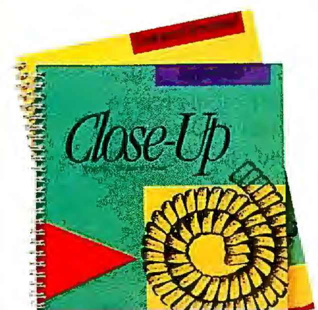

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NANOBYTES

Advanced Logic Research (ALR) (Irvine, CA) **reduced the prices** of some of its 80386-based systems. Most significantly reduced was a 25-MHz 80386 model that will now sell for less than $3495. The price reductions are aimed primarily at the Flex-Cache line. In BYTE Lab tests, FlexCache systems rank among the fastest. The 20-MHz 386/220 is now probably the industry's first 80386-based system to sell for less than $2000.

When **ALR** introduced its Micro-Flex 7000 Micro Channel clone last year, company officials told us the system would boast a 64-bit memory bus. Because of problems with some application software, however, the company had to redesign the computer to use a 64-bit bus only between the system's cache and main memory. Almost all other 80386 systems use a 32-bit bus. The increased width of the 64-bit bus should allow the ALR system to have slightly higher performance than other 80386-based systems.

Addison-Wesley (Reading, MA) has revised the *Amiga Technical Reference Series* to include information on System software version 1.3 and all three Amiga models.

Is **copy protection** coming back in another form? **Rainbow Technologies** (Irvine, CA) says it will be supplying **Ashton-Tate** with its SentinelPro "hardware key" for use with dBASE and Framework. Ashton-Tate will use the devices, which have to be stuck into the computer's printer port for the software to run, in some international markets where piracy rules. An Ashton-Tate official cited the Middle East as a pirate-rife market lacking in protection for owners of copyrights.

Lego, maker of those ubiquitous plastic building blocks, has formally endowed MIT with the Lego Chair of Learning Research. Lego inventor **Seymour Papert** was appointed as the first holder of the chair, which is made entirely of Legos, natch.

much-anticipated 16-megabit DRAM chip. Toshiba took the spotlight with a fast, 45-ns CMOS chip that uses ultrafine 0.6-micron technology. NEC weighed in with a 55-ns chip that uses 0.55-micron technology. And Mitsubishi scientists described a 60-ns DRAM chip with 0.5-micron rules that uses 3.3 volts instead of the 5 V that most chips use.

Each of these chips could hold 2 megabytes of data. It will be some time before such chips appear, however. The industry is only now beginning to see sufficient quantities of 1-megabit chips. The 16-megabit chips, two generations removed from the 1-megabit chips, probably will not be available for two to three years.

Hitachi researchers said they've developed technology that could permit DRAMs to run on just 1.5 V, which would be a boon to battery-powered computers. Hitachi said a 16-megabit 1.5-V DRAM could run for 500 hours on eight batteries.

IBM said that it has developed a 5-ns 128K-bit static RAM chip, the fastest ever made for its size. The chip has a 6.5-ns first-access time and a 5-ns cycle time; combined with 32-bit data I/O capacity, it offers data bandwidth as high as 6.4 gigabytes per second, higher than any previous SRAM chip of 64K bytes or larger.

Texas Instruments, Hitachi, and Toshiba all disclosed high-capacity 1-megabit SRAM chips that break the previous speed record for their size. TI and Toshiba's chips have access times of only 8 ns, while the Hitachi clocks in at 9 ns.

Toshiba scientists said that they have developed a 4-megabit EEPROM device by reducing the number of memory cell components. Texas Instruments announced a 256K-bit flash EEPROM that requires only a single 5-V power supply for program, erasure, and read operations. TI said the chip's cost and performance were comparable to dual-power-supply EEPROMS (those that require 12 V to program and erase and 5 V to read) but that its application would be cheaper since only a single power source is required. The company projects that 5-V flash EEPROMS will be a major nonvolatile memory technology in the 1990s.

TI representatives also described a new 1-megabit CMOS "BurstMode" EPROM that uses 1.4-micron technology and offers 20-ns access time. TI said the speed and cost of this chip will make it a viable alternative to caching architectures that use more expensive SRAM chips.

Nobel Winner: Computers Are Tools, Not Brains

Computers can never replicate the power of the human brain, Nobel Prize winner Arno Penzias told computer scientists at the Association for Computing Machinery's recent conference on computer science, but they "can do an awful lot for us" if we accept them "as a tool rather than as a replacement."

"I see computers as an engine, and that's a good term because computers are like automobiles," said Penzias, vice president of research at AT&T Bell Laboratories. "Computers help you an awful lot with speed but are almost useless in terms of charting direction."

Penzias, who shared a Nobel Prize in 1979 for his work in radio waves relating to the birth of the universe, wants to link fax machines with computers and, of all things, file cabinets. Noting that 90 percent of all paper that is filed is never again retrieved because we can't find it, the physicist thinks we should be able to fax directly to a file cabinet and create at the same time a scanned image of the page that is converted to ASCII so it can be searched and then retrieved. Penzias also wants computer scientists to concentrate on machines that help people rather than work like people. "The real challenge is not to emulate human beings with machines, but to reinforce them," Penzias said.

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LETTERS

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It's a Plot

The Product Focus entitled "Plotters in Perspective" by Stanford Diehl and Steve Apiki (December 1988) was interesting, but I would like to make a few comments.

First, the article should have included data on overshoot. Under some conditions, even a small amount of this can be very annoying.

Also, I believe the term "friction roller" is inaccurate. From what I have read, a grit-covered wheel first makes an indented pattern in the paper. Later travel falls into the same pattern; otherwise, the paper would eventually lose registration.

Finally, why are the prices so high? Even the lowest-cost unit is nearly $800. Surely American industry can do better, or is everything going to end up being built overseas?

Frank J. Wilson
Tomales, CA

Wall $treet Raider Update

I always enjoy Jerry Pournelle's column in BYTE, and I particularly enjoyed the January column, since Jerry had some nice things to say about my corporate takeover/stock market simulation, Wall $treet Raider. However, I should point out that he was reviewing a copy that my former software publisher, Oasis Press, sent him way back in 1986.

Oasis Press, which has moved to Oregon, still sells the program but no longer publishes it. The current publisher of Wall $treet Raider is Intracorp Software (14160 Southwest 139th Court, Miami, FL 33186, (800) 468-7226). The program costs $34.95.

Michael D. Jenkins
Alameda, CA

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

Because of space limitations, we reserve the right to edit letters. Generally, it takes four months from the time we receive a letter until we publish it.

I'll Stick with IntegrAda

I think the review of IntegrAda by Karl Nyberg and Jon Udell (January) grossly misrepresents the product. I bought IntegrAda a couple of months ago, and I love it. It is a Stoneman-like environment surrounding a validated Ada compiler that runs very well on my home microcomputer. It's easy to use, and I have had few problems with it (and most of those were my own fault). And it cost me just $500. I actually prefer it to the multi-thousand-dollar products available to me at my workplace.

Nyberg and Udell stated that they used version 4.0. I have version 4.0.1. I have to believe that most of the reviewers' negative comments are based on the older version, because so many of the faults they point out are nonexistent on my version. Other perceived "faults" seem to be based on a comparison of IntegrAda with products that cost much, much more.

Dan Keller
Huntington Beach, CA

Algorithm Optimizing

I recently noticed a massive speedup of the Sieve of Eratosthenes, one of your language benchmarks. In this algorithm, the idea is to initialize a set of flags, then repeatedly increment a pointer from 1 to an upper limit until it indexes an initialized flag. This, then, is a prime number, so all multiples within range (except itself) have their associated flag cleared. The process then continues so that, at the end, any untouched flag indicates a prime index. But all the multiples of any prime n between itself and n^2 will have been crossed off already because they are of the form $(n \times m)$ where $2 \leq m \leq n-1$, and multiples of all these m have been crossed off already! Therefore, you need only start searching/crossing off at n^2 rather than $2 \times n$, and you need only

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LETTERS

search up to the square root of your upper limit (if max = 8192, you need only search up to n = 90).

So, in BASIC:

```
max=8192 : root=90 : DIM flags(max)
FOR num=1 TO max : flags(num)=TRUE :
        NEXT num
FOR num=2 TO root : IF flags
        (num) THEN
  FOR mult=num*num TO max STEP num:
        flags(mult)=FALSE : NEXT
END IF : NEXT num
```

The chance to fake benchmarks semi-legitimately comes up yet again. But the real question is, How long will it be before an "optimizing compiler" can find speedups like this? Or is there a mass market for "algorithm optimizers"?

Nick Pelling
Hornchurch, Essex, U.K.

News Brief

The January Microbyte entitled "Japanese Giants Offer New Unix Systems" announces Sony's new Unix workstations and attributes "NeWS" to the name of this line of hardware. The name "news" is indeed correct, but, in fact, "NeWS," as printed, is the trademark of Sun Microsystems' network-based graphical windowing system.

Your attention to these details is important and appreciated.

Stacey M. Cannon
Sun Microsystems, Inc.
Billerica, MA

More on Bridges

"When One LAN Is Not Enough" by William Stallings (January) successfully shed light on many important aspects of internetworking. However, the author made several misleading statements and omissions with regard to bridges. Bridges can have considerably more functionality than the article discusses, and readers should understand all that current bridge products have to offer when evaluating internetworking options.

First, bridges do not depend on upper-layer protocols (ISO layers 3 to 7). Upper-layer protocol independency is a characteristic of bridges, routers, and gateways, and it makes bridges the most flexible internetworking solution available. Bridges do not assume anything about any upper-layer protocols. In some cases, they do not even depend on lower-layer protocols. For example, an IEEE 802.5 token-ring bridge will bridge two networks that follow the IEEE 802.5

continued

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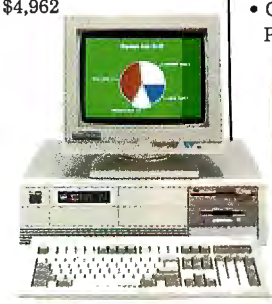

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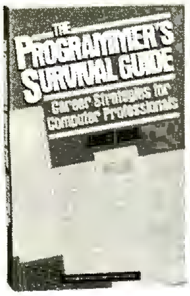

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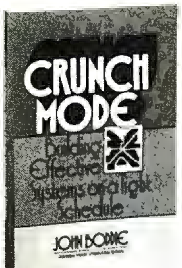

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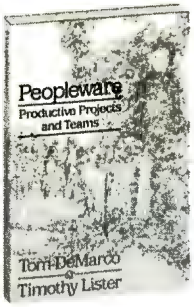

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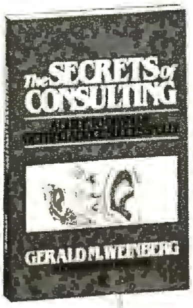

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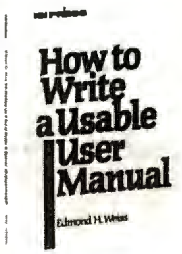

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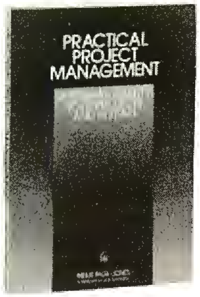

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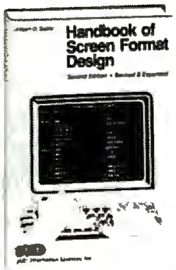

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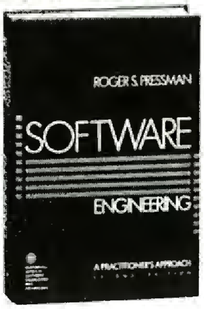

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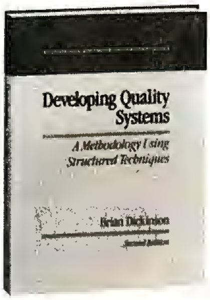

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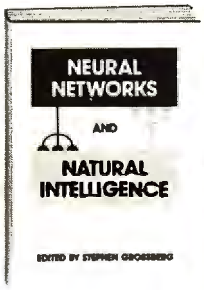

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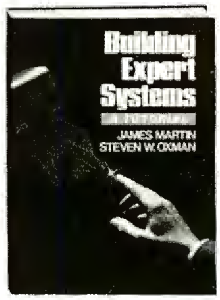

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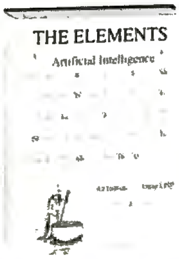

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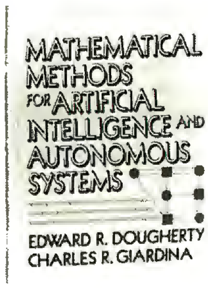

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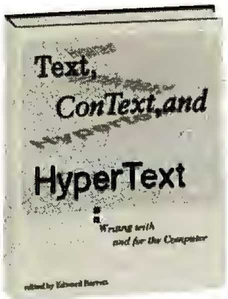

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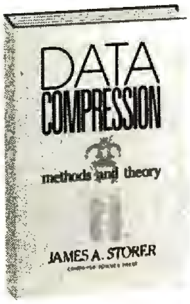

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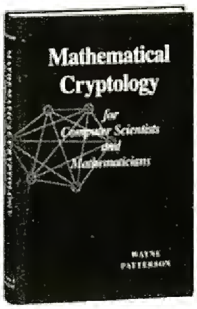

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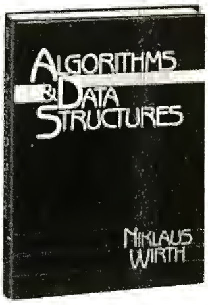

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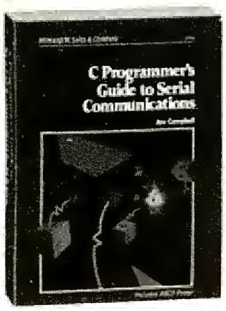

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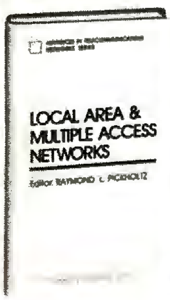

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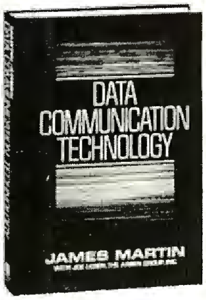

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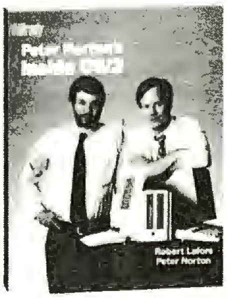

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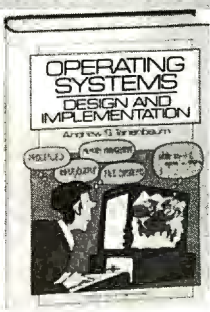

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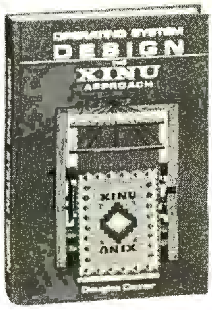

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standard. These two networks can have any combination of NetBIOS, APPC, ISO, IEEE 802.2 LLC, or any other protocol running over IEEE 802.5. Applications using any of these protocols over IEEE 802.5 can communicate through this bridge.

Second, bridges can modify forwarded frames. This modification is not necessarily transparent to network system software, although it is transparent to network applications. A prime example of this is source routing, often used in conjunction with IEEE 802.5. In source routing, all possible routes between two nodes are determined when the nodes begin communicating with each other. After the initial route has been determined, all frames between the two nodes carry the selected communication route with them. Bridges that use a source-routing algorithm can provide much better performance with a much smaller investment of hardware.

Third, ISO layer 2 (Data Link Control, or DLC) is further subdivided into two sublayers—Logical Link Control (LLC) and Media Access Control (MAC). Bridges can be implemented over either the DLC-MAC sublayer or over the physical layer (layer 1). Stallings's article discusses only the latter type of bridge. The major advantage of a bridge over the DLC-MAC layer is that it can support different physical mediums. For example, a 4-megabit-per-second token ring and a 16-megabit-per-second token ring could be bridged. As another example, a IEEE 802.5 token ring and an IEEE 802.3 Ethernet could be bridged. The latter bridge could use a source-routing algorithm on the token-ring side and a different bridging algorithm on the Ethernet side.

Fourth, bridges can be found between very dissimilar networks. An example of this is two LANs in different cities connected through a wide-area network (WAN). Layered protocols could be used in this situation. For example, to bridge two token-ring LANs over an X.25 WAN, a layered protocol of IEEE 802.2 LLC over X.25 might be used. No standards currently exist for layered protocols, although proprietary implementations can be found.

As an sample implementation, NCR's Financial Systems Division is developing an internetworking solution for token-ring LANs and X.25 or SDLC WANs using a proprietary layered protocol. NCR's solution can support both remote token rings and single remote workstations communicating through the same bridge. This bridge operates over the DLC-MAC sublayer and uses a source-routing algorithm to maximize throughput to the extent allowed by the WAN data rate and reliability.

In summary, bridges can be an extremely flexible internetworking solution for both similar and dissimilar networks. They do not require identical upper-layer protocols, and in some cases they don't even require similar lower-layer protocols. LANs and WANs can be internetworked transparently to network applications with throughput limited only by the data rate and reliability of the WAN.

Peter J. Kulik
NCR Corp.
Dayton, OH

Unstructured GOTO

I read "Trees 'n Keys" by Rick Grehan (January, February, and March) with interest, especially since I have some expe-

continued

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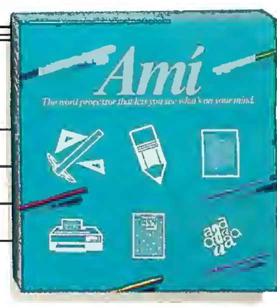

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rience implementing B-trees. My interest arises, in part, from the differences in our approaches to implementing B-trees. Some of my routines, such as insertion routing, are recursive in nature, whereas Grehan's approach is interactive.

I found the series enjoyable and informative. However, I was somewhat dismayed with listing 4 (January, page 390), the pseudocode for SEEK_NEXT_KEY. In particular, I believe that the unstructured use of the GOTO statement is inappropriate. Furthermore, this listing provides an excellent example of the need to use structured code whenever possible.

First, I must assume that there was a typographical error in the listing and that `GOTO L1;` should have read `GOTO L2;` since the only label called L1 is in listing 3 on page 388. Proceeding with this assumption, I found that label L2 was nested within a WHILE loop that is also nested within a REPEAT loop. A GOTO statement should never transfer control to the middle of a control structure, such as a WHILE loop or a REPEAT loop. The question arises, as in this case, as to what happens after the GOTO statement is executed. Since the WHILE statement was not executed, where should control be transferred when the END statement for the WHILE is encountered? Should control be transferred to the WHILE statement or continue on to the next (END) statement? The problem arises again when the END statement for the REPEAT statement is encountered.

If you accept the premise that I have presented, the next question is whether SEEK_NEXT_KEY can be rewritten without using the GOTO statement. The modified code of SEEK_NEXT_KEY in listing 1 illustrates the point. If you compare it with Grehan's listing, you can see how minor the changes are. One line was modified, another line was replaced, and the label was removed. I believe that the modified routine will produce the same results as the original, and it has the added advantage of being more readable.

I hope that Grehan will find my comments useful. On the other hand, if I have misinterpreted his pseudocode, I would appreciate further clarification.

Gary W. Wester
Normal, IL

Listing 1: *Reader Wester's version of pseudocode for SEEK_NEXT_KEY.*

```
SEEK_NEXT_KEY:
     IF number of keys in file = 0 then RETURN file empty error;
     IF file is rewound
          BEGIN
               CURRENT_KEY_SECTOR := Root;
               IFLAG := 0;
               KEYOFFSET := -1;
          END
     GET(CURRENT_KEY_SECTOR);
     REPEAT
          IF IFLAG NOT = 0
               BEGIN
                    IF KEYOFFSET NOT = number of keys on node
                         BEGIN
                              IFLAG = 0;
                              RETURN;
                         END
                    IF Pseudo stack is empty
                         BEGIN
                              REWINDKEY;
                              RETURN end of file error;
                         END
                    POP(CURRENT_KEY_SECTOR, KEYOFFSET);
                    GET(CURRENT_KEY_SECTOR);
               END
          ELSE
               BEGIN
                    KEYOFFSET := KEYOFFSET + 1;
                    IFLAG := 1;
                    WHILE key node pointer at KEYOFFSET NOT = 0
                         BEGIN
                              TEMP := key node pointer at KEYOFFSET;
                              PUSH(CURRENT_KEY_SECTOR, KEYOFFSET);
                              CURRENT_KEY_SECTOR := TEMP;
                              KEYOFFSET := 0;
                              GET(CURRENT_KEY_SECTOR);
                         END
               END
     END REPEAT
```

First of all, thanks for catching the typo; label L2 should have been L1. My intention for the WHILE loop is that the body of the loop continues to execute as long as the enclosing condition is satisfied. Even though the WHILE statement precedes the loop body, control doesn't pass out of the loop at its completion until the condition is reevaluated and found to be false.

Next, the code you presented does show a GOTO-less SEEK_NEXT_KEY algorithm, and I thank you for taking the time to present it. But let me point something out.

The pseudocode that I presented in that particular column was derived from the original machine code. I sought to make the pseudocode as structured as possible while following what was really going on in the assembly code. (In fact, I was amazed at the amount of structure I was able to impart.) Consequently, while the listing you've shown would work, it does not accurately reflect what takes place in the actual program, and I wanted the pseudocode to track the program for the benefit of those readers who would either upload or purchase the source code.

I'll do my best to keep GOTOs out of the pseudocode listings. But if I am forced to include any, I'll be sure to add enough comments to the code so that there will be no confusion over program flow into or out of looping structures.—Rick Grehan

Price Curve

I have a few comments regarding "Migrating: Up or Down?" by Wayne Rash Jr. in the Fall 1988 *IBM Special Edition.*

It seems to me that a distinction should be made between commercial applications and in-house applications that are not usually commercially available. As far as the latter are concerned, Rash is most likely to be right: All that you need to make the mainframe/minicomputer-to-microcomputer move is a suitable compiler and lots of core memory and coffee. However, when it comes to the former class of applications, matters are not quite as simple as that. Most software houses making mainframe or minicomputer software are used to a much healthier profit margin than that of the microcomputer industry. This stems from the fact that buyers usually are at least small-

continued

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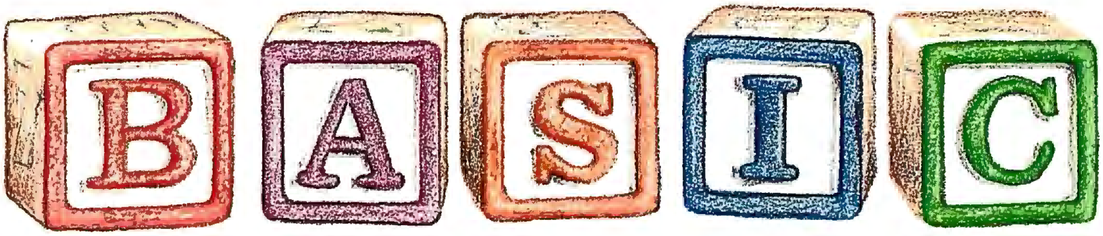

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size corporations that can afford to pay $5000 and up for an application. You would never get away with prices like that in the microcomputer world. Thus, there is not much incentive to port.

I think we'll have to wait for the time when corporations make the shift from the centralized-mainframe way of doing things to the decentralized network-of-high-powered-PC-with-server way of doing things. Alas, that may be quite a while—by the year 2001, perhaps?

T. Christiansen
Copenhagen, Denmark

I have to agree that with prices that normally run less than $1000 (U.S.), there is a smaller margin of profit per package than there is with mainframe and minicomputer software. You must know, of course, that the net profit per package hardly reflects the true profit picture for a software company. Otherwise, Lotus, Ashton-Tate, and Microsoft would be paupers. The reason that they are not is simply that there are many millions more microcomputers than there are minicomputers or mainframes. As a result, these companies make their money in volume. In any case, you are correct.

I was aiming my comments more at organizations that would be moving their own applications rather than those in commercial sales. I think, however, that the same rules apply to any package, whether it is developed in-house or commercial. In addition, the economics work out well for the smaller computer. If you had to sell the same package to a minicomputer user or a microcomputer user, you would probably sell it for about $5000 (U.S.) for the minicomputer package and $750 (U.S.) for the microcomputer package. The difference is in the number of users. Most minicomputers will support between 64 and 128 users. Microcomputers, on the other hand, support one user. Multiply 750 by 64, and you will begin to see why microcomputer software vendors are so profitable.

—Wayne Rash Jr.

Word Processor Woes

Somebody finally said it. Ezra Shapiro's comments on overloaded word processors ("The Blight of Bloated Software," January) are my sentiments exactly. I would add that the bells and whistles craze started before laser printers.

When I put together my IBM clone, I could hardly wait to try out WordStar or some other supercharged word processor. I was disappointed. All I wanted was a fast word processor for letters, memos, and reports. I was leaving a Commodore 64 that, with its word processing cartridge, was up and running before the monitor was warm. Six seconds, and I was producing.

I tried others that were no better. The Commodore went back on-line. A friend recommended PFS. I loaded it and printed out a memo over my lunch hour without help from the manual. All I want now is a spelling checker with the same simple word processor.

Robert Ziller
New Richmond, WI

Awards Candidate

Thanks for "The BYTE Awards" (January). One truly unique hardware/software item that you did not list is Dave Small's Spectre 128 Macintosh emulator (for the Atari ST). To the best of my knowledge, it's the only emulator that allows HyperCard, Excel, Microsoft Word, Microsoft Works, MultiFinder, and so on, to run on a non-Mac computer. This hardware/software emulator uses the 128K-byte Apple ROM chips and runs the programs as fast as or faster than a Mac SE or a Mac Plus.

Spectre 128 emulates a Mac Plus; Small's earlier emulator (Magic Sac) uses the 64K-byte ROM Apple chip set and emulates a fat Mac on the 1040ST. A Translator box is also available that allows Mac disks to read/write on an ST. The Epstart software program lets me use my Epson MX-80 printer as an "Imagewriter" to print out materials.

This emulator has opened up Mac software to thousands of Atari ST users. It's truly an award winner.

Conrad Weiler
Santa Barbara, CA

Author's Lament

I'd like to thank Don Crabb for the very nice write-up of my program, Music Mouse, in "MS-DOS, MiniFans, Math, and Mice" (October 1988). I think there is one point very much worth making, though, in the wake of his description.

Programs like mine are often the work of single individuals, not companies, as Crabb implies by attributing both the program's design and the terminology, concepts, and features it introduces to its publisher (Opcode Systems). To attribute a program's content elsewhere than to its actual designer/author does a substantial disservice to the many independent software authors who have pioneered new uses of computers and helped make these new tools meaningful to people in original ways that would never have happened if design and development

continued

you have to take it apart.

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were left entirely to corporations and marketing departments.

In cases such as Music Mouse's, publishers are responsible for distribution and other services to a program's end users, but not for a program's design or development. This division of labor is especially common in software for music and art.

The U.S. is a country with a long tradition of solitary inventors working at their own expense on their own time to realize personal visions, and some of us in this field still fall into that tradition.

Also worth mentioning is the fact that, in addition to the Macintosh version Crabb described, Music Mouse is now also available in expanded versions for Amiga and Atari ST computers. Anyone interested in these newer versions can write to me at Aesthetic Engineering, 175 Duane St., New York, NY 10013. An update to the Macintosh version, subsequent to Crabb's review, is also available from its publisher, Opcode Systems, and it does run properly under MultiFinder.

Laurie Spiegel
New York, NY

Information Source

"The X Window System" by Dick Pountain (January) was a well-written and generally informative introduction to this emerging standard for device-independent, network-transparent windowing systems.

Your readers may appreciate knowing of another source for information on this technology: the X User's Group, an independent, international organization started in January 1988. XUG sponsors Xhibition, an annual trade show and conference devoted to X Windows, and it publishes *XNextEvent*, a newsletter.

Interested readers can contact XUG by telephone at (617) 547-0634, via Internet E-mail at xug@expo.lcs.mit.edu, or by mail c/o Integrated Computer Solutions, 163 Harvard St., Cambridge, MA 02139.

David Lewis
Cambridge, MA

OS/2 Virtual Memory

I've been following Mark Minasi's OS/2 saga regarding virtual memory because so little has been written or tested about this feature. From the time data that's given in "OS/2 Consumerism" (December 1988), the virtual memory sector write/read swap times can be calculated to be in the range of 3 seconds to 4.3 seconds (on his system). This is not trivial, and, as Minasi has demonstrated, whether virtual memory works or not depends on how the program is crafted.

Consider this. Spreadsheets generally save data in row/column order. So what happens when you recalculate in column mode? Thrash! And what of these humongous programs with subroutines scattered hither and yon when they enter a nested loop? Thrash!

Not that long ago, CP/M programmers had to arrange program modules so that the overlays allowed the program to function in perceived real time. Virtual memory will apparently require the same attention to detail.

For BYTE, the time has now arrived to develop a virtual memory/time test curve in which a program is progressively squeezed into less RAM and its performance time measured. This would establish the Perceived Time Threshold, the point at which the slowing of the program begins to irritate the user, and the

continued

Thrash Point, which marks the spot where the program goes logarithmically into oblivion.

The user would benefit from knowing the real memory requirements of an OS/2 program. After all, it would make a difference whether the program is to operate in the foreground or background, or if the program has switches to allow for speed/memory trade-offs.

Walter J. Rottenkolber
Visalia, CA

FIXES

• "Dialing Up 1990" by Brock N. Meeks (January) states that XMODEM transfers files in 128K-byte packets. In fact, XMODEM transfers files in 128-byte packets.

• Michael E. Nadeau's March text box entitled "Battle of the SXs" (page 278) contained two inaccuracies concerning the Twinhead Superset 490. The unit contains three 16-bit and one 8-bit expansion slots, not four 16-bit slots, as stated. Also, the Magic Combo graphics driver is a chip on the motherboard, not a card. BYTE regrets the errors.

ASK BYTE

Breaking the Barrier

I am considering moving up from an IBM PC XT compatible to an 80386 machine. The problem is that there's an apparent dearth of language software to take advantage of the 80386's capabilities. In particular, I need a language package that will avoid the 64K-byte segmentation that is built into 8086/8088 language packages.

I currently use Turbo Basic, and I'd like to stick with it or some other advanced BASIC. I reluctantly would change over to FORTRAN or some other language just to get around the segmentation barrier, but I have written and use many BASIC programs routinely. A massive translation job would be feasible but very time-consuming.

Do you see on the horizon any big effort by the major software houses, such as Borland or Microsoft, to market upgrades of their 8086/8088 language packages to take advantage of 80386 capabilities? I have written Borland regarding the prospect of its coming out with a new version of Turbo Basic. Borland said that, as a matter of policy, it doesn't reveal its plans of this nature. I understand the company's position in a highly competitive market, but there is a gaping hole in software availability in this regard. Meanwhile, I, and presumably others, hang in suspense.

T. H. Siddall III
New Orleans, LA

There are at least two routes you can take. One is to purchase an 80386 machine and get a copy of MetaWare's High C 386 (MetaWare, Inc., 903 Pacific Ave., Suite 201, Santa Cruz, CA 95060, (408) 429-6382). Coupled with Phar Lap's 386|ASM/LINK assembler/linker package, you can generate true 80386 protected-mode applications.

Another possibility that allows you to keep your XT clone is to purchase an 80386 coprocessor. In particular, A.I. Architects' HummingBoard (A.I. Architects, One Intercontinental Way, Peabody, MA 01960, (508) 535-7510) plugs into an XT or an AT, and running OS/386 gives you a DOS-like environment with many of the advantages of the protected-mode world. This would at least let you run your existing BASIC applications while porting to the 80386 world. OS/386 includes software for patching Microsoft C 4.0 and Microsoft FORTRAN to allow these languages to create protected-mode programs.—R. G.

The Need to Test

I want to build a digital chip tester, and my idea is to let the computer read and set the pins. I would use one line from the computer as a strobe, and the others could set and read latches that would hold input data.

My problem is that I need a parallel port that I can read from as well as write to. I remember an article in BYTE describing how to modify a parallel port to make it bidirectional. Software is no problem for me; I just need some help with the hardware.

Randall Kern
Camano Island, WA

Before you rush off to build your digital chip tester, you might want to investigate Steve Ciarcia's IC Tester in the November and December 1987 BYTE. On the other hand, if you're determined to construct your own tester, refer to the September 1988 Circuit Cellar for the recipe for making a parallel printer port bidirectional.—R. G.

Solving Mathematical Problems

I have written a few programs in QuickBASIC and C that manipulate mathemat-

continued

ical equations. For example, one program finds the definite integral of a function, and another finds the root(s) of an equation. However, every time I work with a new function, I must go back, edit the source code, and then recompile. This gets old fast.

As you can see, I want to enter a mathematical equation while the compiled program is running. I was able to do this using GWBASIC, but the compiled languages do not support the statements that I used in the interpreter.

My question is, Is there some kind of magic subprogram that I can write in assembly language, or in the compiled language itself, that modifies the memory locations in which the language stores equations?

James M. Pothering
Pottsville, PA

What you're looking for is expression parsing and execution at run time, and, as you've discovered, interpreted languages, by their very nature, usually provide this capability. You've already mentioned GWBASIC; in addition, APL's execute operator lets you move program statements into a character array that is then executed on the fly.

There are a number of places you can investigate for quick help. Dick Pountain's "Changing Reverse Polish to Infix" (January 1988) describes a simple parser in FORTH. Or, if you find C more palatable, locate a copy of Herbert Schildt's Advanced Turbo C *(Osborne/McGraw-Hill, 1987). This book includes a chapter on expression parsing and evaluation, complete with source code that you should be able to graft onto your existing applications.*—R. G.

Expanding Floppies

I have an IBM PC with two full-height floppy disk drives. Recently, one of the drives was severely damaged, and I'm thinking of replacing that drive with two half-height disk drives—one 3½-inch

continued

and one 5¼-inch. Can I do this by simply installing a floppy disk controller and connecting the drives to the controller, or is there more to it?

Brian Hong
Glen Ellyn, IL

There's more to it. First, you're looking at installing three floppy disk drives on your system, and that implies some additional controller hardware beyond more drives. Then you've got software problems to contend with. Depending on the age of your XT, it's likely that your BIOS supports only 360K-byte drives, so you'll have to add device drivers (the .SYS files you often see in CONFIG.SYS) to allow your machine to recognize drives of 720K bytes and 1.44 megabytes (the standards for 3½-inch drives). You won't be able to boot from these high-density drives, but if you boot your machine from a hard disk anyway, there's no problem.

A number of vendors provide the necessary controller board hardware, as well as the software device drivers you need to attach 3½- and 5¼-inch high-density floppy disk drives to your XT. Check out these companies:

Manzana MicroSystems, Inc.
P.O. Box 2117
Goleta, CA 93118
(805) 968-1387

Micro Solutions, Inc.
132 West Lincoln Hwy.
DeKalb, IL 60115
(815) 756-3411

Sysgen, Inc.
556 Gibraltar Dr.
Milpitas, CA 95035
(408) 263-4411

—R. G./S. W.

SCSI's for Me

I am a retired electrical engineer with some experience with computers (I am rapidly learning more). From what I have read, the SCSI sounds like what I have been looking for to transfer data between various types of computers and some control systems that I am planning.

Where I can find the standard connectors, pin assignments, and data transfer rates for SCSI?

Robert J. Nedreski
Erie, PA

For a detailed look at SCSI, see the three-part Circuit Cellar series ("Adding SCSI to the SB180 Computer") beginning in the May 1986 BYTE.—R. G. ■

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Mrs. Pournelle's Reading Program

Dear Jerry,

After reading your column for many years, I have finally decided to write. Once again, you have made a reference to your wife's reading program, but I see no mention in the Items Discussed box of where to buy it or how much it costs. As a father of school-age children, I would be very interested in obtaining a copy of this program. Is it commercially available, or is it available only to educational institutions? Other fathers in this area would also like to try out the program.

I also enjoyed your comments on Sprint, since it is the first major piece of software I've bought with my own money (my company buys whatever I need in the way of compilers, assemblers, and editors). I would disagree only with your comments on vanilla Sprint. I'm writing this letter using Sprint, and I enjoy it much more than any other word processor I've used. I'm sure that I'll start customizing the program as soon as I have time, but until then, I'm satisfied with what I've got.

Blaine Binkerd
Orem, UT

I'm finally finishing Mrs. Pournelle's Reading Program; see my Computing at Chaos Manor column in the April BYTE for more details.

Thanks for the kind words. —Jerry

Sprint Solutions

Dear Jerry,

The day after I read your account of Sprint's mysterious file conversion error message, `Conversion error 37`, I had solved the same problem. When converting files, you must execute Sprint from \sprint (or from whatever subdirectory in which you have installed it) and give paths to the input and output files. It seems that for all operations other than file conversion, Sprint can be executed from anywhere and correctly find its files in \sprint.

Your hopping from better to better word processor is fascinating, though your file conversion troubles show there are occasional penalties. I am happy enough just to have upgraded from DisplayWrite 3.0 (the standard at work) to Sprint 1.0 while keeping the ability to export files the secretaries' word processors can read.

Richard J. Wilcox
West Orange, NJ

Thanks!

Actually, I have backslid. I'm back to Q&A Write again. I'm used to it, and it does just about everything I need to do. But I have Sprint on my hard disk, and it's installed in a DESQview window when I need it. —Jerry

Tampering with Digital Evidence

Dear Jerry,

In your closing comments in Computing at Chaos Manor (October 1988), you expressed concern about courts accepting photographs as evidence in light of the ability to process images digitally. Lawyers, of course, have already given this subject some thought.

I've been working for five years with a company whose original business was color separations but is now "electronic color imaging," or ECI for short. For years, the power players in the publishing, advertising, and packaging industries have been taking advantage of the new digital technology available just now to people who use desktop publishing systems. Digital color retouching and "finessed" image assembly at photographic resolutions are old hat to us.

A couple of years ago, a lawyer contacted a supervisor at my company to have the supervisor testify as an expert witness in a case in which some photographic evidence had the lawyer's client red-handed.

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."

Technically, if the photograph could be discredited in court, it would not be admitted as evidence. The supervisor, however, didn't like the idea of going into court to discredit a photo that his own trained eyes knew was bona fide. He declined to testify, but that doesn't mean that the issue of admitting photographs in court will go unnoticed.

I am not a lawyer. There are laws regarding what's allowed as evidence and what's not, even as far as photographs are concerned. Retouching as an art has been with us for years. The crux of the issue today lies in the computer; it's possible to synthesize bogus evidence in photography that leaves no clue of being fake. Textures, features, shadows, even photographic grain (to some degree) can be cloned digitally to produce a completely convincing image. Certainly an adept ECI operator will produce more convincing results than a novice, and the ECI system at hand will determine in practical terms what kind of image manipulation is possible, but, given enough time and money, one can fake quite amazing things.

If I were asked to be an expert witness, I would also decline, given the situation as mentioned above. But I would not be without major reservations about the larger issues:

1. Publicly, who or what do you believe when you know a picture necessarily has no bearing on reality? Suddenly, photographs, which until recently have been accepted unconsciously as relating directly to reality, are only as truthful as illustration.
2. Legally, can an illustration, photographic or especially digital, be admitted in court? This seems unlikely. The courts will have to assess the technology used to produce the imagery in order to determine the reliability of the evidence in the image. This creates a new burden on the court system, read alternatively as a new advantage for those who are privileged with money, good lawyers, or good imaging abilities.
3. Politically, photo propaganda can reach new heights. In situations in which an audience or society might be naive about what can be done with pictures, there are potential windfalls for those who can manage an ECI project to political advantage.
4. Practically, you could be doing ECI tomorrow on your 80386 or Mac II. These systems are faster than the original mainframes used in ECI shops for years. ECI system manufacturers are working constantly to interface small personal systems, used largely now for design, to their own production systems. Just as you send text on disk for typesetting in Atex format, you can do the same with pictures for output as halftones on a Linotronic or as a color print on a MacDonald-Dettwiler.

Ultimately, publishing will be much faster, more colorful, more interesting, and even more fun to do, but it will not come without the price of responsibility in authorship or without responsible awareness in the audience. Ignoring the issue leaves us at the mercy of those who would alienate or manipulate us all—with our own pictures, of course.

Kurt Heintz
Chicago, IL

Thanks! I only raised the question; clearly, you've got a lot more information than I did.

It does look to be tricky . . . —Jerry ■

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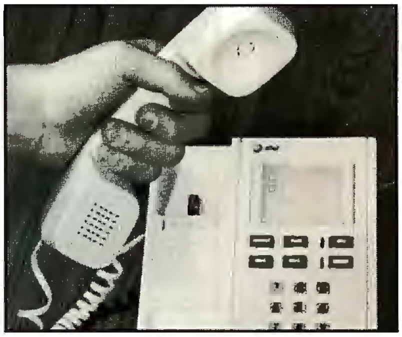

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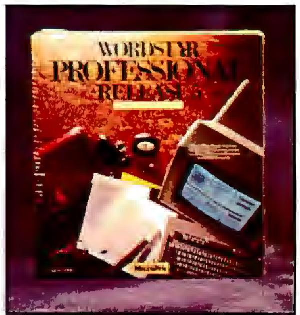

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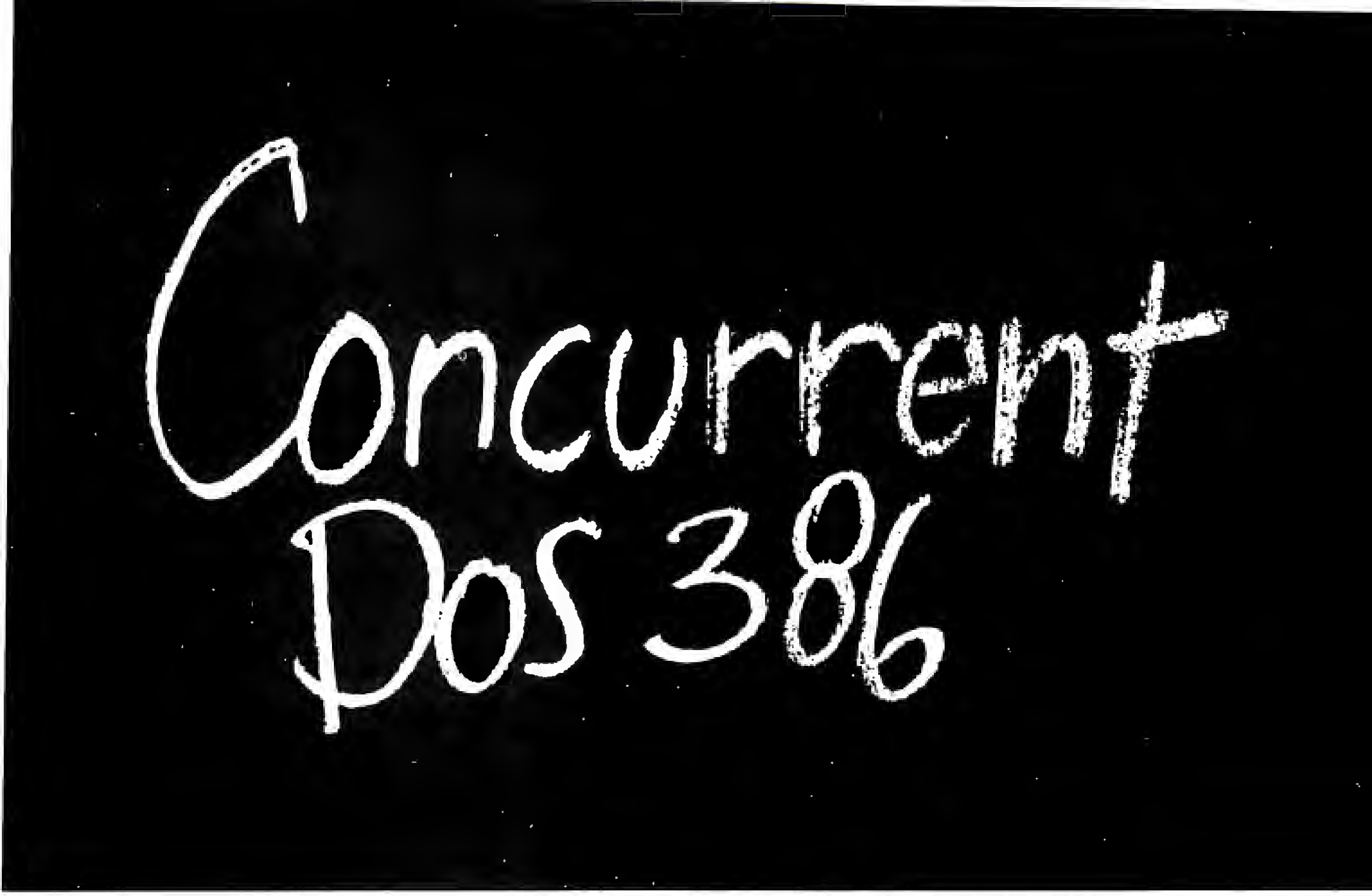

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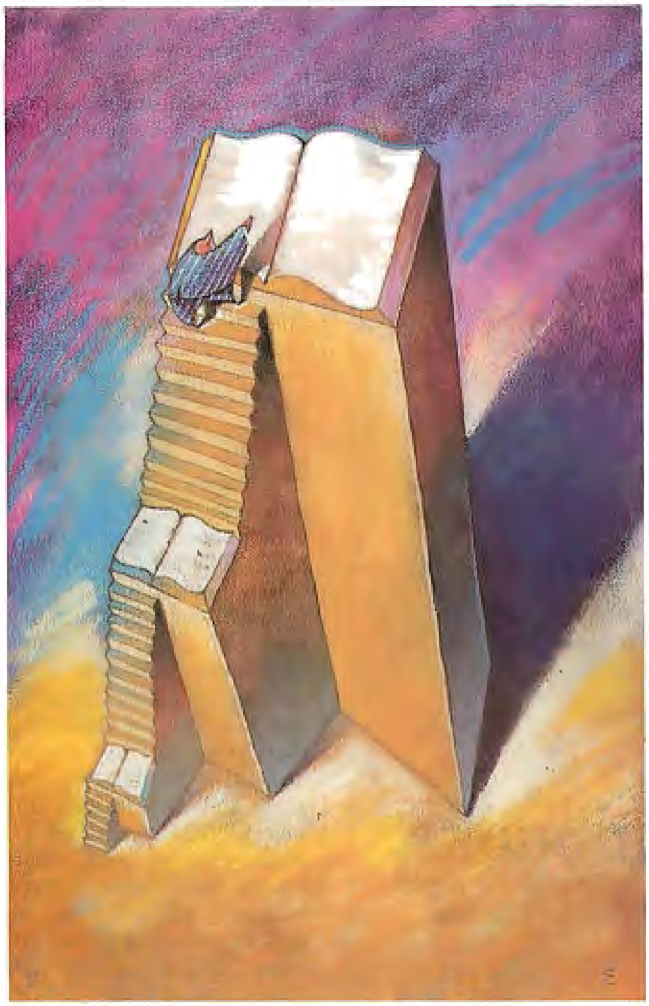

Advanced OS/2 Programming
by Ray Duncan

Microsoft Press, Redmond, WA: 1989, 781 pages, $24.95

Reviewed by G. Michael Vose

When IBM tried to set the microcomputer world on fire with its new OS/2 operating system in the spring of 1987, it focused on OS/2's ability to run more than one program at a time and on the promise of huge RAM memories. A while later, the emphasis shifted to the graphical user interface, the Presentation Manager, and its benefits to a computing public crying for application "ease of use."

Early OS/2 programmers learning version 1.0 were stuck with writing so-called kernel applications—programs that used an Application Program Interface (API) based solely on the OS/2 kernel. The kernel is the part of OS/2 that manages memory, files, timers, multitasking, interprocess communications, and, through device drivers, hardware resources. Only later did a Presentation Manager API arrive that allowed programmers to create applications in a graphical environment.

Since then, programmers have worked hard learning the OS/2 ropes. The OS/2 world of tomorrow will likely be peopled with two classes of software developer: the kernel expert and the Presentation Manager guru. Each class will create slightly different applications.

The kernel experts will write utility programs, program development tools, communications programs, and LAN management tools. The Presentation Manager experts will write paint/draw/illustrator programs, desktop publishing systems, and spreadsheets and database managers richly endowed with features.

The kernel wizards will eventually come to use *Advanced OS/2 Programming* as their bible. This indispensable guide to the inner workings of the OS/2 kernel is the most important book on the subject to date. Many of the programmers who are currently wrapped up in the complexities of the Presentation Manager may ignore this book, which is heavily sprinkled with assembly language code examples, in favor of volumes containing C source code examples of Presentation Manager programs. But every OS/2 programmer will eventually turn to this book for its lucid explanations of OS/2 esoterica, such as writing filters, device drivers, and device monitors.

Detailed Descriptions

The previously published books on OS/2 programming have provided a little more detail with each succeeding "generation." The first wave of books, including those by Microsoft's Gordon Letwin and IBM's Ed Iacobucci, outlined OS/2 design goals and syntax details. The next wave, which brought books by Michael Young and Dave Cortesi, provided explanations of OS/2 based on some real programming experience. Ray Duncan's book provides yet another increase in the level of detail, all based on actual programming experience with OS/2. For example, Duncan's explanation of the use of the `VioPopUp`/`VioEndPopUp` services is twice as long as Young's in *Programmer's Guide to OS/2*. Duncan's description warns against using these services except for true background processes. His warning derives from the dramatic changes in screen mode that these services make possible, which can trouble users.

The level of detail here goes to the heart of kernel programming. Duncan explains exactly how an OS/2 program gets loaded into the computer, and his memory maps detail each step of the process. He gives full-syntax explanations of each component of a module definition file. He even explains the structure of file allocation table (FAT) organization for programmers who might be coming to OS/2 with no MS-DOS background. There is also a section that explains the use of Microsoft's OS/2 programming tools, including Macro Assembler (MASM), C 5.1, LINK, the

continued

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utilities Cref, Make, and Bind, and the Library Manager. This attention to detail permeates every subject and section of the book, including the reference section (more on this later).

These details matter to programmers. You can't get too excited about the fine points of interprocess communication if you can't figure out how to compile and link a program in a new environment like OS/2. Duncan never loses sight of this reality; he provides the compile and link syntax for every sample program in the book, either in the text itself or in the example's source code.

Programmer's Book

Advanced OS/2 Programming is definitely a programmer's book. The average user of OS/2 won't find the book useful in his or her day-to-day work with OS/2. The book's sections tackle programming the user interfaces (keyboard and mouse); programming mass storage (file management, disk internals, and volumes and directories); advanced OS/2 techniques (e.g., memory management, multitasking, interprocess communications, and I/O privilege level segments); and customizing OS/2 (filters, device drivers and monitors, and dynamic link libraries).

Pulling together more than two years of experience with OS/2, Ray Duncan wrote *Advanced OS/2 Programming* from a unique perspective: As an acknowledged expert on MS-DOS, having written *Advanced MS-DOS Programming* and edited the massive *MS-DOS Encyclopedia*, Duncan explains and evaluates many of OS/2's capabilities from an MS-DOS programmer's slant. He describes tasks that an MS-DOS programmer would perform and explains why some MS-DOS programming techniques work while others do not. For example, in the chapter on file management, Duncan explains why the MS-DOS technique of forcing a disk update by closing and reopening a file handle, or by making a copy of the handle and then closing it, is both inefficient and unnecessary in OS/2.

But this MS-DOS insider's view of OS/2 is only one of the book's interesting features. Duncan even talks about how OS/2 calls affect high-level language program portability. C programs that make direct calls to API services for file management instead of using C run-time library calls will be faster and more compact but less portable. By definition, a kernel application is likely to be less portable than a Presentation Manager program. The various APIs being written to put a Presentation Manager face on Unix will guarantee that developers who want maximum portability will write to the Presentation Manager API. Nevertheless, Duncan's discussion of how the use of certain kernel API functions make C code less portable was instructive.

Programmers will also appreciate the many program examples in this book. All the sample code is offered in assembly language, with duplicate C source code for about a third of the programs. The listings are often nifty utilities that you can use to perform some meaningful task under OS/2: A Whereis utility searches a hard disk to find the location of a file; a Snap utility uses a device monitor to eavesdrop on the keyboard for a key sequence that tells the program to take a "snapshot" of the current screen and store it in a disk file; and a Dump utility displays the hexadecimal values of a section of memory. All the code in the book is available on disk from Microsoft Press at additional cost.

There's even some humor here. For example, in one sample program designed to read mouse events and display the mouse position, the program terminates by displaying the words *Have a Mice Day.* In the reference guide, one of the mouse API services defines

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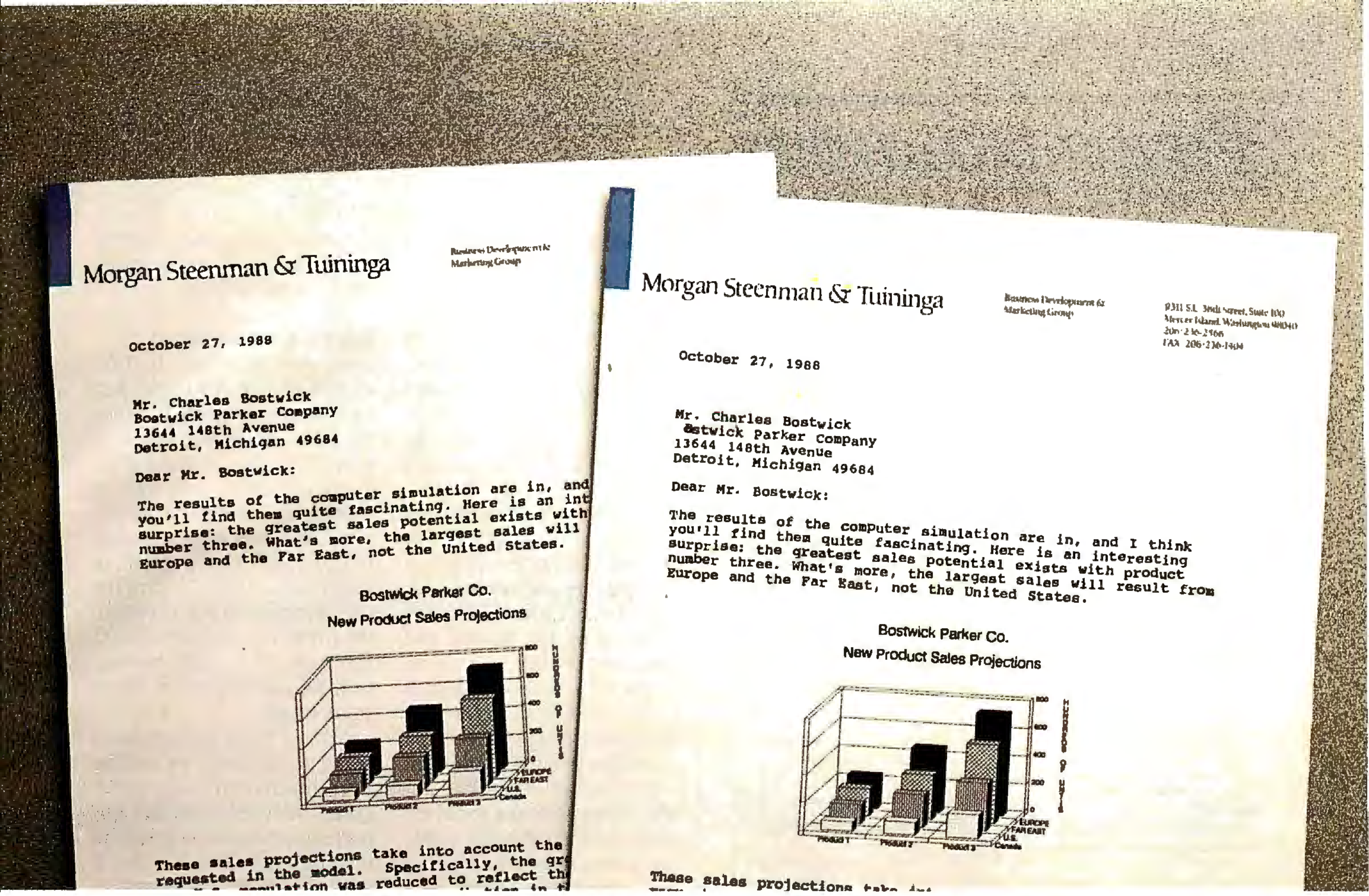

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A Unique Reference

Unlike the earlier book by Gordon Letwin, *Advanced OS/2 Programming* seldom waxes theoretical about OS/2. Even when explaining why OS/2 acts as it does under a given set of circumstances, Duncan's explanations lean more toward the practical. For example, he warns you that multiple threads within a process can access the same file by using its file handle and cautions that this can cause one thread to read or write data to a different part of a file than the thread expects. He goes on to explain that OS/2 does not protect threads from one another or try to make serial requests among threads; programmers must handle this detail themselves. Later, in a section on using semaphores, he explains how you write code to protect threads from one another.

The reference section uses a unique approach to presenting the essential facts about each API service. Icons, including one that features a circle with a diagonal line through it—an international symbol for "no"—superimposed over the letters PM for Presentation Manager, tell you at a glance if a given API service works with the Presentation Manager, if it was added to version 1.1 of OS/2, if it can be called from the I/O Privilege Level (ring 2), if it is a Family API service, or if the service is an advanced `Vio` function designed to work with the Presentation Manager.

In addition, the reference section provides a complete guide to the `DosDevIOCtl` and the `DevHlp` device functions that are essential to writing device drivers. The appendixes contain a complete description of the OS/2 load module format—the so-called new EXE format—including a listing of the NEWEXE.H C header file that defines the structure of the OS/2 load module tables and a description of module-definition file syntax. A glossary and a 20-page index round out the references.

Highly Recommended

Duncan offers a wealth of information in this volume, and he manages to pack it into a very readable 495 pages of main text. His writing style evolved from his early days of writing for computer magazines, and it remains very easy to take. His two-plus years of experience with OS/2 make him one of just a few people in the world who have used OS/2 that long. The understanding that he developed in those years shows.

I don't think the emphasis being placed today on writing Presentation Manager programs will diminish the importance of solid references on the OS/2 kernel. Likewise, it will always be important to write some programs in assembly language to attain maximum performance.

In these pages last July, I recommended books by Gordon Letwin and Ed Iacobucci for any OS/2 programmer's library. Since then, I haven't seen a book I'd recommend more than *Advanced OS/2 Programming*.

BRIEFLY NOTED

Algorithmics: Theory and Practice *by Gilles Brassard and Paul Bratley, Prentice-Hall, Englewood Cliffs, NJ: 1988, 361 pages, $42 (hardcover).* In the 21 years that have passed since the publication of volume 1 of Donald Knuth's immortal *Art of Computer Programming*, the in-depth analysis of algorithms has progressed from an arcane art taught in only a few computer science departments to a required part of any accredited college computing curriculum. Moreover, the development and use of efficient computer algorithms has diffused outward from computer science into areas as diverse as quantitative management,

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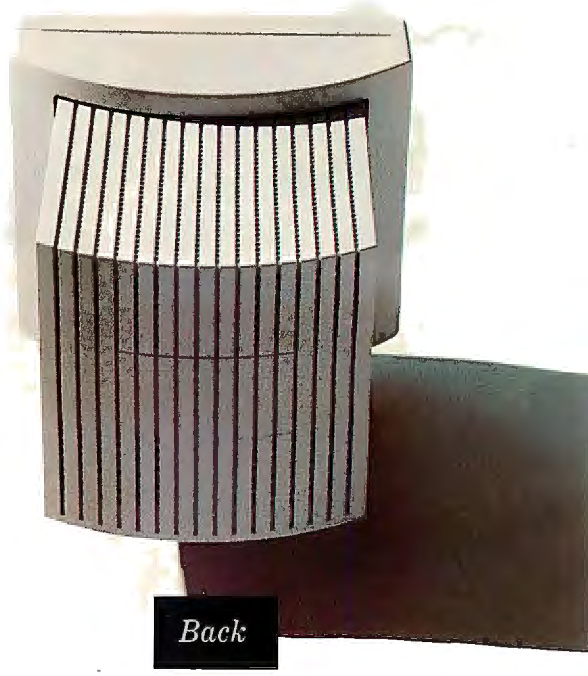
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civil engineering, epidemiology, banking and finance, and cryptography—in short, into every field in which computers have become indispensable tools. Programmers today, whether formally trained or not, are expected to recognize when and where code efficiency is crucial and to be able to make an informed choice as to the type of algorithm to use.

Algorithmics: Theory and Practice is an excellent self-contained guide to the study of efficient algorithms. Although it was written as a college textbook (a purpose that it will undoubtedly serve well), the authors have put together a collection of information that includes almost every important category of algorithm that's available to today's working professional programmers. Chapters on greedy algorithms, divide-and-conquer techniques, dynamic programming, graph searches, probabilistic algorithms, and domain transformations form the core of the book. Practical information on data structures, algorithm specification, efficiency analysis, and computational complexity round out the text, along with an extensive bibliography.

Algorithmics should be on the shelves of programmers, analysts, and data-processing libraries, where it can take its place as one of the most up-to-date and well-written books in its field.—*Eric Bobinsky*

Operating Systems Design: The XINU Approach *by Douglas Comer and Timothy Fossum, Prentice-Hall, Englewood Cliffs, NJ: 1988, 502 pages, $46.* XINU is a recursive acronym that stands for "XINU is not Unix." PC-XINU (the version described in this book) is also not an operating system in the same sense as MS-DOS; that is, you do not boot your computer in the XINU environment. PC-XINU exists as a library of routines that you link into whatever C program you intend to run under PC-XINU. When you execute the program, PC-XINU then takes over and functions independently of MS-DOS (PC-XINU routes all system-level calls around DOS to the BIOS). Within this framework, you can experiment with the fundamentals of a multiprocessing operating system: Your program can "fork" multiple concurrent processes; tasks can communicate with one another through semaphores and message passing; and so on.

Operating Systems Design: The XINU Approach is not an overview text, so don't look here for analyses of how various popular operating systems handle issues of memory management, process scheduling, and so on. This book is rather a discussion of how XINU tackles these problems and, in particular, how the PC version of XINU is implemented.

Don't get me wrong: I am not belittling the book. You'll find plenty of good information here. C source code is peppered throughout, accompanied by clear explanations, so novice and intermediate C programmers can lift programming techniques and tips from the examples. Also, in the process of describing PC-XINU's lowest-level hardware routines (e.g., the disk driver and the keyboard input routine), this book offers working examples for the IBM PC assembly language programmer. I was particularly pleased with the brief but useful description of the disk and video system interrupt calls. If you've ever wondered how to reroute interrupt vectors, you'll find working examples here. And PC-XINU's technique of using assembly language only when necessary provides guidance for writing interrupt drivers in high-level language, shepherded by small, easy-to-understand assembly routines.

As a nice plus, chapter 14 covers PC-XINU's elementary window management system (with the emphasis on

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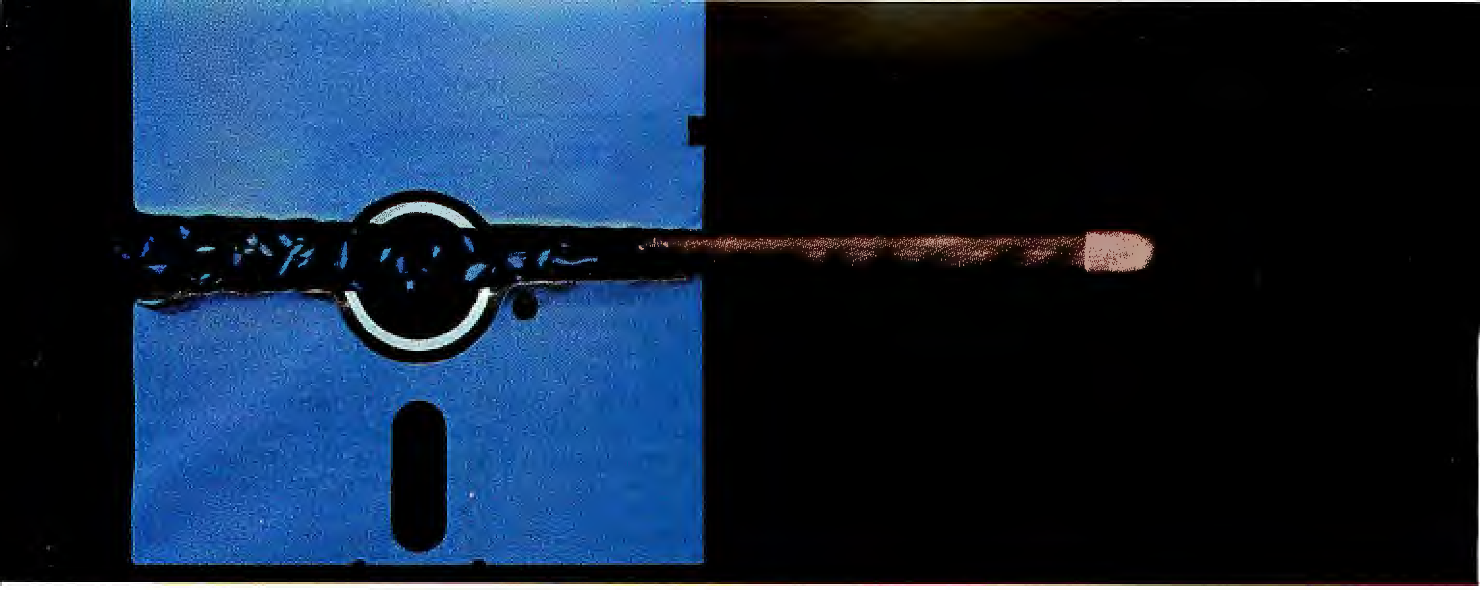

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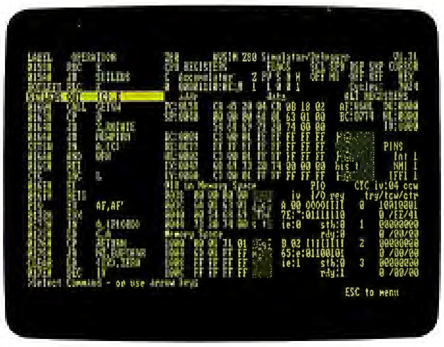

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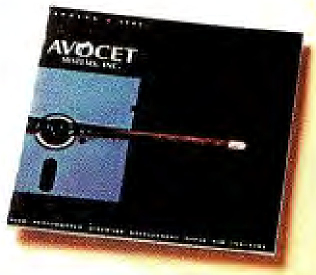

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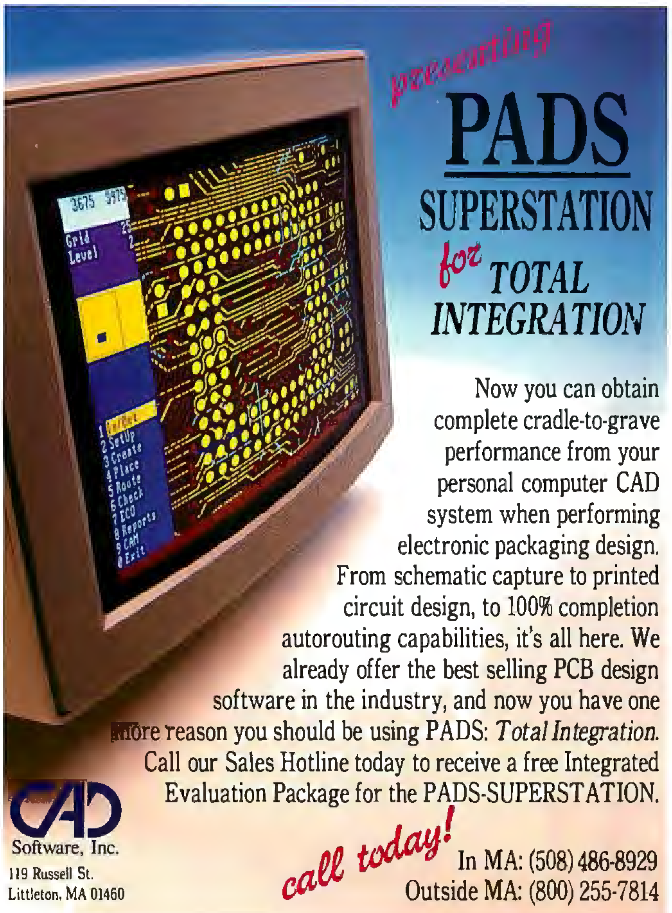


"elementary"). Given the growing acceptance of windows as primary components of an operating system (observe the Macintosh Finder, Sun's SunView, and OS/2's Presentation Manager), it's good to see a description of windows in an operating-system book.

For an additional $79.95, Prentice-Hall will send you PC disks containing all the software that's described in the book. You'll need either Microsoft C with MASM and LINK, or Turbo C. Appendix 2 is the PC-XINU programmer's manual and includes sample programs and command-line scripts for compiling, linking, and executing a XINU application. This appendix also summarizes all the XINU system calls.

My only real complaint with the book is that there's an unusual amount of white space throughout. In many places, more than 75 percent of a page has been left empty; this seems to occur in the vicinity of many of the longer listings—perhaps it was a typesetting problem.

The greatest strength of *Operating Systems Design: The XINU Approach* is that it offers a working example of the fruits of modular design and an eye toward portability. Versions of XINU are now running on everything from the PDP-11 to the Mac II to—of course—the IBM PC. Working examples are always helpful, so if the operating-system section of your library is heavy on theory and needs some balancing on the application side, look for *Operating Systems Design: The XINU Approach.—Rick Grehan*

A Visual Introduction to SQL *by J. Harvey Trimble Jr. and David Chappell, John Wiley & Sons, New York: 1989, 270 pages, $24.95.* This book is written for the nontechnical user, but it is valuable to even the seasoned user of relational databases. Although there has been a great deal of talk about SQL (pronounced "sequel," the acronym for Structured Query Language) in the past few months, little has been written about its use. SQL has become the de facto standard for interfacing application programs with relational database systems. It is also becoming the widely used "quick and dirty" method for users to retrieve data from database systems. SQL is found in dBASE IV, Paradox, Informix, Oracle, and most multiuser relational database systems.

A Visual Introduction to SQL is especially appealing to those of us who are visually oriented learners. Clear and simple diagrams help to build the reader's understanding of the many possibilities of SQL queries. (Metaphor Computer Systems in Mountain View, California, originated the diagraming method.)

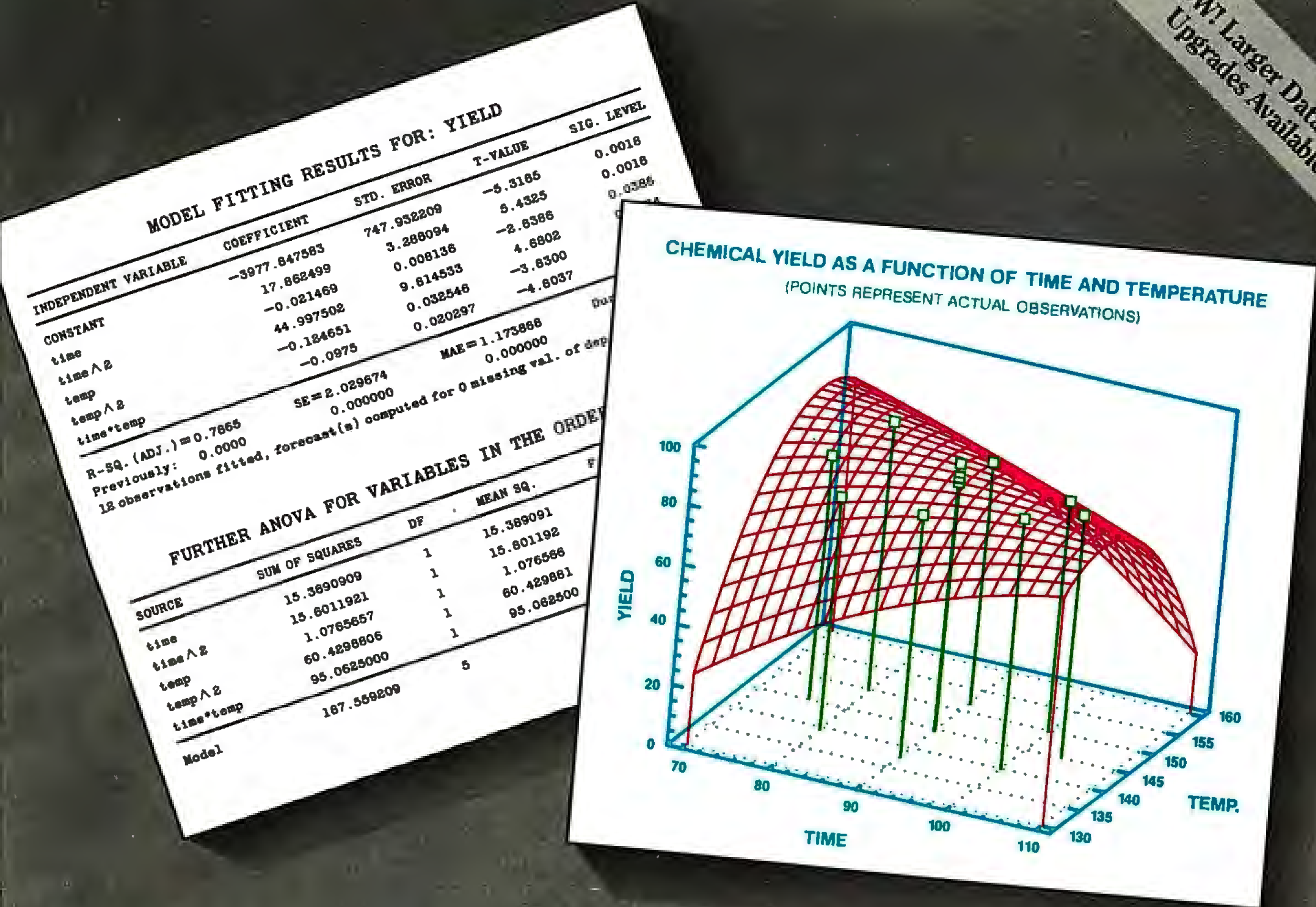
The authors use only a single database made up of five tables (data files) for all the examples throughout the text. They give numerous examples of each concept as they build the reader's ability to retrieve complex, multiple table joins in a single line of SQL. One line of SQL is equivalent to dozens of lines of dBASE programming.

Although the authors cover the querying principles well, they offer little more than cursory treatment of database construction and indexing. They never mention the most common Unix relational DBMS, Informix, or the numerous 4GL products.

A Visual Introduction to SQL is a helpful text for understanding querying, but it is far from a complete reference on SQL.—*Ben Smith* ■

CONTRIBUTORS

G. Michael Vose is a coeditor of *OS Report: News and Views on OS/2.* **Eric Bobinsky** works on computational plasma physics at NASA's Lewis Research Center in Cleveland, Ohio. **Rick Grehan** is director of the BYTE Lab. **Ben Smith** is a BYTE technical editor.



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OPTLINK	125	115
Plink86plus	495	279
PolyLibrarian II	149	131
.RTLink	195	185

MODULA-2

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

OBJECT-ORIENTED PROGRAMMING

	LIST	OURS
ACTOR	495	423
Language Extension I	99	95
C_talk	150	137
C_talk/Windows	450	399
Smalltalk/V	100	85
Communications	50	45
EGA/VGA Color Ext.	50	45
Goodies #1, #2 or #3	50	45
Smalltalk/V286	200	169
Zortech C + +	150	129
w/ source	250	209

OPERATING SYSTEMS/ CONTROL PROGRAMS

	LIST	OURS
Concurrent DOS 386 (3 users)	395	335
10-User System	495	419
DESQview 386 (w/ QEMM)	190	169
QEMM 386	60	55
MS Windows/386	195	130
PC-MOS 386 (single user)	195	179
5 Users	595	539
VM/386	245	209
VM/386 Multi-user	895	759

OS/2 TOOLS

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

PASCAL LANGUAGE

	LIST	OURS
B-tree Filer	125	99
DATABOSS	399	359
M5 Pascal	300	189
Pascal ASYNCH MANAGER	175	137
POWER SCREEN	129	99
Professional Pascal	595	549
Turbo Analyst	99	79

NEW RELEASES

CLEAR+ for C
A complete documentation and debugging tool which instantly produces real programmer's flow charts, multi-level tree charts, formatted source listings, function x-refs and function prototype files.
List: $200 — **Ours: $169**

INCRA
A fully integrated professional assembler development environment, incorporating an INCREMENTAL assembler. Go directly from editing the program to debugging without having to re-assemble or re-link. Compatible with Microsoft Macro Assembler. Environment also includes a syntax-checking program editor, full screen symbolic debugger, fast linker, multi-base calculator, pop-up help screens.
List: $180 — **Ours: $149**

PROTEUS 4.0
Prototype/Demo System with complete simulation capability, a powerful Screen Painter, video effects and custom sound. Exports screens in the Form Definition Protocol supported by the leading interface management systems, giving you a direct link from prototype to final code.
List: $149 — **Ours: $125**

HP System Supports X Windows

The Hewlett-Packard 9000 Model 340SRX workstation offers three-dimensional graphics with 4-MIPS performance on an HP-UX (HP's version of Unix V) operating system. The 340SRX also supports X Windows.

The brains of the 340SRX are Motorola's 68030 microprocessor coupled with the 68882 FPU, both running at 16.7 MHz. It has 4 megabytes of memory (expandable to 16 megabytes).

Besides X Windows, communications involves a built-in RS-232C port and two general-purpose interface bus (GPIB) ports, and you choose either an AUI LAN interface (for thick coaxial cabling) or a ThinLAN interface (for thin coaxial cabling). Supported protocols include ARPA Berkeley, TCP/IP, Ethernet IEEE 802.3, and NFS.

Optional interfaces are available for HP-IB and SCSI.

The system has a 16-inch color monitor with 1280- by 1024-pixel resolution. There are eight three-dimensional frame-buffer planes (upgradable to 24) and 256 display colors (upgradable to 16.7 million). The system also includes the Starbase Graphics Library.

Price: $14,900.
Contact: Hewlett-Packard, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.
Inquiry 1123.

The HP 9000 Model 340SRX does three-dimensional graphics, X Windows, and LANs.

Dolch Ships 25-MHz 80386 Portable

At the heart of the new Dolch portable is a 25-MHz, zero-wait-state microprocessor that Dolch Computer Systems claims is 32 percent faster than the Compaq Portable 386.

The Dolch-P.A.C. (for portable add-in computer) measures 16 by 10 by 8 inches and weighs 20 pounds.

The key to system speed, Dolch says, is a proprietary 64K-byte disk-cache buffer-management system.

The standard configuration includes a CGA display (EGA optional), an 86-key keyboard that's detachable so you can replace it with your own keyboard, three open slots (two full-length 16-bit and one half-length 8-bit), 4 megabytes of RAM, a 1.2-megabyte 5¼-inch floppy disk drive, and a SCSI port.

Price: $9495.
Contact: Dolch Computer Systems, 2029 O'Toole Ave., San Jose, CA 95131, (408) 435-1881.
Inquiry 1125.

You Need This "Virus-Proof" PC

The Immune System, a DOS-based 80286 computer, is designed for security by one of the largest computer security companies in the nation.

Along with some things you'd expect on a standard clone, such as 1 megabyte of RAM, a 1.2-megabyte 5¼-inch floppy disk drive, and a 40-megabyte hard disk drive, there's a "virus-proof" feature that keeps unauthorized .EXE and .COM files from entering or running on the system.

There's also a modem package that purports to secure and encrypt real-time conversations, as well as provide a system-use audit trail, a system-access audit trail, and nearly 25 more security features. American Computer Security Industries has even gone so far as to secure the clock so only specified users can set or change the time.

Price: $2995.
Contact: American Computer Security Industries, 122 Blue Hills Court, Nashville, TN 37214, (615) 883-6741.
Inquiry 1126.

SEND US YOUR NEW PRODUCT RELEASE

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

Personal Mainframe for Your AT

How much number-crunching is enough? Opus Systems thinks there's plenty of room for improvement over a standard AT clone; in fact, the company would like to lift the lid of your machine and drop a new computer inside.

The Personal Mainframe Series 400 consists of a coprocessor board that contains a Motorola 88000 RISC CPU and 4 megabytes of RAM—enough to run Unix, which also comes with the system.

Opus is offering the Series 8000, which consists of a Series 400 coprocessor inside an Everex Step/286. The resulting systems are rated at 35,000 Dhrystones and 17 MIPS, according to Opus.

Price: Series 400, $5000; Series 8000, $9995.
Contact: Opus Systems, 20863 Stevens Creek Blvd., Bldg. 400, Cupertino, CA 95014, (408) 446-2110, or Everex Systems, 48431 Milmont Dr., Fremont, CA 94538, (415) 498-1111.
Inquiry 1124.

continued

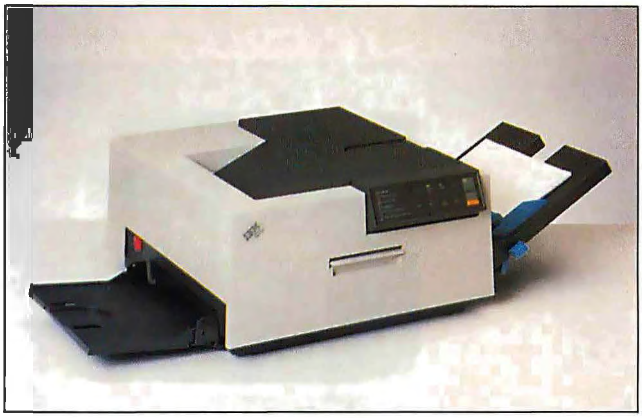
IBM Laser Printer Speaks AppleTalk

Big Blue has acknowledged Apple Computer's dominance of the desktop publishing business with the addition of an AppleTalk port to its PagePrinter laser printer.

In fact, the new IBM PagePrinter II supports Adobe PostScript, HP LaserJet, and IBM ProPrinter emulation and has parallel, serial, and AppleTalk connectors, making it suitable for use with any personal computer system.

The 300-dpi PagePrinter II prints at 6 pages per minute. Inside, it has an on-board 16-MHz 68000 processor and 2 megabytes of RAM, expandable to 4 megabytes. Its predecessor, the PagePrinter, featured a 10-MHz 68000 processor on an add-on board, which used an expansion slot in the host PC and limited its use to IBM PC-compatible computers.

The original PagePrinter had only 13 fonts in ROM. The new PagePrinter II has 43 Adobe PostScript fonts built into ROM and can support an additional 60 fonts with the 2-megabyte memory expansion.
Price: $4999.
Contact: IBM, DRM, Dept. 122, 101 Paragon Dr., Montvale, NJ 07645. For a dealer near you, call (800) 426-7257, ext. 122.
Inquiry 1128.



PagePrinter II supports most PCs and Macintoshes.

Exploit Your NeXT's DSP for CD-Quality Sound

Get a jump on digital-signal-processing (DSP) microchip technology with the Digital Ears-I from Metaresearch. This peripheral allows you and your NeXT computer to enter and record high-quality sounds on compact disk. You can then incorporate them into programs, reports, and applications.

It takes audio-line-level signals (in stereo or mono) and converts them to CD-format digital information for processing by your NeXT computer's DSP. With two channels of stereo line input into two channels of 16-bit, 44.1-kHz digital information, you and your NeXT computer can create sound files with a signal-to-noise ratio of 90 decibels and a channel cross-talk rating (in stereo mode) of −85 dB at 10 kHz.

The package includes sample recordings and software that allows you to create sound files in the standard NeXT format. Total harmonic distortion is rated at −90 dB, A/D input voltage is rated at ±5 volts, and input impedance is 100,000 ohms.

You might consider making a low-cost digital recording studio, developing voice and speech analysis software, or using the peripheral as a high-frequency, high-resolution laboratory voltage-measurement device.
Price: $825.
Contact: Metaresearch, Inc., 516 Southeast Morrison, Suite M-1, Portland, OR 97214, (503) 238-5728.
Inquiry 1129.

Replace Your Keyboard Inexpensively

Membrane-switching technology is approaching capacitance-switching technology in keyboards for IBM PCs, according to Key Tronic Corp.

The Professional Series MB 101 is rated at 30 million life cycles per key switching.
Price: $89.
Contact: Key Tronic Corp., P.O. Box 14687, Spokane, WA 99214, (800) 262-6006; in Washington, (509) 927-5515.
Inquiry 1130.

Erasable, Optical Media Greets Your Mac

For your reading, writing, and erasing whims, the Jasmine DirectOptical disk drive features removable 5¼-inch cartridges with 297.6 megabytes of formatted storage capacity per side.

The drives are based on a Ricoh mechanism, with average seek times rated at 50 ms. Data transfer at the SCSI port is 1.2 megabytes per second.
Price: $4995.
Contact: Jasmine Technologies, Inc., 1740 Army St., San Francisco, CA 94124, (800) 347-3228; in California, (415) 282-1111.
Inquiry 1131.

Scanner Matches Typesetting Resolution

The Hewlett Packard 9195A Image/OCR Desktop Scanner is an 8-bit, 256-level gray-scale scanner.

Add some software from third-party developers, and Macintosh users can scan documents and manipulate the scanned images the way a photographer "custom prints" a photograph, Hewlett Packard claims. While PC users don't have the Macintosh's graphics capabilities, they can use it for automatic scaling and optical character recognition.

Whatever the computer, you can use either laser printers with resolutions of 300 dpi by 300 dpi, or typesetters. The 8-bit scanner matches output resolution from 12 dpi to 1500 dpi in one-dot increments.

DeskScan software for your PC allows you to use the ScanJet Plus as a simple copy machine with a default resolution of 216 dpi.

Interactive scaling displays the effects of size adjustments to the image on your computer screen. Scanned files are stored and brought to PC application software through file formats including TIFF, Microsoft Paint, GEM, PC Paintbrush, and EPSF. Mac users can run HP's Desk Gallery Plus software with image files stored in TIFF, EPSF, MacPaint, PICT, and the Clipboard.
Price: $1595; interfaces for PCs, Macs, and PS/2s, $595 each; document feeder, $595; OCR software, $595.
Contact: Hewlett-Packard Co., 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.
Inquiry 1132.

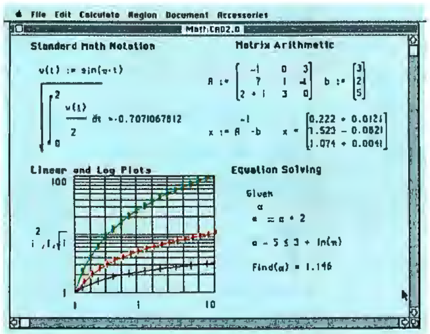
continued

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

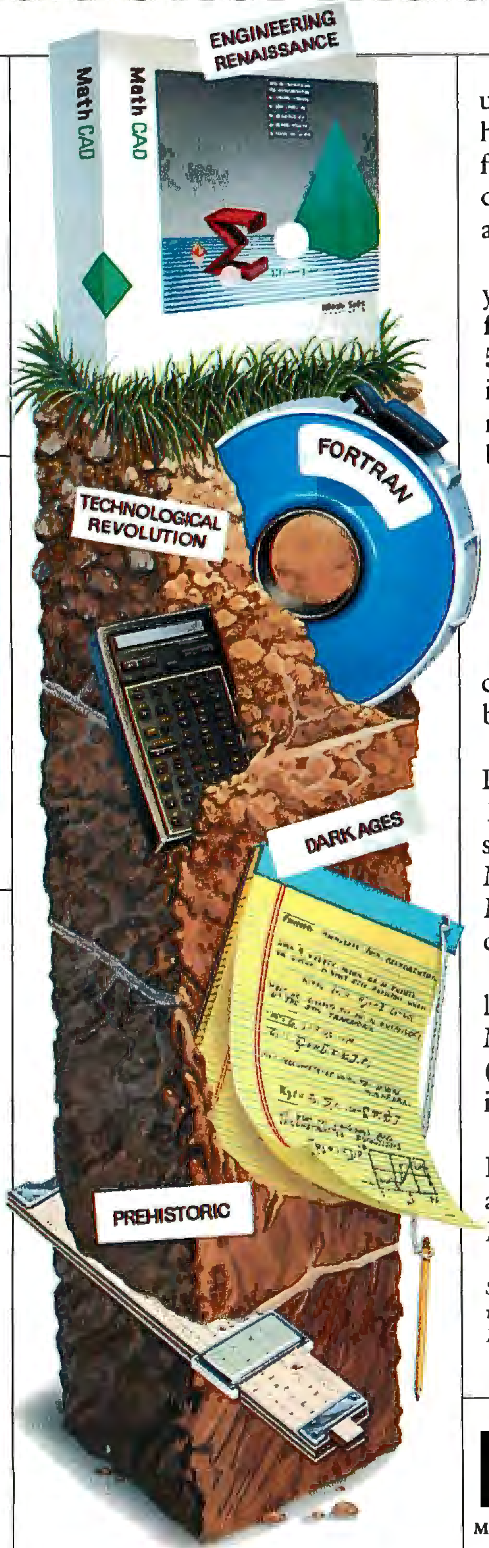
Announcing MathCAD: A Calculating Renaissance For Your Mac.

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

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



MathCAD takes full advantage of the Macintosh® interface, with features that make it simple to enter operators and Greek letters into equations.



MathCAD is the best selling math software in the world because it lets you perform engineering and scientific calculations in a way that's faster, more natural and less error-prone than the way you're doing them now—whether you're using a scratchpad, calculator, spreadsheet, or program that you wrote yourself. It gives you more control and more flexibility than ever before.

MathCAD's live document interface™ lets you enter equations anywhere on the screen, add text, and graph the results. Then print your analysis as a presentation quality document.

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

No matter what kind of work you do, MathCAD has a solution for you. In fact, it's used by over 50,000 engineers and scientists, including electrical, industrial, and mechanical engineers, physicists, biologists, and economists.

But don't take our word for it. Just recently MathCAD was reviewed as being "everything you have ever dreamed about in a mathematical toolbox." And when it was compared to the competition, it was "MathCAD by a mile."

And if you work with an IBM® PC or compatible, there's a MathCAD version designed exclusively for you. Or if you use both Macs and PCs, don't worry: MathCAD files are completely compatible between the two.

Look for MathCAD at your local software dealer. Or call MathSoft at 1-800-MATHCAD (in MA, 617-577-1017) for more information or for a free demo disk.

Speed, power and flexibility. Enter the new era of engineering and scientific calculations, with MathCAD.

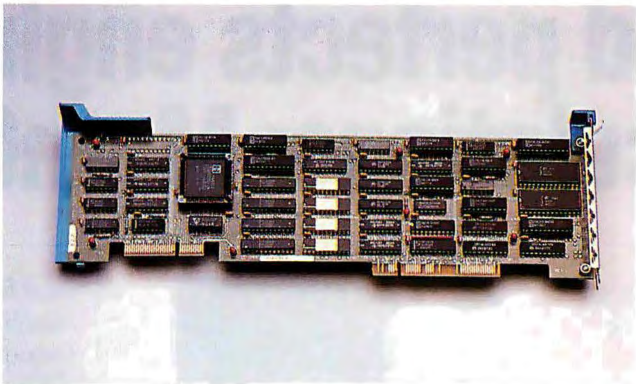
System Requirements: Apple Macintosh Plus, SE or II, with a minimum of 1MB RAM. Supports all ImageWriters® and LaserWriters.®

MathCAD®

MathSoft, Inc. One Kendall Square, Cambridge, MA 02139

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

Circle 165 on Reader Service Card



Polywell's Hummingbird 50/60 revs up PS/2s.

Accelerate Those Model 50s and 60s

The Hummingbird 50/60 is a 20-MHz 80286-based add-in board that boosts the performance of your IBM PS/2 Models 50, 50 Z, and 60 up to that of the 80386-based 20-MHz Models 70 and 80. It also includes 3270-emulator software.

To install it, you use a special "chip-puller" tool to remove the 80286 from the original motherboard. You plug the adapter module into the Hummingbird adapter card, which you plug into the Micro Channel slot.

Once your installation is complete, you've got a zero-wait-state, 20-MHz, CMOS 80286 chip and 32K bytes of 55-ns static RAM. The cache is updated during direct-memory-access reads, and there's a programmable cache for adapter ROMs.

Manufacturer Polywell claims the new system operates exactly as before—with the same support for the 80287 chip, for example.

For software that is dependent on the slower clock speed, the HiSpeed program is available to temporarily disable the cache. The 3270 emulation works at all speeds.
Price: $995.
Contact: Polywell, Inc., 61C Airport Blvd., South San Francisco, CA 94080, (415) 583-7222.
Inquiry 1133.

Scion Captures No-Wait Redraw

The Scion Image Capture Board for the PC and the Image Capture Board II for the Mac II both digitize and display images at 30 frames per second. There's no wait for redraw.

Both 8-bit cards allow 24-bit capturing, cropping, and centering of images for color display. Images are bit-mapped into 256 levels of gray, and both cards can provide halftones.

Input can be any National Television System Committee (NTSC) compatible video source, and the cards save images in TIFF format. Output resolution is 640 pixels by 480 pixels.
Price: $1195.
Contact: Scion Corp., 3 North Main St., Walkersville, MD 21793, (301) 845-4045.
Inquiry 1135.

Give Your PC a SPARC

The SP-1 is a 20-MHz SPARC-based coprocessor system on an AT card. It comes bundled with C and FORTRAN compilers derived from those used in Sun Microsystems' Sun-4 workstations.

The SPARC (Scalable Processor Architecture) chip, model CY7C601, is combined with Texas Instruments' TI8847 FPU and 8 megabytes of interleaved DRAM. Each SPARC chip has 136 32-bit registers, with eight overlapping windows of 24 registers each. Manufacturer Definicon Systems claims 12-MIPS performance.

Once installed, the coprocessor can access graphics cards, serial and parallel ports, A/D converters, disk drives, and other peripherals by using the 80286 or 80386 host CPU as an I/O controller.

The included software translates DOS commands into the Unix-type format that the Sun compilers expect. So you get the DOS you're familiar with and the functionality of working in a Sun environment.
Price: $5495; with 8 megabytes, $7495.
Contact: Definicon Systems, Inc., 1100 Business Center Cir., Newbury Park, CA 91320, (805) 499-0652.
Inquiry 1136.

Surface Mount Allows Field Upgrading

Matrox has introduced three dimensions to its AT graphics controller cards.

With the new PG-1281C, you get two-dimensional graphics and upgrade capabilities through the SM-1281C/F (shading-engine module) for three-dimensional graphics. This upgrade process takes only 30 minutes, Matrox claims.

Alternatively, you can buy the SM-1281C and have three-dimensional graphics automatically, with the same performance as with the two-dimensional and three-dimensional shading-engine module.

The PG-1281C gives you 125,000 vectors per second and 30,000 cps and can be upgraded with the SM-1281C/F for 80,000 three-dimensional vectors per second. Matrox claims that you can then generate up to 20,000 Gouraud-shaded polygons per second for fast rendering of shaded images.
Price: PG-1281C, $4995; SM-1281C/F, $3995; SM-1281C, $8495.
Contact: Matrox Electronics Systems, Ltd., 1055 St-Regis Blvd., Dorval, Quebec, Canada H9P 2T4, (514) 685-2630.
Inquiry 1137.

I'm Not Going to Pay a Lot for an Acquisition Module

The ADAC 5500MF is a low-cost data acquisition module in a half-length AT card. A counter/timer chip provides it with three programmable timers, which allow the 5500MF to be used in pulse-generation, timing, and counting applications.

The 5500MF will accept as many as eight analog inputs multiplexed to a 12-bit A/D converter. Hardware conversion time is 40 μs, and 25-kHz throughputs can be achieved. Each module has 16 lines of TTL-level I/O.

LabTech Acquire software allows you to perform data acquisition on four of the eight analog inputs and one digital input. Up to 50 samples per second can be manipulated.
Price: $295.
Contact: ADAC Corp., 70 Tower Office Park, Woburn, MA 01801, (800) 648-6589; in Massachusetts, (617) 935-6668.
Inquiry 1138.

continued

NEW TURBO C PROFESSIONAL 2.0

Pull out all the stops

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

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

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

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

Only Turbo C Professional gets it all together

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

With Turbo C Professional you get:

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

Turbo C 2.0
- Compiles over 16,000 lines per minute
- Hypertext online Help
- Supports inline assembly
- All six memory models supported
- More than 450 library functions

Turbo Assembler
- Assembles up to 48,000 lines per minute
- Compatible with MASM 4.0, 5.0, 5.1
- Full 386 support
- Assembles multiple files

Turbo Debugger
- Debug any size program
- Browse through structures with data debugging
- Set conditional breakpoints, break on memory access
- Stop, run code, log expressions
- 386 ICE capabilities

Turbo Debugger is a winner

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

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

Bill Machrone, Editor-in-Chief, *PC Magazine*

Debug *any size program*

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

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

Pull out all the stops

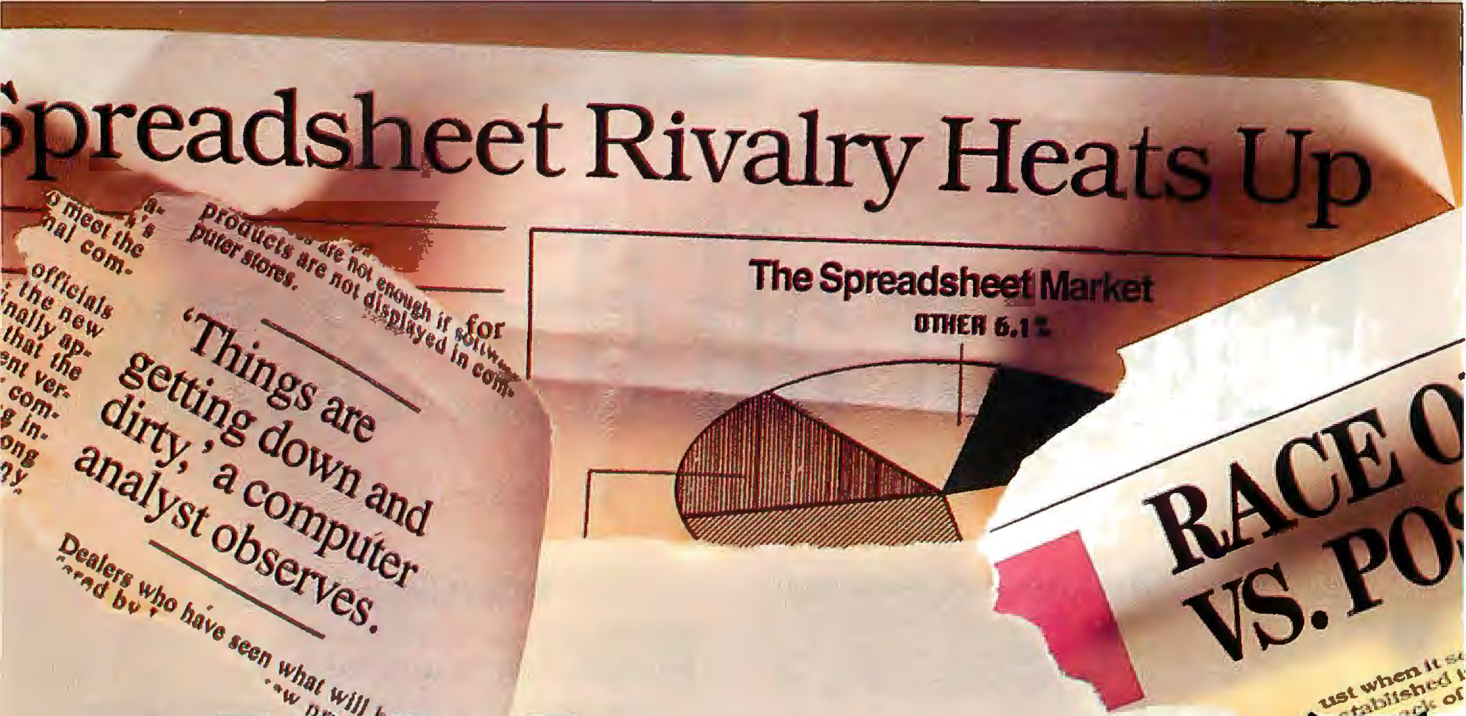
Turbo C's integrated environment lets you completely stop stopping. Your program is never interrupted. No stops and no g aps. You compile faster. Link faster. Work faster. Think faster. So turn to Turbo C Professional: There's nothing stopping you now.

This is no ordinary Demo

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

B O R L A N D

Code: MCO5



We Interrupt T War For This Im

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

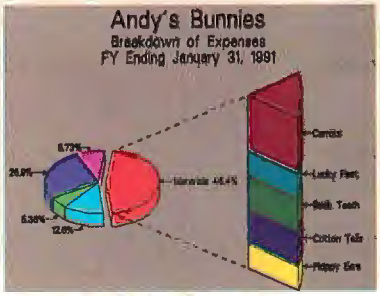
There is, at last, a viable alternative to war: revolution.

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

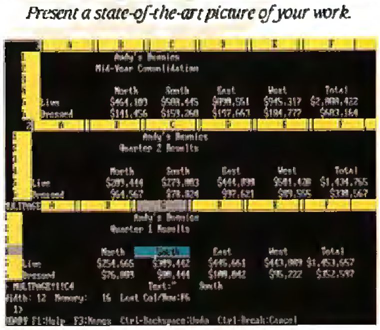
The name of the spreadsheet is SuperCalc®5.

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

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



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



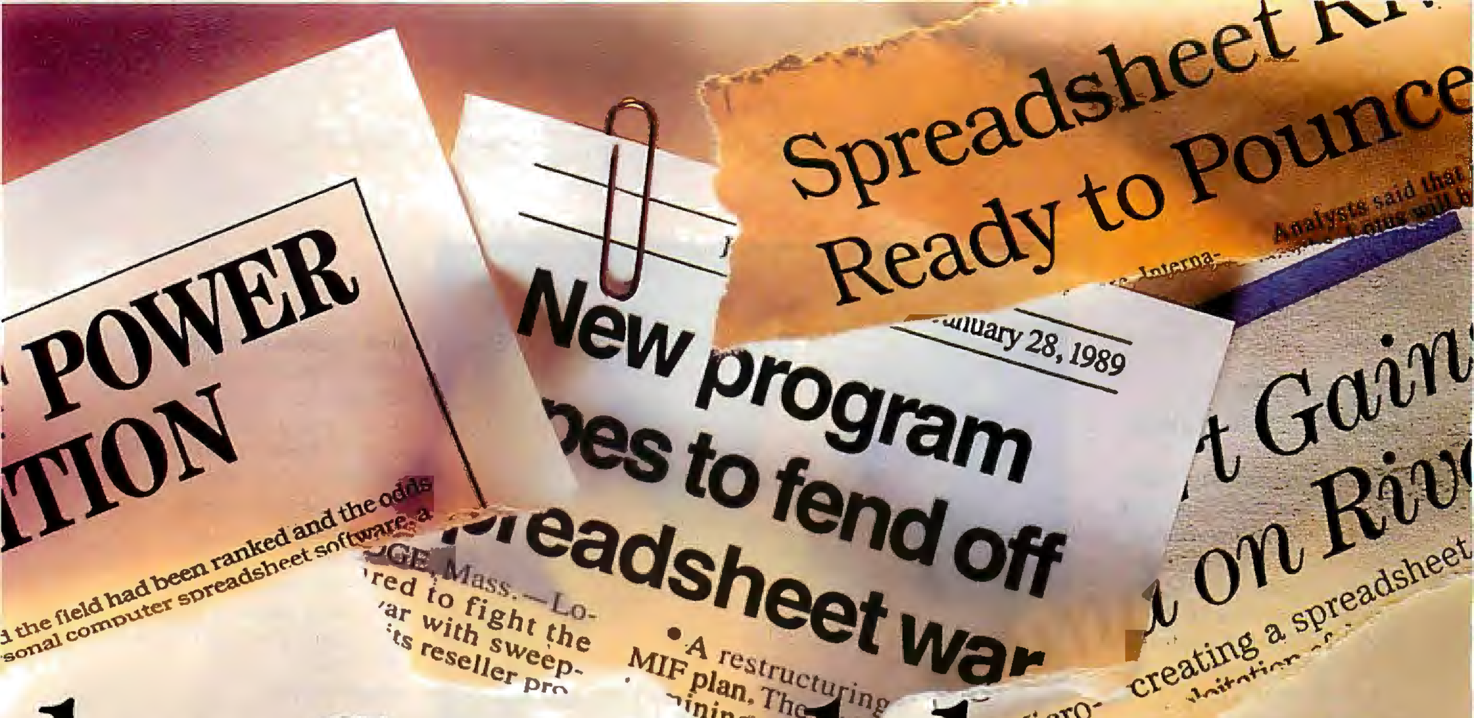
Link just about everything in sight.

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

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

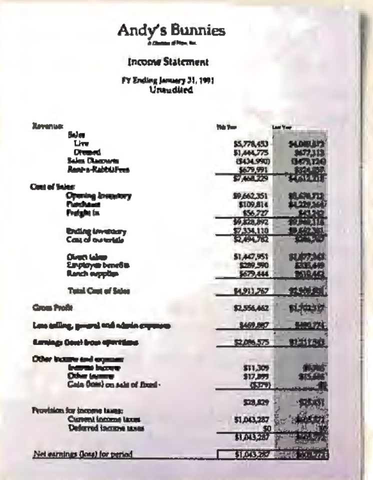
Perhaps even more impressive is the way SuperCalc5 can link spreadsheets. Up to 255

Catch bugs before they come back to bite you.



he Spreadsheet portant Update.

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



Produce annual-report quality output everyday.

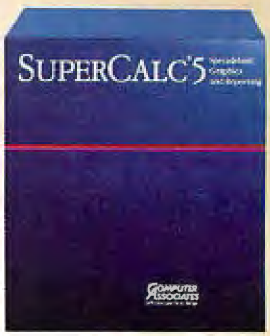
Which brings us to the "L" word. SuperCalc5 not only reads and writes Lotus® 1-2-3® files, it totally coexists with Lotus. Letting you easily move 1-2-3 macros into SuperCalc5 and back again. Even toggling between menus is a snap for SuperCalc5.

But not for Excel®.

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

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

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



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

With SuperCalc5, peace is at hand.

COMPUTER® ASSOCIATES
Software superior by design.

Circle 61 on Reader Service Card

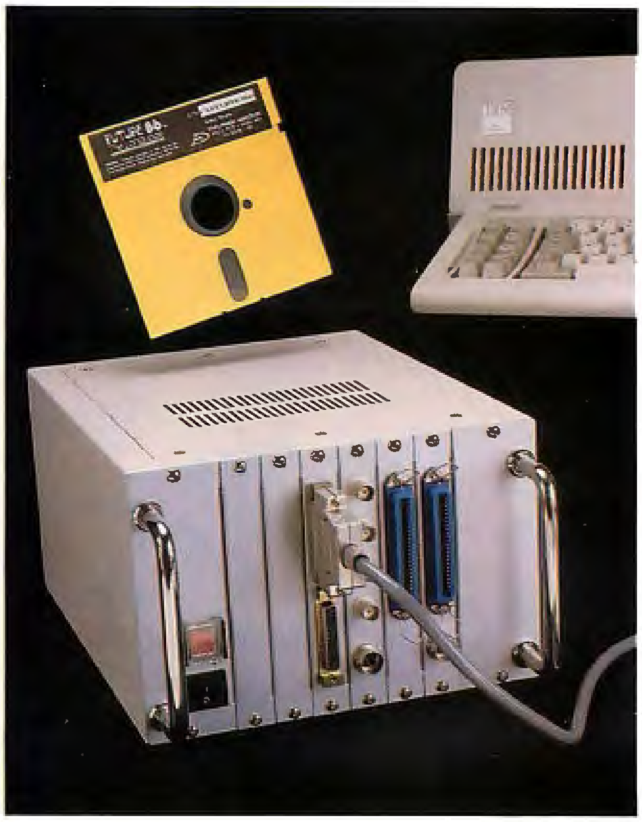
Measurement Control at Its Finest

The Universal Data Manager is a general-purpose data-acquisition and -control system that's run with your 80286 or 80386 machine. It communicates through RS-232C or IEEE-488 channels.

The measurement and control configuration of the UDM can be any combination of analog and digital I/O functions. In the IEEE-488 bus configuration, up to 15 units can be connected to each computer, with multiple communications channels. Signal extenders allow you to locate the UDM some distance from the computer.

Standard equipment on the UDM includes several support libraries (e.g., BIOS, IEEE-488, and RS-232C) and high-level Data Manager commands.

You can manipulate I/O so that it will acquire data automatically at high speed until the system's internal data buffers are filled. Then the computer can perform data reduction and analysis. Data can also be acquired or sent until a particular pattern occurs.
Price: $860.
Contact: Development Associates, 1520 South Lyon St., Santa Ana, CA 92705, (714) 835-9512.
Inquiry 1152.



The UDM controls RS-232C and IEEE-488 I/O.

Gray-Scale LCD Projector for PCs Includes Memory

The PC Viewer is an LCD peripheral for an overhead projector. It comes with 1 megabyte of static RAM for storing computer-generated presentation frames. It works with IBM PCs and compatibles that have CGA, EGA, and VGA graphics capabilities, as well as with the Apple II and Macintosh computers.

With it, you don't need the computer when you make your presentation—all you need is the 12- by 12- by 2-inch PC Viewer and an overhead projector. You simply plug the PC Viewer into your computer, bring up the screen you want to store, and select the screen-capture option using the projector's remote controller. Once you've stored the images, you can leave the computer behind.

PC Viewer is so small because it's made of a heat-resistant LCD material. It comes with an electronic pointer and an infrared hand-held remote controller that can be used to edit the timing and sequence of the stored display frames. Up to 100 frames can be stored in the 1-megabyte memory space.

Price: Gray-scale, $2995; blue/yellow display, $2695.
Contact: In Focus Systems, Inc., 7649 Southwest Mohawk St., Tualatin, OR 97062, (503) 692-4968.
Inquiry 1153.

Plot Faster with Your LaserJet

Plotter in a Cartridge is a complete emulation of Hewlett-Packard's 7475A plotter, and it implements the Hewlett-Packard Graphics Language (HPGL) on an HP LaserJet Series II printer.

Pacific Data claims that Plotter in a Cartridge will plot complex layouts, like circuit boards, more than 10 times as fast as PC-based HPGL plotters.

Plotter in a Cartridge plugs into the font cartridge slot of the printer and is compatible with all the major CAD, presentation graphics, and spreadsheet graphics software. Features include variable pan/line thicknesses, x- and y-axis scaling, arc and circle generation, plot rotation, multiple fill and shading patterns, and paper-sizing capabilities.
Price: $395.
Contact: Pacific Data Products, 6404 Nancy Ridge Dr., San Diego, CA 92121, (619) 552-0880.
Inquiry 1154.

Server Provides Network Access to CD-ROM Drives

The Network-OS CD Server allows multiuser access of up to 14 CD-ROM drives through Novell and CBIS network operating systems.

You can also use it to share printers, disk drives, files, and other resources. It is hardware-independent as long as your networking hardware is NetBIOS-compatible.

The standard Network-OS CD Server system includes one drive in the tower-size file server, which can read any 600-megabyte CD-ROM information in ISO 9660/High Sierra format. It comes with a display, a keyboard, and a 5¼-inch floppy disk drive, and it has a SCSI port.

Its brain is a one-wait-state 12-MHz 80286 CPU with 640K bytes of RAM (upgradable to 16K bytes).

The standard system allows installation of up to seven drives; an optional expansion chassis can have an additional seven drives.
Price: $5250; Network-OS software, $160 per node.
Contact: CBIS, Inc., 5875 Peachtree Industrial Blvd., Bldg. 100/170, Norcross, GA 30092, (404) 446-1332.
Inquiry 1155.

continued

Maxell Corporation of America, 22-08 Route 208, Fair Lawn, NJ 074

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ADIC Guarantees File Server Backup

The LANbacker 8000 guarantees data backup from your IBM PC or compatible NetWare file server, claims Advanced Digital Information Corp. Information is filed and documented by file or session backup date.

Auto Execution Monitor software lets you set up everything in advance, and you can daisy chain up to seven of the dot-matrix-printer-size units. Then you can sit back and let the software and 3M-designed DC-2000 data cartridges do their thing.

Price: With 60-megabyte cartridges, $5995; with 120-megabyte cartridges, $7995.
Contact: Advanced Digital Information Corp., 14737 Northeast 87th St., P.O. Box 2996, Redmond, WA 98073, (800) 336-1233; in Washington, (206) 881-8004.
Inquiry 1142.

Turn Your XT into an X Windows Workstation

PC-Xview is a communications package from Graphic Software Systems. It works in XT compatibles that are already connected on an Ethernet.

Version 1.0 works only with the Exelan 205T Ethernet cards. Version 1.1 will work with any FTP drivers currently written for cards from 3Com, InterLAN (formerly Micom-InterLAN), Western Digital, and others. Version 1.1 will also support LIM/EMS 4.0.

Price: $295; version 1.1, $320.
Contact: Graphic Software Systems, Inc., 9590 Southwest Gemini Dr., Beaverton, OR 97005, (503) 641-2200.
Inquiry 1144.

IGOR Uploads, IGOR Downloads

With accompanying file transfer software, IGOR can be preset to initiate and perform as many as three host sessions and as many as 12 file transfers between your PC and your host. That includes support for 3270 emulators.

IGOR comes either bundled with a 3270 card or unbundled. It requires about 85K bytes of RAM on your IBM PC or compatible. LAN support is planned.

Price: $150 for software alone; software and card, $650.
Contact: Lazarus Data Products, 815 Manhattan Ave., Manhattan Beach, CA 90266, (213) 318-6290.
Inquiry 1151.

Banyan Ships Vines 3.1

Banyan recently enhanced its network operating system, Vines, to support additional add-in cards and a new developer's toolkit.

Vines 3.1 now supports IBM's 16-mbps Token Ring interface cards, 3Com's 3C603 cards, DOS 4.0 for Vines clients, and Compaq's internal 135-megabyte tape drives for 80386-based systems.

An optional toolkit contains a standard Unix System V development environment and a mail gateway to support the integration of Banyan Mail with other vendors' mail systems.

Price: Vines 3.1, $4995; toolkit, $1995.
Contact: Banyan Systems, Inc., 115 Flanders Rd., Westboro, MA 01581, (508) 898-1000.
Inquiry 1143.

AppleTalk File Server

The DirectServe system acts as a file server for up to 20 Macintoshes on an AppleTalk network, something that was previously available only by using at least a Mac Plus or by dedicating a personal computer.

One of the main advantages, Jasmine claims, is speed. With memory-caching techniques, Jasmine estimates a 20 percent to 40 percent increase over using a Mac as the server. And you're still assured of compatibility with the AppleTalk Filing Protocol.

Each DirectServe is driven by a 10-MHz zero-wait-state 68010 microprocessor. The standard motherboard comes with 1 megabyte of RAM and can accommodate up to 32 users. Memory can be expanded to 2 or 4 megabytes.

You'll still need a hard disk drive with a capacity of up to 300 megabytes, depending on your applications.

Price: $1299.
Contact: Jasmine Technologies, Inc., 1740 Army St., San Francisco, CA 94124, (800) 347-3228; in California, (415) 282-1111.
Inquiry 1141.

Server Supports 15 Simultaneous Dial-Up Sessions

Novell is using Quarterdeck's multitasking, multiwindowing DESQview software in a product that will provide improved remote-access capabilities. It's called the NetWare Access Server.

To use it, you'll need DESQview, the NetWare Driver, and Novell wide-area-network interface module (WNIM Plus) boards on an 80386-based machine. You and 15 colleagues on the road or in remote offices can have dial-up access to the Novell LAN resources in the main office through a single dedicated file server.

Each of the WNIM Plus boards supports four simultaneous sessions. Since DESQview supports 15 sessions, you'll need four boards for maximum dial-up support.

Price: Bundled with DESQview, $1995; each WNIM Plus board, $895.
Contact: Novell, Inc., 122 East 1700 S, Provo, UT 84601, (800) 453-1267; in Utah, (801) 379-5900.
Inquiry 1140.

continued

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For the Integration of Fax

Three new products help you integrate fax services through your LAN. Two use intelligent machines, and one is an extension of an E-mail package.

The Facsimile Server from Interpreter bundles a Wyse 286 and a fax add-in card from Brook Trout with software groomed in the legal market. Each unit includes 1 megabyte of RAM, a 20-megabyte hard disk drive, a 1.2-megabyte 5¼-inch floppy disk drive, an Ethernet card (in one of several slots), a serial port, and a parallel port.

Two key features are automatic (and confidential, if you want) routing through the network to the addressee, and transparent conversion of text to editable word processing or spreadsheet formats.
Price: $5600.
Contact: Interpreter, Inc., 11455 West 48th Ave., Wheat Ridge, CO 80033, (800) 232-4687; in Colorado, (303) 431-8991.
Inquiry 1145.

With its first product, called FaxPress, Castelle took a proprietary approach to a fax server. This reduces not only the unit's size (to 3 by 11 by 12 inches) but also its price. You forfeit only the industry-standard bus.

Each FaxPress includes two Motorola 68000 microprocessors, one acting as the fax processor and one acting as the network processor. You get 1.5 megabytes of RAM, a serial port, a parallel port, and an Ethernet board.
Price: $3650.
Contact: Castelle, 2540 Mission College Blvd., Suite 102, Santa Clara, CA 95054, (408) 496-0474.
Inquiry 1146.

FaxPress dedicates PC service on your NetWare network.

FAXlink from cc:Mail uses the Intel Connection CoProcessor board. A single workstation on your network equipped with the board acts as a fax gateway for an entire local- or wide-area network of cc:Mail users.

It's an extension of the cc:Mail software, so you're notified when you have text or graphics just as you are with mail messages on cc:Mail. It's the same user interface. And as with the other products, there are broadcast capabilities and timed capabilities.
Price: $995 per server.
Contact: cc:Mail, Inc., 385 Sherman Ave., Palo Alto, CA 94306, (415) 321-0430.
Inquiry 1147.

How V.22bis Modems Are Progressing

The 2400-series V.22bis modems from Racal-Vadic offer you 2400-bps asynchronous transmission over analog transmission facilities.

Of course, you get the de facto standard MNP-4 (and lower) error control and backward compatibility to 300-bps modems. The modems are available in an internal half-height model, or as an external peripheral for the XT, AT, or PS/2s. There are also some extras, like the ability to store up to four telephone numbers.
Price: $395.
Contact: Racal-Vadic, 1525 McCarthy Blvd., Milpitas, CA 95035, (800) 432-8008; in California, (408) 432-8008.
Inquiry 1149.

Wide-Area Network Solution Greets PCs, etc.

10-NET TCP is a single-network solution for LANs, terminal servers, PCs, and microcomputer-to-mainframe equipment.

With this TCP/IP software, you're transparently connected from 10-Net's LAN equipment to Digital Communications Associates' WAN equipment. All you see is a common interface.

The package includes software modules and utilities for TCP/IP protocols, a file transfer protocol (remote host to PC and back), Telnet terminal emulation (log-on to remote host), and simple mail transfer protocol.
Price: $395.
Contact: Digital Communications Associates, Inc., 1000 Alderman Dr., Alpharetta, GA 30201, (404) 442-4000.
Inquiry 1150.

Frederick Engineering Shrinks a DACS

The μDACS, a miniature version of a digital-access cross-connect switch, consists of a PC-compatible add-in card and application software.

DACSes have long been used for switching as few as 128 "T1" telecommunications lines, with each T1 defined as a stream of electrical pulses at the telecommunications-standard 1.544-mbps data rate. DACSes are priced at a hefty $100,000 or more.

The μDACS lets your personal computer receive as many as 16 telecommunications lines, each carrying information at the T1 rate. Then it reroutes the lines with its own transmitter. It can also switch up to 384 lines at the DS0 rate of 64 kbps.

You manipulate the μDACS either locally through your PC or remotely on an asynchronous terminal connected through the RS-232C ports.

Applications include digital hubbing, "broadcast" cross-connect, channel drop and insert, network management, and facility data link.
Price: $20,000, including an XT clone.
Contact: Frederick Engineering, Inc., 10200 Old Columbia Rd., Columbia, MD 21046, (301) 290-9000.
Inquiry 1148.

continued

C++ for Unix

Guidelines C++ is now available for Unix V/386. The C++ language is a superset of C and is ANSI C compatible. C++ supports object-oriented programming with features such as classes, inheritance, member functions, constructors and destructors, data hiding, and data abstraction.

Guidelines C++ for Unix V/386 works with the standard Unix C compiler and supports cross-translation with DOS as the target system.
Price: $495.
Contact: Guidelines Software, Inc., P.O. Box 749, Orinda, CA 94563, (415) 254-9183.
Inquiry 1110.

Semantic Checker for Mac Programmers

Programming in C on the Mac is simplified with the release of McCLint, a programming tool in the C Programmer's McTool Series from MMC AD Systems.

McCLint (pronounced Mic-See-Lint) semantically analyzes either single or multiple source listings in interactive or batch fashion. The program checks variable types, conditional and assignment statement usage, arithmetic operations in conditional expressions, misplaced semicolons, function argument passing, and variable initialization.

McCLint automatically constructs its own prototypes for any C source code, the company reports. The program also incorporates options that let you select the program's target system and the selective enabling/disabling of individual and/or groups of warning and error messages.

The program supports Finder and MultiFinder. With MultiFinder, the program can analyze C source files in the background while you edit, compile, or perform other tasks in the foreground.

The program also has an editing and search system that lets you create and modify C source code. Editing features include selection of tab sizes, font type and sizes, automatic highlighting of C keywords, comments, functions, Macintosh Toolbox calls, and more. The search facility supports multiple file searches, manual and automatic string replacement, and an optional Unix `grep` facility.

McCLint runs on any Mac with System 4.2 or higher and at least 1 megabyte of memory.
Price: $99.95.
Contact: MMC AD Systems, Box 360845, Milpitas, CA 95035, (408) 263-0781.
Inquiry 1108.

DOS Assembler Upgraded

Version 3.0 of the A86 Assembler includes support for linkable OBJ files, instruction sets for all processors in the 8086 family, assembly-time floating-point-expression arithmetic, and assembly language source file libraries. The company also reports that the process of converting MASM source files to A86 is now easier due to more compatibility features such as forward references to variables.

A86 is a shareware assembler for MS-DOS computers, written by Eric Isaacson. A86 does not require all the red-tape directives that other assemblers require, according to the company. The program's set of OBJ defaults are compatible with most languages, so you can choose to omit the MASM red-tape directives.
Price: $50, includes source file library tool.
Contact: Eric Isaacson Software, 416 East University St., Bloomington, IN 47401, (812) 339-1811.
Inquiry 1111.

Triple Dose of Graphics

Genus Microprogramming's trio of graphics programs let you incorporate graphics into your programs.

The PCX Programmer's Toolkit 3.5 offers over 45 routines to display, save, and print PCX bit-mapped graphics. Seven utility programs let you capture screens, display images, manage image libraries, and print image files. You can also use graphics from PC Paintbrush, scanners, clip art, or captured screens. Version 3.5 adds support for extended VGA modes that can display up to 800 by 600 pixels in 256 colors.

The program PCX Text lets you display text in graphics mode. Routines let you accept user input, scale fonts, and place text anywhere on the screen. A font editor lets you create your own text styles. You can use up to 256 different text styles on the screen at once, according to Genus.

The special-effects program, PCX F/X, lets you fade, wipe, push, roll, slide, split, crush, spiral, and explode your graphics.

The three programs support all modes of CGA, EGA, VGA, Hercules, and 8514/A graphics adapters, according to Genus. Linkable libraries are provided for a variety of languages. To run any of the three graphics programs, you need an IBM PC with a graphics card and DOS 2.0 or higher.
Price: Programmer's Toolkit 3.5, $125; Text, $99; F/X, $99.
Contact: Genus Microprogramming, 11315 Meadow Lake, Houston, TX 77077, (800) 227-0918; in Texas, (713) 771-4914.
Inquiry 1109.

Prototyping in Pascal and C

ProtoGen lets you create prototypes by entering word processor–like commands in an interactive environment, according to MacCulloch. The programming tool lets you generate Turbo Pascal, Turbo C, and Microsoft C prototypes and source code with three kinds of menus.

The program treats prototypes as data and generates object files in your target language. You can make changes to prototypes with a WYSIWYG editor, and you can import screens that you've created with Dan Bricklin's Demo program.

To run ProtoGen, you need an IBM PC with 384K bytes of RAM, DOS 2.1 or higher, and a target compiler for generating code. You don't need a compiler for prototype generation.
Price: $79.99.
Contact: MacCulloch, Prymak, Ltd., 1411 University Ave. W, Windsor, Ontario, N9B 1B8, Canada, (800) 336-1166 or (800) 225-1166; in Ontario, (519) 977-0903.
Inquiry 1112.

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Take the COMPAQ DESKPRO 386/25, for example. For users who require the ultimate in performance, it's the most powerful personal computer available. And with standard features like eight expansion slots, your choice of four different storage devices and a wide selection of graphics controllers, it's one of the most flexible personal computers, too.

The COMPAQ DESKPRO 386/20e brings the power of a 20-MHz 386 chip to personal computer users who are outgrowing their 286-based PC's.

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COMPAQ DESKPRO 386/25

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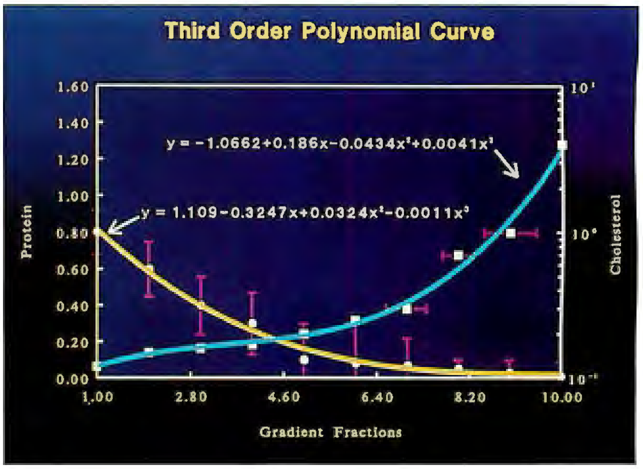

SlideWrite Plus is presentation graphics software created for scientists and engineers.

Graphics from the Lab

Advanced Graphics Software's latest version of SlideWrite Plus is aimed at scientists and engineers who need to produce graphs and charts for publication.

The enhanced version 3.0 has over 100 new features, including increased font support, use of 30 hardware fonts, improved color support, more line types and thicknesses, and more fill patterns.

The 16 software fonts that come with the program can all be accessed at once. Version 3.0 now supports 16 foreground and 16 background colors. Fill patterns include more plotter hatch patterns and halftones for the Hewlett-Packard LaserJet printer and other raster output devices.

Equation plotting capabilities let you plot any equation in the form of $y=f(x)$. You can define up to 12 equations and control the number of points generated for smooth plotting, according to Advanced Graphics Software.

A curve-fitting feature lets you draw a smooth curve through all your data points; you can specify line thicknesses and patterns of each curve. Then you can ask the program to display and print the numbers used to draw the curvefits and equations.

ASCII data can be read into a graph, and you can import TIFF, PCX, and CGM files and use them for special effects in charts. The program can calculate mean, standard deviation, and standard error on the fly when reading in an ASCII data file.

The program comes on three disks, one of which includes a library of figures and sample charts. SlideWrite Plus 3.0 runs on the IBM PC with DOS 2.0 or higher and at least 390K bytes of free RAM. It also supports a mouse, if you have one.
Price: $445.
Contact: Advanced Graphics Software, 333 West Maude Ave., Suite 105, Sunnyvale, CA 94086, (408) 749-8620.
Inquiry 1105.

Least Squares Regression Analysis

FitAll is available in two versions: The Standard Edition (SE) fits data to 20 different built-in functions with over 50 variations. The Research Edition (RE) lets you modify the program so it will fit data to almost any function. The RE comes in source

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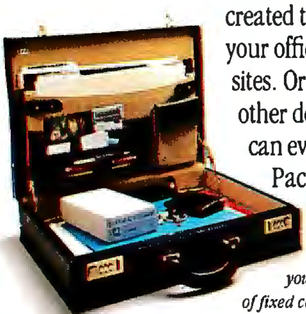

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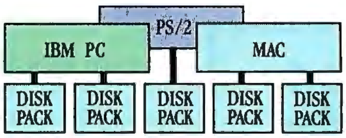

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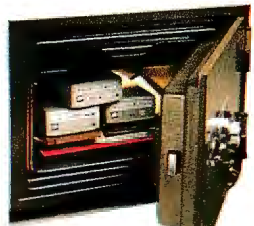
Breakthrough technology makes the Disk Pack four to five times more reliable than other removable products. Access times as low as 13 ms make it one of the fastest hard drives on the market. The Disk Pack doesn't limit you to a single storage capacity either. You can interchange 20-, 40-, 80- or 120-MByte modules in your system and between systems. Link modules up for a whopping Half-GByte + of on-line data. Store them for unlimited off-line data. And do lightning-fast data backups.

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



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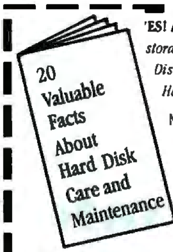

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Mega Drive Systems, Inc.
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Los Angeles, CA 90049 (213) 556-1663

code, which you must compile with TurboPascal.

Both versions of FitAll provide three types of weighting schemes; report standard deviations of the resolved parameters and fit; and make two-dimensional graphs of the data, the fit, and the residuals. Both versions generate calibration graphs and tables and can export tables and graphs to WordPerfect 5.0.

Both the FA-SE and the FA-RE support CGA, MCGA, EGA, VGA, and Hercules graphics. The FA-SE uses an 8087 math coprocessor, if you have one.

To run FitAll, you need an IBM PC with DOS 2.0 or higher, 512K bytes of RAM, and a graphics adapter. To run FA-RE, you need at least a 1.2-megabyte hard disk drive and Turbo Pascal 4.0 or higher.

Price: FA-SE, $50; FA-RE, $75.

Contact: MTR Software, P.O. Box 902, Station P, Toronto, Ontario M5S 2Z2, Canada, (416) 924-2481.

Inquiry 1104.

Engineering Data Software

Tech*Graph*Pad combines data-retrieval, data-manipulation, and data-output capabilities. Version 3.0 includes a worksheet that lets you retrieve data from Lotus 1-2-3, Symphony, or Quattro, an improved user interface, user-selectable color control, and support for Hewlett-Packard output devices.

Other enhancements include the ability to read and plot an unlimited number of data points per set, and the ability to import binary or two's complement data files from data-acquisition devices.

Tech*Graph*Pad runs on the IBM PC with 512K bytes of RAM and DOS 2.1 or higher.

Price: $395.

Contact: Binary Engineering, 100 Fifth Ave., Waltham, MA 02154, (617) 890-1812.

Inquiry 1103.

continued

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- Compatible with SCO XENIX 2.2.3
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Power Output	120 Volt Models	230 Volt Models
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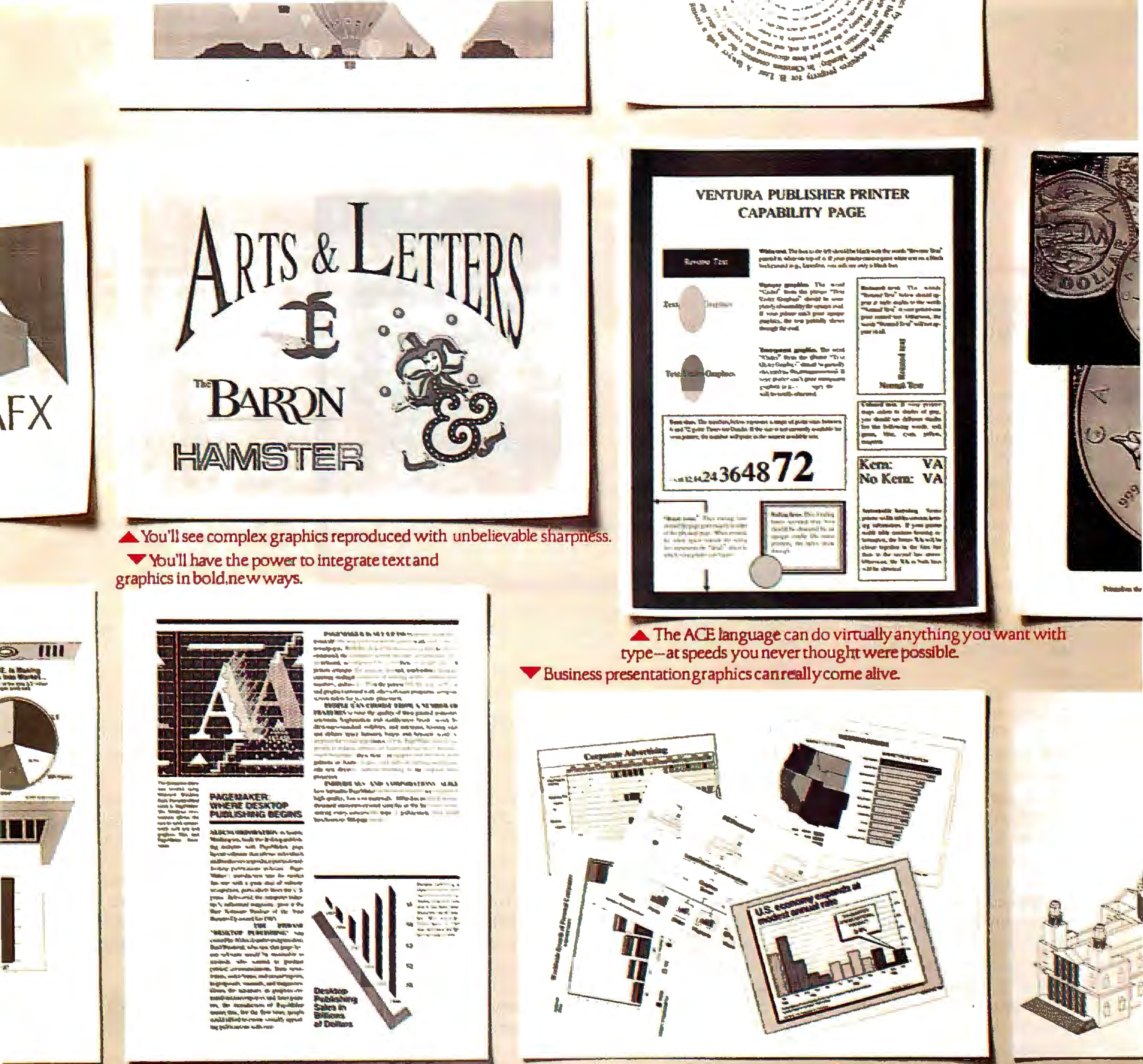

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Circle 118 on Reader Service Card

Plot Demographics with Analysis Tool

PSRC Software's IPSS (Interactive Population Statistical System) is a graphics-based demographics package for business marketers, demographers, and educators. The program can plot the changing demographics in a market area, study the implications of a growing or declining population in a region, and forecast a portion of product demand driven by changing population, the company reports.

Demographic measures of the program include: total births, child mortality, child/woman ratio, crude birth rate and death rate, total deaths, age dependency ratios, population doubling timing, life expectancy at birth, and many more categories.

The program is written in LightSpeed Pascal and Consulair assembly language and is MultiFinder-compatible. With the program, you can create population pyramids, bar and line graphs, three-dimensional population pyramids, and lexis surface and 100 percent surface graphics.

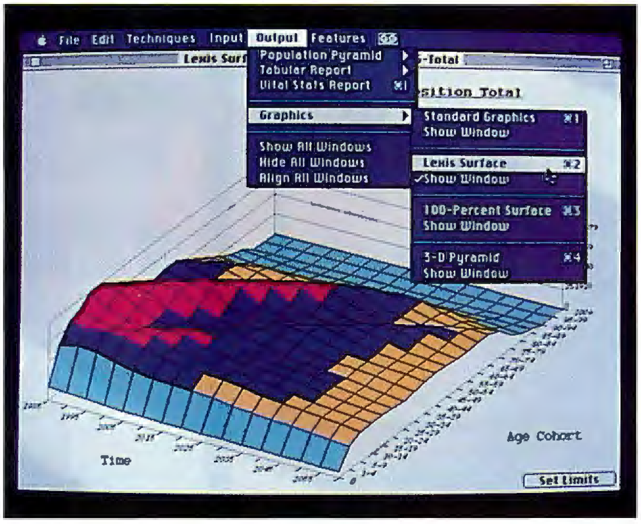
You can use the program to paste graphics directly into spreadsheet or word processing programs and automatically convert them to numerical data.

IPSS works on the Mac Plus, SE, II, or IIx with two 800K-byte floppy disk drives or a hard disk drive and requires 1 megabyte of memory.

Price: IPSS, $295; IPSS II, $395 (requires a 68020/68030 processor and a 68881/68882 math coprocessor).

Contact: Population and Society Research Center, Bowling Green State University, Bowling Green, OH 43403, (419) 372-2497.

Inquiry 1116.



Demographic statistics graphically displayed with IPSS.

New Spreadsheets Claim to Beat Latest Lotus

As spreadsheet users wait for the arrival of Lotus 1-2-3 version 3, two companies have released three-dimensional spreadsheet programs that claim many features of the next 1-2-3.

Computer Associates International reports that its SuperCalc5 coexists with 1-2-3 so completely that it doesn't require an import/export feature for Lotus worksheets. SuperCalc5 automatically recognizes and adjusts for .WKS and .WK1 file extensions. Other features include multiple spreadsheet linking, three-dimensional graphics, and built-in auditing and debugging.

You can mix SuperCalc5 and 1-2-3 menu commands from the menu and in macros. And because macro conversion is reversible, you can move macros back and forth between the two spreadsheet programs.

SuperCalc5's three-dimensional linking method allows you to link spreadsheets in memory or on disk. Up to 255 spreadsheets can be linked.

The program offers more than 100 two- and three-dimensional graphics.

SuperCalc5 will run on any IBM PC or compatible with 512K bytes of RAM, a hard disk drive, and DOS 3.0 or higher.

Price: $495.

Contact: Computer Associates International, Inc., 1240 McKay Dr., San Jose, CA 95131, (800) 531-5236; in California, (408) 432-1727.

Inquiry 1114.

Mosaic Corp.'s Twin Level III also includes many of the promised features of the next Lotus 1-2-3, including the ability to view several spreadsheets at once, background and minimal recalculation, linked files, and three-dimensional worksheets.

One feature allows you to link forms into the database or user-defined functions. Another feature, called Easyform with Data Entry, allows you to use spreadsheet cells as a form.

Twin Level III requires 375K bytes of RAM and will run on any IBM PC or compatible with dual floppy disk drives.

Price: $249.

Contact: Mosaic Marketing, Inc., 1972 Massachusetts Ave., Cambridge, MA 02140, (617) 491-2434.

Inquiry 1200.

continued

Word Processor for Windows Imports Graphics

Myriad, a word processor that requires Microsoft Windows, has several features that you would normally associate with desktop publishing programs. It can import and export graphics and text through the clipboard and wrap text around an imported image. By using the program's multiple-document windowing capabilities, you can cut sections of one document and paste them into another, according to the program's publisher.

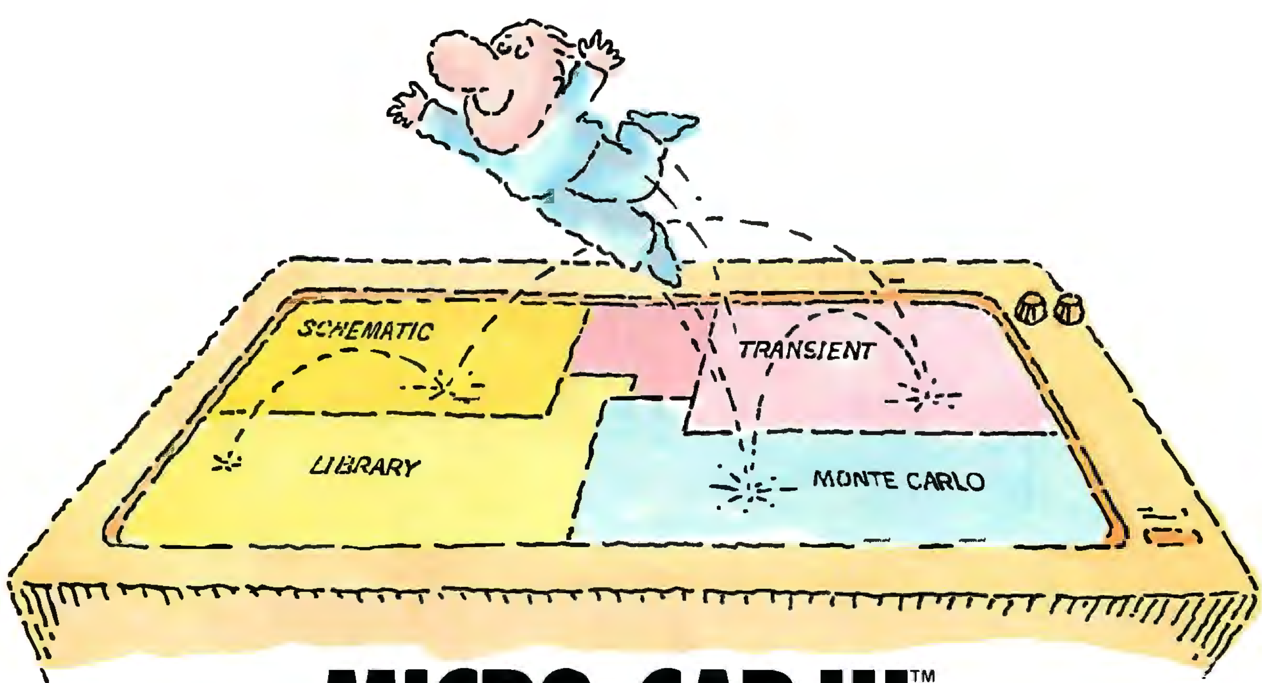
Myriad can also add borders from hairline to about ⅓-inch width around the graphical image. Borders are used to associate a graphics frame with enclosed text—if you move the paragraph or other body of the document, the frame moves with it. Myriad also provides style sheets, document merge, table and index generation, full-page preview, headers and footers, automatic footnote placement, and WYSIWYG presentation.

Included with the program is Beckman Associates' Thesaurus & Speller. Myriad requires Microsoft Windows 286 or 386 version 2.03 or higher. The company recommends 1 megabyte of disk space.

Price: $249.95.

Contact: Beckman Associates, Ltd., 928 Oakcrest St., Suite A, Iowa City, IA 52246, (319) 354-5116.

Inquiry 1113.



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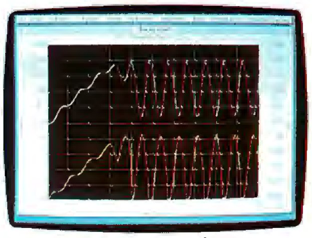
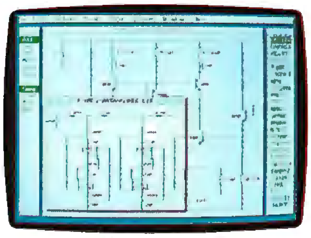
MICRO-CAP III,™ the third generation of the top selling IBM® PC-based interactive CAE tool, adds even more accuracy, speed, and simplicity to circuit design and simulation.

The program's window-based operation and schematic editor make circuit creation a breeze. And super-fast SPICE-like routines mean quick AC, DC, Fourier and transient analysis — right from schematics. You can combine simulations of digital and analog circuits via integrated switch models and macros. And, using stepped component values, rapidly generate multiple plots to fine-tune your circuits.

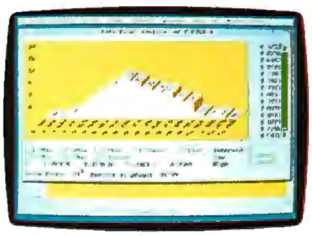
We've added routines for noise, impedance and conductance — even Monte Carlo routines for statistical analysis of production yield. Plus algebraic formula parsers for plotting almost any desired function.



Transient analysis



Schematic editor



Monte Carlo analysis

Modeling power leaps upward as well, to Gummel-Poon BJT and Level 3 MOS — supported, of course, by a built-in Parameter Estimation Program and extended standard parts library.

There's support for Hercules,® CGA, MCGA, EGA and VGA displays. Output for laser plotters and printers. And a lot more.

The cost? Just $1495. Evaluation versions are only $150.

Naturally, you'll want to call or write for a free brochure and demo disk.

spectrum

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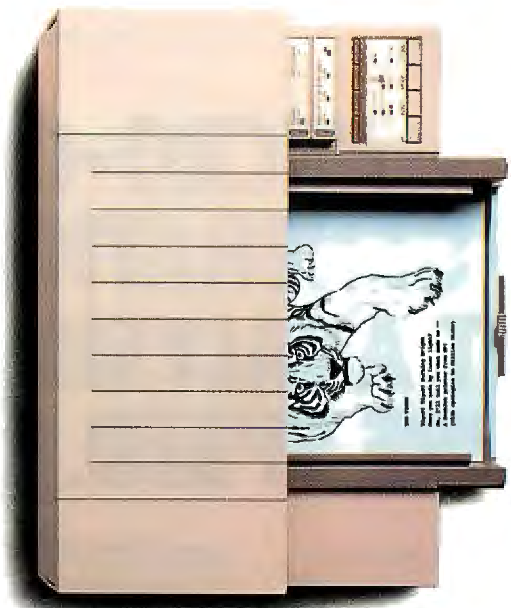
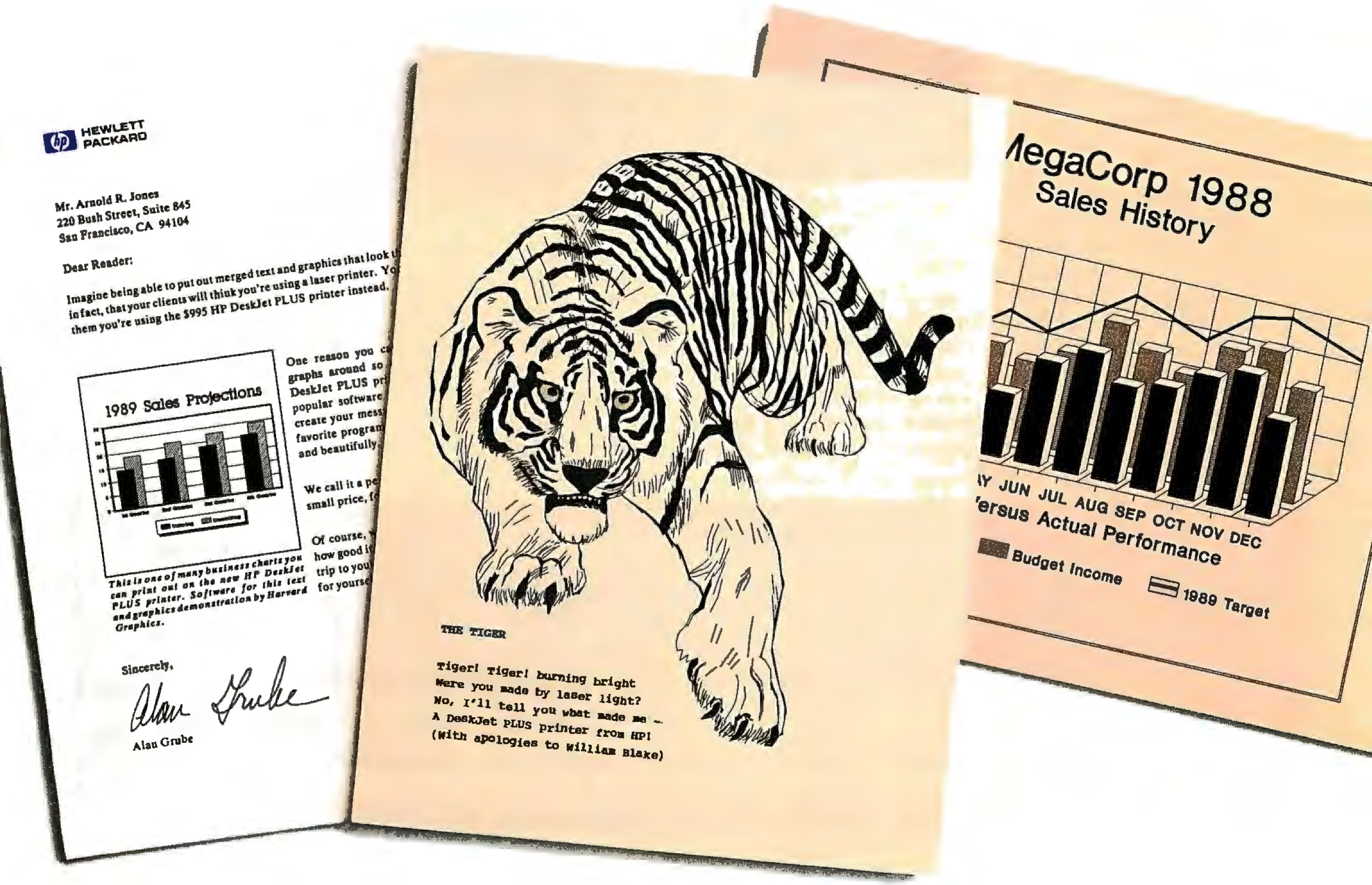
We keep telling people this is not a laser printer.



The new $995 HP DeskJet PLUS Printer.

But they keep looking at the evidence.



You won't believe your eyes (or ears), either. The HP DeskJet PLUS printer gives you the same crisp, black lettering. Clean, sharp graphics. And whisper-quiet operation. But it uses advanced inkjet technology to supply these laser-like qualities for the price of a 24-wire printer.

For just $995, you get 300 dpi in a trim 15-pound package that's twice as fast as the original. What's more, it has built-in landscape and improved font selection. Including ten built-in fonts and over 100 optional fonts, with sizes up to 30 points. And its 20,000-hour MTBF assures a long, happy life.

So call **1-800-752-0900, Ext. 276J** for the name of your nearest authorized HP dealer. Then judge the HP DeskJet PLUS printer for yourself.

HEWLETT PACKARD

Timberline and Autodesk Interface

With the Precision CAD-Link interface, building estimators can take off dimensions and building specs electronically from any AutoCAD drawing files. Using Precision Estimating Plus software from Timberline, Precision CADlink links similar information needs of various building phases.

While using the interface, you still have all the capabilities of AutoCAD available, as well as the facilities of Precision Estimating Plus such as spreadsheet-based estimating and user-designed formulas.

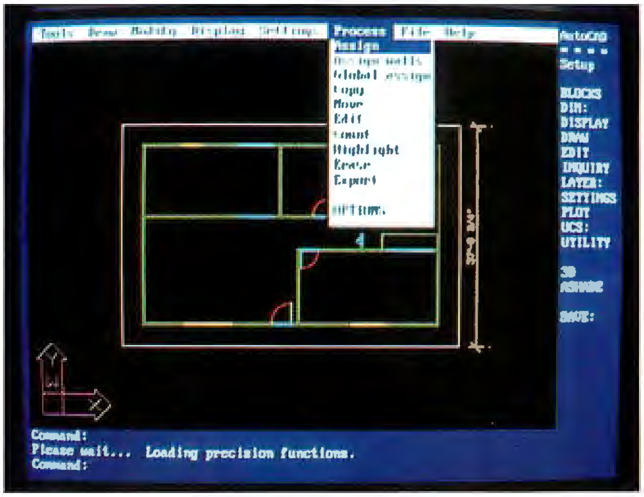
Precision CADLink is compatible with AutoCAD version 10 and with the AEC template for full architectural drawing capabilities.

To run the interface, you need AutoCAD version 10 running on an IBM PC with 640K bytes of extended memory, DOS 2.1 or higher, and at least 512K bytes of RAM.

Price: $490.

Contact: Timberline Software Corp., 9405 Southwest Gemini, Beaverton, OR 97005, (503) 644-8155.

Inquiry 1118.



Precision CADLink integrates information for building designers and construction cost estimators.

Two for the Mac

Two recently released programs offer different approaches to CAD on the Macintosh.

Claris CAD is a straightforward two-dimensional design program that includes mouse and keyboard entry, the ability to construct fillets, tangents, and perpendiculars, and auto-dimensioning. The program offers over 5000 methods for creating and editing geometry, according to Claris.

The program supports freehand and object-oriented sketching. You can read all files created by MacDraw and output them in PICT format. IGES and DXF translators are

continued

optional, enabling you to import or export files to and from AutoCAD and other CAD programs. Claris reports that the number of layers is limited only by memory.

Claris CAD runs on the Mac Plus, SE, or II with at least 1 megabyte of memory. Recommended system software includes System 6.0, Finder 6.1, MultiFinder 6.0, and LaserWriter 5.2.

Claris CAD comes with a tutorial videotape and workbook.

Price: $799; IGES and DXF translators, $299 each.
Contact: Claris Corp., 440 Clyde Ave., Mountain View, CA 94043, (415) 960-1500.
Inquiry 1119.

An upgraded VersaCAD also offers two-dimensional construction but goes a step further than Claris, with three-dimensional viewing, HyperCard stacks, and the ability to operate under Apple's A/UX operating system.

VersaCAD also includes IGES, DXF, and ASCII file translators.

Enhancements to version 2.1 include improved refresh, zoom, and pan operations. Radial and diametral dimensioning of arcs and circles is also added.

VersaCAD's A/UX feature supports the Macintosh Binary Format, providing Unix users with an ability to run Macintosh and A/UX applications with complete file transfer, the company reports.

VersaCAD/Macintosh Edition runs on the Mac Plus, SE, or II with a minimum of 1 megabyte of memory. A math coprocessor is recommended.

Price: $1995.
Contact: Versacad Corp., 2124 Main St., Huntington Beach, CA 92648, (714) 960-7720.
Inquiry 1120.

Three-Dimensional Solids Modeling

Protool helps you prepare mechanical designs by letting you see your creation in three dimensions before you construct it. The program verifies all clearances and lets you see all parts. Once you've approved the plan, you can easily draft the technical documentation from the program's model.

Protool calculates volume, mass, center of gravity, and total or selected wire-frame with hidden line removal or shaded views. The program uses Boolean operations. Other capabilities of Protool include automatic cross-sectioning with hatching, preparation of exploded views, and presentation of 18 views at the touch of a key.

To run Protool, you'll need an IBM PC with 512K bytes of RAM (640K bytes for large designs), a hard disk drive with at least 1.5 megabytes, and a CGA, EGA, or Hercules display card. The company recommends an 80286 or 80386 processor.

Price: $1900.
Contact: CSE Corp., 600 Seco Rd., Monroeville, PA 15146, (412) 856-9200.
Inquiry 1121.

Circle 122 on Reader Service Card (DEALERS: 123)

Microprocessor Troubleshooting Clinic

Micro Systems Institute is sponsoring a four-day course designed to provide a background in microprocessor fundamentals and troubleshooting techniques for technicians and engineers. Equipment familiarization and hands-on experimentation will be emphasized.

The seminar will cover a background in microprocessor systems and explain TTL and CMOS devices, probes, programming, I/O, memory and memory devices, diagnostic programs, interrupts, emulation, signature analysis, bus systems, digital troubleshooting, test equipment, and logic analyzers. The seminar will be held June 13 to 16 in Portland, Oregon, at the Red Lion-Jantzen Beach hotel.
Price: $845.
Contact: Micro Systems Institute, 73 Institute Rd., Garnett, KS 66032, (913) 898-4695.
Inquiry 926.

Send Us Your Local News

BYTE is expanding its coverage of the Pacific region. If you would like your event, conference, or users group covered, please send information to: Regional Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please take into account a 2½-month lead time.

Two IEEE Conferences on Circuits

The IEEE Custom Integrated Circuits Conference will be held at the Town & Country Hotel in San Diego, California, May 15 to 18. Scheduled sessions include programmable devices, data converters, mixed analog/digital applications, highly parallel architecture and neural nets, and telecommunications circuits, to name a few.
Price: Before May 1: $125 for IEEE members, $155 for nonmembers; after May 1: $160 for members, $190 for nonmembers.
Contact: Technical Program Coordinator CICC '89, 1597 Ridge Rd. W, Suite 101C, Rochester, NY 14615, (716) 865-7164.
Inquiry 931.

The 1989 IEEE International Symposium on Circuits and Systems will be held May 9 to 11 at the Portland Hilton in Portland. Topics of sessions include CAD, VLSI design, fault analysis, high-speed circuits, circuits and systems theory, analog signal processing, linear and nonlinear digital filters, large-scale networks, multidimensional signal processing, and many others.
Price: $240 for members; $280 for nonmembers.
Contact: Gail Floyd, P.O. Box 500, M.S. 50-370, Beaverton, OR 97077, (503) 627-6107.
Inquiry 932.

continued

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Seagate ST225	20mb/65ms	$ 225
Seagate ST238	30mb/65ms	249
Miniscribe 3650	40mb/65ms	349
Seagate ST251	42mb/40ms	355
Seagate ST251-1	40mb/28ms	445
Seagate ST277R	65mb/40ms	445

ST506 Interface – 5¼" Full Ht.

Micropolis 1325	72mb/28ms	$ 695
Seagate ST4096	80mb/28ms	599
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Newbury Data 1140	120mb/25ms	1,395
Maxtor XT2190	150mb/28ms	1,895

SCSI Interface – 5¼" Full Ht.

Newbury Data 3170S	147mb/19ms	$1,595
Maxtor XT3280S	244mb/16ms	1,895
Siemens 2300	310mb/16ms	2,295
Newbury Data 3380S	320mb/19ms	2,495
Maxtor 4380S	320mb/16ms	2,795
Siemens 4420	383mb/16ms	2,495
Maxtor XT8760S	660mb/16ms	5,195

ESDI Interface – 5¼" Full Ht.

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Newbury Data 4380E	320mb/19ms	2,295
Maxtor XT4380E	320mb/16ms	2,795
Siemens 4410	383mb/16ms	2,495
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Alps IBM	360k	69
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Fujitsu	1.2mb	110

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Circle 536 on Reader Service Card

Report Helps Users Groups Gain Tax-Exempt Status

Although the benefits for a users group are numerous, gaining tax-exempt status involves considerable time, effort, and, quite possibly, a lot of hair and teeth pulling—the process can be complicated and time-consuming. Users groups will do well to use the services of an attorney or accountant from the start: A nonprofit organization does not by definition automatically qualify for tax-exempt status, and your group may need to submit additional information beyond that of your original application.

Although most users groups opt for the 501 (c) (3) educational route, a group can also qualify as a social club, civic league, or other classification. Gaining 501 (c) (3) status has the most advantages for the typical users group, but it also carries the highest number of restrictions.

If you want to form a tax-exempt users group or convert to that status but don't know where to begin, the Apple Computer User Group Connection will provide to any users group a 60-page report that will show you how. Prepared by Thomas Warrick, a lawyer and former president of Washington Apple Pi, the report covers why a users group should consider becoming tax-exempt, the advantages and disadvantages of each classification, and steps to take in the application process.

Contact: Apple Computer, Inc., User Group Connection, 20525 Mariani Ave., Cupertino, CA 95014, (408) 974-6343.

Optical Storage Forum in San Jose

The fourth international Optical Storage Forum will convene May 9 to 11 at the Fairmont Hotel in San Jose. The forum will focus on the actions required by optical storage companies to make the transition from a promising technology to a major growth industry.

Price: $995.

Contact: Cartlidge & Associates, Inc., 3097 Moorpark Ave., Suite 202, San Jose, CA 95128, (408) 554-6644.

Inquiry 927.

MUMPS Users Group Annual Meeting

Everything from introductory tutorials on the MUMPS (for Massachusetts General Hospital Utility Multi-programming System) language to writing MUMPS applications will be featured at the eighteenth annual meeting for users of the language. The conference will be held in Seattle May 15 to 19 at the Washington State Convention and Trade Center.

Price: Full registration, $275; one day only, $170.

Contact: MUMPS Users' Group, 4321 Hartwick Rd., Suite 100, College Park, MD 20740, (301) 779-6555.

Inquiry 929.

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For consideration, please submit resume with salary history to: **Kaiser Permanente, Dept. 9095/RH/JOU-102-5/89, 393 E. Walnut Street, Pasadena, CA 91188-5080.** Equal Opportunity Employer.

CD-ROM with over 15,000 Programs

PC-SIG has started shipping the sixth edition of its PC-SIG Library on CD-ROM. The new disk contains the equivalent of 1240 disks, with more than 15,000 programs.

PC-SIG reports that the disk's directory, which contains program descriptions and file listings for every program on the disk, is over 3 megabytes long. To help you search for a program by title, disk number, filename, or key word, the company included the WordCruncher text retrieval system from Electronic Text Corp. PC-SIG also included a Copy-Access program to automate the process of going to a program on the CD-ROM and copying all the program's files to another disk.

All the programs on the disk are shareware or public domain. The disk works with any Hi Sierra-format CD-ROM player.

Price: $495.

Contact: PC-SIG, 1030-D East Duane Ave., Sunnyvale, CA 94086, (408) 730-9291.

Inquiry 906.

DEC Text-Processing Utility Emulation

Designed for experienced users of Digital Equipment Corp.'s Text Processing Utility (TPU), nu/TPU lets you define its interface to work in the same way you're used to working in the VAX/VMS, Unix, or DOS environment.

a/Soft developed the text editor as a full implementation of DEC's TPU with features that include multiple windows and buffering, definable interfaces, 92 built-in editing procedures, flexible keyboard mapping, EDT and EVE editing keypads, automated error recovery, and a high-level procedural language.

EVE, EDT, VI, and WordStar interfaces are included with the product: you can modify the interfaces or use nu/TPU to build your own editing interface.

In the DOS environment, nu/TPU works on the IBM PC and compatibles with DOS 3.0 or higher and requires 300K bytes of RAM.

Price: DOS version, $325; Unix-based versions, between $395 and $2500.

Contact: a/Soft Development, Inc., 1353 Salem St., North Andover, MA 01845, (508) 683-4369.

Inquiry 900.

PixelPaint 2.0 Features Pantone, Dithering

PixelPaint, the 8-bit color paint program that helped establish the Mac II as a machine for engineering and graphics arts, now features Pantone color-matching capabilities. The program's developer, SuperMac, reports it has solved the "banding" problem sometimes evident in 8-bit color paint products.

The PixelPaint 2.0 toolbox has also been enhanced with masking tools to create airbrush effects, smoothing, blending, and dithering techniques for the application of color.

PixelPaint 2.0 reads and writes files stored in MacPaint, PICT, PICT2, EPS, and black-and-white TIFF file formats. The program supports QuickDraw and PostScript output devices, including digital typesetting and color-separation equipment.

The recommended minimum requirement is a Mac II or SE/30 with 2 megabytes of memory, a hard disk drive, an 8-bit graphics card, System 6.0 or higher, and a color or gray-scale display.

Price: $395.

Contact: SuperMac Technology, 485 Potrero Ave., Sunnyvale, CA 94086, (408) 245-2202.

Inquiry 904.

Scheduler Links to Word Processor for Detailed Info

PCCAL is a scheduling utility that you can link to your word processor or text editor for in-depth information on an upcoming meeting or event. You can use the program to schedule individuals by themselves or in groups, thereby avoiding scheduling conflicts when you need to schedule a workgroup meeting. If a conflict occurs, the program tells you and helps find an open slot.

You can display several schedules side-by-side on screen, and you can view a list of those attendees by requesting appointment detail.

PCCAL's three-week display allows for canceling and moving appointments and the automatic scheduling of repeat appointments. Category assignments let you include only those for meetings pertinent to their job responsibilities.

The program runs on the IBM PC or compatibles with DOS 3.1 or higher and 256K bytes of RAM. Other versions of the program can run on SCO Xenix systems, PC networks, and the HP3000.

Price: PCCAL for PCs, $95; SCO Xenix version, $395; HP3000 version, $795; PC Network version, $795.

Contact: Bradford Business Systems, 25301 Cabot Rd., Suite 201, Laguna Hills, CA 92653, (714) 859-4428.

Inquiry 1199.

Four Connectivity Products for the Mac

One difference between the Mac SE/30 and the Mac SE is that the 030 Direct Slot's 120-pin Euro-DIN connector isn't compatible with the 96-pin Mac SE expansion slots. The MaraThon 120/96 Bus Adapter card, one of six new Dove Computer Corp. products, allows expansion cards designed for the original Mac SE to function on the SE/30.

The company's new MaraThon Scanner Card allows a Mac II user to access Canon's IX-12 and other similar scanners. The card lets you move scanned images into the Mac II to use with graphics, optical character recognition, and page layout programs with NuBus speed and performance, the company reports.

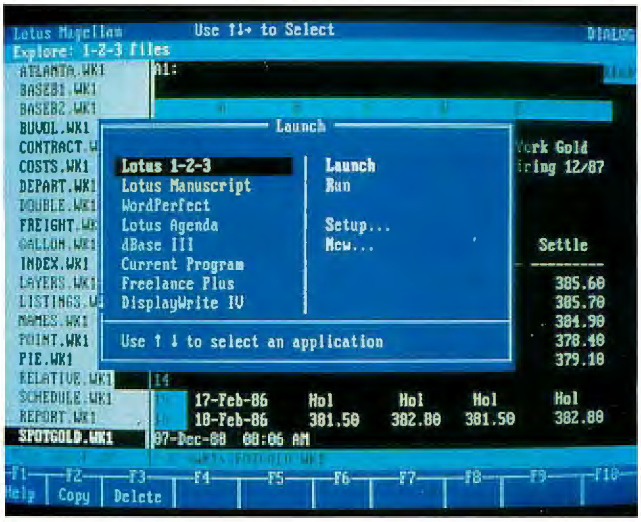
The MaraThon 030X is a 32-MHz accelerator card for the Mac IIx. Dove reports an average of 25 percent performance increase, up to 40 percent in processor-intensive tasks. Similarly, the MaraThon 030/SE is a 32-MHz accelerator card for the Mac SE, which Dove reports will double the machine's performance. It can accommodate up to 4 megabytes of on-board RAM, and it fits in the SE expansion slot.

Price: MaraThon 120/96 Bus Adapter, $199; MaraThon Scanner Card, $199; MaraThon 030X, $1599; MaraThon 030/SE, $1999.

Price: Dove Computer Corp., 1200 North 23rd St., Wilmington, NC 28405, (800) 622-7627; in North Carolina, (919) 763-7918.

Inquiry 903.

BYTE editors' hands-on views of new products



Circumnavigating the Disk with Magellan

Magellan is one of a growing number of DOS file management systems on the market designed to narrow the ease-of-use gap between IBM PC-compatible and Macintosh microcomputers. The Lotus product, similar to Norton Commander and XTree, lets you locate, organize, and sort files across multiple drives, directories, and subdirectories through a cursor-and-function-key interface.

Magellan also harnesses two software technologies that set it in a class by itself: a file indexing/text search system permitting rapid file retrieval with "fuzzy" search criteria, and a file viewer that lets you peer into the contents of files without loading the applications that generated them.

Magellan incorporates a proprietary new indexing scheme that requires only 6 percent to 7 percent of the space used by the source files, yet it is very fast. For example, in 9.5 seconds, I searched 12 megabytes' worth of files for references to software lawsuits and found 127 files (on a 20-megabyte hard disk drive in an 8-MHz 80286 machine).

To perform fuzzy searches with Magellan, your queries can be English-like and free-form. For example, I looked for references to "optical or laser storage systems," and I found 146 files with three exact matches in 10.75 seconds.

Once you've selected a file, Magellan determines from its data structure which application program generated it and then calls up an appropriate viewer. The viewer shows the contents of the file in native mode (i.e., as it would appear inside the host application).

Magellan is fast enough that the view window fills almost instantaneously after the filename is highlighted, so you can really use the program to browse through your hard disk, file by file.

Using arrow keys, you can also enter the view window, scroll around inside the file, and copy sections to other files. Or, if you wish, you can launch into the application directly from the view window.

Like most shell programs, Magellan gets around the notorious inadequacies of DOS in file handling and file information presentation. You can gather files into groups, regardless of their paths, based on criteria like subject matter (via searches) or filename and extension (including logical NOT, useful for excluding irrelevant files), and you can display them by group or in a tree diagram. You can sort file groups very quickly by name and/or extension, date/time stamp, size, and so on.

I found both the file viewer and the index with fuzzy searching to be powerful and clever, but I do have some criticisms.

After years of performing text searches, I missed the specificity of exact matches. Often, my goal is not to gather loosely related information but to find a specific citation. My biggest complaint is with the speed of travel within view windows. The index helped me find files quickly, but having done so, locating matches within a file was a lot slower.

In all fairness, I must confess a tough precondition: I try to use every software package I evaluate without first reading the manual. Although Magellan uses conventions made familiar by Lotus 1-2-3, like highlighted options and first-letter or cursor selection of actions, I sometimes got lost in the program. Like any sophisticated product, Magellan has features and power not immediately apparent, but there were also basic functions I couldn't figure out without consulting the manual.

My biggest question about Magellan is that I'm not sure if finding files on a hard disk is as big a problem as Lotus would have you believe—especially because to solve this problem, you have to employ a new and different file management system that, for all its strengths, also introduces its own set of limitations. The basic directory/subdirectory organization has come in for criticism mostly from software companies trying to sell DOS enhancements.

Finally, your most important decision factor before buying Magellan is whether you use the applications that it now supports: Nonsupported data types can't necesarily be

continued

THE FACTS

Magellan
$139 until June 30;
$195 thereafter

Requirements:
IBM PC or compatible
with 512K bytes
of RAM, DOS 2.1
or higher, and
a hard disk drive.

Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
Inquiry 1025.

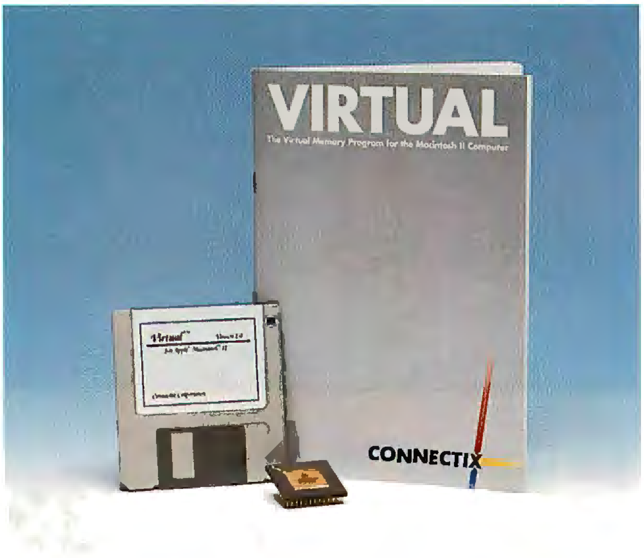
viewed, nor can their host applications be launched, from within Magellan. Applications that the program currently supports include Lotus 1-2-3, Symphony, Manuscript, Agenda, WordPerfect, DisplayWrite, dBASE, Word, WordStar, and MultiMate. You can also view ASCII files.

Although Lotus is confident that viewers will be developed for other applications, this will depend on whether Magellan becomes a market standard. Until that happens, only users of the most popular programs will enjoy the full power of Magellan.

—Andrew Reinhardt

More Mac RAM for Less

One of the great dilemmas Macintosh II users face this year is whether to spend their hard-earned dollars on additional RAM for their systems (to run the new generation of memory-hungry applications on the market) or on a new hardware peripheral. Beyond 2 megabytes, you must add RAM in 4-megabyte increments. At the stratospheric price of $1999 per increment, it's enough to make you consider buying a large hard disk drive or a tape backup unit instead.



Connectix now offers hope in the form of real virtual memory (where sections of code are swapped as needed from limited memory to and from a hard disk) for the Mac II with its appropriately named **Virtual**. Virtual implements 8 megabytes of demand-paged virtual memory using a software INIT, 2 megabytes of physical RAM, the Motorola 68851 paged-memory-management-unit (PMMU) chip, and an 8-megabyte contiguous region on your hard disk. Since the 24-bit addressing scheme of the current Mac operating system limits you to 16 megabytes (with half of that dedicated to ROM, I/O, and slots), you can obtain a maximum of only 8 megabytes of memory, virtual or otherwise.

Virtual works by using the PMMU chip to determine when a chunk of memory—called a page—should be swapped from disk into memory. In combination with the PMMU chip, a pseudo least-recently-used algorithm decides what part of RAM has had the least amount of activity and swaps that page out of the disk to make room for the page being loaded in. Naturally, the more physical memory you have, the better your system's performance will be, since less time is spent swapping pages to the hard disk. If you've spent your cash on a high-speed hard disk drive, you'll also be rewarded with a more responsive machine.

You may notice a delay and some hard disk activity when you pull down a menu or click on a tool icon as the memory holding that piece of code loads into RAM and executes. This type of delay becomes particularly noticeable when you have many applications running under MultiFinder.

For this reason, Virtual is well suited for use with MultiFinder: The foreground application gets most of its code swapped into RAM, while all the background applications get their code swapped to disk. When you select a background application to work with, thus making it the foreground application, its code gets swapped back in as you use it.

Nevertheless, Virtual has its limits. If you're working with huge sets of data or have many large applications running, Virtual can get in a situation called *thrashing*, where it spends more time swapping pages to and from disk than executing code. The only solution to this problem is to use smaller data sets, run fewer applications, or (ouch!) buy more RAM. Also, Virtual might not work with NuBus boards or certain SCSI peripherals that write directly to RAM, thus bypassing the virtual memory system.

Virtual comes in two versions. The first one costs $695 and supplies the PMMU chip and the software INIT. For those who already have a PMMU chip installed, there's a software-only version for $295.

I installed Virtual on a Mac II equipped with a 40-megabyte internal Apple hard disk drive, 2 megabytes of RAM, and SuperMac's Spectrum/24 video board and 19-inch monitor. The chatty 34-page manual has plenty of information on how Virtual works, tips for using it with MultiFinder, a troubleshooting guide, and four photos that show exactly how to remove the hardware-memory-mapper-unit chip inside the computer and replace it with the PMMU chip. After that, it's just a matter of dragging the INIT to the start-up disk's System Folder and restarting the Mac.

I used my typical day-to-day mix of applications with Virtual: the MindWrite 2.1 word processor, Think C 3.0, ResEdit 2.1, PixelPaint 1.0, MasterJuggler, Mathematica 1.1, and the usual army of utilities and INITs. Unfortunately, Virtual 1.0 gave me intermittent crashes, and it hung if I tried using an external SuperMac 150-megabyte DataFrame hard disk drive as the start-up disk. It did work with

continued

THE FACTS

Virtual
with PMMU, $695;
software only, $295

Requirements:
Mac II with 2 megabytes of RAM and a hard disk drive running System 6.0.2/Finder 6.1 or higher.

Connectix
125 Constitution Dr.
Menlo Park, CA 94025
(415) 324-0727
Inquiry 1026.

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3. Readable Assembly Language Output: The compiler generates assembly language code *with your C language source code embedded as comments*, so you can see each statement's compiled output.

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6. Register Optimization: Ten registers are reserved for your register variables, and there's an option to automatically declare all stack variables as *register*, so you can instantly optimize programs that were written without registers in mind.

7. C Library Source: An extensive C library containing over 47 C functions is provided in source form.

8. No Limitations: No matter how large your program is, **CrossCode C** will compile it. There are no limits on the number of symbols in your program, the size of your input file, or the size of a C function.

9. 68030 Support: If you're using the 68030, **CrossCode C** will use its extra instructions and addressing modes.

10. Floating Point Support: If you're using the 68881, the compiler performs floating point operations through the coprocessor, and floating point register variables are stored in 68881 registers.

11. Position Independence: Both position independent code and data can be generated if needed.

12. ANSI Standards: CrossCode C tracks the ANSI C standard, so *your* code will always be standard, too.

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CrossCode C comes with an assembler, a linker, and a tool to help you prepare your object code for transmission to PROM programmers and emulators. And there's another special tool that gives you symbolic debugging support by helping you to prepare symbol tables for virtually all types of emulators.

CrossCode C is available under MS-DOS for just $1595, and it runs on all IBM PCs and compatibles (640K memory and hard disk are required). Also available under UNIX, XENIX, and VMS.

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(ask for extension **2001**)

Outside the United States, please dial

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

SOFTWARE DEVELOPMENT SYSTEMS, INC.
DEPARTMENT 21
4248 BELLE AIRE LANE
DOWNERS GROVE, ILLINOIS 60515 USA

an external Rodime Model 140 Plus 140-megabyte hard disk drive using the 2.10 driver. A call to technical support at Connectix got me the latest version (1.03) of the INIT: We linked our Macs by modem and used the XMODEM protocol to transmit the new INIT to me.

Since then, Virtual has been solid and reliable. I've managed to hang the machine only once, and it took a lot of effort. Avalon Development's PhotoMac application also causes Virtual to hang. Connectix is aware of the problem. Be sure to check with Connectix to see that your hard disk drive and applications are compatible with Virtual.

Nevertheless, it's nice to cut and paste graphics from Mathematica (which uses 2.5 megabytes) to PixelPaint (using 2 megabytes) on a Mac II with only 2 megabytes of physical RAM. I've run a Howtek Scanmaster color scanner on the system with no problems. MultiFinder really sings when you have enough RAM to load a lot of applications, and the background printing is nice once you can make use of it.

Virtual's price is attractive, considering what you'd have to spend to get the equivalent physical memory ($3998). If you're lacking a PMMU chip in your Mac II system, *it's a* good way to get one, particularly with Apple's own 32-bit operating system and virtual memory implementation due sometime this year. If your work demands acres of RAM, but you're short of both memory and cash, Virtual provides a cost-effective alternative.

—Tom Thompson

Turn Your Compaq into a LAN Server with Gigabytes

Modern applications like LANs, multiuser environments, and very large databases require fast, heavy-duty hard disk storage. Previously, Compaq owners were limited to using only one large hard disk drive. But, with the **Compaq Fixed Disk Drive Expansion Unit**, you can have up to 1.2 gigabytes of on-line hard disk storage.

Compaq Fi[illegible]ed Disk Drive Expansion Un[illegible]
$6999; second 300-megabyte hard d[illegible]

Compaq Deskpro 28[illegible] or 386 computer, Compaq's version of MS-DOS 3.3 [illegible] high[illegible] and one full-le[illegible]

The Expansion Unit is an external hard disk system for Compaq computers. It features one or two 300-megabyte hard disk drives, an ESDI hard disk drive controller card, a case with a built-in power supply, a 4-foot connecting cable, and software. You can also install two Expansion Units in one system.

The two drives in my review unit were MiniScribe 9380Es. This 5¼-inch full-height drive has a very fast 16-microsecond access time and a 1-to-1 interleave. Coupled with the 16K-byte forward-reading buffer on the controller card, Compaq says, the system has a data transfer rate of 10 megabits per second.

I tested the Expansion Unit with a Compaq Deskpro 386/20e and found that it's easy to install. First, I had to remove the existing hard disk drives in my system, since the ESDI drives can't coexist with other types of hard disk drives and controller cards. Next, I plugged the ESDI controller card into a 16-bit slot. A cable connects the system with the external Expansion Unit. The Unit's size is 14½ by 6⅔ by 16½ inches, and it resembles the Deskpro computers.

Compaq recommends using its version of DOS 3.3. The Expansion Unit comes with a disk of utility programs, including replacements for the standard FORMAT and FDISK DOS programs and a CACHE program to create a hard disk cache in system RAM or expanded memory.

One interesting feature is that the drives are not limited to the 32-megabyte partition imposed by DOS. With the EXTDISK.SYS device driver program on the utility disk, you can partition each 300-megabyte drive as one logical drive. Thus, you can have files as large as the total capacity of the drive.

When used on a LAN, you can configure the system to provide disk mirroring or disk duplexing. Disk mirroring, using one controller card and two identical drives, creates two drives with identical files. Disk duplexing, using two controller cards and two disk drives, improves the performance. The LAN with disk duplexing can service two read requests by accessing the drive that can perform the read operation faster.

Who needs all this storage space, and who's going to pay over $13,000 to get it? Someone who needs a file server on a LAN, most likely. Compaq even throws in the software for using the unit with the Novell LAN system. At first glance, the Expansion Unit appears to be a very expensive peripheral, but combined with a fast 80386-based system, it's the type of hardware that dreams are made of.

—Stan Wszola

MultiBoot Brings OS/2 Back to Earth

When I installed IBM's OS/2 1.1 on my system, little did I know that I was in for a rude surprise. The dual-boot feature that had been in the Software Development Kit versions of OS/2 and had let me boot either DOS or OS/2 at start-up was gone. But thankfully, Bolt Systems has come to the rescue with a program called **MultiBoot**, which does away with the dual-boot prob-

continued

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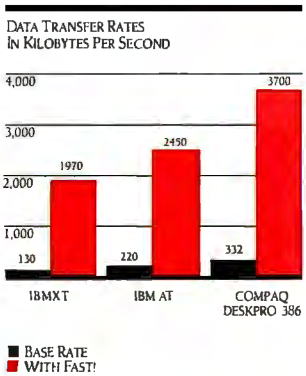

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Circle 112 on Reader Service Card (DEALERS: 113)

THE FACTS

MultiBoot
$49.95

Requirements:
An 80286- or 80386-based IBM PC, PS/2, or compatible with OS/2 Standard Edition 1.1 or higher, DOS 3.0 or higher, and a hard disk drive.

Bolt Systems, Inc.
4340 East-West Hwy.
Bethesda, MD 20814
(301) 656-7133
Inquiry 1028.

lem for good. Now that it's installed in my system, I can boot either operating system from my hard disk. [Editor's note: *For more on MultiBoot, see Mark Minasi's OS/2 Notebook in this issue.*]

Sure, OS/2 does have the compatibility box, which ostensibly lets me run DOS applications from within OS/2. But I've found that some DOS programs just don't run correctly in the box, and others slow down appreciably. Furthermore, I was chagrined to find that in order to start my system in DOS, I'd need to create a DOS start-up disk, on a floppy disk no less. It took me nearly an hour to make up the disk and get DOS back up on my screen.

MultiBoot, on the other hand, automates the process of booting under either OS/2 or DOS. The reason dual booting is possible at all is the result of the different ways DOS and OS/2 start up. When you start DOS, it looks for a file called IBMBIO.COM, which must be the first file in your directory and start in the first sector of the hard disk. OS/2 also looks for a file called IBMBIO.COM, but it doesn't care where it's located on the disk (as long as it's contiguous).

Since both DOS and OS/2 look for different system files that would otherwise have the same name, as well as for AUTOEXEC.BAT and CONFIG.SYS files, setting up a dual-boot option involves modifying one of the systems so that different names can be used for each operating system's critical files. Then both OS/2 and DOS files can be copied to the same hard disk. This is exactly what MultiBoot does.

Installation is easy. You need a floppy disk–based DOS boot disk, but I already had one. I booted my system under DOS from the floppy disk, ran a preinstallation program that automatically modified the OS/2 system files, and then ran the actual installation, specifying that I wanted DOS as my default start-up operating system.

That's all there was to it. When I rebooted my system, MultiBoot (which was appended to both my DOS and OS/2 boot records during installation) took initial control. If I don't take any further action, MultiBoot starts up DOS. But if I want to start up OS/2, all I need to do is press the Caps Lock key within 4 seconds.

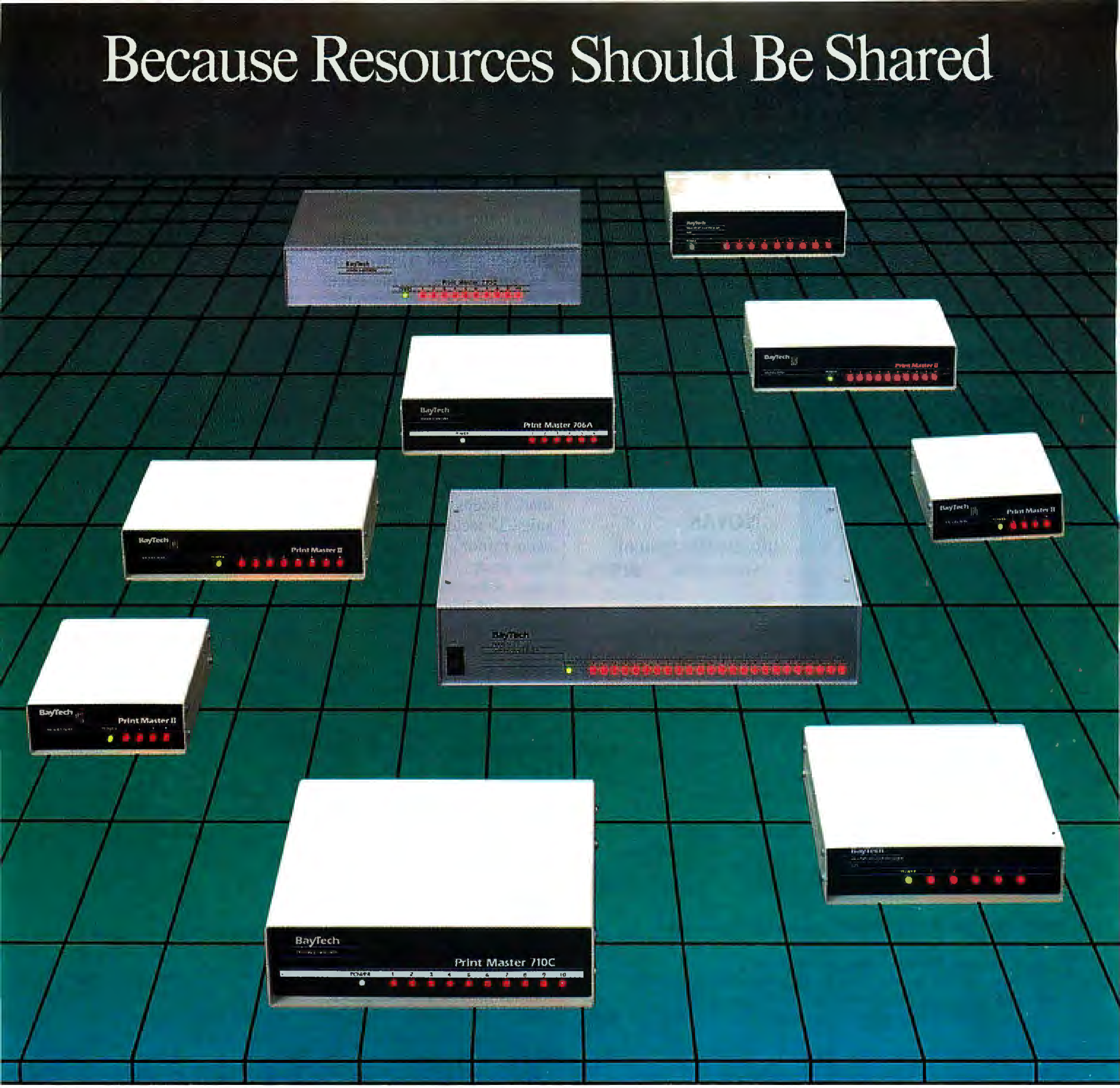
MultiBoot is simple, inexpensive, and foolproof, and it works flawlessly. It's a good example of a utility that fills a much-needed niche.

—Stan Miastkowski

Disk Technician Advanced Keeps Disks Virile

The weak link in any microcomputer is the one you depend on for so much, your hard disk drive. Because it's an electromechanical device and works with tiny tolerances, a hard disk drive does wear. Platters warp, heads get out of alignment, and the repeated stresses and strains of on/off cycling take their toll.

continued



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Circle 39 on Reader Service Card (DEALERS: 40)

Although many programs claim to fix ailing hard disk drives, they all work on problems *after* they occur. Prime Solutions' **Disk Technician Advanced** (DTA), the latest incarnation of a program that has been around for a few years, is an entirely different animal. It takes the unique approach of predicting problems and taking steps to avoid them.

DTA is designed to be run every day. Its approach is to repeatedly and thoroughly test the entire drive. But more than that, it keeps a record of its results. If sectors start to show even minor, seemingly random errors, DTA moves the data, low-level formats the area, tests it again, and moves the data back. If enough soft (random) errors show up, the sectors eventually get locked out. And it's all done automatically.

If you tell it to, DTA also optimizes the interleave of your hard disk drive. I've found that many hard disk drives have interleaves that are too high. DTA tests the disk for optimum interleave and changes it on the fly. This can result in increased performance.

DTA performs three levels of testing: daily, weekly, and monthly. Each level of testing is more rigorous and requires more time. On a 30-megabyte drive, a daily test takes about 5 minutes, a weekly test 1½ hours, and the exhaustive monthly test almost 4 hours.

THE

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Over a three-month period, I ran DTA on five different machines. Two of the machines had identical 32-megabyte hard disk drives, and the remaining three used a variety of different drives with capacities ranging from 20 megabytes to 64 megabytes. It's surprising to see how similar drives can behave very differently when they're subjected to regular testing. DTA hasn't found a single problem with one of the 32-megabyte drives, while the other one has numerous soft and hard errors.

I also tried to trick DTA by using a run-length-limited controller with a hard disk drive that isn't rated for the 26 sectors of the RLL controller. So instead of the 20 megabytes that the disk was designed to handle, it was formatted for 30 megabytes. This situation, which I don't suggest you try, put DTA to the supreme test, and it passed with flying colors. Nearly every time it runs, DTA finds soft errors. It's kept itself very busy moving data around and reformatting sectors. And the drive continues to work just fine.

You can run DTA from either your hard disk or the floppy disk. I found that running it from a floppy disk, though less convenient, does make more sense since the program also keeps a record of your disk's FAT (file allocation table), enabling it to recover data after a drive crash. DTA also comes with a resident automatic head-parking utility that consumes a paltry 700 bytes of RAM.

Early versions of the original Disk Technician occasionally had their problems, but DTA is now a mature, reliable, and versatile product. It works with virtually all hard disk drives and controllers, and it isn't copy-protected. At first glance, I thought that its $189.95 price tag was very high. But the more I use it, the more I realize that it's a true bargain—a veritable fountain of youth for your hard disk drives.

—*Stan Miastkowski* ■

MAPPLICATIONS ■ Sean O'Sullivan

DESKTOP MAPPING ENTERS THE MAINSTREAM

Fortune 500 companies are playing *visual "what-if"* with their databases

Database Information Merged With Maps *MapInfo is the only software designed to directly tie dBASE files with maps. The parcels shown here were auto-matically shaded based on the data about each. A window is displayed that reveals the actual data behind a particular parcel.*

When The Wall Street Journal, Forbes magazine, Business Week and Financial News Network start covering a new type of software, it's a good indication of the potential for mainstream business use. That is what has happened to MapInfo Corp.'s MapInfo desktop mapping software — and in just over a year's time.

Part of the cause for the groundswelling interest in MapInfo is the recent estimates that 80 percent of business organizations with PC's can benefit from this new tool, once they discover its capabilities. In fact, MapInfo is being used in over 100 different applications by corporations, governments, and utilities. Here are some examples:

■ Fortune 500 companies are using MapInfo, and for many different purposes. They are displaying information about existing customers, prospects, and market demographics on a variety of street, regional, national or world computer maps. Some, with thousands of outlets or branches nationwide, are using MapInfo to optimize allocation of resources. Others are plotting their delivery sites on computer maps with MapInfo to help with routing and dispatch.

Find Addresses *MapInfo Corp.'s street maps come with every address already in place, accurate to the correct block and side of street. Simply type an address and MapInfo locates it for you. Or, automatically plot existing data on the map for "what-if" analyses.*

■ Government is using MapInfo in a big way, from federal applications right down to the local level. In fact, cities and towns across the nation are using MapInfo's computer map of their municipalities to monitor highway maintenance, store zoning information for land use, maintain accurate tax parcel maps for proper assessment, and establish efficient snow and garbage removal patterns. And their police, fire, and emergency services also picked up quickly on the power of MapInfo for speeding the delivery of their services, as well as making them more efficient, and adding a whole new trend analysis capability.

■ Utilities, including telephone, cable, electric and gas, are finding MapInfo to be an indispensable tool. MapInfo lets them draw their networks onto existing computer street maps and plot all existing customers and prospects to help with route planning, new installations, maintenance and overall facilities management.

Since every address is already in MapInfo's metro street maps—to the correct block and side of street—anyone can use MapInfo to instantly find the location of specific addresses, or to plot the locations of records in existing databases. Moreover, with MapInfo's capabilities, anyone can play a visual "what if," for everything from planning their reseller networks, sales territories, distribution routes, promotional campaigns, resource allocation, and so forth.

> ***"80 percent of business organizations with PC's can benefit from this new tool ..."***

That's just a small sampling. MapInfo Corp. has set up a toll-free hot line to answer questions about your applications. For more information write to MapInfo at 200 Broadway, Troy, NY 12180, or call 518-274-8673, or 1-800-FASTMAP toll free.

Surge.

And finally, the T5200, which has enough power to replace virtually any desktop PC.

But we haven't just concentrated on power and portability. We've also constantly looked for ways to make our machines more durable, more reliable, and easier to use—down to the 800 number our customers can call for help with any technical question that might come up.

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

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FIRST IMPRESSIONS ■ Nick Baran

Two Powerful Systems from Sun

Thanks to a high-speed SPARC processor and a 68030 CPU, two externally identical new workstations from Sun offer workstation performance at PC prices

There has been much discussion about the blurring distinction between high-performance personal computers and low-end workstations. Indeed, this phenomenon is no longer a matter of conjecture and speculation; now, it's a reality. In recent months, there has been a flurry of new product announcements from traditional minicomputer and workstation vendors offering powerful, Unix-based machines for under $10,000. Among the most competitive and important introductions are two new workstation product lines from Sun Microsystems.

The first of these is the Sun's new SPARCStation 1. It is one of the first systems based on Sun's high-performance SPARC chip. SPARC stands for Scalable Processor Architecture, which is the Sun version of RISC architecture. The SPARCStation is said to perform at a rate of 12 million instructions per second (MIPS), yet it is priced at $10,000.

Next, I'll look at the new Sun-3/80, a 3-MIPS machine using the Motorola 68030, with base prices starting at around $5000. These two machines represent the entry-level systems of each of the new product lines.

An important, but optional, component of these new machines is a unique graphics accelerator, called the GX, which I will also describe in this article.

The product lines also include high-end members such as the Sun-3/400, a 33-MHz 68030 machine priced at around $35,000, and the SPARCStation 300, which has a 25-MHz SPARC processor and starts at about $25,000. I will not cover these higher-end machines in this article, although it should be pointed out that these machines offer full binary compatibility with their entry-level counterparts.

At first glance, the Sun-3/80 and SPARCStation 1 stack up favorably against comparably priced personal computers, such as the Mac II, the IBM PS/2 Model 80, and even the NeXT computer. However, these new machines are still very much traditional Unix workstations, and there is no interface "layer" insulating the user from the Unix operating system. In other words, there is no slick graphical interface such as NextStep or the Macintosh interface, although there are development tools for creating such interfaces. But the bottom line is that you have to know Unix to use these machines and you have to rely on individual applications developers to provide a friendly interface. Sun says this will change, but as of this writing, if you buy one of these workstations, be prepared to learn Unix.

Another thing about Sun workstations is that you can't just hop down to ComputerLand and buy one. They are distributed through direct sales and value-added resellers. Your local newsstand will probably not feature magazines advertising software for Sun workstations. You need to get Sun's huge Catalyst catalog; with it, you can order software directly from the vendors. Nevertheless, these are machines that deserve serious consideration for serious work. They provide excellent graphics, high performance, and a substantial software base.

From the Outside Looking In

Externally, the SPARCStation 1 and the Sun-3/80 are identical machines (see photo 1). The system unit for each is a sleek 16- by 16-inch package, only 2½ inches high, designed by Frog Design, which is also responsible for the NeXT computer's external design. It features a universal 85-watt power supply and bays for one 1.44-megabyte 3½-inch floppy disk drive and two 100-megabyte 3½-inch hard disk drives. The 100-megabyte drives have an average access time of 23 milliseconds and throughput of about 1.2 megabytes per second. An optional expansion box is also available that can store a 327-megabyte 5¼-inch hard disk drive as well as a 150-megabyte tape backup unit.

Both the 3/80 and the SPARCStation come with an optical mouse and an IBM PC AT–compatible keyboard (called the Type 4 keyboard), which has been standard on the 80386-based Sun386i, introduced last year (July 1988 BYTE). This keyboard is now standard on the entire Sun product line.

A variety of monitors are available with the systems. They range from 17- and 19-inch monochrome and gray-scale monitors to 16- and 19-inch 8-bit color monitors, all with 1152- by 900-pixel resolution.

The rest of the machine resides on an 8½- by 11-inch logic board. It is on the logic board where the similarity ends between the Sun-3/80 and the SPARCStation 1 (see photo 2).

continued

Photo 1: *The SPARCStation 1 and Sun-3/80 (inset). The exterior appearance and form factor are identical. The footprint is 16 by 16 inches. The SPARCStation 1 is shown with the new 17-inch monochrome display.*

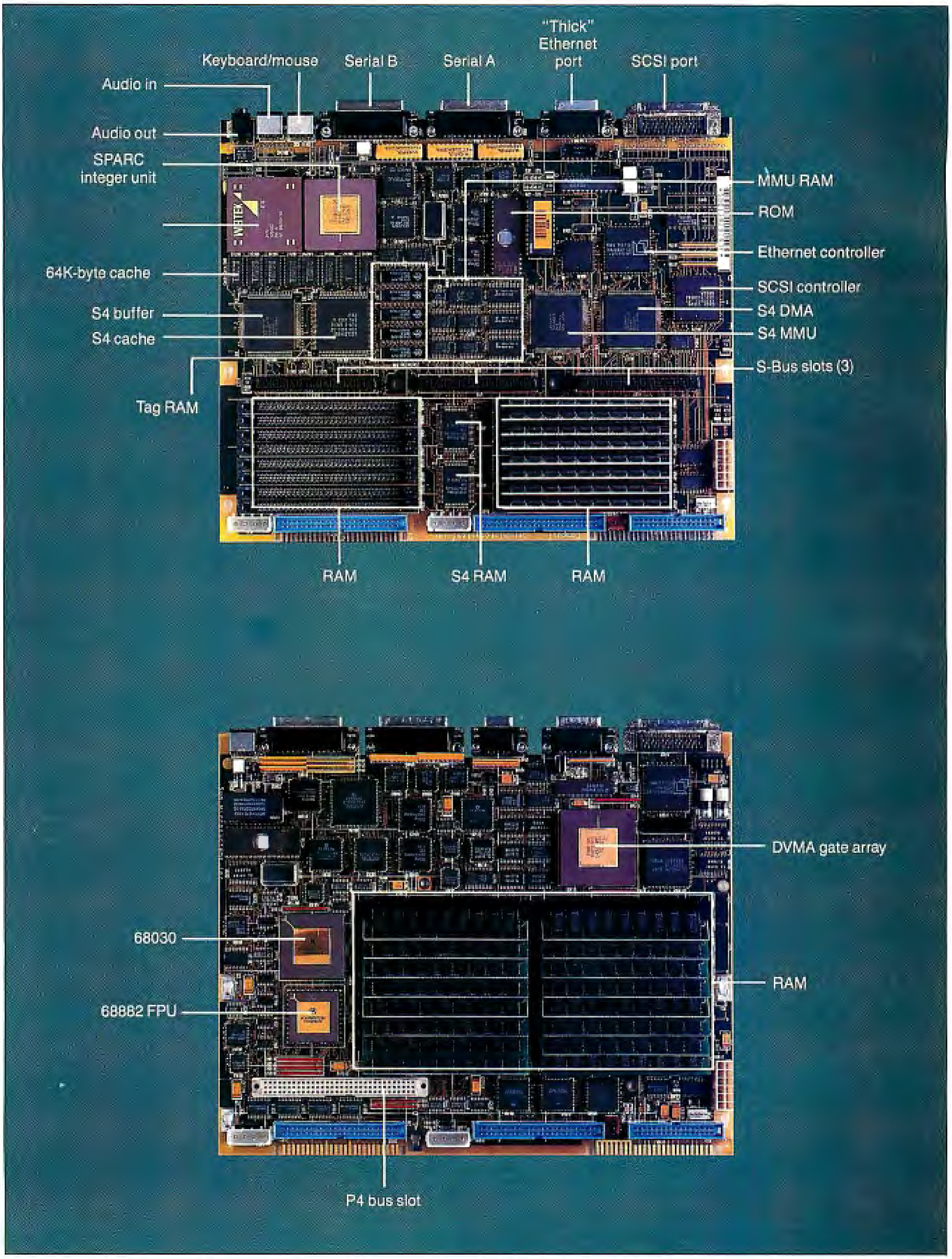


Photo 2: *The logic boards for* **(a)** *the SPARCStation 1 and* **(b)** *the Sun-3/80. The SPARCStation board has three S-Bus expansion slots, versus the single P4 bus slot on the 3/80 logic board. Note the S4 DMA controller, which controls the DMA of the SCSI, Ethernet, and serial ports to the S-Bus. The SPARCStation board also features a 20-MHz SPARC CPU and custom FPU. The 3/80 features the 20-MHz 68030 and 68882 FPU.*

The SPARCStation 1

The SPARCStation features a SPARC CPU with a clock speed of 20 MHz. A block diagram of the SPARCStation logic board is shown in figure 1. The machine comes standard with an FPU that offers performance of about 1.5 million floating-point operations per second (MFLOPS), which is about 10 times the performance of the Motorola 68882 FPU used in the Mac II, the NeXT computer, and the Sun-3/80.

The SPARCStation comes with 4 megabytes of RAM and is expandable to 16 megabytes. The system board currently uses 1-megabit single in-line memory modules, but it will accept 4-megabit SIMMs when they become available.

The logic board includes two serial ports, one Ethernet port, one SCSI port, and three expansion slots controlled by a new proprietary bus called the S-Bus.

The S-Bus is one of the most interesting features of the SPARCStation. It is a synchronous 32-bit bus that operates at the clock speed of the host CPU (20 MHz, in this case) and features direct memory access capability, allowing the CPU to offload much of the I/O processing to the separate DMA channels on the S-Bus.

The S-Bus is more than just an expansion-slot bus. It includes separate channels for the SCSI, Ethernet, and serial ports, which all have DMA and direct virtual memory access (DVMA) through the S-Bus. The CPU has access to a 64K-byte cache memory, allowing it to operate at full speed during most I/O operations. A six-chip VLSI chip set controls the cache, memory management, DMA and DVMA, the clock, the keyboard, and the mouse, as well as access to the peripheral ports (SCSI, Ethernet, and serial).

The S-Bus expansion slot connectors are used primarily for video cards, frame buffers, and graphics accelerators, and possibly for a second Ethernet card. Add-in boards are 5 by 4 inches and can be either single- or double-sided. It should be noted that the S-Bus is a multiple master bus. This means that, in addition to the CPU, the S-Bus expansion cards (e.g., an Ethernet controller) can temporarily take control of the bus for faster processing. The three-slot S-Bus on the SPARCStation has two master slots and one slave slot.

The S-Bus can operate at burst data transfer rates of about 60 megabytes per second, which is several times faster than the VME bus used on other Sun workstations and on many Unix-based workstations from other vendors.

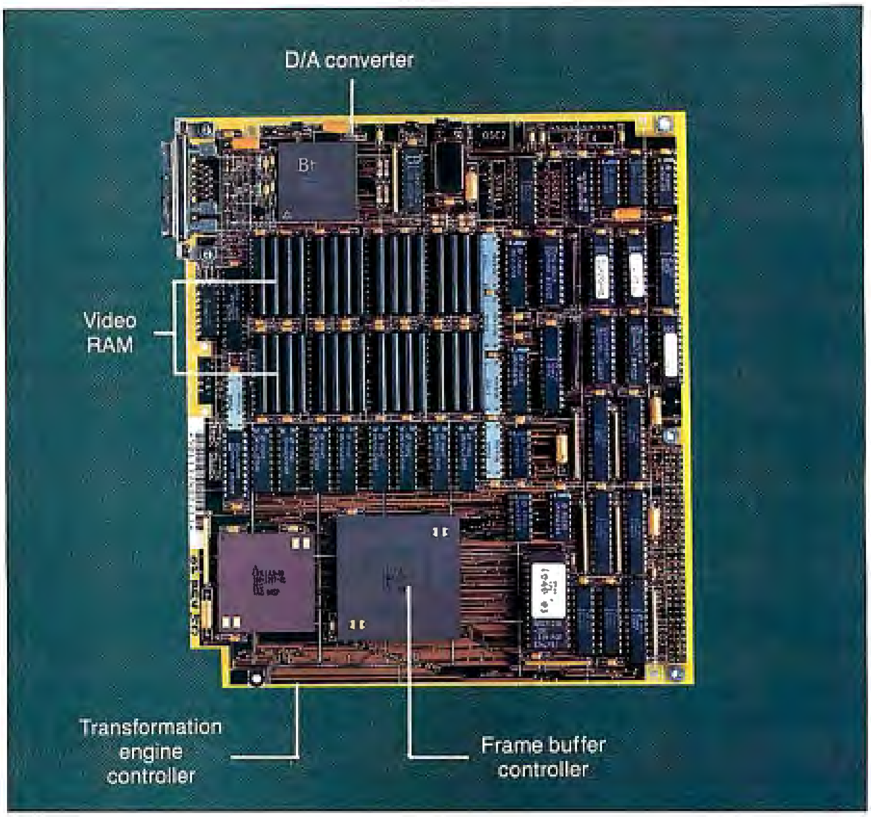


Photo 3: *The GX graphics accelerator card. Note the two gate arrays on the lower left side of the board. The left chip is the coordinate transformation engine. The right one is the frame buffer controller.*

The S-Bus is currently available only on the SPARCStation 1, but it will become the standard bus on future Sun machines (however, higher-end machines will continue to offer VME slots in addition to Sun's proprietary bus architecture).

The SPARCStation includes a single-channel audio interface chip and an internal speaker as well as a jack for connecting to external speakers. The system software, which is discussed later in the article, includes a Sound Tool which can handle 8000 8-bit samples per second. However, the audio capabilities of the SPARCStation are fairly minimal when compared to either the Apple Sound Chip or the sound capabilities of the NeXT computer. Graphics and numeric processing are the real strong points of the SPARCStation.

The Sun-3/80

The Sun-3/80 is the successor to the popular Sun-3/50 and -3/60 workstations. Although SPARC may be Sun's architecture for the future, the company is not about to abandon its large Motorola user base. Motorola-based machines still account for over 60 percent of Sun's revenues, and there is a large investment in Sun-3 software. So, rather than neglect its Motorola line, Sun has greatly improved it by stepping up to the Motorola 68030 processor.

The Sun-3/80 features a 20-MHz 68030 and a standard 68882 FPU. The 3/80 uses the same single-slot, proprietary 32-bit asynchronous bus as the earlier Sun-3 models. This bus, called the P4 bus, also provides high performance like the S-Bus, but it does not include the DMA or multiple master capabilities of the S-Bus.

Sun is sticking with the P4 on its Motorola line and also on its higher-end SPARC machines simply to provide compatibility with the earlier models (in other words, users can upgrade to these new machines and still use their old frame buffer cards).

The Sun-3/80 comes standard with 4 megabytes of RAM (made up of 1-megabit SIMMs) and is expandable to 16 megabytes. The logic board has two serial ports, one parallel port, one Ethernet port, and one SCSI port. The machine does not have audio capability.

Basically, the Sun-3/80 is a Sun-3/60

continued

in a much smaller and more elegant package (the 3/60 had a 21- by 17-inch footprint compared to the 16- by 16-inch footprint of the 3/80). The Sun-3/80 also offers a modest 10 percent to 15 percent performance increase over its 68020-based predecessors.

Graphics Is the Key

Sun offers a wide range of graphics options for its workstations, ranging from a basic monochrome frame buffer to an expensive and sophisticated 32-bit graphics accelerator with Z-buffering for three-dimensional applications. The low-end workstations are usually equipped with monochrome or color frame buffers (8-bit or 24-bit color) or with the new GX 8-bit color or gray-scale graphics accelerator board.

The new GX graphics accelerator deserves some special attention because the board represents some innovative engineering. The GX board (see photo 3) features two custom gate arrays that provide a two- and three-dimensional coordinate transformation engine and a frame buffer controller. The transformation engine performs matrix mathematics at high speed for coordinate translation and rotation, scaling, and pan and zoom. It also controls a 32- by 32-pixel hardware cursor that eliminates the cursor overlay plane in memory, used in most conventional frame buffers. Results from the coordinate transformation engine are sent directly to the frame buffer controller, which performs antialiasing, raster operations, clipping, and bit-blt operations. The board has 1 megabyte of video RAM, which interfaces through the D/A converter to the 1-megapixel display.

According to Sun engineers, the performance of the GX board depends entirely on the processing power of the host CPU and FPU. The GX can execute coordinate transformations up to a theoretical performance limit of 51 MFLOPS. It has been benchmarked at about 15 MFLOPS when running with a Motorola 68020, according to Sun engineers.

But you have to see the GX in action to appreciate its performance. In a demonstration on a Sun-3/60, the GX showed blazing speed in everything from text scrolling to pan and zoom on highly complex circuit diagrams. Sun claims that the GX offers up to 50 times the performance of conventional frame buffers.

The GX board fits in either the Sun-3/80 or SPARCStation 1 (P4 or S-Bus configurations). In the SPARCStation, the GX board takes up two expansion slots. The GX board is ideal for two- and three-dimensional drafting and wire-frame work and would also be beneficial for desktop publishing work.

The Software

The new Sun workstations all come with the Sun's version of Unix, SunOS version 4.0. SunOS 4.0 features shared libraries, allowing multiple applications to share libraries in memory. Note that this is a feature promised for the NeXT computer but was not functional in the beta release of the NeXT operating system. The system software includes Sun's Network File System and the System Network Administration Program (SNAP), which allows automated file backups and maintenance on the network. An on-line help facility and Desktop Organizer are also included.

On top of SunOS, the system software includes the X11/NeWS windowing system, the X/View developer's toolkit for developing window applications, and the Open Look specification and style guide for designing Open Look–compatible user interfaces. This package is called OpenWindows, and its availability was announced at the Uniforum show in San Francisco in late February. Sun is also offering three applications based on Open Look: SunWrite, SunPaint, and SunDraw.

The OpenWindows package is fine for software developers working on Open Look applications. What is missing, however, is a standard user interface for end users. The customer still has to know how to install and "bring up" Unix on the system. And the end user still has to know how to load applications and how to execute Unix commands from the console. According to one Sun product manager, Sun will soon offer Unix preinstalled on the hard disk with a "plug and play" installation routine so that uninitiated users will be able to start up the system easily.

Having Unix preinstalled on the disk is certainly a step in the right direction. But Sun must recognize that it needs an easy-to-use, graphical user interface if it wants to be successful in the mainstream personal computer market. Engineers and students may have no problem picking up Unix. But less technical users are intimidated by the Unix command language, and with good reason.

The lack of a user interface represents a major deficiency in Sun's overall product offering. We can only hope that Sun rectifies this situation soon. It would be a shame to see such powerful and well-engineered hardware be compromised by the lack of equally well-engineered operating-system software.

Sun offers a wide range of programming languages and compilers, text editors, debuggers, and utilities. A recent addition is the Soft Co-Processor, an MS-DOS-emulation program from Phoenix Technologies, which Sun distributes under the name Dos Windows. In addition, there is indeed an enormous variety of third-party software applications available for SunOS, with everything from advanced scientific and statistical packages to desktop publishing software. While all SunOS applications will run on either the Motorola or SPARC architectures, there is no binary compatibility between the two architectures. Applications must be compiled separately to run on either platform (this compilation, of course, is taken care of by the software developer).

Pricing

At the time of this writing, Sun had not made final decisions on pricing. Price comparison is further complicated by the fact that Sun sells only complete systems; there is no price breakdown by components. I can give some ballpark estimates, however. The SPARCStation 1 will have a base price in the neighborhood of $10,000. If you add a 100-megabyte hard disk drive and a monochrome monitor, the price will be about $12,000. If you add the GX accelerator board, figure a total of about $14,000.

By contrast, the Sun-3/80 starts at around $5000. A color system with a 100-megabyte hard disk drive would cost about $10,000. Add another $2000 or so for the GX accelerator board. Again, these are rough estimates. By the time this article is in print, Sun will have announced more exact pricing.

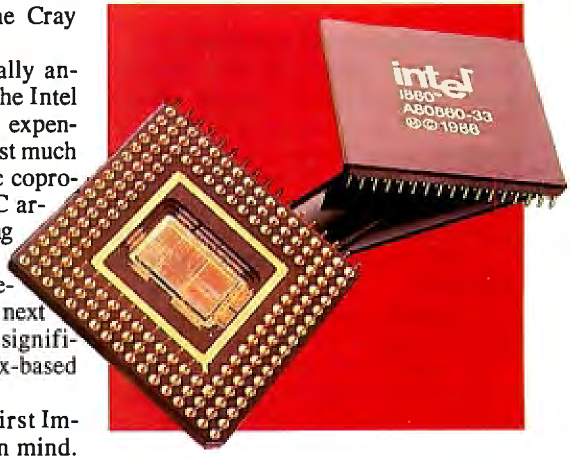
When you put together a complete system, these machines are still well within striking distance of fully configured Mac IIs or IBM PS/2 Model 80s. The NeXT computer comes in substantially cheaper if you stick to the slow optical disk. But none of these machines offers the level of performance or graphics capability available in the SPARCStation 1. The Sun-3/80 equipped with the GX accelerator is also a formidable competitor.

The Sun-3/80 and SPARCStation 1 are impressive machines and will undoubtedly be very successful. The one missing link, however, is a powerful and easy-to-use graphical interface. With the addition of that link, these Sun systems would be hard to beat. ■

Nick Baran is a BYTE senior technical editor based in San Francisco. He can be reached on BIX as "nickbaran."

Intel's Cray-on-a-Chip

Designed as a microprocessor version of the Cray 1, Intel's new high-speed 80860 RISC microprocessor sports an on-chip FPU and a 3-D graphics processor



Last fall, speculation was running rampant about Intel's forthcoming 80486 microprocessor. Rumors circulated that it was a veritable mainframe-on-a-chip—a CPU so powerful that it could serve as the heart of the entire computer industry, from desktop microcomputers to supercomputers. Now it appears that some of those rumors weren't about the 80486 after all, but about another new chip from Intel, the 80860.

The 80860, Intel's first full-scale RISC processor, made its initial appearance in February at the IEEE's International Solid-State Circuits Conference in New York City. Known then only by its code name, "N-10," the chip appeared to be the highlight of the show. Intel's designers described their brainchild as a 64-bit processor containing 1 million transistors. It could run at up to at 50 MHz and could perform at a rate of 105,000 Dhrystones per second—about 13 times faster than the fastest 80386-based system. Moreover, the 80860 included an on-chip FPU that was capable of performing 17 million floating-point operations per second (MFLOPS) and a three-dimensional graphics processor. The designers of the 80860 claimed that it was a one-chip version of the Cray supercomputer.

Two weeks later, Intel officially announced the chip and dubbed it the Intel 80860. The new chip would be expensive, to be sure, but it wouldn't cost much more than a high-speed numeric coprocessor. Although the chip's RISC architecture prevents it from being 8088 compatible, it could become extremely popular nonetheless. When it becomes available next month, the 80860 should have a significant impact on graphics- and Unix-based systems.

When I set out to write this First Impression, I had three questions in mind. Exactly how good is the 80860? Is it really a Cray-on-a-chip? And if it's really that fast, how did it get that way?

YARP?

In some ways, you might tend to dismiss the 80860 as YARP—yet another RISC processor. Several other RISC processors are already available. One of the most popular is the SPARC chip set, which is used in the Sun-4 workstation line and the new Sun SPARCStation 1 (see page 108). Running second in popularity is the MIPS processor, which is the CPU for the Silicon Graphics Personal IRIS workstation (see "Silicon Graphics Brings Down Cost of 3-D Graphics," Microbytes, November 1988, page 16). A third contender, Motorola's 88000, is just beginning to appear in workstations from Opus, Everex, and Data General. A fourth is IBM's own RISC CPU, the processor used in IBM's RT PC. The RISC processor market has become so crowded, in fact, that one chip maker, AMD, has decided to pull its RISC chip, the 29000, out of the competition.

But the 80860 is special in several ways. First, while its more established competitors are actually chip sets, the 80860 is a single chip. The SPARC, for example, uses separate chips for integer math, floating-point math, memory management, and other functions, typically five chips in all. The 88000 improves on that; it has all the math functions on one chip and requires only two extra chips for instruction and data caches. By contrast, Intel designed the 80860 with a million transistors, which allowed the designers to fit everything, including the memory caches, on a single chip. Among other things, this means that the 80860 will take up less space on printed circuit boards or add-in cards, and it should use less power.

But there's another advantage to having everything on a single chip: speed. RISC processors, after all, are purposely designed to run fast. Their instruction sets have been pared down to a bare minimum of simple instructions that can each be performed in a single clock cycle. In the case of very fast processors, however, when memory is on one chip and the processor is on a separate one, the transfer of information from one chip to another cannot keep up with the CPU's internal speed. Faster RAM helps, but there is still a natural speed limit to how fast you can move data around on a printed circuit board. And when you are trying to save

continued

nanoseconds, even the small distances between chips can seem like light-years.

With everything on a single chip, the 80860 sidesteps many of these delays. Once data or instructions are read into the cache through the 64-bit-wide bus, they move around the chip internally on pathways as wide as 128 bits—and at transfer rates that are reportedly more than a billion bits per second. The caches are big enough (4K bytes for instructions, 8K bytes for data) that reasonably large loops (those that have up to 1000 instructions) will fit completely into the cache.

Parallel Processing and Pipelines

Another very sizable part of the 80860's speed comes from its parallel design. The new chip is designed to do three things at once: integer math, floating-point addition, and floating-point multiplication. This is possible because the chip's three math units are separate and can work on different problems at the same time.

In addition, each of the three math units is designed for pipelining. In most CPUs, each math instruction actually consists of a series of smaller, simpler operations. When most CPUs receive an instruction, they take a piece of data and perform each of these smaller operations separately on the data until the instruction is finished. The CPU then begins work on the next instruction and the next piece of data. By contrast, a pipelined system such as the 80860 is like an assembly line, with each of the smaller operations lined up in sequence on the production line.

As soon as the the first piece of data has completed the first stage of the assembly line, the CPU can start work on the second instruction and the second piece of data. Thus, even though an instruction may take dozens of clock cycles to complete, the 80860 can still produce one new result every clock cycle—from *each* of the math units. That means that, at 40 MHz, the 80860 can theoretically produce as many as 120 million results per second.

One problem with pipelining is that it requires that the CPU perform exactly the same operation on the data each time the pipeline is used. In other words, you cannot retool the assembly line. Another problem involves memory. Pipelining works effectively only when there is data in the data cache. This cache feeds the assembly line at much higher speeds than regular memory can.

The 80860's floating-point adder and multiplier can also be linked together for vector operations. Indeed, Intel's designers say the 80860 is specifically modeled after Cray's vector-processing supercomputers. The company also claims that many of the vectorizing programming tools that were originally designed for the Cray will also be able to optimize 80860 software, but because the 80860 isn't limited to a vector register architecture, it is reportedly easier to program.

Graphics: Z-Buffers and Shading

To give the 80860 even more power, Intel filled one small hole in the chip with special three-dimensional graphics hardware. This feature takes up only about one-thirtieth of the chip's area, but it provides special functions like *z*-buffering and Gouraud and Phong shading. Z-buffers store information on the third dimension of each pixel in an image and allow high-speed three-dimensional imaging.

IBM and Intel have already shown an 80860 on a PS/2 graphics card that can probably run rings around most other workstations.

The on-chip graphics processor makes sense for a chip that wants to do the work of a Cray, since a large proportion of supercomputing consists of graphics rendering. In fact, it is in a graphics coprocessor board that the 80860 will probably first appear as a product. IBM and Intel have already shown a PS/2 Micro Channel bus-master card built around the 80860 that can probably let a Model 80 run rings around most other workstations. Unfortunately, neither IBM nor Intel has indicated when the card will be available as a product.

It is easy to conclude that the chip might be confined to graphics workstations, but one Intel engineer pointed out that the company isn't just interested in the traditional workstation market. "We want to sell a lot of chips—a lot more than Sun sells workstations," he said.

The 80860 will go anywhere Intel can find a niche for it. It is designed to work easily in parallel with other 80860s, with existing 80386s, or with the forthcoming 80486s. It can work either as a coprocessor or as part of a multiprocessing system. That means it could work in the whole range of computer applications, from plug-in personal computer cards to minisupercomputers. Indeed, Intel says a minisupercomputer will be in beta test by the end of this year.

In June, a 33-MHz version of the first 80860 will become available. A 40-MHz version will be out by the end of the year, and the 50-MHz version should arrive in 1990. The 33-MHz version will be available in quantity for about $750—roughly as expensive as an 8087 math coprocessor was in 1981. And as more 80860s are produced, the price will begin to drop. Within two or three years, the price of an 80860-based workstation should be well below $10,000.

By then, there should be plenty of software to take advantage of the chip's power. Although the chip cannot directly run DOS or OS/2, it should be a powerful Unix engine. In fact, two separate versions of Unix are currently in the works—one from AT&T (System V release 4, which should be available by the end of the year) and a multiprocessor version from Olivetti. And although the 80860 cannot run OS/2 directly, Intel claims that there are already hooks in OS/2 to use the 80860 as a coprocessor. C, FORTRAN, and Pascal compilers are reportedly already available, along with math libraries for the functions that aren't provided on-chip.

Competition with the 80486?

Although Intel might sound as if it wants the new 80860 to become as ubiquitous as its popular 80x86 family, the new chip is not designed to replace the 80486 or its successors. In fact, the company made a point of saying that the 80486 would be officially announced around the time you read this. The two chips share much of the same technology, but the 80860 is the more ambitious of the two, aiming at supercomputing.

The 80860 is clearly a very exciting chip. Whether that will be enough to grab a big share of the graphics, workstation, and supercomputing market remains to be seen. But as it stands, it's the fastest thing on silicon—and the closest anyone's come yet to a Cray-on-a-chip. ■

Frank Hayes is a BYTE associate news editor based in San Francisco. He can be reached on BIX as "frankhayes."

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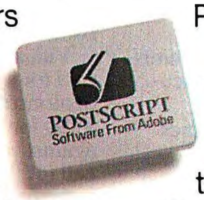

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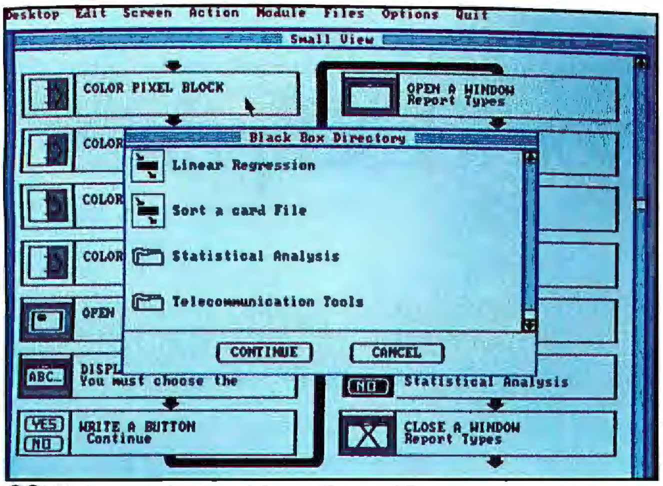

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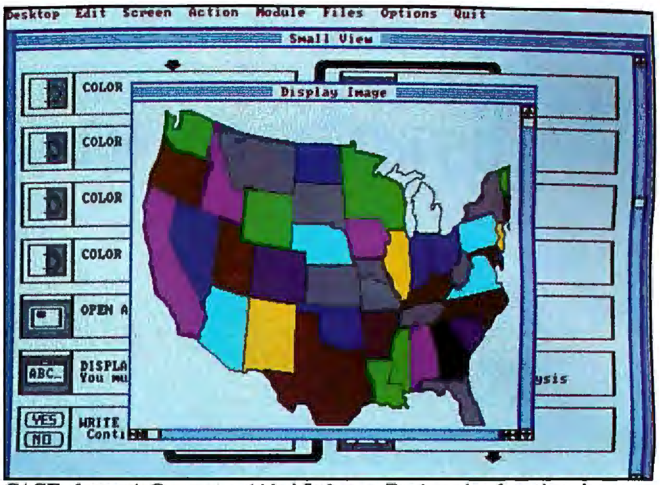

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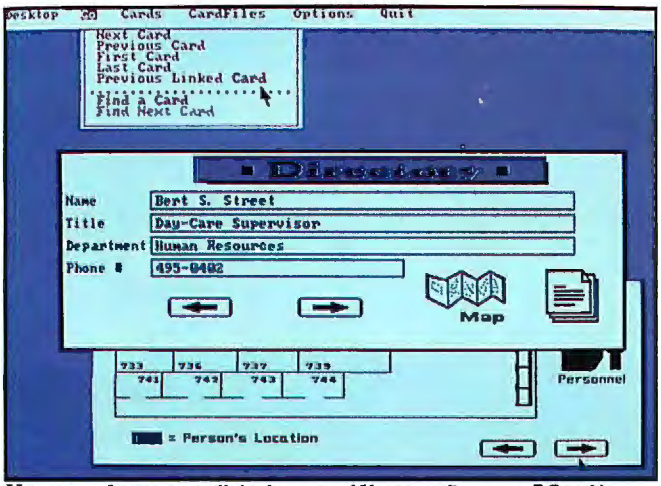

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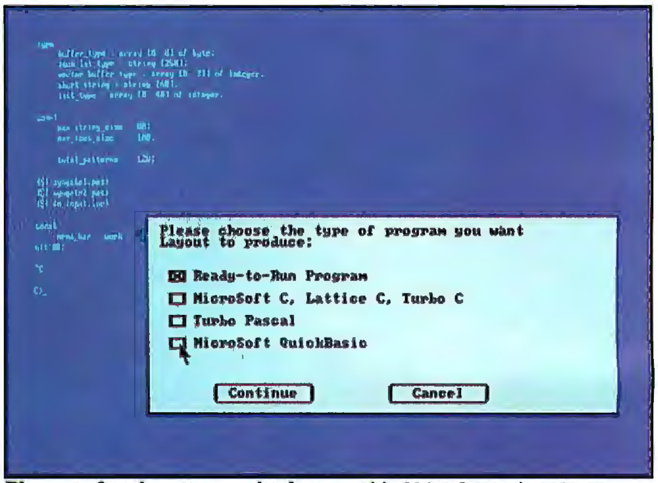

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Apple's New Compact Mac IIx

By chopping the number of expansion slots in half, Apple creates a sleek new version of its top-of-the-line Macintosh

In early March, Apple introduced yet another member of its growing family of Macintosh II computers. This new addition to the family is called the Mac IIcx, and, as you might be able to guess from the name, it is essentially a compact version of the Mac IIx.

It has a footprint of about 12 by 15 inches (see photo 1) and can sit either horizontally on the desktop or a bookcase, or vertically on the floor. The system's smaller size is made possible by having only three NuBus expansion slots instead of the six slots available in the Mac II and IIx.

Although smaller, the new Mac has the same 16-MHz 68030 processor as the Mac IIx and offers exactly the same performance. Additionally, its logic board (see photo 2) has the same circuitry as the IIx. This includes the new 256K-byte single in-line memory module (SIMM) ROM and the FDHD (for "floppy disk high-intensity") internal floppy disk drive controller that can read and write to MS-DOS, OS/2, and Apple II 3½-inch floppy disks.

One minor difference, unfortunately, is that the ROM SIMMs are soldered rather than removable as they are in the Mac IIx and SE/30. However, there are empty ROM sockets on the board for inserting new ROMs, should the need arise. Apple engineers told us that the ROMs were soldered simply to reduce the manufacturing cost.

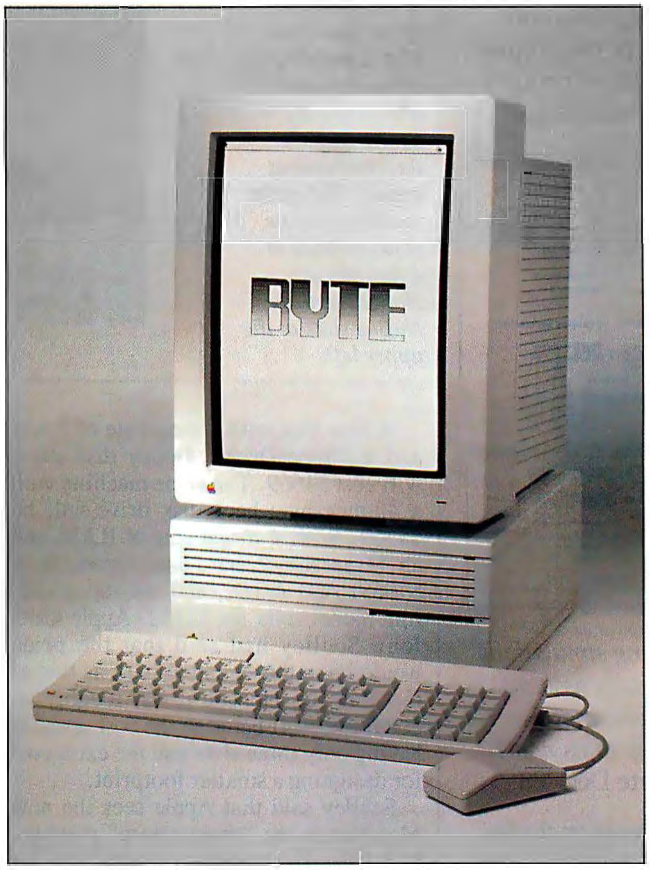

Photo 1: *The Mac IIcx shown with the Apple Portrait Display. The reduced footprint covers an area of slightly more than a square foot. You can place the computer itself either horizontally or vertically.*

What is interesting about the Mac IIcx is its physical design and modular construction, which remind me of the IBM PS/2 series. The cover, power supply, and drive housings all have snap fittings made of high-impact plastic. This allows you to disassemble the entire machine in a few minutes.

As mentioned earlier, the machine should be equally at home either on top of your desk or beside it. There are no vent slots on the sides or bottom of the unit that might be accidentally blocked. The unit even comes with removable feet and has a bezel on the rear that would allow you to insert the unit into a wall bracket (the bracket will be provided by third-party suppliers).

The IIcx has a quiet 90-watt power supply (in contrast to the 220-W power supply on the Mac II and IIx) and two 3½-inch bays for a floppy disk drive and a hard disk drive (the Mac II and IIx have 5¼-inch bays, although they can also be used to carry 3½-inch drives).

Other new features include an external DB-19 serial port for connecting an external floppy disk drive and an auto-restart capability. The auto-restart causes the machine to automatically reboot itself in the event of a power outage. This feature makes it ideal for use as a network file server.

continued

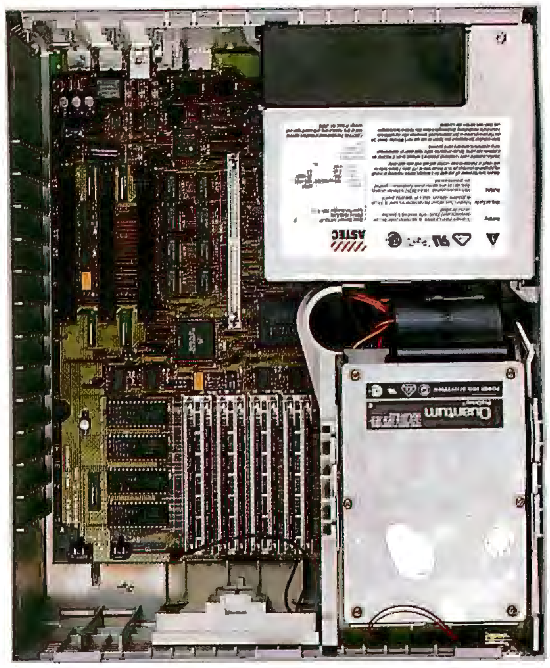

Photo 2: *An overhead view of the internals of the Mac IIcx. The cover snaps off at the rear, allowing easy access to the components inside. The entire machine can be disassembled in a few minutes. Notice the three NuBus slots at the upper left.*

A Mac IIcx with 1 megabyte of RAM and a "SuperDrive" floppy disk drive will cost $4669. The same machine with a 40-megabyte hard disk drive will be $5369. With 4 megabytes of RAM and an 80-megabyte hard disk drive, it is $7069. Add A/UX, and the top-of-the-line model sells for $7552. Apple CEO John Sculley had said that the price would be in the same ballpark as that of the Mac IIx. He said it was roughly an equal trade-off between the cost saved in having only three slots and the extra cost for designing a smaller footprint.

Sculley said that Apple sees the new Mac IIcx as the "mainstream" machine of its Mac II "modular product line." It is certainly the most physically appealing. Unless you need six expansion slots, the Mac IIcx is a more practical package than the Mac IIx. It's quieter and takes up less room, but it's just as powerful.

New Monitors

Apple has also announced a new 15-inch portrait-oriented gray-scale monitor, the Apple Portrait Display ($1099), which features 640- by 870-pixel resolution (80 dots per inch). The monitor requires the the use of a Mac II Video Card Expansion kit ($599), which can be configured with either 2-bit or 4-bit pixel depth (allowing display of four shades of gray).

The monitor is shown in photo 1 with the IIcx. A nice feature of the Apple Portrait Display is that it has three Apple Desktop Bus connectors, so you can connect it directly to the keyboard, mouse, or other ADB device. This, along with the fact that Apple supplies a 6-foot cable for connection to the host computer, allows you to place the computer at a comfortable distance away.

The Portrait Display provides an excellent, crisp picture. It is ideal for word processing and desktop publishing.

In addition, Apple announced a new landscape-style 21-inch gray-scale monitor offering 1152- by 870-pixel resolution (with the standard 77 dpi). Called the Apple Two-Page Monochrome Monitor ($2149), it also requires a special video card ($599) that is slightly different from the card used with the Portrait Display. The Two-Page video card comes with 2-bit pixel depth, allowing two or four gray levels. An optional 4-bit-per-pixel upgrade (consisting of eight video RAM chips) allows display of 16 gray levels. Apple says the Two-Page Monitor will be available in May.

The new Apple products do not constitute a revolutionary change in the Macintosh world. However, they reinforce a sense of continued improvement in the Mac line, which is welcome indeed. ■

Nick Baran is a BYTE senior technical editor based in San Francisco. You can contact him on BIX as "nickbaran."

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SPRINGTIME RENEWAL

Jerry uses a "relentless application of logic" to convert an old program and rebuild an old computer

I had really intended to get this in early, but instead I'm late. No matter how fast I run, I seem always to be doomed to stay about three weeks behind. I do have reasons. . . .

What happened this time was a trip to Washington, DC, to help the Smithsonian Institution set up Zeke II. The old boy looked pretty happy in his new quarters in an attic of "the nation's attic." It's getting crowded up there, but he had a table all to himself, and they seem to appreciate him.

He's in the Museum of American History; if you haven't been there, you should go. There are exhibits of everything from the original copy of "The Star-Spangled Banner" to technology, including bridge cable, early steam locomotives, and old typewriters. They haven't yet set up the History of Computing section where they're hoping to put Zeke, but that's coming soon.

Another reason for my Washington trip was to present the SSX (Space Ship Experimental) briefing to the Office of Management and Budget and the Space Council. The SSX is, technically, a multiengine, *savable* Single Stage to Orbit Vertical Takeoff and Landing Aerospike ship. What that means is that it flies up and down like the Apollo Lunar Module, but with this difference: if an engine goes out on takeoff, you can hover the ship, burn off the fuel, and land it again.

Several things make the SSX possible. One is new capabilities in airframe structure. Another is small computers: while there will generally be a human commander aboard the SSX, the stick-and-rudder pilot will be a microcomputer. If you want a model of the SSX taking off, get a plastic bottle of soda water, empty half of it, and try to balance it on one finger as you push it rapidly toward the ceiling. It's something a skilled human can just do—as long as there aren't any strong winds and other distractions. Of course, it's duck soup for a computer to control, wind or no wind. You could even write the control program in compiled BASIC, like Microsoft QuickBASIC 4.5.

The Citizens Advisory Council on National Space Policy is recommending the SSX as the low-cost way to get America moving in space again. Now if we can just get enough people behind it. . . .

Printer Problems

I've been making refinements in Mrs. Pournelle's Reading Program while we look for a publisher. The program is now completely converted to QuickBASIC 4.5, and it runs like a charm.

I'm also converting my old accounting system. I use it because it's still the only accounting system that makes your books look like the examples you see in Accounting 101 texts. The program handles everything: each month I type in the credit-card expenditures and bills—for regular bills, I have to put in only the amounts—and everything is written up into journals, with expenses allocated to their proper accounts (business or personal). Then it writes the checks. Before I wrote this system, tax time at Chaos Manor was sheer hell. It's not all that easy now, but it's sure better.

My accounting package was originally written for CP/M. The Golem, my big CompuPro 286, runs concurrent CP/M and has a Z80 slave board that runs the package (and all my other old CP/M programs). The problem is, last December the Golem went back up to CompuPro for a full refurbishing, including conversion to the new CompuPro 386 cards. When he comes back, he'll be awesome.

Alas, accounting and bill paying won't wait. There was nothing for it: I had to get my accounting and check-writing system running on the Big Cheetah 386 under DOS. Worse, since I'd put things off, I had one evening to do it.

Still, it seemed simple enough: my son Alex long ago recompiled all those programs to run with DOS; they're available from Workman & Associates. However, eons ago when I wrote those programs, I carefully formatted the output of the check-writing program and had checks printed; and in those days my main printer was a serial NEC Spinwriter.

Connecting serial printers is a black art. Among other things, you need a printer driver, which is a program that tells your computer what your printer expects; and I don't have one for the NEC Spinwriter.

I don't need one. My PCompatibles connect to printers through the Printer Optimizer, which is intelligent enough to accept standard parallel output from your computer and convert that to whatever protocol your printer expects. In other words, the Printer Optimizer is capable of being just about any printer driver you'd like it to be.

The Printer Optimizer is "programmed" in hardware; there's a small gizmo like a miniature telephone switchboard that lets you connect up the output the way the printer expects and some DIP switches to let you set up communications protocols. This is all explained in the manual. Alas, although the NEC Spinwriter and my Hewlett-Packard LaserJet Plus are both serial printers, the Spinwriter expects an entirely different setup from the LaserJet Plus.

I could, of course, carefully record how things were set for the LaserJet Plus and then change the wiring to fit the Spinwriter, but I hate to take chances.

continued

While we do production printing on the big Kyocera F-3010 laser printer—like the upcoming *The Children's Hour*, a novella set in Larry Niven's shared-universe Man/Kzin War series—I do a lot of work with the LaserJet Plus.

Then I remembered: a year or so ago ACT sent me their new and updated Printer Optimizer, and I still have the old one I'd used for years. I *knew* it would run the Spinwriter because long ago it once had, even though it had since been reset to run the LaserJet Plus. There's hardly any memory in the old Printer Optimizer (that got sent back), but what the heck, a check-writing program doesn't need a lot of memory; I don't write *that* many checks each month.

It wasn't as easy as I thought it would be, because I've forgotten the Spinwriter settings. The Printer Optimizer manual has diagrams of how to set the switches and wire patches for nearly every conceivable printer; but I long ago misplaced the Spinwriter manuals, so I can't tell what its data transfer rate, parity, and other protocol settings are; and naturally this was in the middle of the night, so I couldn't call anyone who had the manuals. There are 36 ways the NEC might conceivably be set. I could see this might be a career.

Actually, it wasn't all that bad. I started with the suggested default settings from the Printer Optimizer manual, studied the switch settings on the Spinwriter, and tried to remember what we'd done back in the dark ages when that was my main printer. I thought I remembered that we'd set it on "Mark Parity," but the rest was a mystery. Time to experiment. Turn off the Printer Optimizer. Change a switch. Turn it back on. Go over to Big Cheetah, do Control-P, and type a letter. Nothing. Go back and try again.... On about the sixth try, I got a satisfactory click from the printer. After that, it was easy.

It's still not set absolutely right. I can print checks one at a time, but if I send over a number of them at once, I get data check errors. That means I've overrun the Spinwriter's buffer, and when it frantically tells the Printer Optimizer to stop sending data, the Printer Optimizer isn't listening because some switch is set wrong. By this time, it was late enough that I didn't care, and I printed one check at a time. Next month, I'll do it right.

QuickBASIC 4.5

It has been a long time since I wrote those accounting programs. CP/M has only 64K bytes of memory, limiting features and forcing me to use some very cryptic commands. Now that memory isn't a problem, I could fix a lot of that.

Some of the programs were written in Microsoft BASCOM 1.0, but most are in CBASIC CB86. CBASIC still exists, but the publishers haven't made any improvements in years. However, Minnow Bear Computers makes a toolkit that keeps CBASIC relatively current; until Microsoft brought out version 4.0 of QuickBASIC, CBASIC CB86 with Minnow Bear CBC Tools was probably the best compiled BASIC in the world.

If you work with CBASIC, you should be aware of Minnow Bear; it's the only support for the language you're likely to get. Minnow Bear also publishes a program that will convert your CBASIC programs into C (Microsoft, Aztec, or Borland Turbo versions). However, I have no desire to learn C, which in my judgment is a fine language for full-time programmers, but not so hot for people like me who program in bits and pieces.

I'd like to move all those programs from BASCOM 1.0 and CBASIC CB86 to QuickBASIC 4.5. The problem is that QuickBASIC 4.5 has some bugs in its conversion system.

I found this out when I tried to read in ALLOC.BAS from the old BASCOM 1.0 code. ALLOC.BAS takes a journal in which you've entered items in any order you please (including stuff from previous years) and allocates all those entries to the right journals. It's useful because credit-card entries often don't get onto my bill for several months after the purchase was actually made.

BASCOM permitted you to have continued lines—that is,

```
INPUT # 1, A(1), A(2), A(3),
A(4), A(5)
```

would read in the five variables in BASCOM; but when I read that line into QuickBASIC 4.5, all it saw was the first physical line and left the second line *blank*! It did that for nearly 40 entries scattered throughout the old code.

This was disconcerting to say the least; I spent half an hour cutting and pasting and generally getting the code entered properly. (That was the dumb way to do it, of course; what I should have done was use a programming editor to go through and concatenate all those continued lines. Ah, well.) Eventually, the program compiled, but it still didn't work, mostly due to problems with IF...THEN statements not properly terminated with END IF. It took another hour to track those down, but now I'm

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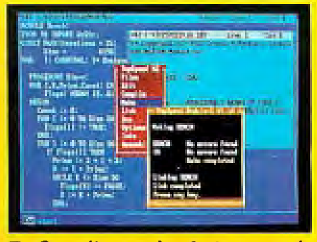

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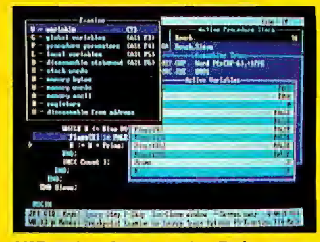

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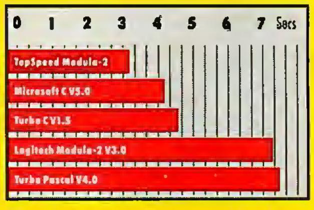

Sieve benchmark measured by the British Standards Institution (BSI)—25 iterations on an 8MHz AT.

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happily adding features to ALLOC.BAS.

Next, I want to convert the other files from CBASIC. Of course, CBASIC also allows continuation lines, and I used a lot of them. Fortunately, they're all marked by a slash at their end, so I suppose it will be possible to search through the sources with the Norton Editor and close all those lines up. It will also be a fair degree of bother; and CBASIC uses multiline functions in quite a different manner from QuickBASIC 4.5. That conversion isn't going to be easy.

Of course, it's hardly Microsoft's fault that converting from CBASIC is work; but I do wish they had some mechanism for continuing lines. If you must put everything on one line, the source code gets very long and very ugly, nearly impossible to read, much less print out in a decently structured format. Sometimes it's no problem to code in short lines, but once in a while there are disadvantages. In the example above, I'd have to do

```
INPUT #1, A(1), A(2), A(3)
INPUT #1, A(4), A(5)
```

which works, of course, but unless the compiler is smarter than I think it is, it's going to be somewhat slower. Maybe the thing to do is to debug everything in the readable format, then take out the continuations just before the final compile.

I understand that Microsoft has moved QuickBASIC from the languages group over to consumer products. I hope that doesn't mean they think the language is finished. There are a number of things it needs, starting with some mechanism for continuing lines. They can also fix some overflow bugs: even in version 4.5, there are programs that will run in the interpreted mode but blow up when compiled. (In fairness, most—nearly all in fact—of those problems seem to be peculiar to 80386 machines with an 80387 math chip.) I'd also very much like to see a compiler toggle that complains if you try to run with undeclared variables.

Then they can make some improvements in their code generator. That's no easy task, given all the features of QuickBASIC 4.5 with its on-line context-sensitive help (which can often be more useful than the rather oddly organized documents). I suspect the proper way to reduce the size and generally speed up Microsoft QuickBASIC code would be to write a second compiler whose input is code already known to compile and run; perhaps *already compiled* code, the output of the present compiler. That second compiler wouldn't need so many debug-

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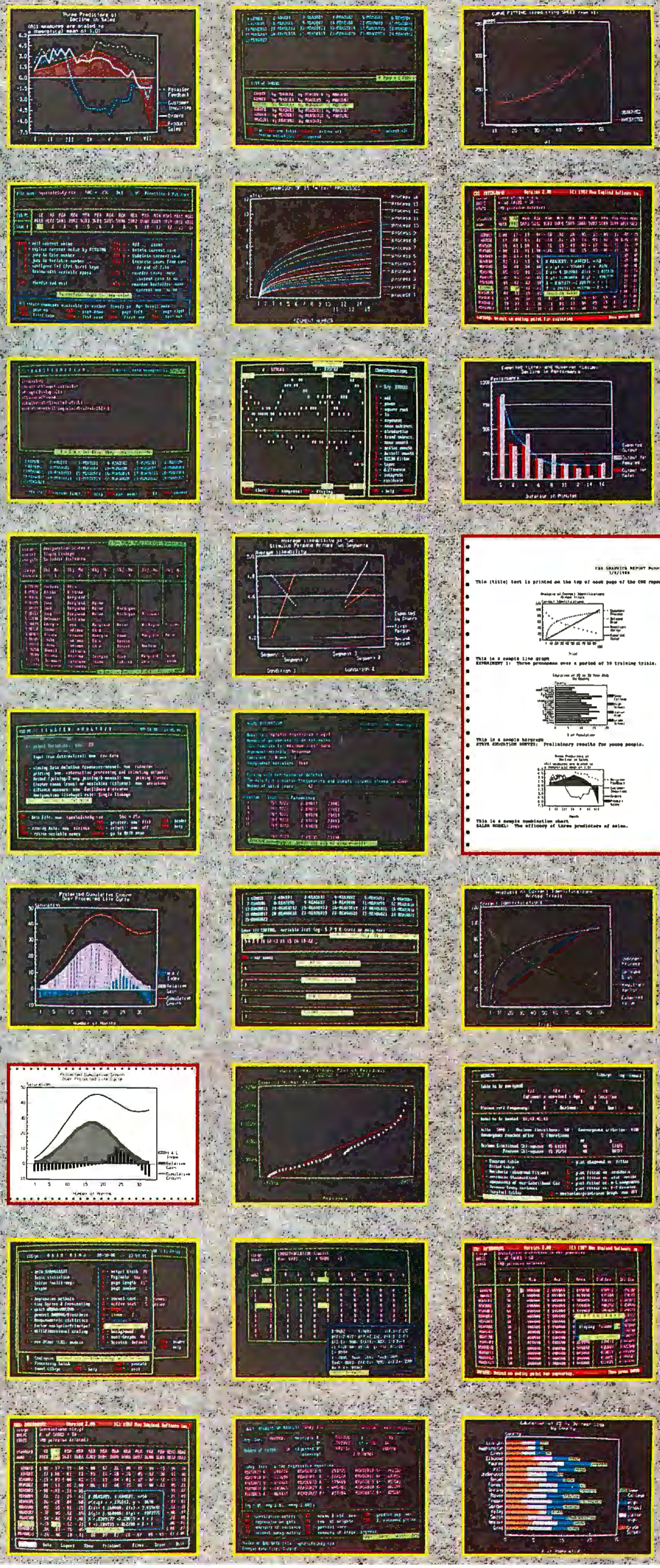

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ging features, nor would it have to do so much error checking.

For all that, I'm getting quite fond of QuickBASIC 4.5, and I continue to work with it.

QuickBASIC Tools

I have two major packages of QuickBASIC tools: QuickPak Professional from Crescent Software and ProBas (Professional BASIC Programming Library) from Hammerly Computer Services. They're both quite useful. Each company has additional toolkits: Hammerly has the ProBas Toolkit, which takes the stuff in their first kit and combines it into a number of complex programs, while Crescent has a Graphics Pak. Alas, what with everything else this month, I didn't get much chance to look at the advanced packages, but I have worked with the QuickBASIC tools.

Comparing these toolkits isn't easy; each has features the other lacks. If I had to buy just one, I'd get the Crescent package for two reasons: first, it contains more assembly language functions that can be manipulated by name in QuickBASIC 4.x and higher. For example, something very useful in both packages is a way to determine if a file exists without having to use the ON ERROR GOTO error trap. (Error traps add a lot to code size and complexity; while they're useful as diagnostics and debugging aids as you build the program, it's far better to do without them in the final version.) ProBas does that this way:

```
CALL EXIST (Filename$, Found%)
IF Found% THEN PRINT Filename$;
"exists."
```

QuickPak accomplishes the same job with:

```
IF EXIST(Filename$) THEN PRINT
Filename$; " exists."
```

There are many other such instances. Clearly, the QuickPak way is simpler. Of course, only QuickBASIC version 4.0 and above work that way; for earlier versions, QuickPak has to use the same method ProBas does.

The other reason I mildly prefer QuickPak is that it has more higher-level routines, such as menu construction, which are available only in the extra-cost ProBas Toolkit. In contrast, there are more functions in ProBas.

There's considerable overlap in the two toolkits. They both let you add mice to your programs. Both have editing functions, screen managers, and the like. However, the overlap is not 100 percent, and each package contains some useful stuff that the other doesn't have. Anyone doing serious QuickBASIC programming would do well to get both, and either one is worth having.

Project X Dies

Shortly after my problems with their copy routine—see last month's column—Project X Software vanished: their telephones were disconnected, and mail is returned unopened.

In a way, that's a pity. Both Crescent and Hammerly have stated that Project X made rather free with other people's code, which is a pretty serious charge; and I certainly had enough trouble with their DOS routines. On the other hand, they also had some features, such as dialog boxes, that were pretty nifty and not available in the other toolkits.

There's not much to be done about

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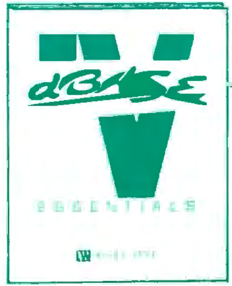

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that, of course. Although Crescent will send you the source code to their assembly language routines—you have to request it when you register—Project X didn't do that, and I don't think I want to try their code without having a look at the source. Much of Project X's stuff didn't quite work with QuickBASIC 4.5, while the rest has to be viewed with some suspicion; I wouldn't want to go through last month again. I suppose it's all moot anyway.

Jazzing Up Big Cheetah

The conventional wisdom is that computers are plenty fast enough; what slows things down are disk operations. That was certainly true enough in the old days. It may not be so now. Certainly, a number of colleagues have been surprised when they did careful analyses of what operations were being performed during long compiles, recalculations of spreadsheets, and things like that. They found that more often than not, the systems were compute-bound rather than I/O-bound.

On the other hand, machines are getting faster. My Big Cheetah 386 can run fine at 25 MHz, and the people at Cheetah are anxiously awaiting 33-MHz chips from Intel. The Cheetah board should work with those at full speed, and that, they think, should definitely put the speed limits back in disk operations.

In anticipation of the event, they've been experimenting with new disk controllers. Last week, Cheetah sent Larry Aldridge, from Sterling Solutions (1824 Starfire Ave., Corona, CA 91719, (714) 371-1767), with a whole batch of new goodies: a new power supply, a new Cheetah motherboard with new ROMs, and the new Distributed Processing Technology (DPT) intelligent disk controller. We figured it would take about 4 hours to install the works. Of course, nothing goes the way you think it will. . . .

Big Cheetah is a tower machine. This means that when you want to work on him, you can either get down on the floor or lift him onto a workbench. In most places that would be no trouble, but in Chaos Manor, finding a workbench not covered to three layers isn't easy. Eventually, I cleared off a cart and we took Big Cheetah apart.

Once you get them up on the table, tower machines are quite open, and everything is at least as easy to get at as in a conventional desktop machine. It took about 20 minutes to change power supplies.

The new one is called the Turbo Cool 250 and comes from P.C. Power & Cooling. It delivers 250 watts of power (formerly 200). It also puts out considerably more air—and thus more noise. Compared to the 8-inch disk drives I endured for years, the new fan is as quiet as a field mouse; but you certainly can hear it. Given all the electronics we installed, I expect I'll just have to get used to it.

Larry Aldridge, who studies these things, says the Turbo Cool 250 is the best power supply on the market. It runs cooler, and there's more power filtering than in the standard power box. Since the best power supply doesn't cost a lot more than the cheapest, it's foolish to stint.

Changing the motherboard took another 20 minutes or so. Then it was time to install the new disk controller.

Frustrations

The new controller is DPT's PM3011 Caching Disk Controller for ESDI drives. Cheetah's Gene Sumrall con-

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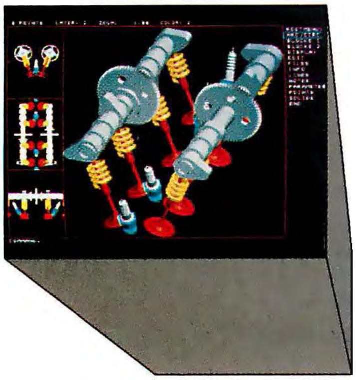

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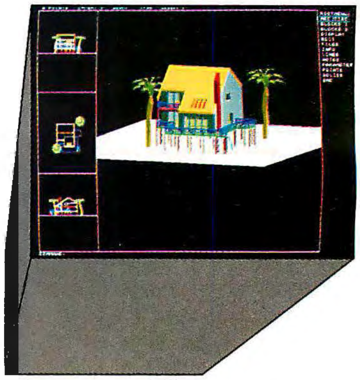

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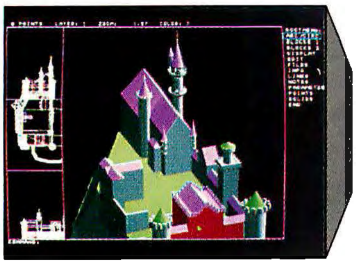

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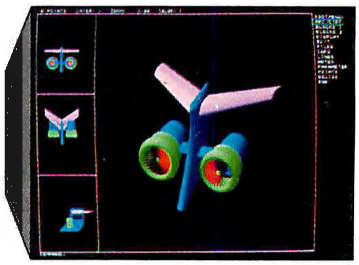

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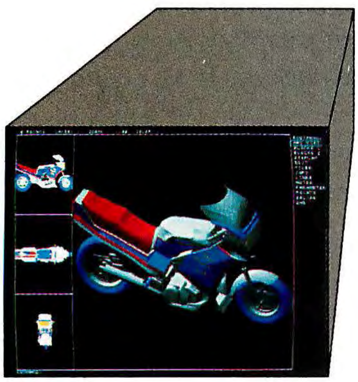

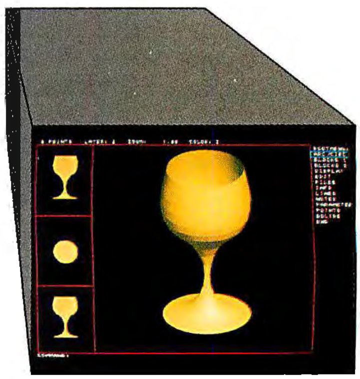

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siders this the best all-around microcomputer controller in the world. The controller card has a 68000 chip on-board; in fact, this controller is smarter than the 128K-byte Macintosh was. It comes with half a megabyte of disk cache memory; you can also get an optional 4 megabytes on a second board. The two boards are to be connected with a ribbon cable, and that was our first problem.

Big Cheetah wants his disk controller in the first slot (in a tower, that's the top slot). The next two slots are for 32-bit memory and are labeled "High Word" and "Low Word." Thus, the PM3011 needs to go in slot 1, and its additional memory has to go in slot 4. The problem was that the cable Larry brought was just long enough to bridge one of the memory boards. There was no way it was going to bridge two; we had to leave out the extra memory.

It doesn't seem to matter: the PM3011 can use all that memory when it's servicing a number of busy users, but there's not much way that I'll need it, even if I keep a dozen DESQview windows open at once. The Coretest utility can't even measure the seek times on this controller and the Priam drive: something less than half a millisecond! I have the memory board here, and I suppose one day I'll install it; but I doubt that I'll notice the difference.

It was now time to reformat the Priam 330-megabyte hard disk drive. In preparation, I had copied everything off onto the Maximum Storage WORM (write once, read many times) drive. That took almost an hour, since I decided to copy all the files onto a new WORM cartridge. Next time, I'll copy only those with dates later than the last backup, but we were due for a new complete backup.

The DPT format program asks you for your disk's defect list. We laboriously read that off the table glued on top of the Priam drive; something we'll never have to do again, since the DPT software will write off the list to a floppy disk. I've since learned, though, that this is needless work; the DPT format program automatically finds all the bad sectors anyway.

Before formatting, we put Big Cheetah back together again. I thought that was an act of defiance sure to be punished by the gods; generally, I do all my tests before putting the case back on. Larry Aldridge disagreed. "I don't see how it can be good for a disk to format it while it's on its side," he pointed out. "There's sure to be gravity drag, and it just doesn't seem reasonable." After I thought that over, I had to agree. I do know a lot of people who take an ordinary machine and stand it on edge (and, thus, the hard disk drive on its side). I don't know if that causes any problems, but perhaps it's best not to take chances.

Once Big Cheetah was back together, we tried to fire him up. It didn't work. The controller couldn't find the hard disk. The PM3011 wants you to tell it that your hard disk is a Type One, even though it's not likely to be. The controller then looks at the disk to determine the true number of heads and tracks and sectors. Unfortunately, it didn't at all like what it was finding out about my Priam drive.

It turns out that some early Priam drives were formatted to only 310 megabytes rather than 330. I'm not sure why; I think Larry explained it, but I've forgotten. The important point is that the controller couldn't recognize this format, and it kept making plaintive noises while it hunted.

The solution was to remove the data cable while the machine booted up from a floppy disk. Then we reconnected the cable and started the format process. That takes a bit more than 2 hours, so we went to lunch. When we came back, the formatting was done, and it was time to partition the disk.

There are many partitioning programs. If you don't want any single partition to be larger than 32 megabytes, the DOS FDISK utility will do the job. If you want larger partitions, there are a number of choices. One is DOS 4.0x, which also has other advantages; but from everything I have heard, it will be another few weeks before that's stable enough to use reliably. I'm a believer in the old adage of "Be not the first by whom the new is tried, nor yet the last to cast the old aside," and I think I'll stay with DOS 3.3 for a while yet.

If you rule out DOS 4.0x, there are several commercial programs to make large partitions. The one that I normally use is SpeedStor. Larry Aldridge likes Disk Manager from Ontrack Computer Systems. Both Cheetah and DPT recommend Disk Manager. In our case, it didn't matter. We used Disk Manager to set up my big Priam drive with two 32-megabyte drives and one humongous 260-megabyte drive, but when we booted

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up the system, it wouldn't work. We could access the smaller C and D drives, but things got flaky when we tried to read and write to the enormous E drive. Worse, when I used XCOPY to bring some files from the WORM drive (now F), it all seemed to work, but only about half the files actually got copied. Something clearly was wrong.

The next step was to repartition the disk. We needed to get rid of that enormous logical drive and divide things up into a bunch of 32-megabyte drives.

That didn't work, either. XCOPY still wasn't reliable. Neither were some other utilities. Something was really wrong.

It was also well after midnight. Between one thing and another, we'd been at this for over 10 hours, and while Larry Aldridge was willing to stay on, I sent him on his way; but first, I made sure that I kept all the parts that had been replaced on Big Cheetah.

Troubleshooting

Back when I was in the aerospace business, I sometimes had to run laboratories. In those days, we were creating new technology, particularly in medical electronics, and invariably, just before a big test something would go wrong. I got a reputation as an electronic genius because we'd send for the engineers, and while they were trying to understand what had gone wrong, I'd very likely get the equipment going.

My reputation was truly undeserved; most of that stuff was far beyond my technical competence, and if I'd tried to reason my way, I'd have been as lost as the engineers were. Instead, while they were thinking, I puttered about. "Relentless application of logic," I'd mutter, while trying to put things back the way they were the last time it all worked; then I'd add a component at a time, testing as I went along.

It seemed to me that the same technique was called for here. The problem with Big Cheetah was that we'd made several changes at the same time; the thing to do was put the machine back the way it was and start over.

First, I put the old motherboard back in. Next thing would be to put the original Priam controller in. On the other hand, reformatting would take hours. It was already very late, well after midnight, and I had heard a lot of good things about the DPT controller. It couldn't hurt to give it one more try....

My first attempt was an utter failure. It turns out that the red stripe on the drive cable goes to the left on floppy disk drive A, but to the right on B (which is a 3½-inch drive). It's also not clear which way it goes on the controller. Once I got that fixed, I held my breath and booted up.

It worked fine. Disk access was faster than anything I'd ever seen before, and after half an hour I was pretty well convinced the system was reliable. Later, I found out that the problem was an intermittently faulty chip on the new motherboard.

For the moment, though, I had a different problem. Since I now had the same disk partitions I'd had the day before, except for the last one (the DPT controller formats about 10 more megabytes on the Priam drive than it had previously), it seemed logical simply to copy all the files from the WORM right back to where they'd been. That would be simple enough, since I'd created directories C1, D1, E1, and so forth on the Maximum Storage WORM cartridge and used XCOPY to move everything, subdirectories and all, for each logical drive. To restore it then, all I had to do was type:

```
XCOPY N:\C1\*.* C: /v/s/e
```

and repeat that for drives D through J (there not being anything worth keeping on drives K through M).

All went well until I got to drive F; then I got DOS error messages. Strange DOS error messages.

It was now very late, but I was determined to have the machine running before I went to bed.

New Norton Disk Doctor

The first thing I tried was Norton Disk Doctor. There's a story to that. You may recall that when I used NDD the last time I had problems with my hard disk, it managed to vanish my C drive. I wrote that up and sent a copy of the manuscript to Peter Norton.

The next morning, I'm told, Norton instituted a crash program to fix the problem. A week later, a messenger delivered an updated NDD with a note promising that this one would work properly. I tried it out on a couple of other machines without difficulty, but of course that didn't tell me much. Here was a chance to test it on a disk with real problems.

It looked at drive F and asked, "Do

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Circle 264 on Reader Service Card for MS DOS Products. (All others: 265) you get bizarre results when you attempt to access this drive?"

"I sure do," I muttered. When NDD offered to fix things, I told it to have at it.

NDD suggested that there were fragmented files, cross-connected files, and other problems with the FAT (file allocation table) on drive F, and it suggested that I first run CHKDSK/F to gather up all the lost chains.

That sounded good to me, but it didn't work. The disk held about 20 megabytes of garbage. CHKDSK trundled for a while and reported: "Insufficient room in root directory — Erase files from root and repeat CHKDSK."

Sheer Madness

There were two problems with this. First, I couldn't read the root directory of drive F, and ERASE F:*.* produced no result whatever.

Second, I must have taken leave of my senses. It's one more reason why you shouldn't do this sort of thing at 4:00 a.m. after a long day of frustration. Somehow I got the notion that instead of the root directory of logical drive F, the problem was that I had no space on C:\, the primary root, and I had to erase some files *there*. Of course, in the cold light of day that sounds as absurd to me as it does to you, but it seemed like a good idea at the time. I invoked Norton Commander and selected all the files in C:\, figuring to erase them, then bring back the few I needed. Norton Commander warns you when you're about to erase a READ ONLY file, but I didn't pay any attention. Do it, I said.

I managed to delete not only COMMAND.COM, but IBMBIO.COM before I realized what I was doing and frantically hit Control-Break.

Too late. I couldn't exit from Norton Commander, and when I reset the machine, it refused to boot.

The first rule is, don't panic. It was clear I'd have to reboot with a floppy disk and transfer the files back to the C drive. That would have been simple enough, but I was still muddleheaded: I *copied* COMMAND.COM and IBMBIO.COM from drive A to drive C. The result was that I could access the C drive, but I couldn't boot from it; and when I tried to use SYS.COM to transfer the system over to the C drive, I got "No room for system on target disk."

I expect the proper way to recover from that would be to use Norton Commander to erase the first several files in the C:\ directory—probably the COMMAND.COM I copied previously—since IBMBIO.COM has to be the first file in the FAT; but by then I was plain disgusted and did FORMAT C: /S.

That was partly an experiment to see if you really can format one logical drive without disturbing the others. I've always wondered, and what with everything backed up on the Maximum Storage WORM drive, there would never be a better time to try. It worked fine. All the files on drives D and E were undisturbed. Drive F was still giving bizarre results.

All right, thought I, if FORMAT works on the C drive, it ought to work on the F drive, so let's try that.

There's only one problem. FORMAT demands the volume name of the drive, and if you don't know it, the program refuses to proceed. I have a utility called VOLNAMES (and there's DOS's VOL); using that showed that while none of my other logical drives had volume names, drive F had a garbage label containing control and graphics characters. There was no way I could type that in.

Examining the index references in the DOS documents and Chris DeVoney's book *Using PC-DOS* gave no hint of a way to remove a volume name except by formatting the disk; but to format the disk, I'd need the label.

By this time, I was frothing at the mouth. There had to be some way of doing this without reformatting the whole disk. If FORMAT wouldn't work, would FDISK? I tried that, and it indeed offered to remove a partition. Fine, thought I. Remove the F partition. It did; then, of course, it closed things up, so there was an F again, this time without a volume label; on the other hand, I was short some 32 megabytes of drive space. Worse, NDD informed me that drive G was acting in a bizarre manner.

Fortunately drive G had no volume name, so I could format it easily enough. The DPT controller does that quite rapidly, so I wasn't losing much time; and after that was done, there were no problems other than the missing disk space. For a moment, I thought of ignoring the problem. After all, I had nearly 300 megabytes and wasn't using half of it. I could live without that space....

Sure I could, but there was no chance I would. I got out FDISK again and told it to create one more logical drive using all

continued

the space it could find. That took no time at all, and lo!, I was finished.

There's one anomaly and one footnote to the adventure. The anomaly is this: I have 11 logical disk drives. C through K are identical in size at 33,298,932 bytes. Drive L is quite small, 1,871,872 bytes. So far that's what you'd expect; but the last drive, M, has 32,915,976 bytes. That's a consequence of my unpartitioning space, then reclaiming it again.

The footnote is that I didn't need to do that. DOS 3.x and higher has the LABEL command, which will let you change or delete volume labels. Unfortunately, it's not properly indexed, so you either have to know it's there or read the DOS manual to find out about it.

The bottom line to all this, though, is that the DPT controller has worked splendidly. It's superfast and superquiet. The Coretest Performance Index is 48; by contrast, a generic XT with a fast hard disk drive might get as high as 3.8, while the Priam drive under its ESDI controller was about 22. The DPT controller works with DESQview, Windows/386, and everything else I've tried on it. Moreover, as long as I'm using normal DOS-size partitions, there's no need for ESDI.SYS, thus saving several kilobytes of primary memory. I don't really have any need for a controller this good, but if you're looking for something to control a big multiuser system, or a file server, or if you just want high speed and high reliability, you'll love the PM3011. Highly recommended.

System Sleuth

If you have ever been curious about your computer, you'll want this program. System Sleuth will tell you all kinds of things: what your CPU processor is, how many heads and tracks on your hard disk, what disk drives you have, how much RAM, who copyrighted your BIOS, what your display adapter is, and in general, more than you ever thought you'd want to know about your system.

It gives you an I/O map and memory maps. This can be especially useful if you're trying to make use of the memory between 640K bytes and 1 megabyte. DESQview's QEMM.SYS and LOADHI.SYS can use that memory to store device drivers (like the mouse or WORM drives) up beyond main memory. However, 16-bit VGA video also uses some of that space and is loaded before LOADHI.SYS can get at it. The result can be fairly mysterious crashes if you don't know what's happening. The thing to do is boot up without QEMM.SYS, then use System Sleuth to look at those memory blocks and see what's in use.

This is one of those programs that I didn't know I needed until I got it; now, what with all the hardware I try out around here, I use it all the time, and I can't think how I got along without it. There's one odd omission: it doesn't tell you whether or not you have a math chip. Oh, well.

System Sleuth is simple to use, and the main reason to refer to the documents is to find out just why you wanted to know something the program is telling you.

Highly recommended.

Duet

This is another one of those programs you don't know you need until you try it. Duet is a memory-resident program that sets your laser printer: if you have a font cartridge, Duet will tell the printer to use it. It will also cause the LaserJet Plus to print sideways. Finally, it will build a

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file queue and print it in background. (I can do all that with my Printer Optimizer, but in fact it's even simpler with Duet.)

Duet will also grab and print a .WKS or .WRK file without Lotus 1-2-3 or Symphony. You can specify a range, define a range, put in headers and footers, and choose sideways or normal printing, as well as specify fonts.

Duet will format a document into a disk file that can later be printed simply by sending it to a laser printer from a computer that doesn't have Duet.

The whole thing is simple to use and gets the job done.

Winding Down

As usual, there's a huge pile of stuff to write about, but I'm out of space. This time one thing is different: this column is so late that I'm going to write the next one tomorrow. Next month, I'll have more on laptops, including the Cambridge Z88 (I'm beginning to like it); Traveling Software's View-Link (wonderful) and Wizard-PC Link, as well as Sharp's Wizard pocket computer itself; a program that lets you do PostScript printing on ordinary laser, ink-jet, and dot-matrix printers; the Northgate keyboards that have become standard at Chaos Manor; and, as the saying goes, much, much more, including my recent trip to Microsoft's annual systems software seminar.

Next month, I'll also have a contribution to the Macintosh Special Edition, so I guess I have my work cut out.

The book of the month is *The Art of David Em: One Hundred Computer Paintings* by David A. Ross and David Em (Abrams, 1988). Em is a fine artist who for years has used a computer to make paintings. He has worked with the Jet Propulsion Laboratory's James Blinn (who did the Saturn fly-by simulations, as well as the computer work for *The Mechanical Universe* series.) Em gave a fascinating exposition on his work at this year's annual meeting of the American Association for the Advancement of Science. The book has 100 color paintings and considerable text on the use of computers in the fine arts. The visuals are stunning.

Now for the Macintosh article, then next month's column. It's *work* time. ■

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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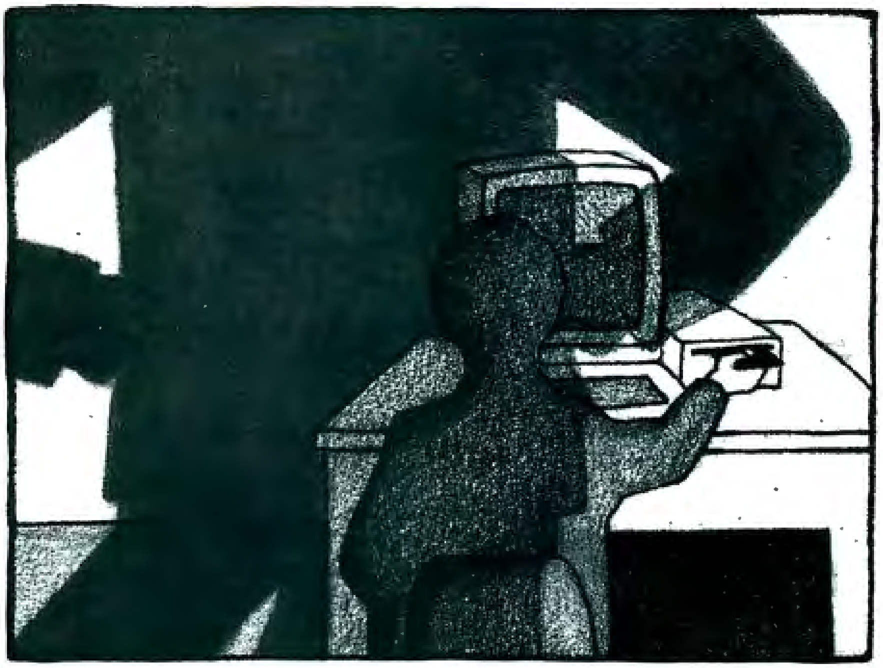
SOFTWARE DESPOTISM: TRUTH AND FICTION

Are company software standards being applied too vigorously?



I recently received a truly disturbing letter from a reader. For reasons that will be obvious, I can't disclose this person's name. I've also obliterated references to specific programs.

The person writes: "I've used Product A since I bought my first computer a number of years ago, and I'm now using the latest version. At work, my bosses have required all personnel to use Product B exclusively. If they find another program on your company hard disk, you'll be disciplined. One of my coworkers, who had been with the company for over 12 years, was fired for using Product C on a company machine.

"I still prefer Product A; it's an old, comfortable friend. Though I've become quite proficient with Product B, I still use Product A on my computer at home. I prepare my data on my own equipment, then transfer the information to the company machine at work."

Have we sunk this low? Are goon squads roving the corridors of office buildings late at night, checking hard disks for impure software? Pretty scary.

Look, I understand the need for software standards within a company. A controlled environment reduces the risk of virus infection, software piracy, and data loss. It also enables one employee to finish another's work in an emergency. But healthy caution is one thing, and authoritarian paranoia is another.

Today, most application software packages are amazingly adept at importing and exporting foreign file formats (as my letter writer has discovered). It strikes me as particularly thick-skulled to object when an employee uses an unsanctioned program to prepare rough drafts or personal workfiles. As long as a document doesn't require heavy-duty macro programming or sophisticated formatting, what's wrong with opting for employee convenience?

One of the greatest benefits of the personal computer phenomenon is that individuals can customize their environments to accommodate work habits and preferences. Why sacrifice this flexibility? I've heard dozens of horror stories about companies standardizing on software that employees didn't like, but this is the first instance I've encountered of someone being fired based solely on software selection. I'm hoping this is a random incident, rather than the first symptom of a trend, so I'd be interested in hearing about any other cases of bureaucracy running amok. Please let me know about similar experiences.

Simulated Supply and Demand

Back in the early days of this column, I wrote about Balance of Power, Chris Crawford's game of geopolitical brinkmanship. Though sold as entertainment, Crawford's simulations provide such sharp insight into current events that they're required purchases for anyone interested in the world around us. They are admirably suited for educational institutions as well as individual use. They blend subtle AI technology and the metaphor of game design to reduce complex interrelationships to an easily digested "learn-by-doing" formula. They're important programs.

It took me a certain amount of whining and cajoling to get Crawford to give me a copy of his latest effort roughly a month before it was even ready for beta testing. Neither release date nor price has been set by Mindscape, Crawford's publisher, but the product is real enough for him to be demonstrating it at computer shows. The version I received was buggy, but it was conceptually complete and quite playable. I suspect it will be available late

continued

this summer in a Macintosh version, followed shortly by a port to MS-DOS.

Crawford has delivered another stunner. It's called Guns & Butter, and it's based on, of all things, macroeconomics. Before your eyes cross at the thought, let me point out that the academic theories behind the game have been brilliantly translated into strategic elements that require no prior background in the subject. You can learn all you need to know by playing the game.

Here's the scenario: You're the benevolent despot of a country on a computer-generated continent. You have cities, resources, and a population of peasants. At the outset, all your workers are engaged in farming with primitive tools. Your job is to create an industrial economy by tapping your resources, building factories, and manufacturing products. Along the way, you must maximize agricultural efficiency, allocate your labor force, plan your economy, and cope with surpluses and shortfalls.

The incentive for all this activity is competition; you're not alone on the continent. Computerized opponents are busily strengthening their economies, intent on developing military hardware with which to wipe you off the map.

Eventually, the course of events draws you into this arms race. If you don't manage your country's growth successfully, you'll be invaded. On the other hand, if you're a canny planner, you can stock your arsenal and march off to conquer the world. Thus, Guns & Butter combines both economics and military tactics; the result is mesmerizing.

Guns & Butter is not an exact simulation; corners have been cut to make it playable. Output is limited to industrial and military goods; you don't have to worry about housing or clothing your population. Your military is limited to conventional ground forces—tanks and howitzers, but no airplanes.

Guns & Butter will probably offend theoretical purists; some will attack the underlying algorithms as Marxist in nature, while others will argue that the game is not Marxist enough. In truth, the game does allow for economic experimentation, and the lessons you'll learn are generalized enough to give you an understanding of the basic underpinnings of political economics.

Once again, Crawford has given us a program to delight people of all ages. He has provided entertainment that doesn't involve blasting aliens or chasing gorillas up ladders. I urge educators to make a place for Guns & Butter on the shelves of our high school social science classrooms, next to the copies of Balance of Power that should already be there.

ITEMS DISCUSSED

Allways $149.95
Funk Software, Inc.
222 Third St.
Cambridge, MA 02142
(617) 497-6339
Inquiry 1021.

Guns & Butter ...... Not priced yet
Mindscape, Inc.
3444 Dundee Rd.
Northbrook, IL 60062
(312) 480-7667
Inquiry 1022.

IS/ADB
with corded pen $595
with cordless pen $695
Kurta Corp.
3007 East Chambers St.
Phoenix, AZ 85040
(602) 276-5533
Inquiry 1023.

Spreadsheet Ecstasy

Let's say you're a die-hard Lotus 1-2-3 user, but you've been having conniptions trying to print Lotus worksheets on your laser printer, and you've been drooling at Microsoft Excel's formatting capabilities. However, let's also say you don't want to shell out the bucks for a new software package, you don't want to train yourself or your staff to the idiosyncrasies of a different spreadsheet program, and you have no desire to re-debug all your macros in the process of converting your files from Lotus 1-2-3 to Excel.

So do you know about Allways, the latest utility from Funk Software? This company brought you Sideways, the grandfather of all spreadsheet printing utilities. And this new $149.95 program may well be the answer to your prayers.

Designed as an add-in module for versions 2.0 and 2.01 of Lotus 1-2-3 , Allways is a superb spreadsheet formatter. With Allways, you can use up to eight typefaces on most popular dot-matrix and laser printers, including PostScript and PostScript-compatible devices. On a graphics monitor (i.e., CGA, EGA, or VGA), you get a WYSIWYG display, similar to the page-preview mode available in many of the newer output-oriented programs. (The program will also work just fine with a character-based monitor, but you can't see the fonts.)

Allways lets you specify type style by cell or by range, add boxes and underlines, change column widths and row heights, and even include .PIC charts and graphs inside a worksheet printout. You can get access to any of your printer's built-in hardware fonts, support for Hewlett-Packard LaserJet Plus and Series II cartridges, and three soft fonts (Times, Courier, and a Helvetica called Triumvirate), so dot-matrix printer owners won't feel neglected.

When I hooked Allways up to my Okidata Microline 192, it performed impressively. But for the real torture test, I hauled the Tandon IBM PC AT clone into the room where the Apple LaserWriter IINT printer lives, disconnected AppleTalk, plugged in a serial cable, and let her rip. The IINT is a great printer, with solid blacks and crisp edges, and the combination of Allways and the IINT was good enough that I couldn't tell that printout had been prepared on a computer that wasn't a Mac.

About the only frustration I can see with using Allways would be if you've spent hours and hours writing convoluted printer-control macros; I can guarantee that you won't ever use them again. There's not much more to say. Allways works, it's inexpensive, and it will prolong your allegiance to Lotus 1-2-3 for a while longer. Highly recommended.

The Search Goes On

I continue to hunt for the perfect alternative to the mouse. Back in the days before Apple's Lisa, there was a lot of discussion about pointing devices. Nobody was too sure the mouse was the best idea. Well, the little rodents seem to have won the marketing battle for the moment, but I steadfastly maintain that the issue is still not resolved.

I'm hoping that by endorsing mice without bothering to include them with the PS/2s, IBM has pumped some new blood into the marketplace. Though I'm running out of options from the products available today, I'm hoping we'll see more possibilities come to life in the next few years.

My latest acquisition is a digitizing tablet from Kurta. The tablet I tested came with two pens: one with a cord, and one that communicates to the tablet by means of a teeny radio transmitter in the top of the barrel. This gizmo is hot stuff, perfect for anyone who has despaired of generating freehand drawings with a personal computer.

You still can't get quite the feel you can achieve with a traditional medium, largely because of the internal human mechanism of eye-hand coordination.

continued

However, this is about as close as you'll get without busting your bank account. Digitizing tablets are not as cheap as mice, trackballs, and joysticks, but the expense is worth every penny if you're serious about your artwork.

The unit I'm testing is the IS/ADB model for the Mac, but you can get identical features for your IBM PC with Kurta's IS/One line. The IS/ADB has an active area of 12 inches by 12 inches, which means the whole thing is more like 15 inches by 16 inches. There's a margin of an inch or so on all sides, and Kurta includes a sensitized strip at the top of the tablet, separate from the drawing area, which has configuration options and 13 function "keys" that are mapped to the function keys on the regular keyboard. The tablet therefore occupies a good deal more real estate than a mouse, and I've had to redesign my work area once again in order to use the thing.

I've found I prefer the corded pen to the optional cordless pen. The cord is a minor annoyance, and the response feels quicker than that of the cordless pen, which requires a heavier hand to operate. If you're doing precision tracing or CAD work or using the digitizing tablet as a programmed input pad, you can also purchase corded and cordless cross-hair cursors from Kurta. All this stuff is sold with a lifetime guarantee, and it all performs without a hitch.

This is the most sophisticated, best-designed, and most accurate of all the devices I've come across in the past few months. On the other hand, it's the most expensive and most desktop-hungry. I think it's one of those products that sells itself; if you suspect you need one, you need one, so go out and buy it.

Here are my reactions to everything I've tried. First, the mouse. Trini Cemo of Kurta gave me the best line I've ever heard on the subject; she said that drawing with a mouse "is like drawing with a bar of soap." Extensive mouse use hurts my elbow, the little Teflon pads on the mouse wear off, and you lose a square foot of desk area. But mice are cheap (they come free with the Mac) and relatively efficient for nonartistic applications.

Trackballs are a step up, though I find them better suited to CAD than to freehand drawing. They're fine for routine operations, take less space than mice, and cost about the same. But I'm not sure about longevity. Though my MicroSpeed unit for the PC has never failed, I've already had to replace the Abaton trackball for the Mac once.

The joystick offers better control than mice and trackballs for games and drawing, but it loses to the tablet on CAD. I'd love to see a high-end joystick someday, with a thin stick rather than a pistol grip and a contoured base with a wrist rest. But so far, no manufacturer has decided to produce a mass-market model of this idea.

There you have it. Conclusion drawn from this exercise? Simply this: Don't think you have to use a mouse because they're ubiquitous right now; other devices are available, and they might better match your requirements. ■

Ezra Shapiro is a consulting editor for BYTE. You can contact him on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

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

S O F T W A R E   S E C U R I T Y

WHETHER REPORT.

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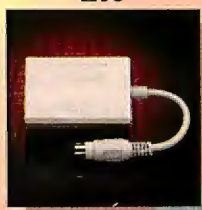

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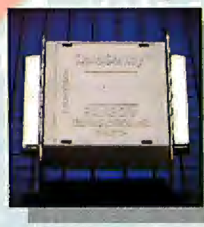

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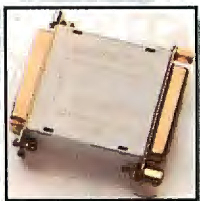

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Here are C language interfaces for the entire set of API functions. It supports the Lattice™ C, Metaware™ C, Microsoft® C, and Turbo C compilers for all memory models. Included with the C Library package is the API Reference Manual and source code for the library.

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API Panel Designer

This interactive tool helps you design windows, menus, help screens, error messages, and forms. It includes an editor that lets you construct an image of your panel using simple commands to enter, edit, copy, and move text, as well as draw lines and boxes. You can then define the characteristics of the window that will contain the panel, such as its position, size, and title. Finally, you can specify the locations and types of fields in the panel.

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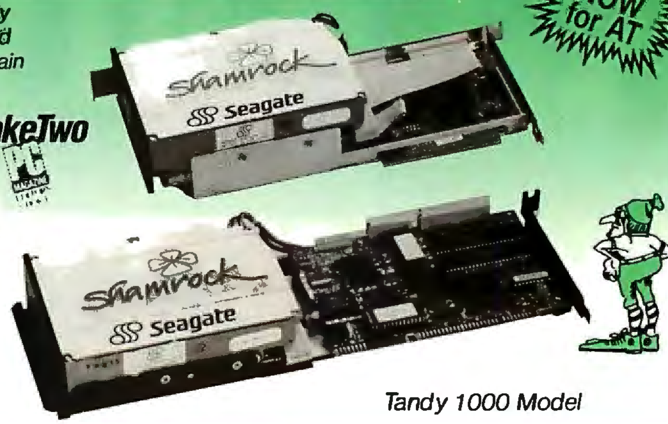

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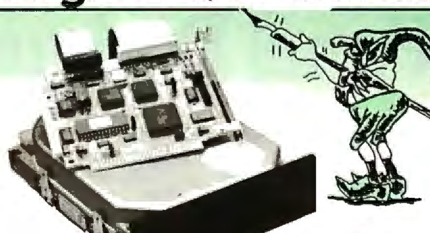

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UNCOMMON COMMONALITY

A few smart companies let you use the same software on different machines

Her analysis complete, consultant Leslie Scott presses the F7 key on her personal computer to tell WordPerfect to save the document. A few minutes later, Scott transfers the document to her company's VAX 8650 computer, giving her project team access to it so that the final document can be assembled for delivery to the client. After she has completed the transfer, Scott again calls up WordPerfect to look at another document—but this time she calls it up on the VAX.

The most noticeable difference between the microcomputer and minicomputer versions of WordPerfect is the slight delay in screen response due to the relatively slow 2400-bps transmission speed used by the VAX. Otherwise, everything looks the same, and the keystrokes are nearly the same. To run WordPerfect on the VAX, Scott is using a terminal emulator called the EM-220, which remaps the emulated VT-220 keyboard into one closely resembling the keyboard used by the personal computer version of WordPerfect.

Common Software

Leslie Scott is the beneficiary of a relatively new trend in business software that provides for a common user interface on vastly different computers. In this case, the common user interface is provided by different versions of the same software. WordPerfect Corp. has gone to great lengths to make its product look and work alike on different platforms. In addition, these products all support the same data formats, so that a file created on the VAX can be used on the personal computer without conversion.

While WordPerfect Corp. is certainly the leader in this trend, it is hardly alone. Last year, for example, Lotus Development Corp. announced that a version of its popular 1-2-3 spreadsheet was being developed for IBM mainframes. Lotus has yet to deliver on this product, but two other companies have not waited. Mosaic Software and The Santa Cruz Operation have both begun shipping Lotus-compatible products that run in Unix and Xenix environments.

Choose Your Partner

Finding compatible software that will cross system boundaries can be tricky. For example, not every Unix system will support a 1-2-3 clone. In addition, you have to decide what level of compatibility you need.

There are two levels of compatibility to consider when choosing these packages. The first involves the user interface, and the second concerns the data. In some cases, only one or the other is enough.

A common user interface eliminates retraining for the use of different platforms, and it greatly reduces error. People become accustomed to a single way of doing things, and they are not required to change when they use different computers. As more companies incorporate personal computers into their operations and begin to use them in place of terminals to connect with their mainframes, this elimination of retraining becomes significant in reducing costs.

The ability to use a common data format is a significant time saver as well. While a number of programs will convert one word processing or spreadsheet format to another, these conversion programs do not always do a complete job; you have to go through the file and clean up the places where the software failed in the conversion. This is especially the case with word processing programs,

continued

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ITEMS DISCUSSED

EM-220 .... $189
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Inquiry 981.

FoxBASE+ $395
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FoxBASE+ 386 .... $595
FoxBASE+ Mac $395
FoxBASE+ Mac Multiuser ... $595
Fox Software, Inc.
118 West South Boundary St.
Perrysburg, OH 43551
(419) 874-0162
Inquiry 982.

Lotus 1-2-3M
(price not yet available)
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
Inquiry 983.

SCO FoxBASE+ ...... $795 to $995
SCO Xenix .... $595 to $795
AT&T 3B2 .... $1295 to $2495
IBM RT PC $1495
NCR Tower .... $1295 to $2495
Sun-3 .... $1295
SCO Professional ..... $795 to $895
The Santa Cruz Operation
400 Encinal St.
Santa Cruz, CA 95061
(408) 425-7222
Inquiry 985.

Twin $99
Twin Advanced $149
Twin Level III $249
Twin/UX:
AT&T .... $495 to $1195
SCO Xenix $695
Microport $695
Prime EXL $1995
Microsoft $695
Mosaic Software, Inc.
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Inquiry 984.

WordPerfect 5.0 .... $495
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WordPerfect Data General .... $1800 to $16,500
WordPerfect 370 .... $6000 to $20,000
WordPerfect Corp.
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Inquiry 986.

which seem to have incompatible formats intentionally.

WordPerfect

WordPerfect is one of the best examples of software that supports multiple platforms well. It runs on IBM PC clones and the VAX, as I've mentioned. It also runs on IBM 370 architecture mainframes, Data General minicomputers, Apples, Commodore Amigas, and Atari STs, among others. In all cases, the data is compatible. If you create a file with WordPerfect version 4.2 on the PC, you can use that file on the VAX or the Macintosh.

User interfaces are compatible for the most part. The screen of the PC version of WordPerfect looks just like the one used by the VAX version or the Data General version. There are exceptions. The Macintosh version uses the Macintosh interface, for example.

WordPerfect Corp. has stated a goal of continuing the spread of its software to additional platforms. Already there are LAN versions of WordPerfect, and additional Unix versions are on the way.

Lotus Clones

Lotus 1-2-3 remains the top-selling business software in history. At this writing, however, there is only one version of that popular spreadsheet, and it runs on the IBM PC and compatibles. While Lotus has announced that an IBM mainframe version is in the works, there's no indication from Lotus when that will be forthcoming. In addition, Lotus said that it has no plans to develop software for other environments. It is this dearth of support on non-PC systems that has brought forth the clone makers.

One of the most ambitious makers of 1-2-3-compatible products is Mosaic Software. This company makes a variety of products for IBM PC clones, including one called Twin Level III that anticipates the long-awaited Lotus 1-2-3 version 3. In addition to its PC products, Mosaic says it will soon have versions of Twin for Unix and Xenix systems, and for the Macintosh as well. All these products will have the same user interface and will share the same data in the Lotus 1-2-3 format.

The Santa Cruz Operation, maker of the popular SCO Xenix, has also entered this segment of the market with SCO Professional. This product is compatible with 1-2-3 version 2.01 and has an identical user interface. SCO Professional works only with SCO Xenix, but that's not a great hardship, considering SCO's popularity.

These packages allow a user trained on the PC to use packages on a Unix-based multiuser system. They also let you create a spreadsheet file on your PC at home and send it to the office system when you get to work.

Back to dBasics

Another extremely popular package, dBASE III Plus, has the clone makers busily creating new versions. In one case, the resemblance was so great that Ashton-Tate boss Ed Esber sued Fox Software of Perrysburg, Ohio, as soon as he saw its version. Esber also had his lawyers sue SCO for manufacturing something called SCO FoxBASE+, a dBASE clone for Xenix.

One strong point of the SCO product is the ability to add dBASE language compatibility to a Xenix system. Of course, the user interface is essentially identical to that of dBASE. That's what made Esber so angry. In addition, FoxBASE+ is completely compatible with dBASE databases. All this compatibility means that you can create systems on a personal computer and then run them on a multiuser Xenix system.

While SCO markets the Xenix version of FoxBASE+, Fox Software has written its program for the Macintosh. Like its Xenix cousin, the Macintosh software will support dBASE language programs and use dBASE databases.

There was once a time when the rumor mill talked of a Unix version of dBASE from Ashton-Tate, but it never materialized.

continued

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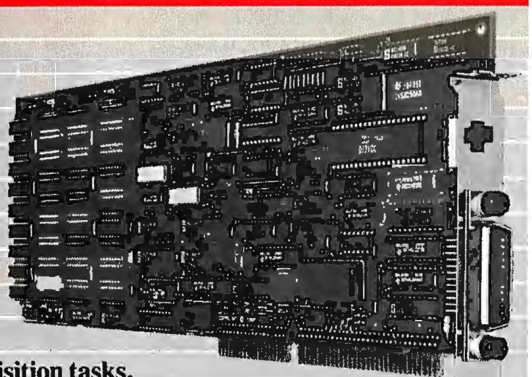

The Future

The need for compatibility of software and data across systems is clear. The success of WordPerfect, SCO, and others make it obvious. While the current spate of lawsuits as a form of competition will slow this down some, it is bound to continue. One reason it will continue is that companies like WordPerfect Corp. are so successful, in part because they support multiple platforms. Another reason is that IBM has endorsed the idea.

IBM's Systems Application Architecture is a clear move to a common user interface and compatible data. The specification sets out screen designs, for example, that include such things as a common method for operating pull-down windows. SAA is already implemented in Presentation Manager, and applications that work with Presentation Manager are expected to support SAA.

At this point, however, SAA is still mostly in the future. Today's users have to worry about software that is available now, on platforms already in their companies. That's why they will support the use of software that runs everywhere they work, just like Leslie Scott supports a system that runs WordPerfect on both her personal computer and the VAX.

Printer Server Update

In my December 1988 column, I talked about printer servers. These are devices that allow several computers to use the same printer. I aimed the article at two such devices that fit inside the HP LaserJet II, as well as a couple of other products from the same companies. Since then, I have been taken to task by several other manufacturers for leaving their products out of the column.

Some of these products are genuinely interesting, and some have features that could nearly classify them as LANs. Clearly, these machines deserve a look, and they will get one as soon as I can get a few to look at. They were not, however, the topic I intended to look at in my December column, which is why I didn't evaluate them. ■

Wayne Rash Jr. is a consulting editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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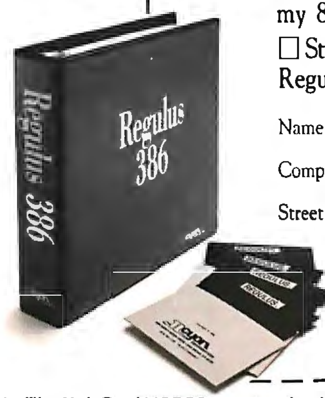

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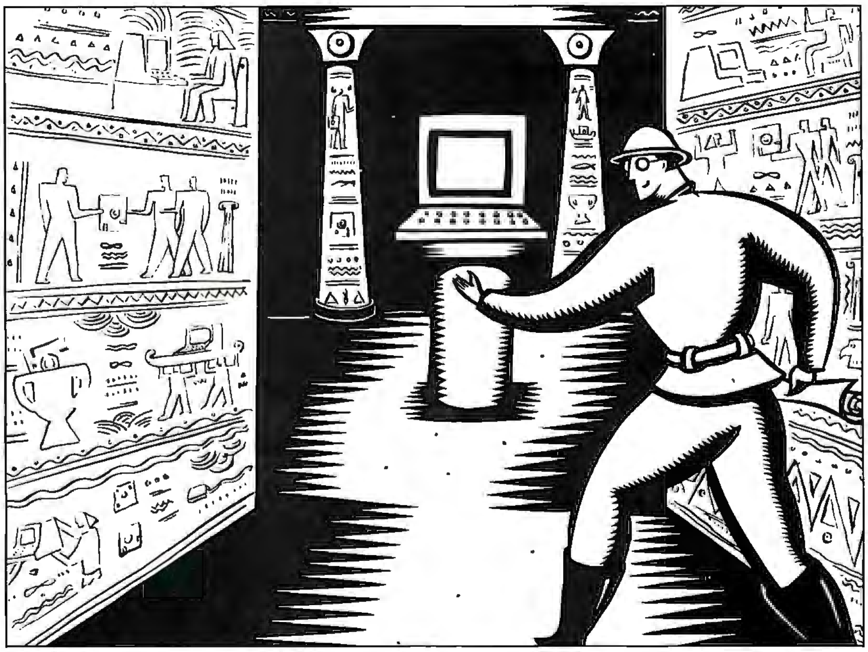
A PERFECT WORD PROCESSOR AT LAST?

The search for the ideal Mac writing application might be over



I've been looking for the "perfect" word processor for five years now. The search has gone from WordStar, WordPerfect, and Word on the PC to MacWrite, WriteNow, Word, MindWrite, and FullWrite Professional on the Mac with significant detours using the EMACS full-screen editor on DEC-20s and Unix minicomputers. While I've found some very good word processors, I've never encountered one that comes close to my ideals.

I use computers for lots of different purposes. But more than anything else during the day, I use them to write. I write programs. I write memos. I write class schedules. I write grant applications. I write course descriptions. I write E-mail. I write articles and columns—lots of articles and columns.

What I need is a *writer's* word processor. That means I prize editing features above all others, especially those that allow me to customize my editing environment.

On the Sun-3/50 workstation, I stick with GNU EMACS. It's a full-screen editor that's extensible with macros and macro libraries. I can edit programs, E-mail, schedules, and the other items using special editing environments that GNU EMACS allows me to load and save whenever I need them.

Until recently, I had been using Ashton-Tate's FullWrite Professional for my Mac II work. Although FullWrite isn't extensible like GNU EMACS, and it's still too slow (even on an 8-megabyte Mac II), it has a number of highly desirable writer's tools. These include the lifesaving Get Info command, which returns statistics on the length of an article; a good outliner; a dictionary; and a thesaurus. It also works well with the Tempo II and AutoMac III macro makers.

The program has many user-definable preference features (such as auto-saving a document) that help protect writers like me who do their best work at 3:30 in the morning but might forget to save their work. FullWrite also includes a bunch of jazzy desktop publishing features for those times when I actually have to print out something and make it presentable, as opposed to simply sending ASCII text across the electronic void.

But two weeks ago, things changed. I found Nisus.

Full of Features

Users of the QUED and QUED/M program editors will recognize the Nisus word processor immediately. Paragon Concepts, publishers of all three programs, has built Nisus into an unusually complete word processor based on these two popular program editors.

Like QUED and QUED/M, Nisus is fully extensible and comes with a complete macro programming capability similar to GNU EMACS. It includes many functions for managing text files. Nisus rounds out the feature list with some elegant writer's tools: a thesaurus, a dictionary, comparison operations, index and table-of-contents generators, line numbering, unlimited Undos, 10 Clipboards, and a Get Info command even more complete than FullWrite's.

Like FullWrite, it follows the practice of keeping the complete Font, Size, and Style menus on the menu bar where they belong, and not hidden in other menus like Word 3.02 does.

Besides its text and document management power, Nisus includes a bunch of desktop publishing and graphics design features that position it squarely in competition with FullWrite and Microsoft Word 4.0. This means I can use Nisus for

continued

my regular text work and still print off snazzy-looking reports and memos without having to switch back to FullWrite. Since I don't do much desktop publishing, but I do a lot of writing and editing, I set out to test Nisus from the perspective of a writer and editor.

The first glaring omission in Nisus is the lack of a good outliner, like you have in FullWrite or MindWrite. At least Paragon didn't bother grafting on a lousy outliner like the one in Word 3.02. So far, I've made up for this missing organizational aid by using Symmetry's Acta desk accessory outliner, but I really need Paragon to incorporate an outliner in its next release. The other missing piece is footnote/end note capability. Nisus can do neither, making it unusable as a scholar's word processor. These missing pieces keep Nisus from being the best writer's word processor currently available for the Macintosh.

Other than the missing outliner, I could find no real faults with Nisus in two weeks of constant use. One bit of strange behavior: The displayed text occasionally blanks out (except the line you are typing), usually when the screen is scrolling rapidly. This funky screen behavior doesn't lose any text, but it's something the Paragon folks should take a look at.

But let's get back to the good stuff. Nisus includes an auto-saving feature that allows you to auto-save a file to two different disk volumes: handy if you are especially paranoid about losing text. Nisus also saves a backup file in the same directory called `filename.bak` that includes the current text in the file buffer. Since Nisus is a memory-based word processor, these special file-to-disk saving strategies are particularly welcome and help prevent text losses. Unlike FullWrite's text auto-saving, you don't lose any text if you continue to type during Nisus's auto-save cycle. If you did that with FullWrite, you could lose several words, depending on the speed of your disk and how fast you type. Since I tend to type in bursts, FullWrite's auto-save behavior is a big nuisance that Nisus seems to have resolved.

Professional Tools

One of the slickest and most informative aspects of Nisus are its rulers. Besides giving you the usual information about the margins, tabs, line spacing, paragraph spacing, line justification, and the like, these rulers include an info bar that tells you which line you're on in a page (or document) and how many characters you've typed in a particular paragraph.

ITEMS DISCUSSED

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You can also bring up Nisus's graphics and drawing tools into an expanded ruler (called a graphics ruler) by toggling a graphics button that adjoins the ruler and sits on top of the vertical scroll bar. Another button toggles the text ruler functions, while a third pops up a partially editable page-preview display that lets you alter the number of columns, among other desktop publishing tricks.

The real power of Nisus, though, is its programmability. With a little practice and some patience, you can create a text-editing environment that rivals that of EMACS in many respects and exceeds it in others.

The heart of Nisus's programmability is its macros. The application comes with over a hundred macros that you can access immediately from the Tools menu. These range from simple font-change macros (e.g., changing bold to italic) to the sophisticated extraction of references from a document.

There's also a selection that converts QUED/M macros to run under Nisus. All supplied macros can be viewed and edited directly in Nisus, which makes it easy to see how the macro language is implemented. The macro language and Nisus both support variables. Text variables can be used to mark specific dates, times, document names, page numbers, or cross-reference listings.

The Nisus macro language lacks some of the programming features of a generalized language, however. It does not include any direct conditional structures similar to the IF...THEN...ELSE statements, nor does it permit looping. Most of the omissions in the macro language need not hamper the creation of sophisticated macros, though, since Nisus includes an extensive implementation of the Unix `grep` (for global regular expression parser) utility. This utility supports more kinds of pattern matching than you may have thought possible and includes metacharacters, literal text, wild-card text, and multiple string patterns. Nisus also supports recursive macro calls, so the lack of iterative control structures is not a big problem.

Besides writing and editing Nisus macros directly, you can also record them, which makes the Nisus macro facility easy for novices to use. The macro recorder captures commands (including other macros), keystrokes, or mouse-clicks to be executed. With Nisus's macro recorder, you would select text in a macro by using built-in keyboard commands, rather than mouse click-and-drag. All macros that are recorded or typed can be used from the Tools menu just like any Nisus command. You can modify any macro using the macro editor regardless of how it was created.

By Comparison

Nisus can compare any two files automatically, and rather painlessly. If (like me) you generate two drafts of a document, put them aside for a few days, and then come back to them to finish the job, an automatic file-comparison procedure is a gift from the heavens. No matter how clever I am at naming files, I always end up forgetting which file contains what information and in what state. Nisus pops up the two files side-by-side and compares them on-line for you in real time, pointing out where they differ. You can even tell Nisus to ignore blank spaces.

Sometimes it's handy to have two different files on-screen at the same time, especially if one is a notes file you refer to while writing. Nisus lets you scroll them synchronously, so you're always as far into one as you are into the other.

One of the things I always count on EMACS catching for me are orphan parentheses and quotation marks. Until Nisus, I couldn't expect the Mac to do the same for me. Nisus keeps track of all parentheses and quotation marks and alerts you to missing ones.

After I've used this program for several months, I'll be back with an updated report on how it's fared as my main Mac word processor. If its first two weeks are any indication, Nisus may end my search for the perfect word processor. ■

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."

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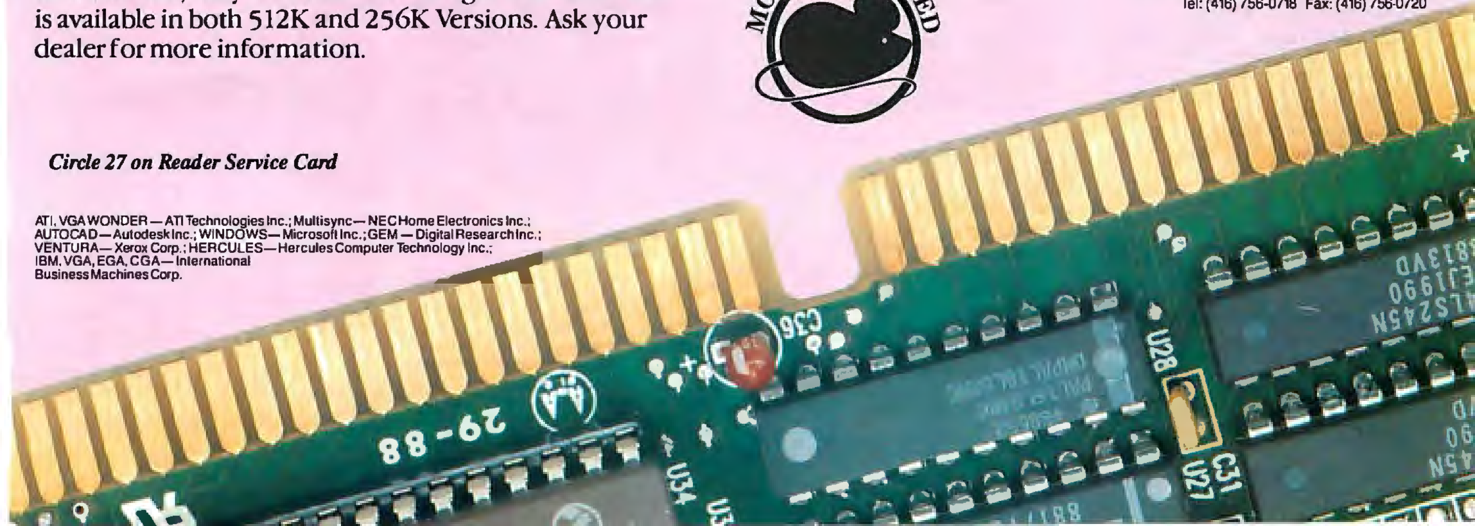

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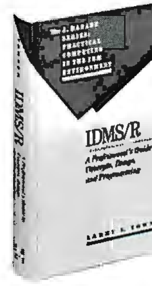

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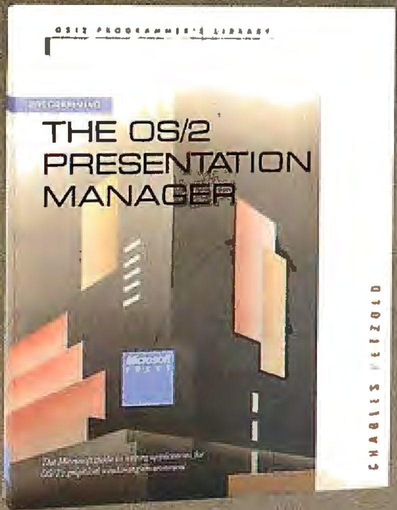

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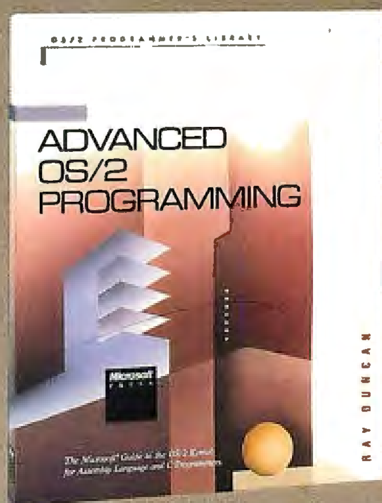

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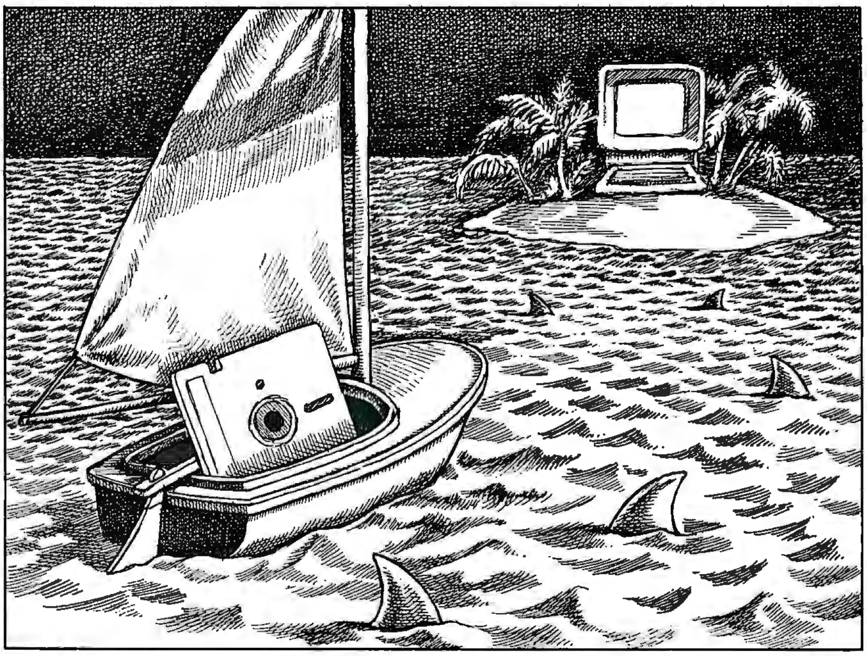
SETTING UP OS/2

Hints and tips to make the installation of OS/2 as painless as possible



Now that I've shown you how to assemble an inexpensive OS/2-ready workstation, I'll show you how to install OS/2 on that workstation. While I'm at it, I'll also describe how to install DOS and convince the two to coexist peacefully. (I'm assuming that you, like most of the world, also use either MS-DOS or PC-DOS and wish to continue using it.)

Before you get started, however, a word of caution: The OS/2 installation itself is simple, but it will remove DOS from your disk. Therefore, before you do anything else, ensure that you have a bootable DOS floppy disk around. I'll fix the DOS problem later with an inexpensive utility, but keep the floppy disk handy for now—you may need to get to DOS.

Why? The first reason that comes to mind is easy access to a text editor. Until you get comfortable with one of the OS/2 editors, you'll need your current one to modify CONFIG.SYS files and the like, and your current editor probably needs DOS to run. Remember, the days of the three-line CONFIG.SYS file are over—a minimum reasonable CONFIG.SYS file is more than a screen's worth of text, so you'll *need* an editor to handle CONFIG.SYS changes.

You can, of course, use your DOS editor in the compatibility box—oops, IBM doesn't call it the compatibility box anymore, it's now called the DOS mode session. But if you mess with the CONFIG.SYS file to the point where OS/2 won't boot, you'll have to do some surgery on the CONFIG.SYS file from a booted floppy disk. As OS/2 is too large to boot from a floppy disk, any editor started from a floppy disk *must* be a DOS program.

Also, be sure that you have 8 megabytes or more of free space on your hard disk, or you won't be able to install OS/2.

Next, back up the disks that OS/2 arrived with using DISKCOPY. When you copy the disks, first write-protect them. I stress this because I was reminded of this advice the hard way—I tried to boot OS/2 on a defective 1.44-megabyte floppy disk drive. The drive trashed the disk.

The (ahem) *original* disk.

I know that this is old advice, but please heed it—here at the Moulton, Minasi & Company Charles Babbage Memorial Computation Center, we've ended up with two bad 1.44-megabyte drives out of five: two bad Mitsubishis and three good TEACs. And I hear unconfirmed rumors that PS/2 1.44-megabyte drives are more problem-prone than the average drive.

However, if you decide to write-protect the backups, be sure not to protect the backup of the disk labeled Installation Disk. OS/2 writes some kind of log file to that disk while installing and won't install if it finds the disk write-protected.

You start installing OS/2 by inserting the Installation Disk into drive A and then rebooting. Your first indications of whether the process is working or not are the usual copyright notices and a five-digit *build number*. My build number is 88300 on regulation IBM OS/2 1.1. If you have IBM OS/2, you'll probably see the same number.

Don't worry about the amount of time required to boot OS/2. From the time that the disk starts to grind to the time it asks you some questions will be about 2 minutes. Remember, this program is loading into *megabytes* of space, so it will take some time.

After you see the opening screens showing *IBM* in 5-inch-high letters and

continued

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some basic instructions, you'll see a screen asking you whether or not to format the disk. If you have a disk larger than 32 megabytes and you intend to use both DOS and OS/2 on your machine, I'd recommend that you *not* allow the small installation program called the Installation Aid to format the disk. The reason is simple: To accommodate disks larger than 32 megabytes, OS/2 1.1 and DOS 4.x use a disk ID, or boot record, whose format is different from previous DOS boot-record formats. That boot record looks like a bad disk to DOS 3.3.

ITEM DISCUSSED

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Under DOS 3.3, as many of you know, a disk larger than 32 megabytes is addressed by using FDISK to "fool" DOS. You can use FDISK to partition a single physical disk into multiple *logical drives*, all 32 megabytes or smaller. Recall that FDISK under DOS 3.3 cannot create a partition larger than 32 megabytes. However, FDISK under DOS 4.0 and OS/2 1.1 *can* create larger partitions.

If you let OS/2 format your disk into a single logical drive larger than 32 megabytes, the only version of DOS that will be able to recognize these drives is DOS 4.x. So be sure to leave your options open—format the disk with DOS 3.3, use FDISK and FORMAT to create multiple logical drives, and *then* turn OS/2 loose.

Unpacking Takes Time

By now, the Installation Disk has loaded itself, as well as a minimal version of OS/2, onto the hard disk. This minimal OS/2 can't do anything yet except boot the Installation Aid. Reboot the system, and the Installation Aid will appear. It instructs you to insert, in turn, disks 1 through 4 in the drive and wait.

A word of advice—make sure you have something else to do, because it will take up to 10 minutes to read each disk. That's because the files on these disks are what IBM calls *packed* files—files shrunk with a compression algorithm of some kind. Bulletin board junkies in the audience will recognize the same idea in the form of files with the extension .ARC. Such files have been compressed to reduce transmission times. I suspect IBM compressed the OS/2 files to save on disk costs (1.44-megabyte floppy disks are, after all, still expensive) and so as to not shock people by presenting them with 10 1.44-megabyte floppy disks when they tried to install OS/2.

The files are uncompressed with the UNPACK.EXE utility provided with OS/2 1.1. IBM has a new file-naming convention—files whose names end with @ are compressed files. UNPACK.EXE looks for these files. (In case you're wondering, no Pack program is provided with OS/2.)

About 30 minutes later, you'll see a message telling you that everything is done, and you need only reboot to start OS/2. Reboot, and you'll see the initial Presentation Manager screen. The prominent feature of the screen is a window called Start a Program. By the way, if you look closely, you'll notice that something is a little strange about the text on the screen—PM uses proportionally spaced fonts. No kerning yet.

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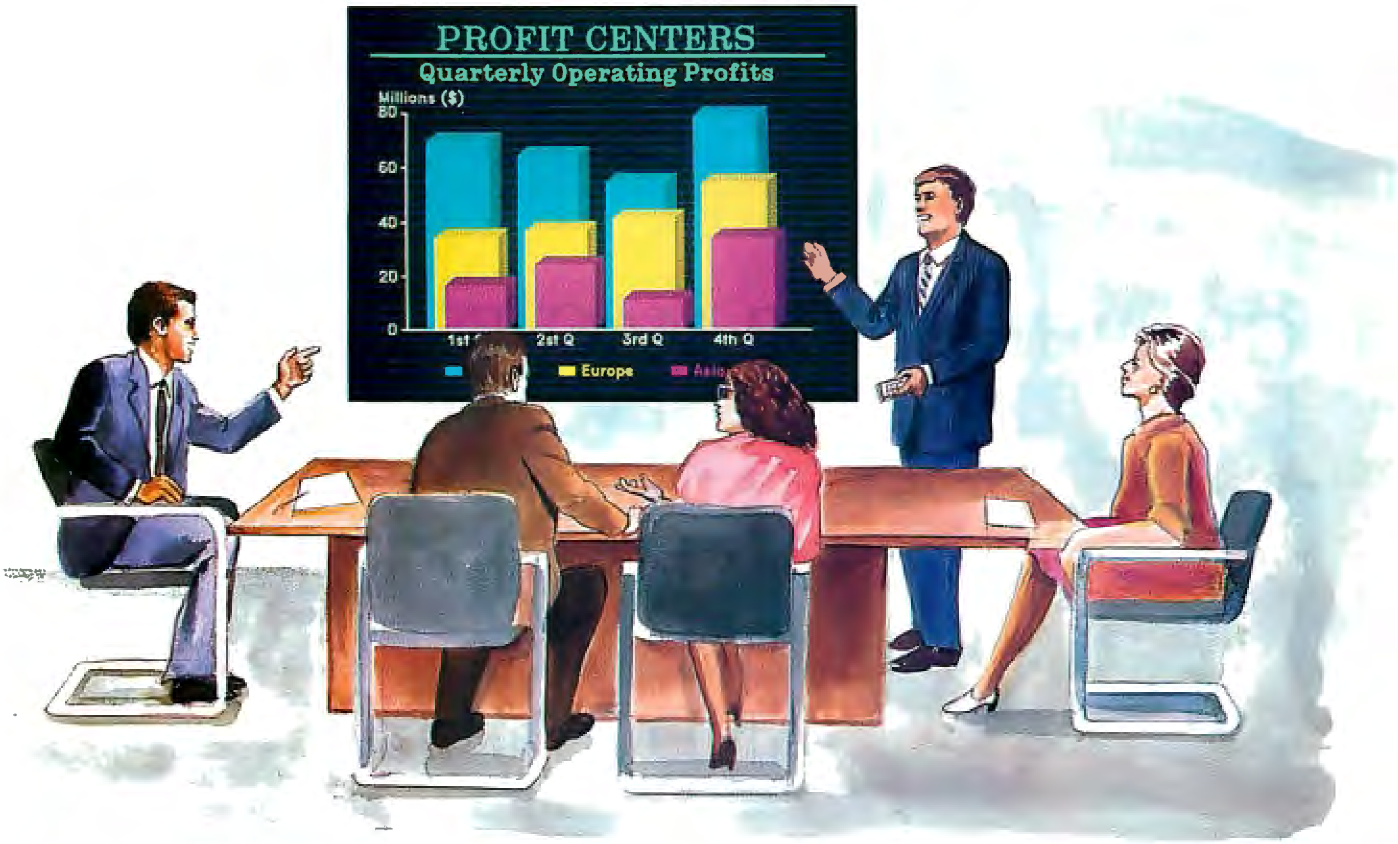

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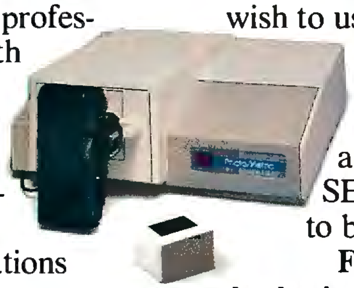

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Just to see if everything works, try moving the cursor in the Start a Program window to the OS/2 full-screen command prompt, then press Enter. You'll then see the familiar DOS-like C:\ command prompt. Run CHKDSK, and you'll find that OS/2 is installed into about 8 megabytes' worth of disk.

Adding DOS Back to the Disk

The IBM version of OS/2, as well as some other versions (Compaq's comes to mind), lacks a *dual-boot* option. This means that, as I said before, the installation wipes the DOS boot files—IBMBIO.COM and IBMDOS.COM if you have IBM, or Compaq DOS, IO.SYS, and MSDOS.SYS for MS-DOS—off the hard disk. You can hand-install a dual-boot option, but believe me, it's no fun. Bolt Systems, a small software company, has developed a terrific solution, which it calls MultiBoot.

MultiBoot moves the OS/2 system files and modifies the boot record on your disk so that DOS can be reinstalled with the SYS C: command. MultiBoot also lets you decide which is your default operating system. When you boot up your system, MultiBoot gives you a message like, "I'm going to boot DOS unless you press the Caps Lock key in the next few seconds, in which case I'll boot OS/2."

Once you've spent thousands of dollars on OS/2 and an OS/2-ready workstation, what's another $49.95 to have easy access to DOS? Highly recommended. [Editor's note: *For more on MultiBoot, see "MultiBoot Brings OS/2 Back to Earth" on page 100.*]

One Last Step...

Now you're set up to play around with OS/2. Before you do that, however, do yourself a favor and be sure to kill the spooler.

In the OS/2 conference on BIX, Ray Duncan and a host of helpful people field numerous questions, but the most common one is something like, "I keep getting fatal error messages from the print spooler. What am I doing wrong?" The answer from the experts is always the same: Shut the thing off. It is, as they say in the business, brain dead. How, then, do you disable it?

Believe it or not, the answer isn't obvious. First, activate the Control Panel. You can do this by navigating through the PM menus, or you can just create an OS/2 full-screen command prompt, then type PMCPL. Then pull down the Setup menu and select Spooler Options. You'll receive a box labeled "Spooler is selected" with an *X* in it. Just click on the *X* with your mouse, and "Spooler is not selected" will appear. The next time that you reboot, the spooler will not appear. Eventually, these spooler problems will be resolved. But for now, you should just disable it.

Next Month

Just what *are* all those 8 megabytes? How can I set up PM to start programs by themselves or in windows? Find out the answers to questions like these and yet more. ■

Mark Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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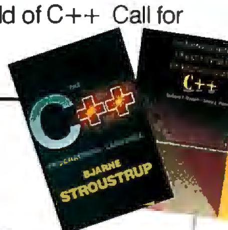

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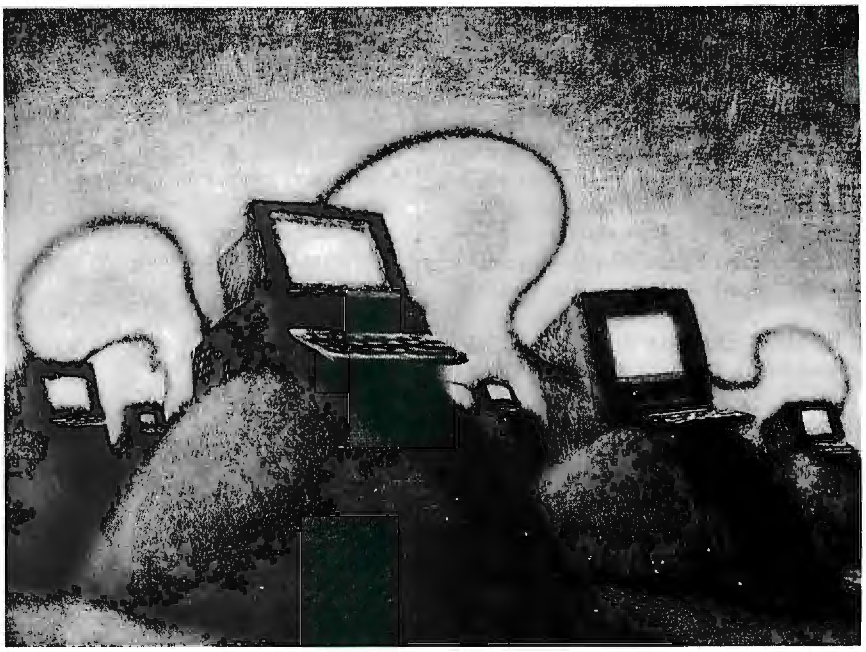
THE MAC MAKES CONNECTIONS

Several new products give the Mac real connectivity clout



References to the Macintosh in this column have been conspicuous by their absence. There are a few reasons for this apparent oversight. First, whether you're using a Commodore 64 or a Cray X-MP, moving bits through a telephone line or over a satellite link is accomplished in basically the same manner.

Second, I don't harbor any ill will toward the Mac, but I don't want to pony up the money for another machine to replace the one I have that works just fine. However, Apple has poured a lot of money into the Mac to equip it to take over the desktop publishing realm. As such, it's demanding better connections with the rest of the computer world.

At the recent MacWorld Expo, I saw several products that indicated a definite push toward connectivity. These weren't rushed or poorly thought-out products, but solid, well-planned devices and programs. What follows are some of the highlights.

Tour de Force

3Com put on quite a spectacle while introducing its connectivity products. Bill Krause, 3Com's president, lifted passages from several of President Bush's speeches during a press conference, claiming, "This has nothing to do with a thousand points of light, but may have to do with a thousand connections."

A heavyweight panel marshaled by 3Com during its press conference included former Apple evangelist Guy Kawasaki (now vice president of Acius) and Bill Campbell, president of Claris, who gave testimony to 3Com's newest products: An EtherLink/SE card and an enhanced version of 3+ for Macintosh LAN software.

Users of Macintosh-based LANs such as LocalTalk are locked into data transfer rates of about 230,000 bps. Although this speed is fine for small networks, large applications normally require Ethernet LANs with data transfer rates of 10 megabits per second. The EtherLink/SE card gives SE users on a LocalTalk network access to Ethernet speed.

In the benchmarks I saw, there was no contest between the performance of the EtherLink/SE card and the LocalTalk network; the EtherLink/SE card was clearly the winner. This card is especially handy for anyone who uses database applications or runs a desktop publishing program, such as PageMaker, over a network. These two applications ran as much as five times faster using the EtherLink/SE card.

The migration from LocalTalk to Ethernet is a snap, literally. The card snaps into the SE slot, and you can hook up the cable in 10 minutes. Using the EtherLink/SE card, you could, for example, go from a PhoneNET network running LocalTalk to Ethernet performance on your current twisted-pair wires.

Enhancements to 3+ for Macintosh now allow Macs on Ethernet or LocalTalk networks to use IBM PCs as servers. One Macintosh wag claimed, "The only real use for a 386 is as a server, anyway." 3+ for Macintosh software has supported the IEEE 802.3 Ethernet network adapters since 1987, but with the enhancements, it now supports Apple's LocalTalk PC adapter for PC servers as well.

This new version of 3+ software also fills a void: remote dial-in support for Mac networks. With remote access, you can share data locally or with a geographically separated site. This means that from home, you can access either your Mac or a PC server.

In addition to providing remote dial-in

continued

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access, the E-mail capability has been upgraded. The 3+ for Macintosh mail enhancements give Mac users "point and click" access to a list of all the individuals and groups on the network, without requiring the user to know correct spelling or server location. The enhanced mail features also include sorting of E-mail by sender, receiver, message date, or subject, and they provide automatic retrieval of mail in the background.

The E-mail industry has been trying to standardize auto-retrieval for some time. In fact, the new CCITT X.500 standard proposes this type of directory access. 3Com is definitely ahead of the game in this respect.

More Ether

Farallon Computing's PhoneNET system is about to get better. This system allows Macs to be configured on a network using simple twisted-pair phone wires. As good as PhoneNET is, it was still hampered by the 230,000-bps data transfer speed of LocalTalk. Not any more.

Farallon's newest product is an Ethernet connector that will allow PhoneNET users to upgrade to Ethernet speeds of 10 megabits per second. It has no formal name or model number yet, and it's not shipping yet. Farallon showed me how its new connectors will allow PhoneNET users to set up parallel PhoneNET systems in the same modular design as current LocalTalk PhoneNET systems.

The concept is strikingly simple. By using a series of modular connectors, controllers, and repeaters, you will be able to integrate an Ethernet-speed network into a working PhoneNET system. (The controllers handle the network management function, and the repeaters extend the range of a network.)

Viewing this new Ethernet setup, I saw nothing mysterious. The hardware is basically the same simple design as that of PhoneNET—except that, with the new configuration, you can operate at Ferrari-like speeds. The twisted-pair wiring and the plug-in connectors to the back of the Mac are the same. The connectors hook into Farallon's StarControllers, which are typically located in the telephone wiring closets. The controllers are then connected to the repeaters.

Farallon's design and implementation have a kind of simple elegance. Following this parallel network architecture scheme, even I could install an Ethernet-based network.

Larry Jones, Farallon's product manager, assured me that the new Ethernet products are IEEE 802.3 compatible. He also noted that the product will fully comply with the 10 Base T (emerging) standard designed for Ethernet on twisted-pair telephone wires.

I also looked at Farallon's Timbuktu/Remote screen-sharing software. Shared screens are something of a latecomer LAN application (if you don't count Doug Englebart's pioneering On-Line system developed back in the mid-1970s). In fact, screen sharing can be considered the fourth major LAN application after printer access, file service, and E-mail.

Screen sharing gives two people simultaneous access to the same information on both screens. Moreover, each user can manipulate the information on the other's screen from the local keyboard. Not only does screen sharing save you from going to another office just to confer over something, it eliminates having to crowd several chairs around the small Macintosh screen.

Farallon's first Timbuktu program was designed for screen sharing. But now with Timbuktu/Remote, those who are sharing that screen can be on opposite coasts, operating on separate LANs.

You can efficiently handle this process by tying together the two physically separated LANs via a high-speed modem. Once the link is established, a Boston user can control a San Francisco user's screen, and vice versa, just as if they were in the same room sitting at the same computer. The possibilities for this application are legion. Customer support suddenly takes a real-time approach. Researchers and educators can collaborate in real time.

When I used Timbuktu/Remote, I was able to perform several functions, including deleting files on the remote system (don't panic; it has a full security system, so only an authorized user can delete files) and writing to the remote computer's disk. I was able to select options such as "observe only," which, if needed, would have let me show the remote user a particular "how to" process without his or her interfering.

I was also able to transfer several files in either direction. The program created a "files received" folder on the Mac I was using, so I didn't have to hunt for the newly arrived files. I wasn't locked into this procedure, however, and I could have specified the folder in which I wanted to put the files. Should you want to transfer files and be productive at the same time, all these functions work in the background.

With Timbuktu/Remote, you also can set up your computer as an unattended host, so that you don't have to wait up for your late-night colleague. While you're watching "Late Night with David Letterman," on TV, your colleague can access your Mac. Of course, several layers of password security are built in, so you can tailor a remote user's access to your liking.

Hardware Bytes

All this connectivity is dependent on hardware of some sort. Two new products that I saw at MacWorld Expo bring this into sharp focus.

The first product is aimed at Apple's new Mac SE/30. With all the added horsepower under the SE/30's hood, Mac-to-mainframe connectivity should be a natural. With Apple's official announcement of the SE/30 only minutes old, Avatar Corp. announced MacMainFrame SE/30, a card and software combination with which you can connect the SE/30 to an IBM 3720 network. With this software, you can achieve full IBM 3278/79 terminal emulation and file

continued

ITEMS DISCUSSED

EtherLink/SE $595
3+ for Macintosh Enhanced
(due to be shipped in April) $495
3Com Corp.
3165 Kifer Rd.
Santa Clara, CA 95052
(408) 562-6400
Inquiry 1071.

MacMainFrame SE $795
MacMainFrame SE/30 .... $995
Avatar Corp.
65 South St.
Hopkinton, MA 01748
(508) 435-3000
Inquiry 1073.

PhoneNET Ethernet connector $1000
(estimated cost per node; not yet shipping)
Timbuktu/Remote $295
Farallon Computing, Inc.
2201 Dwight Way
Berkeley, CA 94704
(415) 849-2331
Inquiry 1072.

TeleBridge $499
Shiva Corp.
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When I used the MacMainFrame card, I liked the full-keyboard mapping that the software provided. There are also pull-down menus and cut-and-paste support for grabbing that particular piece of information from the mainframe.

But not all user interfaces are created equal. The solution? Create your own if you can. With MacMainFrame, you can. Avatar provides a programmer's toolkit that comprises Avatar's API, HyperCard API, and MacWorkstation TLPM, for development of customized interfaces. I cajoled a programmer-type friend, who works at the UC San Diego Supercomputer Center, into giving API a quick run-through. He was pleasantly surprised. I trust his judgment, and I'll pass it along to you. His assessment was "Primo."

The other piece of hardware at MacWorld Expo that impressed me was a modem-like device from Shiva called the TeleBridge. With this bridge, you can link geographically distributed LANs across the street, across the continent, or across the world. All you need is a clean phone line and a high-speed modem.

The TeleBridge is compatible with PhoneNET and LocalTalk networks and operates at speeds of up to 57,600 bps. (You'll need a leased line to get the maximum performance out of the modem.) TeleBridge weighs in at just 3 pounds and is small enough to fit on a desktop without intruding.

In the physical network, the TeleBridge sits right before the modem, and you'll need one on each end to make the whole setup work. The TeleBridge isn't multiplexed, however, and if someone else gets to it first, you'll have to wait to use it.

Shiva also includes Dial-In Network Access software, a nice touch. Essentially, with this software, you can dial into your local LAN, access the TeleBridge, and then access the remote LAN on the other end of the TeleBridge.

Shiva further includes Internet Manager software. Using this product, you can achieve network administrative control of both networks. You just plug in two connectors, connect the modem, and turn on the power. With the Internet software, any Mac on the network can act as an administrator. Thus, you can group networks into zones, control network traffic, and, if you desire, restrict access between zones.

Lead, Follow, or Get Out of the Way

There were several other network-related products that I didn't get to try out at the MacWorld Expo, but from the volume of products announced, it looks like Mac connectivity is certainly coming into its own.

From the days when company personnel smuggled their first Macs in through the back door, to today's purchase orders for Mac IIs, a lot has changed. Corporate MIS departments can no longer ignore the Macintosh as a viable computing resource. From all the products just announced, it's clear that Mac connectivity is on the front burner. ■

Brock N. Meeks is a San Francisco–based freelance writer who specializes in high technology. You can reach him on BIX as "brock."

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

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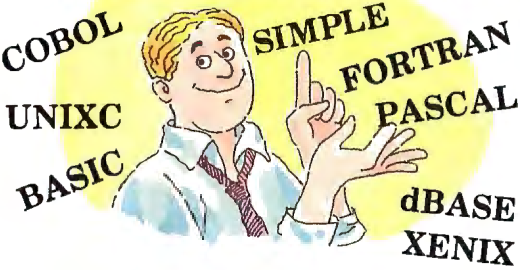

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TUESDAY, 5/2, 9 PM EST. "Which bus should you take to work?"
Some people who work in the IBM PC world prefer IBM's official Microchannel bus. Others are partial to the EISA bus. The pros and cons of each will be discussed at the IBM PC conference's regular "First Tuesday" session in May (after all, fare is fare). Come along for the ride. (join cbix, then select Band A, Channel 1)

THURSDAY, 5/11, 8 PM EST. "Live, from San Jose, it's DevCon"
Tune in David Szetela, Director of Developer Services, and find out what's been happening at the Apple Macintosh Spring Developer's Conference. (join cbix, then select Band A, Channel 1)

All-Month Conferences

Supermicros—Al Aburto, of the Naval Ocean Systems Center in San Diego, will join BIX moderators Ron Fox and Bill Nichols. Throughout the month, their topics will range from Unix to OS/2 to Pick to VM and VAX/VMS. Discussion may even extend to distributed systems, depending on your interest. (join supermicros)

R WARS—For 10 years, Unix advocates have divided into Berkeley and AT&T camps. But Berkeley faction leader Sun Microsystems announced a deal with AT&T to unify the two systems. Others rallied behind the Open Software Foundation's development of a Unix free from AT&T control. Find out more about the people, politics and technical merits of svr4, Motif, X/OPEN, POSIX and other Unix developments. (join rwars/unix.feud)

CAD—This month's CAD conference discussion, "Aspects of 3D CAD," will cover high-powered graphics for CAD—wire-frame vs. surface modeling, file interchange, etc. (join cad)

Uploads/Downloads

One of the major features of BIX is its Listings area—the place to find source and executable code for your computer, and to post programs and other information you want to share. Here's a sampling of what's in Listings, compiled by Sue Rosenberg, moderator of BIX's "other" group. The all-caps words starting each paragraph identifies the conference with which the files are associated.

IBM.PC: (Many picture files) "To-do" list, 386 fractals, unpack MAC "stuffit" file, graphic display of system configuration, hard disk utility, fractals for 386, drawings, golf handicap, rewrite floppy FAT. Latest ARC, DOS front end, financial calculator, IBM Tech Reference replacement, Telix reference guide. Arithmetic for Turbo 4.0, chart maker, Apple MS-DOS compatibililty guide.

C.LANGUAGE: Text reader, fast fourier transforms, more. INT 9 tsr, polynomial roots, case filter, string search.

IBM.AT: Pictures, along with ways to view them. Format 360K disks in 1.2 MB drive.

MACINTOSH: Pictures, desk accessories, game, Small-C benchmarks. Stack for developers, virus killers, Icon language, games, BYTE's Small-C benchmarks, read other stacks, explore stacks, show messages, field tabs, change startup to finder/multifinder. Diagnose networks, bit operations and base conversions, prettifier, BIX blinking utility.

WRITERS: Hugh Kenner's Word Frequency Counter.

SUPERMICROS: Sieve benchmarks.

UNIX: Clear screen, grep/egrep source, security book programs, programs from Topics in C.

UTILITIES: Access ANSI.SYS, hard disk utilities, allow multiple boot configurations, automate 3270 actions, text editor, list utility, EEMs driver, compress programs, set clock to Naval Observatory time. Latest ARC, DOS front end, SEA vs. PK lawsuit, file compare and update, file transfer for MS-DOS, system information, time and date stamp. Boot control, file compare, menu generator, tech reference, rename directory, system info, word counter, keyboard utility.

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The Third Dimension

Three-dimensional modeling brings new excitement to microcomputer-based CAD

Brad Holtz and Jon Udell

To build a computer-based model of a three-dimensional object five years ago, you'd have had to use a graphics workstation. Although such machines and their software remain the tools of choice for those who can afford them, microcomputer-based modelers are coming fast.

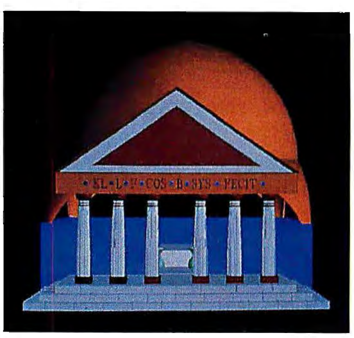
You can use the packages we review here to design buildings, landscapes, gear assemblies, molecules, automobile bodies, or robot arms. In all cases, you construct a single model. From that can flow orthographic drawings, a bill of materials, rendered perspective views from anywhere outside or even inside the model, an animated tour made from a sequence of such images, an analysis of the static and dynamic physical properties of the *entities* represented in the model, and a program that instructs a machine tool to cut a copy of the model.

Because these downstream applications are various and complex and often require additional tools, they're largely outside the scope of this review. We'll look mainly at the process of 3-D modeling as implemented in a representative sample of CAD programs: AutoCAD, CADKEY, DataCAD, DesignCAD 3D, MaxxiCAD, Mega Model, MicroStation PC, ModelMate Plus, and VersaCAD Design (see table 1). (Also see the text box "On the Horizon" on page 188 for a preview of three additional products—CADVance 3.0, FastCAD 3D, and SilverScreen—that were in late beta testing but should be available now.)

Most of these products are wire-frame-and-surface modelers: They can create what looks like a wire-frame model but actually represents a collection of planar surfaces. Three of the packages—DesignCAD 3D, ModelMate Plus, and SilverScreen—can attribute solidity to the space defined by such surfaces. These solid modelers herald an exciting new trend.

Within each school, the packages have very different personalities. Because 3-D CAD solves a highly complex problem—the abstract representation of physical structures—those personalities can be overwhelming. These programs are as big, powerful, resource-hungry, and difficult to master as anything you're likely to encounter on a DOS-based computer.

Some of these programs began as two-dimensional drafting programs and have grown into the third dimension, while others attacked 3-D modeling straightaway. Some appeal to mechanical engineers, others to architects and construction engineers. All provide modeling capabilities that existing CAD users have yet to fully assimilate and in some cases may not need. Those capabilities are redefining what is possible on a microcomputer and, consequently, enlarging the scope of the CAD market.



The BYTE Pantheon

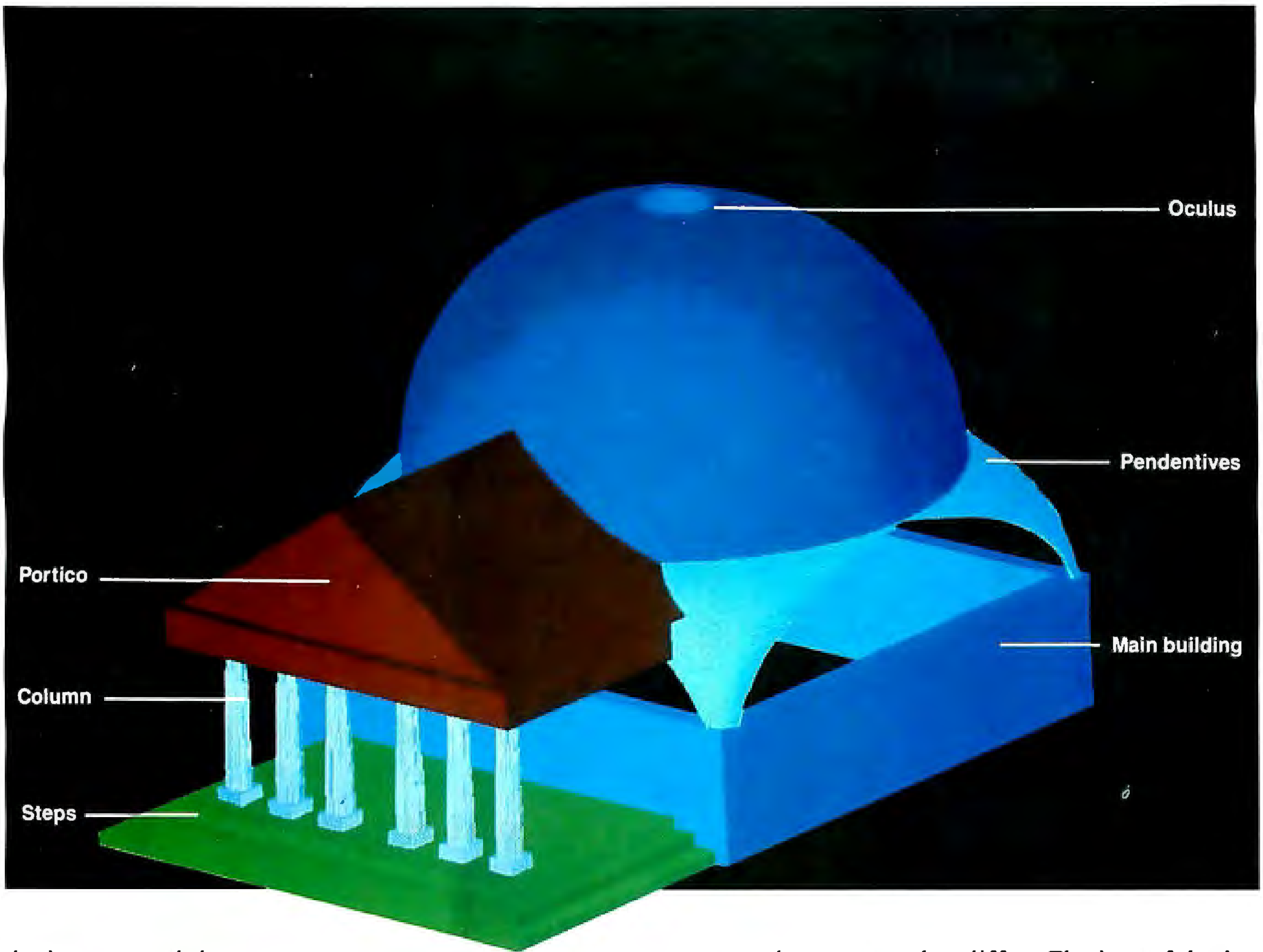
To focus our interaction with the products, we specified the model illustrated in photos 1 through 6. Our pantheon, though architectural in spirit, exercises a range of general-purpose modeling capabilities. Some features are quite basic; others demonstrate complex capabilities. The steps, for example, are simple foot-thick slabs—entities that all the packages can create easily. But the columns are harder to construct. We specified a shape defined by a spline (a curve governed by a set of control points) and then constructed the shape by revolving that spline about a vertical axis—the center of the column—to create a tapered column.

Pendentives are the spherical/triangular arches that support the dome. For these, we specified a *surface patch* or *Coons patch*, which defines a complex surface bounded by four curves. Failing that, a triangulated grid gives a reasonable approximation. The sloping roof of the portico can have a ruled or meshed surface—whatever works best to display the intersection of the portico with the dome and the pendentives. Our design calls for the pendentives, the dome, and the walls of the main building to have a thickness of 2 feet.

An *oculus* (the hole at the top of the dome) points up the differences between surface and solid modelers. With solid modelers, you build a dome and then punch a cylinder through it. With surface modelers, your choices are to prepare an arc that, when revolved, creates the dome with the hole in place or, alternatively, to create a complete dome, slice through its top with a cutting plane, and attach a circle to the resulting arc endpoints.

[Editor's note: *The specification for the BYTE pantheon is available in a variety of formats. See page 3 for details.*]

We attempted the pantheon twice with each package. First, we built the model on our own, to get a feel for how each package treats an inexperienced user. Then we solicited and followed the ven-



dors' recommended procedures to ensure that we saw each program perform to the best of its abilities.

Not every package can model the pantheon as specified, but the completeness of the exercise wasn't our only goal. Rather, we wanted to explore a variety of 3-D modeling features and to investigate differences in their implementations.

Managing Model Space

In 2-D CAD programs, you work in a single plane inhabited by points, lines, curves, and polygons. Three-dimensional CAD is an infinity of such planes through which 2-D primitives can extrude or revolve, producing rectilinear and curvilinear entities that have length, width, and height. It's not so obvious how to map those planes to 2-D I/O devices. Controlling the 3-D orientation of a model is a difficult task, one that these packages approach in a variety of ways.

A *view* is an image of the model. A *construction plane*—where you construct the 2-D primitives that become 3-D entities—may or may not correspond to a view. When the view and construction plane end up coinciding, 3-D modeling looks a great deal like 2-D drafting does.

For example, we often set up a plan (top) view to create the rectangles that extrude to become the steps of the pantheon, and an elevation (front or side) view to draw the half-outline of a column. That way, we could snap to points and measure distances on a 2-D grid. However, that 2-D grid needs a depth (or elevation) or z-coordinate that anchors it somewhere on the axis perpendicular to the screen.

The construction plane is first set to zero elevation. But before you draw the next step, you might want to raise it to an elevation of 1 foot. And to draw the outline of the first (leftmost) column, you could establish a plane that's 8 feet deep with respect to a front elevation view.

In some systems, you can move the origin of the construction plane to any 3-D location. Others work with a depth variable that you set to do the same thing. Still others use a 3-D cursor (a mouse- or keyboard-driven 2-D cursor that has an adjustable z-coordinate for raising and lowering the construction plane). Of course, most systems don't require that you move the construction plane in order to draw at a new elevation. You can also typically establish one point at the new elevation by entering its absolute coordinates and then specify remaining points relative to it.

The view and the construction plane can also differ. That's useful when you're making a 3-D entity from 2-D primitives that lie in different planes. For example, we normally chose an isometric view unrelated to the current construction plane in order to select the arcs that defined a surface patch for the pendentives. That makes it possible to see and point to arcs in the xy, xz, and yz planes all at once. Such a view requires the ability to rotate a model about the x, y, and z axes to any desired orientation or, equivalently, to move a *camera* or *viewpoint* around the model. All the systems do one or the other.

Views tend to proliferate as you build a model, and it helps to have tools that can manage them effectively. With AutoCAD, DataCAD, MaxxiCAD, MicroStation PC, and VersaCAD Design, you can save and recall named views. AutoCAD, MicroStation PC, and VersaCAD Design can list the names; DataCAD and MaxxiCAD let you select names from menus. CADKEY, Mega Model, and ModelMate Plus store views by number only and don't provide menus of views.

These 3-D CAD packages retain the layering and coloring techniques popularized in 2-D counterparts. With 3-D, these techniques are even more useful. Complex geometry can quickly turn into

continued

Table 1: *A summary of the CAD packages' features (N/A = not applicable).*

	Format	System requirements: Computer	Operating system	Display	RAM (bytes)	Price	Options
AutoCAD 10	4 5¼" or 3½" floppy disks	IBM PC XT or compatible with math coprocessor	DOS 2.0 or higher	Hercules, CGA, EGA, VGA, and upward	640K	$3000	AutoShade ($500), AutoCAD AEC ($1000)
CADKEY 3.12	16 5¼" or 10 3½" floppy disks	IBM PC or compatible with math coprocessor	DOS 2.0 or higher	Hercules, CGA, EGA, VGA, and upward	640K	$3195	Advanced IGES Translator ($1995), CADKEY Solids ($995)
DataCAD with DC Modeler	5 5¼" or 9 3½" floppy disks	IBM PC AT or compatible with math coprocessor	DOS 3.0 or higher	Hercules, CGA, EGA, VGA, and upward	640K	$3990	DataCAD Velocity ($2000)
DesignCAD 3D 2.0	6 5¼" floppy disks	IBM PC or compatible	DOS 2.0 or higher	Hercules, CGA, EGA, VGA, and upward	512K (640K recommended)	$399	N/A
MaxxiCAD 1.02	7 5¼" or 4 3½" floppy disks	IBM PC or compatible	DOS 2.0 or higher	EGA only	640K	$1895	N/A
Mega Model	3 5¼" or 1 3½" floppy disks	IBM PC or compatible with math coprocessor	DOS 2.0 or higher	Hercules, CGA, EGA, VGA, and upward	512K	$995	Mega Shade ($395), Mega Draw ($195), Mega List ($295)
MicroStation PC 3.0	10 5¼" floppy disks	IBM PC AT or compatible with math coprocessor	DOS 3.0 or higher	Hercules, CGA, EGA, VGA, and upward	640K	$3300	MicroCSL Customer Support Libraries ($1000)
ModelMate Plus 2.8	18 5¼" floppy disks	IBM PC XT or compatible	DOS 2.1 or higher	Hercules, CGA, EGA, VGA, and upward	512K (640K recommended)	$1495	N/A
VersaCAD Design 5.4	7 5¼" floppy disks	IBM PC XT or compatible with math coprocessor	DOS 2.1 or higher	Hercules, CGA, EGA, VGA, and upward	640K	$2995	N/A

an indecipherable tangle of lines, so it's necessary to be able to distinguish components and to view them selectively. To create such geometry, it's often necessary to put up temporary scaffoldings; these should occupy scratch layers so that you can easily remove them. And as you add 3-D entities to a model, it takes longer to redraw it, so you can often speed things up by inactivating layers that you don't need at the moment.

3-D Entities

Entities are points and their derivatives: lines, multisegment lines, arcs, splines, surfaces, and, in some cases, solids. Entities can look identical but consist of different primitives. For example, a wireframe cube can be 12 individual lines, a single rectangle with a thickness attribute, or a true six-sided box. These lookalikes behave differently. You can't remove one of the faces of an extruded rectangle, for example, as you can with a six-sided box. To distinguish lookalikes, it's useful for entities to be able to reveal their types. Commands that perform this function include AutoCAD's LIST, CADKEY's VERIFY, DataCAD's IDENTIFY, DesignCAD 3D's ID, MicroStation PC's ANALYZE, and VersaCAD Design's EXAMINE.

With surface patches, you can model curved shapes like automobile fenders and propeller blades. A surface patch is to the curves that define it what a spline is to its defining points: a smooth spatial interpolation governed by a set of constraints. With AutoCAD, CADKEY, DesignCAD 3D, and ModelMate Plus, you can apply a surface patch directly to four boundary curves. DataCAD and Mega Model offer a more limited facility. First, you create a patch, and then you attach it point by point to a skeleton of arcs.

The elements that compose repetitive

continued

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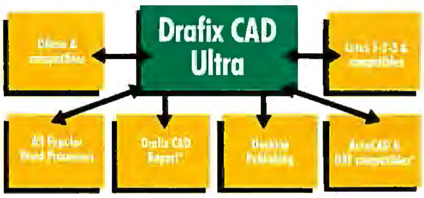

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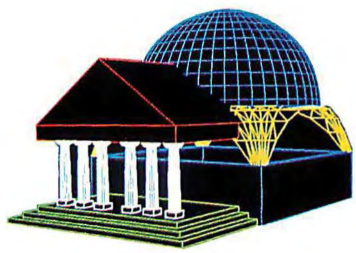
entities like the columns should belong to an aggregate that you can manipulate as a single entity and store for later use in other models. Such aggregations are variously called symbols, blocks, patterns, groups, and cells. DataCAD has a good scheme for managing symbols. It stores them in libraries and can display the contents of a library iconically; to retrieve copies of the column, you simply point to its icon. But all the systems support some sort of aggregation.

Hidden-line removal is the most basic visualization tool. It serves two basic purposes: During the construction of a model, it helps make geometry legible; it's also one way to present a finished model. Nearly all the packages include an integrated hide utility. Shading—the painting of the polygonal surfaces of a model—yields a more sophisticated presentation. DesignCAD 3D, MicroStation PC, and ModelMate Plus have integrated shaders; most of the other packages provide the tool as an option. All the packages give you some way to create a walk-through or slide show made from a series of images of your model.

CAD users are mechanical designers, urban planners, architects, furniture makers—anyone who must precisely document physical structures. Because they're used in so many different ways, CAD programs have traditionally been organized as extensible toolkits complete with their own built-in programming languages. That extensibility becomes even more critical with 3-D CAD. All the packages except DesignCAD 3D, MaxxiCAD, and Mega Model provide full-fledged programming languages.

Building a spiral staircase, for example, takes a fair amount of work in all the programs. Ideally, you'll want to capture that work in a script that you can reuse. But more important, with a true programming language, you can vary the elements of the staircase—the width, depth, number of treads, and so on—and thereby automate the construction of an entire family of related objects. Because most designers work variations on themes, the ability to set parameters for standard elements is essential.



We tested the packages on a Compaq Deskpro 386/20 with 4 megabytes of LIM/EMS memory and a VGA display. In the following sections, we describe our experiences building the pantheon with each package.

AutoCAD 10

Release 10 of AutoCAD is a comprehensive 3-D surface-modeling toolkit. You can specify point locations manually using absolute or relative polar or Cartesian coordinates, or you can do so automatically by snapping the 2-D cursor to grid points or to vertices, intersections, midpoints, perpendiculars, or tangents of 3-D entities. There are many ways to reorient the plane in which the 2-D cursor moves: You can translate its origin along the *x*, *y*, and *z* axes of an existing plane, rotate it about any of its axes, align it to any view, or align it to any plane in your model on which you can identify three points.

All the basic entities—lines, curves, and polygons—are defined by 3-D points. Thus, you can have any orientation in space. In AutoCAD, you extrude planar entities by modifying their thickness and elevation. To model the steps, for example, you can draw rectangular polygons on construction planes at 0-, 1-, and 2-foot elevations and then select them and change their thicknesses to 1 foot. Or you can draw all three rectangles in world space—the original zero-elevation construction plane—and then selectively modify both the thickness and elevation of each. There are many ways to select entities. In any view, you can refer to the last entity created, point to an entity, or use a window to select it.

AutoCAD can create a surface of revolution based on a line, polyline, arc, or spline. For the pantheon's columns, we specified 25 flutes (rotational divisions), 11 vertical divisions for the main part of the column, and nine vertical divisions for the capital. AutoCAD handled all these details easily; it lets you control the number of rotational and longitudinal faces in a surface of revolution.

Creating the arcs that define the pendentives was trickier. In such situations, it's often easier to enter the arc control points manually than it is to establish each construction plane and then draw with the cursor. Sadly, AutoCAD won't let you do that for arcs, so we had to establish separate *xy*, *xz*, and *yz* planes.

Once we did all that, the rest went smoothly. In an isometric view, we pointed to the four boundary entities—a 90-degree arc along the base of the dome, a right-angled polyline on top of a corner of the main building, and two vertical arcs joined to the endpoints of the arc and the polyline—and used the EDGESURF command to form a meshed surface.

AutoCAD's UNDO command is one of its strongest assets. Most of the systems can reverse the effects of one or more operations that create points, generate entities from points, and delete entities. AutoCAD does that and can also undo operations that copy, move, extrude, and revolve entities. Moreover, it can undo commands that change the orientation of a view, construction plane, or viewport configuration. Since 3-D modeling is tricky, a powerful UNDO command can make life much easier.

Like many of the programs, AutoCAD includes a programming language—called AutoLisp—that you can use to automate repetitive drafting and modeling operations. AutoCAD's command line is unique in that it interprets statements in that language. If you type (+ 2 2), AutoCAD answers with 4; if you type (command "line" '(0 0 0) '(0 0 1) ""), then AutoCAD will draw a line from the origin to a point one unit along the *z*-axis. That easy interaction between AutoLisp and AutoCAD simplifies the development of AutoCAD extensions.

CADKEY 3.12

Favored by mechanical engineers, CADKEY is nonetheless a general-purpose package with all the tools we needed to model the pantheon (see photo 1). Some conveniences, like multiple viewports and integrated hidden-line removal, are missing. But CADKEY has some powerful features that aren't found in the other wire-frame-and-surface packages.

Excluding the solid modelers, CAD-

continued

KEY did the best job slicing a cap from the top of the dome to create the oculus, because it can use a plane to section, or break, line entities. CADKEY also has an impressive set of masking tools (as does VersaCAD Design). You can, for example, create masks that help you to select all the points in the active layer, all entities that aren't circles, or all entities drawn in red.

Surfaces of revolution work well in CADKEY, although we couldn't easily get the columns to look like a stack of foot-high components. That's because CADKEY lets you control the number of rotational divisions but not the number of vertical segments. It also has an assortment of techniques for establishing a construction plane.

A particularly useful technique is the view/depth method. We used it to set a construction plane for drawing the outline of a column. First, we plotted a point at the column's center as seen in the plan view; then, we switched to an elevation view and used that point to anchor the construction plane at the correct depth.

CADKEY supports manual entry of points using polar or Cartesian coordinates. Its on-line calculator makes that task easier because you can store point coordinates in variables, do arithmetic on them, and then feed the results to CADKEY's *x*-, *y*-, and *z*-prompts (AutoCAD also has this capability).

View management isn't too convenient. The system controls views by number and offers eight standard views; you can define views 9 and above for your own use. You define a view by rotating the model about its axes. Each time you do so, CADKEY creates a new numbered view. We didn't realize this until we suddenly discovered that we had created 26 views. The problem is that there's no way to see and manipulate an annotated list of views. If you don't track them manually, things can become confusing.

CADKEY's rendering tools aren't part of the basic modeling package. A separate tool, Solids Synthesis, comes bundled with CADKEY. You can use it to create hidden-line and shaded views of a model. To use Solids Synthesis, you export your model to a CADL file. CADL is both a file transfer protocol and CADKEY's extension language.

Separately, in CADKEY, you execute a CADL macro that lets you take a series of snapshots of your model. Here, you specify the kind of rendering (hidden-line removal or shading) that you ultimately want. The macro writes an animation script that, along with the CADL description of your model, serves as input to Solids Synthesis. You then exit CADKEY and run Solids Synthesis, which reports the mass properties of the entities in the model, generates the rendered views in a new CADL file, and then quits. Finally, you reenter CADKEY and execute the CADL file that contains the renderings.

CADKEY displays the rendered frames in sequence. We found the process to be cumbersome, but to be fair, we hadn't anticipated exporting the geometry while we were constructing it, which is what you should do.

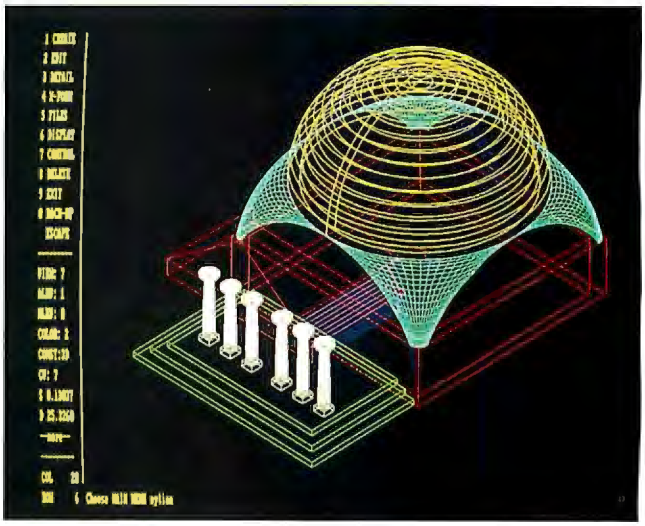


Photo 1: *A CADKEY image produced on a Mitsubishi 19-inch monitor; the adapter was an Imagraph Image Plus with 256 colors and 1280- by 1024-pixel resolution.*

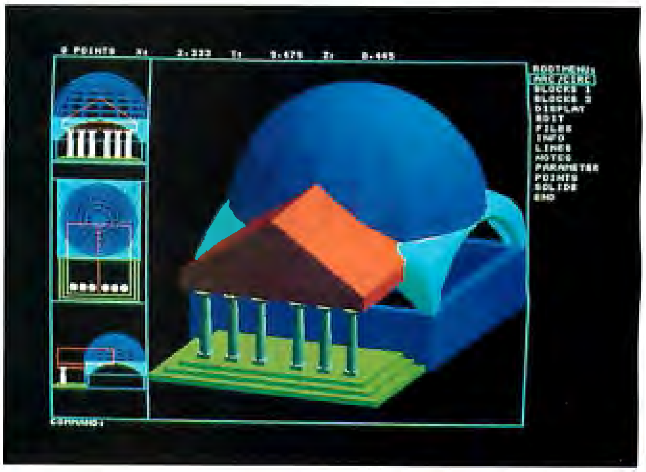


Photo 2: *A DesignCAD 3D image shown on a Mitsubishi DiamondScan monitor; the adapter was an ExtraEM with 256 colors and 640- by 480-pixel resolution.*

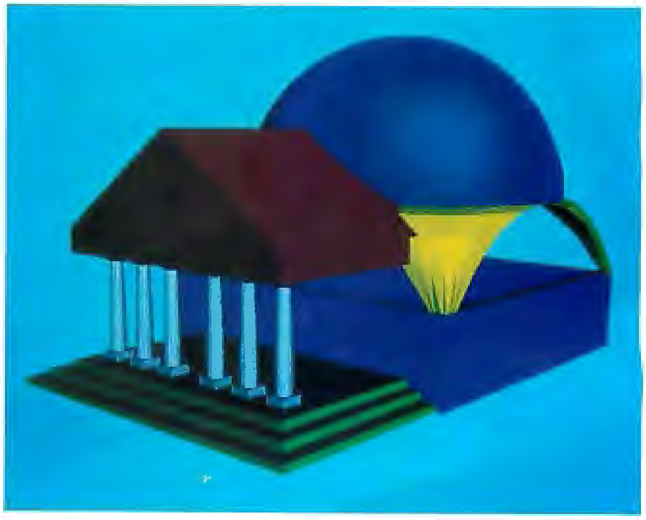


Photo 3: *A Mega Model image produced on an IBM 8514 monitor and 8514/A adapter with 256 colors and 1024- by 768-pixel resolution.*

We succeeded in rendering simple entities, but because Solids Synthesis is picky about the geometry you ask it to analyze (e.g., every entity must help to define a closed surface), we bogged down trying to create a pantheon rendering.

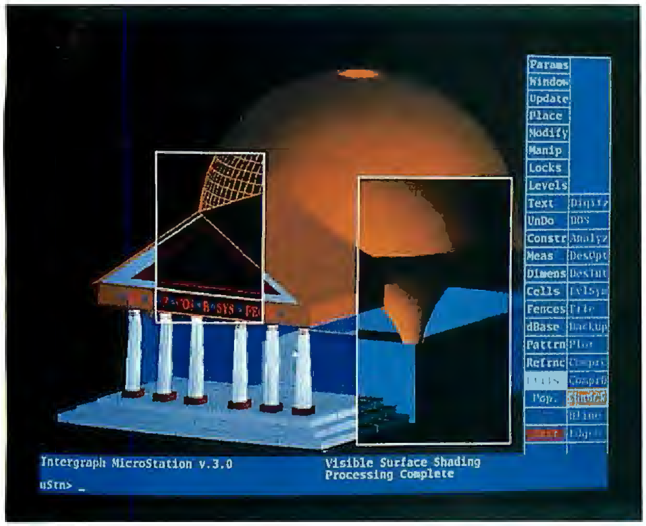


Photo 4: *A MicroStation PC image on an Intergraph 19-inch monitor with a Matrox board.*

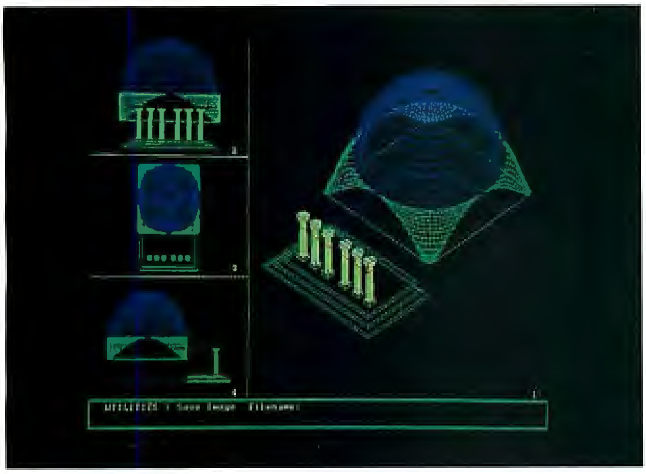


Photo 5: *A ModelMate Plus image produced on a Turbo PGA adapter with 256 colors and 640- by 480-pixel resolution.*

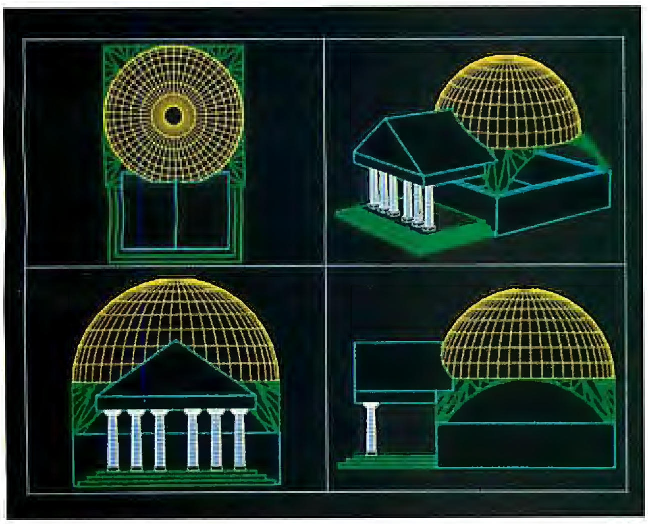


Photo 6: *A VersaCAD Design shade file transferred directly to film using a Hewlett-Packard 7510 film recorder.*

DataCAD

DataCAD's focus is the Architectural and Engineering Construction market. The basic package comes with an AEC macro package (written in DataCAD's extension language, DCAL) that automates the modeling of residential and commercial buildings. By using these macros, which are integrated with the program's menu system, you can quickly place walls, stairs, elevators, plumbing, and furniture in a 3-D model of a building. Hidden-line removal is built into the program. DataCAD Velocity is an optional rendering tool.

DataCAD supports surfaces of revolution and can do surface patches, but these features—not typically required for AEC applications—aren't as comprehensive or as easy to use as they are in some programs. You can draw splines but can't revolve them, so we built the columns from an arc and a polyline. We didn't succeed in modeling the pendentives, although in principle you should be able to do so by creating a 16-point surface patch and then maneuvering those points into position along the defining arcs.

DataCAD can store layer and color information on a per-view basis, as can MicroStation PC. This feature can be confusing at first. But once you understand what's happening, it provides powerful control over the display of the model. You can't see multiple views concurrently, but it's easy to rotate the model to create a desired view. You can then name it, place it on the menu of views, and select it. In addition, you can use three points to define a construction plane oriented anywhere in space. Keys on the numeric pad make the zoom and pan functions accessible and simple to use. The system supports polar and Cartesian coordinates. You can enter units in feet and inches, although the syntax is unusual: 14.4.1/2 means 14 feet and 4½ inches.

DataCAD's walk-through facility is particularly well done. You establish camera and target locations in plan view and then use commands like WALK FORWARD, TURN LEFT, and LOOK UP to move through the model; after each step, you can adjust the incremental distances and angles. Macros written in DCAL, a Pascal-like programming language, provide additional capabilities for managing views. You can create a slide show that presents a series of live (i.e., modifiable) views, animate the views established during a walk-through, and loop through all your named views.

DesignCAD 3D 2.0

At $399, DesignCAD 3D was the least expensive package we saw, yet it was one of the more powerful. The program has a complete set of surface-modeling tools. It can also create primitive solids like boxes and cylinders and can convert

continued

more complex wire-frame entities into solids. In either case, you can perform Boolean operations on the resulting solids. There are many ways to get things done: menus, a command line, and a mouse- and keyboard-driven 3-D cursor. Photo 2 shows DesignCAD 3D's finished rendering of the pantheon.

DesignCAD 3D's organization is unique. In most systems, you invoke a command (e.g., to draw an arc) and then place the defining points; typically, you see the arc drag or stretch to the desired shape. In DesignCAD 3D, you set the points first and then invoke the command. That may seem backward at first, but the method can be effective.

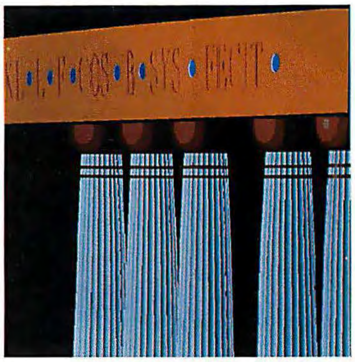
The points define everything in a model, so they have to be set correctly. When you're trying to anchor points to locations in 3-D space, you can often make mistakes—snapping to the wrong entity or specifying the wrong coordinate. In some packages, those mistakes leave debris on the screen that you must clean up before proceeding.

With DesignCAD 3D, you just undo one or more points and keep trying to reset them until you've got the right ones. That discipline can result in efficient use of the drawing commands. This style might not appeal to everyone, though. One thing you can't do, for example, is put an entity somewhere and then drag it to a new location; in some ways, therefore, the procedure is less flexible than the usual one.

But the points-first method does yield some interesting economies with respect to basic drafting. To draw the vertically oriented arcs for the pendentives, for example, we typically drew a three-point arc aligned with the front and one side face of the building, and then trimmed it in half. To do that in most systems, you draw a temporary line intersecting the arc's midpoint, select that line as a trimming tool, select the arc as the entity to be trimmed, invoke the trim command, point to the part of the arc you want to retain, and delete the temporary line. In DesignCAD 3D, you set two points—one at the endpoint of the part of the arc you want to remove and one at the midpoint. Then you issue a POINT MOVE command, and you're done.

We also found the EXTRUDE VARYING command intriguing. To model the 2-foot-thick walls of the pantheon's base, we drew a rectangle representing the bottom of the inner wall, followed by two points at the center of that rectangle and two more 11 feet above that. We then invoked EXTRUDE VARYING and associated scale factors with those points so that the rectangle extruded up to form the inner wall, out 2 feet for the top surface, down 11 feet for the outer wall, and in 2 feet for the bottom surface.

Most entities aren't automatically solids, but they can be converted to solids if need be. We modeled a 2-foot-thick dome using surfaces and used SOLID SET to convert it to a solid. Then we created a cylinder—which is a solid primitive, so it requires no conversion—and subtracted it from the dome to form the oculus. We could have done the same



kind of thing with the pendentives—joining exterior and interior surface patches, converting that and the portico to solids, and trimming—but we didn't, since the HIDE and SHADE commands gave good results using just an exterior surface.

MaxxiCAD 1.02

The least powerful of the systems reviewed, MaxxiCAD is nonetheless an attractive product. It features telescoping menus that display the path you've taken to each subcommand. And there's a palette of icon-based tools for controlling layers, colors, and line styles. You can dynamically resize and even overlap viewports, and you can rotate the views in them to any desired orientation. All views are active, so you can begin a line in one view and then continue it in another view (MicroStation PC does this, too). There's also a clever help system that uses animation to illustrate how to use the drawing commands. And the package has a good masking facility.

Still, modeling the pantheon was somewhat cumbersome. Since the system doesn't support polylines, we built the steps from individual line segments. But because MaxxiCAD can't treat a rectangle as a single entity, we had trouble selecting the rectangles we wanted to extrude. Splines can't revolve, so we built the column with an arc and several line segments. MaxxiCAD supports surfaces of revolution, but with fewer rotational divisions than the 25 we'd specified. When we saved the first column as a block, and then recalled a copy, it came back sans rotational surfaces. These can't currently be part of a saved block, so we ended up just copying the column.

Surface patches aren't supported, although MaxxiCAD did a nice job of plotting points on the pendentives' arc skeleton and, in an isometric view, snapping triangles to those points. The system felt sluggish, however, and the HIDE command garbled the image.

Mega Model

Like DataCAD, Mega Model targets the AEC market. It's strictly a modeler used to prototype 3-D designs; you can't add dimensions and produce finished orthographic drawings. The program is well organized and accessible to beginners. It's divided into three modules: one for creating entities, one for modifying them, and one for viewing them. Switching among the modules is relatively painless, but you do have to invoke a redraw in order to redisplay some derived surfaces, like domes.

In create mode, the system presents two views. One contains the construction plane. It defaults to the *xy* plane, but you can easily reorient to the *xz* or *yz* plane. The other displays a perspective view, which serves as a useful reference. In modify mode, the system defaults to four active views—front, top, side, and perspective—but you can fill the screen with any one of these for detailed work.

The view mode presents a plan view, which you use to move the camera and target, and a perspective view that shows the results. When you establish a new perspective, it automatically becomes the perspective view Mega Model uses in the create and modify modes.

Mega Model doesn't support relative Cartesian coordinates and has no convenient way to establish a nonrectilinear construction plane. You can rotate parts of the model, or the whole model, about any axis, but you can't align a construction plane with an existing entity (e.g., the sloping roof of the portico). You can manually enter *x*-, *y*-, and *z*-coordinates, however, so we had no trouble roughing in the rectilinear parts of the pantheon.

The complex surfaces were more challenging. Mega Model doesn't support true surfaces of revolution (Mega CADD says that a forthcoming release will). It also doesn't support splines. So we drew the column's outline with an arc and a polyline. Revolving that defeated us, so

continued

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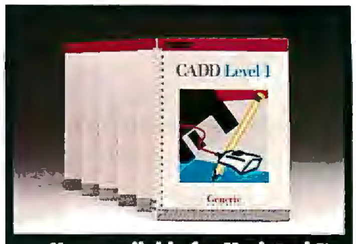

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On the Horizon

We looked at three packages that should be available by the time you read this: SilverScreen from Schroff Development, FastCAD 3D from Evolution Computing, and CADVance from IsiCAD. Each looks promising; here's a preview.

SilverScreen

This package makes solids come alive. Schroff Development's rendition of the BYTE pantheon was a tour de force of solid modeling. Everything in the model was a true solid. The pendentives were built by first sweeping a circle at the base of the dome down to join the outer top surface of the building. That, along with the dome itself, served as a tool for trimming the portico. Then the inner base of the dome was swept down to the inner top face of the building to define another solid; subtracting that from the first left an apron-like 2-foot-thick wall supporting the dome. That was halved and then halved again, and arcs that extruded along two axes formed templates that were used to tunnel out the arches. The resulting entity was copied radially to complete the pendentives. All the solid manipulation and the rendering that followed took place with remarkable speed.

SilverScreen manages entities in an innovative way; it uses an object-oriented database and, instead of layers, a tree-structured system. Entities have path names, just as Unix and DOS files do. Moreover, each has its own *entity space* (an imprint of the construction space that was in effect when the entity was created) and axes of rotation. So you can rotate an entity about its own axes at any time; you don't have to first align it with construction space.

Further, a child object inherits the orientation of its parent. For example, if you model a robot arm so that the root object contains an arm that in turn contains a hand, you can move the hand along with the arm and then rotate the hand about its own axis.

SilverScreen supports multiple viewports and can display different models concurrently in separate viewports—a unique feature. A 3-D cursor operates in all views, in a construction space that you can orient by means of a rich variety of techniques. SilverScreen can place patterns on surfaces and display those patterns with perspective. The program comes with built-in hidden-line removal and shading; the shader can optionally show the edges at the intersection of solids.

Extensibility was clearly a major consideration in the design of SilverScreen. The script language is syntactically equivalent to the menu-driven command system, and you can automatically generate scripts by recording sequences of modeling commands. There are also two full-fledged languages—one based on C, one based on BASIC—that can wield the system's resources in more sophisticated and programmatic ways. SilverScreen is an impressive package. Watch for it.

FastCAD 3D

FastCAD 3D lives up to its name—it's written in assembly language and is very fast indeed. FastCAD 3D can create a hidden-line rendering of the BYTE pantheon in about the time it takes some of the other programs to draw it in wire frame.

Macintosh users will like FastCAD 3D's interface. You access functions by way of pull-down menus and a palette of icons; there's also a command line, which is something we wouldn't want to live without. The program features a rich assortment of tools for moving and resizing windows and for adjusting the views displayed in those windows.

All views are active, although we ran into problems with the beta software when trying to draw interactively with the cursor. Grids and cursor tracking weren't working properly, so it was tough to snap to grid points and measure distances with the cursor. Evolution Computing assured us that these functions will work when it starts to ship the product.

FastCAD 3D provides two schemes for establishing a depth perpendicular to the screen. You can use the Zoom Plane command to slide the construction plane in and out along a given view's *z*-axis, or you can use Depth Mode to specify depth on a point-by-point basis. In the latter case, you'd draw the column's vertical line by marking its *x*- and *y*-coordinates in plan view and indicating its *z*-coordinate in a front or side elevation view. Both methods work, but they require functional grids and cursor tracking to be useful. In the meantime, we were able to build the pantheon by keying in absolute and relative coordinates.

FastCAD 3D's dome primitive did everything we wanted in a single command: You can control both the thickness of the dome and the size of an aperture at its top. The surface patch works well, and as a bonus, you can vary the resolution of all the meshes in a model—after they've been created—by adjusting a system variable. Remarkably, FastCAD 3D crammed all the data required to model the pantheon into 5K bytes—significantly smaller than the files other systems produced.

CADVance 3.0

CADVance is missing some features you need to model the pantheon. It doesn't support surfaces of revolution or Coons patches. But its Visual Guidance System interface deserves attention. The VGS displays three grids concurrently, aligned with the *xy*, *xz*, and *yz* planes, and you can lock the cursor to any of these. You can begin a line horizontally in the *xy* plane—using its grid—and then switch to the *xz* plane and use its grid to extend the line vertically.

In the midst of a drawing command you can switch planes, and you can even slide a plane in and out along its perpendicular axis. It's a wonderfully intuitive system that makes operating in 3-D space natural and easy. A powerful set of view controls enables you to orient the three interlocking grids any way you like; here, too, you can pause in the middle of a drawing command, make an adjustment, and continue.

Currently, there's an uneasy alliance between CADVance's 2-D and 3-D subsystems. As with VersaCAD Design, you create arcs and curves in the program's 2-D mode and then export them to 3-D mode. Some capabilities not yet natively supported, however, can be simulated with the help of CADVance's extension language; IsiCAD showed us how to make the pantheon's columns and dome that way. The program isn't intended to compete head to head with full-fledged 3-D modelers: It's a drafting tool with 3-D enhancements. Still, those enhancements are impressive; of all the 3-D interfaces we've seen, the VGS was the most comfortable.

we turned to Mega CADD for help. Its procedure entailed modeling a cross section of the column with thickness and then, in plan view, projecting the faces of the section to a point to form a wedge.

Once that was done, we manually rotated and copied the wedge to form a column. That worked for one column, but, due to constraints on how many points the system can manage, we couldn't do all six that way. Instead, Mega CADD recommended another procedure: extruding and scaling the top faces of three cylinders. That's an approximation of the desired shape, but it's the same one that you get by revolving a polyline.

We also had trouble creating the pendentives on our own. Here's the procedure Mega CADD described to us, the results of which appear in photo 3. Begin with a 90-degree arc at the base of the dome and then scale and lower it in several increments to create a frame. In plan view, identify the control points of these arcs and attach triangles to them. Finally, since you can't snap directly to the z-coordinates of the arc control points, switch to elevation view to move the triangles to the correct elevation.

To walk through the pantheon, you mark a series of camera and target locations in plan view; the PLAY command steps through the views you've established. For rendered views of the pantheon, we exported the model to Mega Shade; it's licensed from Control Automation and is functionally equivalent to the rendering tools built into ModelMate Plus.

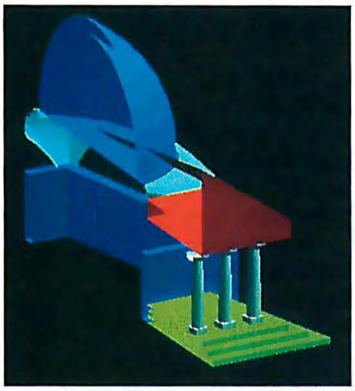
MicroStation PC 3.0

MicroStation PC is a sophisticated general-purpose package that's attractive to organizations that also use its VAX-based counterpart, IGDS, but that stands alone as a powerful microcomputer-based surface modeler. The package comes with three weighty manuals, and it's not the type of program that you can learn through casual use. But it does everything a surface modeler must do—with class.

MicroStation PC supports multiple active views and can display layers on a per-view basis. The construction plane is governed by a depth variable that's convenient to set. For example, to set the depth for drawing a column outline in front view, you set a point in the top view on the column's center, invoke the ACTIVE DEPTH command, and point to the window containing the front view.

MicroStation PC handled the pantheon's columns nicely. The grid can display major divisions in feet and minor divisions in inches, which makes it easy to mark off points for the arc in an elevation view. Another useful feature is tentative point-snapping. Pressing both of the mouse buttons simultaneously (we used a Microsoft Mouse) or the middle button on a three-button mouse establishes a tentative point. If it's the correct one, you press the left button to accept it. MicroStation PC's UNDO command can unwind a whole sequence of construction steps, although you can't undo view rotations and zooms as you can in AutoCAD.

Intergraph showed us yet another way



to build the pendentives. First, we established a 90-degree arc at the base of the dome—actually, a *shape* made of two arcs joined at the endpoints—so we could model the dome with thickness. Then we set a point directly above the corner of the building at the same elevation as the base of the dome. With the system's scaling factor set to 0.8 and that point as a reference, we repeatedly executed the PROJECT SURFACE command.

The result was a series of diminishing arc shapes that descended from the base of the dome to the top of the building along a curved path equidistant from the control point. PROJECT SURFACE, which we also used to form the steps, the block at the base of the column, and the walls of the building, joins the surfaces that it projects, creating enclosed solid-looking objects. Given that MicroStation PC doesn't yet support true surface patches, this was a good solution.

MicroStation PC includes integrated hide and shade utilities. We couldn't run the shader because our VGA supported just 16 colors, and we'd have needed 256. But hidden-line removal worked well—it was faster than on most other systems. You can even fence a portion of a model and restrict rendering to just that portion. Photo 4, provided by Intergraph, shows a fully rendered view of the pantheon. Finally, MicroStation PC is built to take advantage of a network; multiple users working on a large project can share *reference files*. That facilitates interdisciplinary work and avoids duplicate storage of data.

ModelMate Plus 2.8

ModelMate Plus concentrates strictly on 3-D modeling. And like DesignCAD 3D, ModelMate Plus can work with solids. These two packages (and SilverScreen, which is discussed in the text box at left) were the only ones able to represent the dome as a 2-foot-thick solid and then cut the oculus by subtracting a solid cylinder from it (see photo 5).

A version of ModelMate Plus's core program is also available from Generic Software. Generic 3-D Solids is less expensive, but it doesn't include ModelMate Plus's modules for Boolean operations, mass properties analysis, and file conversion. If you add these optional modules to 3-D Solids, the package costs a bit more than ModelMate Plus.

ModelMate Plus's interface isn't as smooth or consistent as DesignCAD 3D's, but it got the job done. A construction plane, which you can display as a rectangular icon, guides the placement of most entities. When you add an entity, its 3-D center is initially at the origin of that plane (i.e., at the center of the rectangular icon). This can be disconcerting. For example, when we added a box to create the first step, we expected that it would materialize on top of the construction plane. In fact, it appeared 6 inches lower, so that in elevation view the plane was halfway between the step's top and bottom faces.

It was simple to move the step up 6 inches. But, in general, this method requires that you halve all x-, y-, and z-dimensions in order to orient the construction plane correctly. Control Automation plans to change this in a future release; according to the company, a significant rewrite of ModelMate Plus's interface was in the works as of this writing.

ModelMate Plus's 3-D cursor is both its most powerful and most confusing feature. Unlike the other packages, this one doesn't present a cursor when you boot the system. Only when you ask the system to add an entity can you invoke the cursor, by pressing the space bar. It's both a mouse- and keyboard-driven cursor and a menu of subcommands that you use to snap to locations, enter absolute coordinates, and draw splines and arcs. We thought that this made ModelMate Plus difficult to explore and to learn.

After getting the hang of the system,

continued

COMPANY INFORMATION

American Small Business Computers, Inc.
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Inquiry 1045.

Autodesk, Inc.
(AutoCAD)
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Sausalito, CA 94965
(415) 332-2344
Inquiry 1046.

CADKEY, Inc.
(CADKEY)
440 Oakland Rd.
Manchester, CT 06040
(203) 647-0220
Inquiry 1047.

Computer Resource Technology Corp.
(MaxxiCAD)
2164 East Broadway
Tempe, AZ 85282
(602) 921-9638
Inquiry 1048.

Control Automation, Inc.
(ModelMate Plus)
P.O. Box 160100
Altamonte Springs, FL 32716
(305) 682-7077
Inquiry 1049.

Evolution Computing
(FastCAD)
437 South 48th St., Suite 106
Tempe, AZ 85281
(602) 967-8633
Inquiry 1050.

Intergraph Corp.
(MicroStation PC)
One Madison Industrial Park
Huntsville, AL 35807
(800) 345-4856
Inquiry 1051.

IsiCAD, Inc.
(CADVance)
1920 West Corporate Way
P.O. Box 61022
Anaheim, CA 92803
(714) 533-8910
Inquiry 1052.

Mega CADD, Inc.
(Mega Model)
65 Marion, Suite 301
Seattle, WA 98104
(800) 223-3175
Inquiry 1053.

Microtecture
(DataCAD)
1224 West Main St., 4th floor
Charlottesville, VA 22903
(804) 295-2600
Inquiry 1054.

Schroff Development
(SilverScreen)
18 Ash Swamp Rd.
Scarborough, ME 04074
(207) 883-3936
Inquiry 1055.

Versacad Corp.
(VersaCAD Design)
2124 Main St.
Huntington Beach, CA 92648
714-960-7720
Inquiry 1056.

we were able to build all the pantheon except the pendentives. And with Control Automation's help, we succeeded in doing that. After establishing the four boundary curves—using the 3-D cursor in an isometric view to snap to locations on a set of reference arcs—we selected the curves and applied the patch.

In ModelMate Plus, the selection of entities, or of polygons within entities, works differently than in most systems. Instead of pointing, you scroll through a list of entities—each is highlighted in turn—until you reach the one you want. You can also select an entity by specifying its numeric handle, but since there's no way to name entities or to annotate a menu of numbers, that's not too useful.

Cutting the oculus in the dome was straightforward. We added a cylinder with a diameter of 6 feet, then used the Boolean utility to subtract it from the dome. It prompted for the numeric handles of the entities involved, forked a separate executable to perform the Boolean operation, and returned us to ModelMate Plus's main menu. When we reloaded the model, the cylinder was gone and the oculus had been formed.

VersaCAD Design 5.4

VersaCAD Design 5.4 did a good job with the pantheon (see photo 6), but we had a hard time figuring out how to construct it. That's partly because VersaCAD Design doesn't integrate 2-D drafting and 3-D modeling—they're two separate modules. Moreover, the 3-D modeler itself is divided into two parts—a Create environment in which you construct the elements of a model, and a Scene environment in which you assemble those elements. To model the pantheon, we used all three modules.

You can create splines only in the 2-D drafting module, so we created the outline of the column there. The surface of revolution command resides only in the Create environment, so we revolved the column's outline and made its components into a block there. Finally, we imported the block into the Scene environment to duplicate the columns and place them on the steps. When moving from one environment to another, we frequently had to reset the color, layer, grid, snap, camera, and target. These aren't global settings in VersaCAD Design—they're module-dependent.

Revolving a column, saving it as a block, and inserting copies of the block took a long time. And screen refreshes took longer than with, say, AutoCAD or CADKEY, despite the fact that VersaCAD Design's triangulated representation of the pendentives used fewer surfaces. A graphics card that supports display list processing (off-CPU vector computation) would have speeded things up. Versacad claims that its system makes efficient use of such coprocessors.

Despite these frustrations, VersaCAD Design impressed us as a powerful 3-D package. We particularly liked its implementation of a 3-D cursor. No matter what the active view, you can move the mouse cursor along the *x*-, *y*-, and *z*-axes of a world coordinate system. Hot keys can anchor the cursor along any one, any two, or all three of the axes. To create an arc at the base of the dome, we locked the *x*- and *y*-axes so the cursor could move only along the *z*-axis, set the *z*-coordinate to 22′, and locked *z* and unlocked *x* and *y* in order to draw the arc's control points.

Because you can move along all three axes and because VersaCAD Design displays all views in perspective, the cursor takes some getting used to. Moving the mouse up, down, left, or right on your desktop translates into quite different movements of the cursor on the screen; initially, it's easy to lose track of the cursor entirely. But the technique is powerful, and with practice, you can operate almost entirely in a perspective view that helps you make sense of the geometry you create.

VersaCAD Design offers another handy navigational aid. In object snap

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mode, the cursor will move only to the vertices of entities. That, in conjunction with a feature called Big Points that enlarges the vertices, made it easy to attach a network of triangular surfaces to the arcs that define the pendentives.

The Perspective View

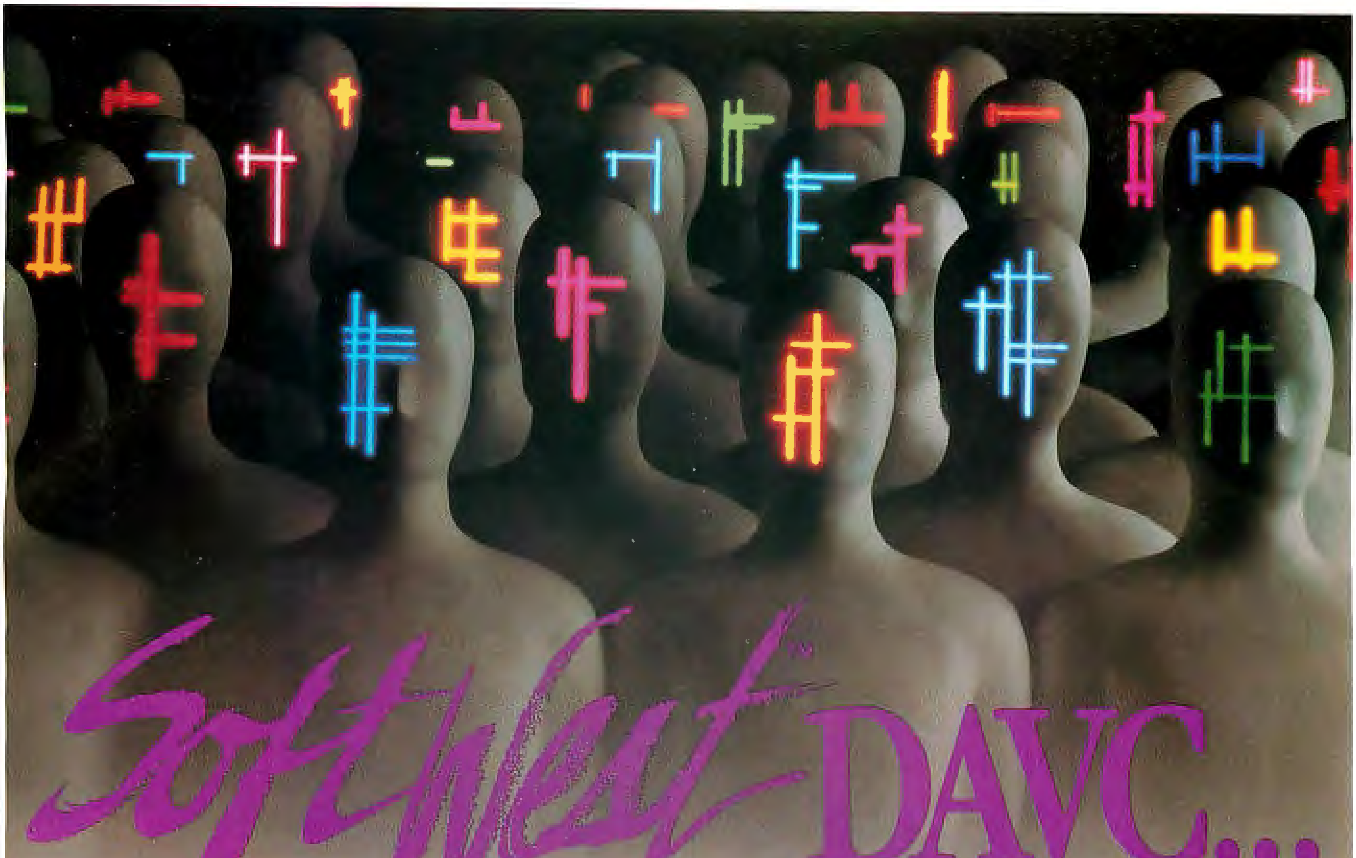
The 3-D CAD market is changing on a monthly basis; we've just taken a snapshot of it. The traditional CAD packages all have unique strengths and deserve their solid reputations. AutoCAD is both powerful and forgiving; it offers many ways to get things done, and if you run into trouble, you can always use UNDO and try another approach. CADKEY's 3-D features are well integrated. The program supports one of the richest sets of geometric primitives and tools for selecting, stretching, trimming, and slicing those primitives.

DataCAD is a strong AEC package with full 3-D capability and an especially useful walk-through facility. MicroStation PC's reference files and network support make it an attractive choice for multiuser projects. VersaCAD Design's 3-D cursor works as well as any we've seen. The program is slow on a standard VGA, however. More than most of the other programs, VersaCAD Design requires a graphics adapter with a display list processor.

The modeling packages have unique strengths, too. DesignCAD 3D combines effective modeling with true solid manipulation. Don't be fooled by the remarkably low price; this program can really perform. Both MaxxiCAD and Mega Model offer attractive and well-organized interfaces that make them easy to learn and use. ModelMate Plus can also do solid modeling, and it does mass properties analysis as well.

The story isn't over yet. These 3-D CAD programs initially appeared on low-end hardware in response to the needs of users of traditional 2-D CAD packages. But the migration of 3-D modeling to the microcomputer is attracting new kinds of users, who in turn influence the development of these products. Expect more and better integration of 2-D drafting and 3-D modeling and a strong move toward solid modeling. These are exciting times for CAD, and the best is yet to come. ■

Brad Holtz is president of WBH Associates, a CAD consulting firm in Bethesda, Maryland. You can reach him on BIX c/o "editors." Jon Udell is a BYTE technical editor. He can be reached on BIX as "judell."



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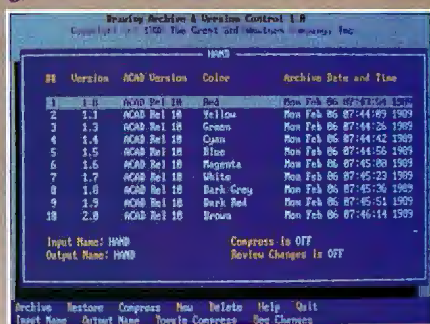

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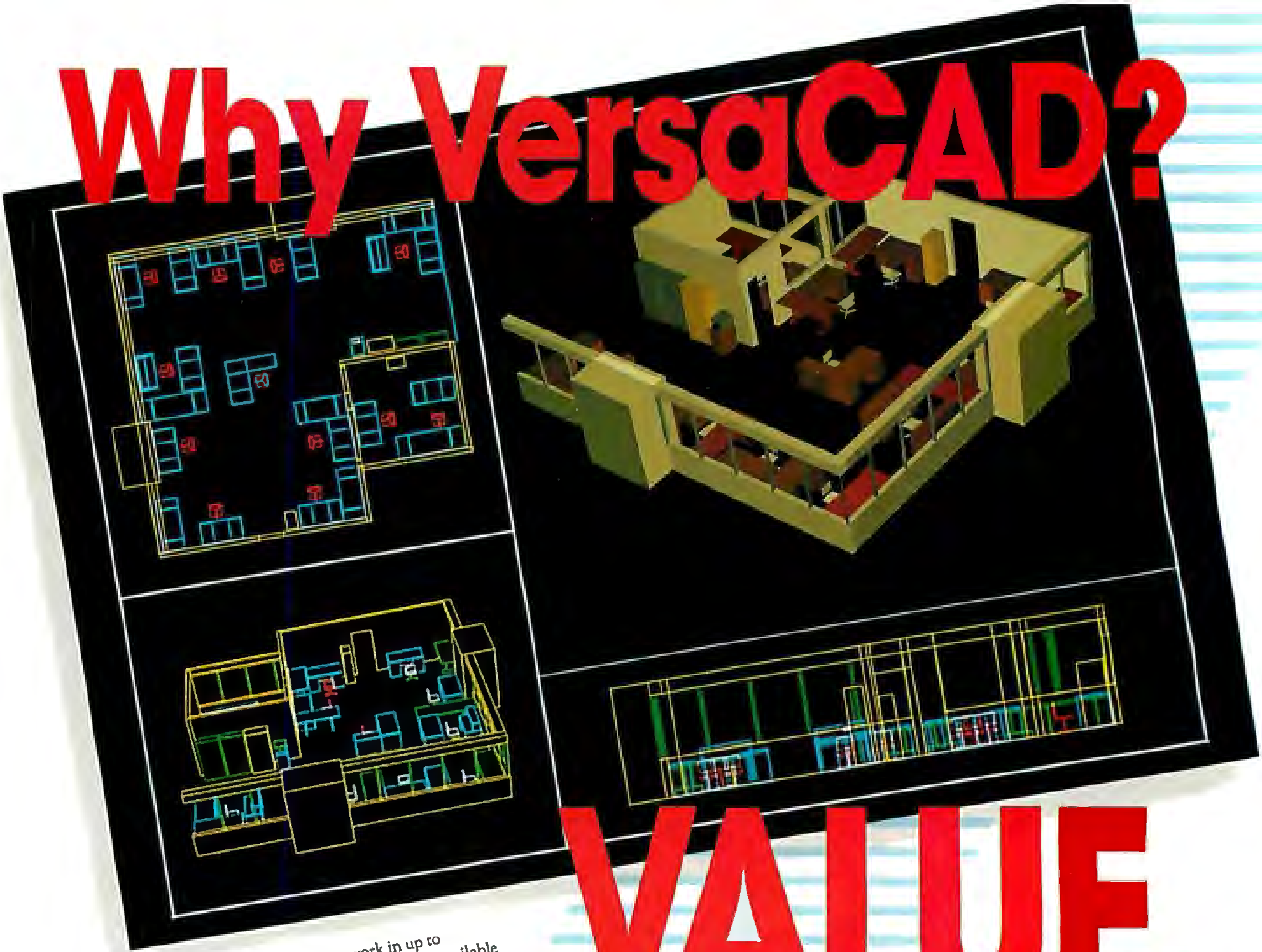

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Computing in Hand

▲ *Sharp Wizard*

Psion Organiser

Hand-held computers like the Sharp Wizard and the Psion Organiser pack a lot of functionality into a small size

Wayne Rash Jr.

It wasn't that long ago that the first laptop computers were making headlines. But now, things have changed. Much of the functionality of a laptop computer of the past can now fit into a hand-held computer that slips comfortably into a coat pocket.

The Sharp Wizard OZ-7000 seems to have been designed with exactly that purpose in mind. It's almost the same size and weight as a pocket appointment book or Day-Timer. The Psion Organiser II Model XP is a little larger but not much different in functionality. Both handheld computers resemble calculators more than they do personal computers, but looks aren't everything. They're both full-fledged computers, capable of the same tasks as their larger brethren.

But these machines are not as easy to use as larger computers are. Because they are quite small, so are their keyboards and screens. Both the Wizard's and the Organiser's keyboards are laid out in an alphabetic, not QWERTY, format. You wouldn't want to use either of them for word processing, but you can use them for other tasks that don't require much typing. And if you do need to use a real keyboard, both machines can be connected to a desktop computer.

These machines are designed for functions that people are likely to need while away from their desks: They keep track of appointments, tell you the time, signal you with alarms, and work as calculators. They also have notepads and places to store addresses. Finally, they both support serial communications so that you can move information between them and your office computer.

The Sharp Wizard OZ-7000

The Wizard is aimed primarily at the users of pocket appointment books or Day-Timers. Unlike a Day-Timer, it beeps at you when you have a meeting, and it triggers an alarm at a set time. Also unlike the Day-Timer, entering the appointment information is awkward. Typing on tiny keys, even for a brief period, just isn't very convenient. The documentation has suggestions for using the user dictionary to enter commonly used words, but it's cumbersome. This is one area where it's hard to beat a pencil and paper for actual functionality.

Most of the standard features of the Wizard are related to time. One button displays your schedule, and another displays a month at a glance. A clock shows your local time, and a world clock tells you the time in any of 200 cities.

The calendar looks good on the Wizard's clear eight-line display. You see the entire month, as well as a line that tells today's date, the day of the year, and the number of days remaining in the year. You can scroll through the months and the days of the month at will, using the arrow keys on the keyboard.

continued

Sharp Wizard OZ-7000

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Sharp Electronics Corp.
Sharp Plaza
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(201) 529-8874

Components
Processor: Custom proprietary 8-bit CPU running at 32.768 kHz
Memory: 32K bytes
Mass storage: None
Display: 16-column by 8-row LCD
Keyboard: 73 keys plus touch pad for IC application cards
I/O interfaces: 4-pin option jack; 15-pin option jack
Battery: Two CR-2032 lithium cells (life: 90 continuous hours); one CR-1616 memory backup (life: two years)

Size
Open: $7\frac{7}{32} \times 6\frac{13}{32} \times \frac{17}{32}$ inches;
Closed: $3\frac{11}{16} \times 6\frac{13}{32} \times \frac{27}{32}$ inches;
8 ounces

Documentation
Owner's manual

Price
$299

Inquiry 853.

Psion Organiser II Model XP

Company
Psion plc.
Psion House
Harcourt St.
London W1H 1DT, U.K.
(01) 723-9408

XEC Products
13575 58th St. N, Suite 123
Clearwater, FL 34620
(813) 538-4190

Components
Processor: Hitachi HD6303X 8-bit CPU running at 1 MHz
Memory: 32K bytes of ROM; 32K bytes of RAM
Mass storage: Up to 256K bytes on EPROM Datapaks
Display: 16-column by 2-row LCD
Keyboard: 36 keys
I/O interface: 16-pin expansion port
Battery: 9-volt alkaline (life: approximately six months)

Size
$6 \times 3\frac{4}{5} \times 1\frac{1}{5}$ inches; 9 ounces

Documentation
Owner's manual

Price
$249.95

Inquiry 854.

The schedule feature lets you set a meeting for any day. You can also enter two kinds of repeating, anniversary-type dates: absolute dates, such as birthdays, and relative dates, such as a meeting on the second Wednesday of every month. You can set an alarm to let you know when it's time for the meeting, and you can include as much information as you need about the meeting, up to 512 characters. You can scroll past the eight-line limit.

Unfortunately, the Wizard has no word wrap when you type in text; it simply splits a word wherever it falls at the end of the line. The calendar makes up for that by having a nice variety of displays for showing you your scheduled time. The daily display has a slick, Gantt chart-type display that shows you the time and duration of each appointment.

The other three standard functions are the telephone list, the memo pad, and the calculator. The phone list lets you save and recall names and phone numbers. It's a reasonably effective way of storing phone numbers, and you can transfer your list from your PC using the $179 Wizard PC-Link from Traveling Software (18702 North Creek Pkwy., Bothell, WA 98011, (800) 343-8080). In fact, I can't imagine creating a list in any other way, since typing from the keyboard on the Wizard itself can be tedious. Wizard PC-Link can directly handle SideKick files, but not SideKick Plus files. It is not hard to use, and it closely resembles Lap-Link, also from Traveling Software.

The memo pad is useful for making notes to yourself, lists of things to do, and the like. The memo pad has the same limitations as other text entry on the Wizard. You can use the user dictionary to enter frequently used words and phrases, but unless you're entering or replacing a really long string with the user dictionary, any long memos become a real chore with this machine.

There are two calculators on the Wizard: a simple one with four functions, and another that uses the display as a paperless tape. The latter is a pleasure to use. The eight-line display acts as the paperless tape, and previous entries scroll up the screen so you can keep track of what you've already done. You can also edit previous entries, and the Wizard corrects the results. Unfortunately, the Wizard's calculator supports only the four basic functions plus percentage and square root. This is a shame, because the display has enough room for complex math formulas and could show charts and graphs.

Optional Firmware

In addition to the built-in functions, Sharp offers three optional plug-in IC cards: Time Expense Manager ($120), Thesaurus Dictionary ($130), and 8-Language Translator ($100).

The Time Expense Manager card has three applications plus its own separate 32K-byte RAM bank: a To-Do List Manager, an Expense Manager, and a Time Accounting Manager.

The To-Do List Manager sets up a list of tasks or projects. You can sort and view the list according to deadline date, to-do description, priority, manager name, or project name. The Expense Manager lets you enter traveling expenses for business trips. You can enter the expense description, date, type, amount, payment type, and whether you received a receipt. The Time Accounting Manager is designed to track billable time. You can enter information on client name; task name; date; starting, ending, and total time; and whether the time is billable or not.

The Time Expense Manager files can be transferred to your PC-compatible computer with Wizard PC-Link. PC-Link can also convert the files into the Lotus 1-2-3 format. The Time Expense Manager functions can also use the user dictionary to enter words and phrases to cut down on typing.

The Thesaurus Dictionary card can check the spelling of over 87,000 words. It also contains over 500,000 synonyms for 42,000 words. The dictionary and thesaurus are based on *The American Heritage Dictionary* and *Roget's II: The New Thesaurus*.

Finally, the 8-Language Translator card can translate 450 phrases and 760 words into any of eight languages: English, French, German, Italian, Spanish, Swedish, Japanese, and Chinese. The words and phrases are arranged into 13 categories, such as air travel, restaurant, sightseeing, and doctor. You're on your own when it comes to pronunciation.

I wasn't able to test the IC cards because they became available only after I wrote this review.

Using the Wizard

The Sharp Wizard is clearly aimed at the business user; that's why it slants its

continued

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Circle 25 on Reader Service Card (DEALERS: 26)

functions toward time management. I question, though, whether a busy executive will spend time laboriously pecking in the details of a luncheon meeting. It takes one-third of the time to enter information in my Day-Timer than it does to enter the same information into the Wizard. In any case, I find it hard to believe that someone would prefer this method over simply writing the information in a pocket appointment book.

Of course, the Wizard has advantages over a Day-Timer—the alarms, for example. The Wizard also has password protection on entries you want to keep secret, an advantage should your Wizard fall into the wrong hands.

In general, the Sharp Wizard is well designed. The keys, though tiny, are clearly marked. The letter and number keys are in separate sections of the keyboard, and you're not likely to confuse them.

The Psion Organiser II Model XP

The Psion Organiser is much more of a general-purpose computer than is the Sharp Wizard. It has a wide variety of software and hardware available, and it performs functions that are well beyond what the Wizard could ever hope to accomplish.

On the other hand, the Organiser is not the sleek executive's package that the Wizard is. It's thicker, the screen is smaller, and the keys are even more tiny than the Wizard's. Because of its size and shape, it resembles an enlarged scientific calculator.

Two factors immediately distinguish the Organiser from the Wizard. The first is that the Organiser has its own programming language. The second is that it has removable mass storage. This means that you can write and compile applications and then store them in a Datapak. The Datapaks are 16K- to 128K-byte EPROMs that function like disk drives; you can insert or remove them as needed. They cost from $30 to $150.

Commercial software is available on the Datapaks. They use the same A, B, and C designations as your PC's disk drives, and when you install a Datapak for the first time, the system formats it automatically. You can erase and reuse a Datapak by uncovering a clear window and exposing the chip inside to ultraviolet light.

Programming the Organiser

The Psion Organiser II's programming language, called OPL (Organiser Programming Language), has some of the attributes of both BASIC and the dBASE language. While the Organiser contains a programming editor, the keyboard makes this difficult to use for anything beyond very short programs. You can, however, create the programs on any computer and upload them to the Organiser. The file transfer worked fine.

Because OPL is built into the Organiser, the functions and procedures of the language are available to everything on the system. This means that you can enter a formula into the calculator, define it as a procedure, and later use it in a program. Likewise, procedures developed for use in a program can be used by built-in software, such as the calculator.

It takes one-third of the time to enter information in my Day-Timer than it does to enter the same information into the Wizard.

Organiser in Action

You open the Organiser by sliding it out of a gray plastic shell. Once the keyboard is exposed, it locks into place with a solid click. The screen displays a menu, and you can select a choice either by moving the cursor to the choice and pressing the Exe key or by pressing the first letter of the choice. The entire menu requires more space than is available on the two-line screen, so you can scroll the choices sideways by holding down the cursor-control keys.

As with the Wizard, a number of the Organiser's functions involve time management. You can set up to eight alarms and program them to go off once or repeatedly. The repeat on the alarm can be any period from once a week to once an hour. It also has a clock and an appointment calendar. Because the screen has only two lines, the time is set on the first line, and the details of the appointment on the second. If your appointment entry exceeds the 16-character screen width, it scrolls sideways. When you display the

continued

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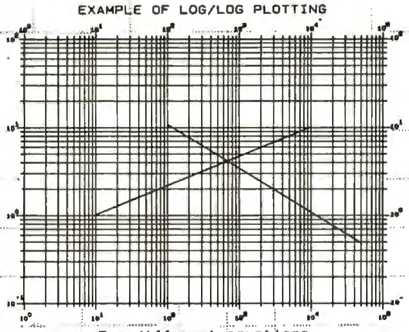
Circle 210 on Reader Service Card (DEALERS: 211)



line, it scrolls sideways automatically.

The Organiser's Save function is a sort of free-form database. Anything you save, such as names, phone numbers, addresses, notes, or other data, is retrievable via the Find function, also accessed from the main menu.

The Organiser's calculator program allows far more sophistication than the Wizard's, partly because the calculator has additional capability built in, but also because it has access to math routines that are part of the OPL language. These routines include trigonometric functions, and they can include any procedures that you wish to define yourself.

The small screen makes the excellent calculator program harder to use, because you can see only a small part of a formula at a time. You can scroll through it, but this is less convenient than having it all on the screen.

Two of the menu choices reflect the use of Datapaks for mass storage. Info shows you how much space is available in the storage locations, and Copy lets you copy files from one Datapak to another in much the same way that you would copy between disks on other machines.

Commercial Software

The Psion Organiser II has a strong following in both the U.K. and the U.S. This encourages a reasonable variety of commercial software, which in turn makes the computer more attractive. The Organiser that I reviewed came with a communications package, a spreadsheet program compatible with Lotus 1-2-3 versions 1 and 2, an enhanced calculator program, a database package, and a development environment for OPL programs. I'm not going to review the software, but it was easy to install and use and, more important, worked well in conjunction with a desktop personal computer.

The communications package, Comm Link ($100), forms an important part of the Organiser's environment, however. It consists of an EPROM and cable that plugs into the top of the Organiser and PC-compatible software. With this combination, you can transfer files between your Organiser and a PC.

To this extent, the Organiser and the Wizard are much alike, since the Psion Comm Link and Sharp's Wizard PC-Link perform much the same functions. The Psion product can do much more, however. It also acts as a terminal package, and it can do ASCII and XMODEM file transfers with any computer. This means that you can use the Psion Organiser as a terminal to connect with BIX. While the tiny screen is a handicap, telecommunicating with the Organiser is possible.

Peripherals

While printers are available for both the Wizard and the Organiser, you can also get bar code readers, magnetic card readers, and a modem for the Organiser.

These peripherals are supported by software for applications such as meter reading, inventory, point-of-sale record keeping, sales route management, and marine navigation. These are all applications for which the Organiser is well suited, and they help to explain its popularity.

Hand-Held Impressions

During the review, I found myself using the Psion Organiser II more and more, and the Sharp Wizard less and less. I had expected the opposite to be the case, especially given the larger screen and better keyboard design of the Wizard. However, the Wizard didn't fill a niche for me. It was designed to be a replacement for a Day-Timer, and while it does indeed fill many of the same functions and adds others, it is harder to use. I might have had a better impression of the Wizard if more software had been available.

The Psion Organiser, on the other hand, continued to be useful, partly because it is a little easier to use. The machine operates entirely from menus. In addition, the software is consistent among applications. You always use the Exe key to select and run a menu choice. You always use the Mode key to change between Datapaks.

More important, the Psion Organiser is more flexible. You can program it to do what you need it to do, and commercial software is available to meet most needs. Interestingly, even the appointment functions seemed well thought-out in the Organiser; for example, you can automatically set the alarm for a meeting for a period of time ahead of the meeting.

The ideal hand-held computer would have the functionality of the Psion Organiser II and the design of the Sharp Wizard. I choose the functionality and flexibility of the Psion Organiser II over the construction of the Sharp Wizard. ■

Wayne Rash Jr. is a consulting editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

Microsystem Engineer's Personal Assistant

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Serial Communications by RS232

S3 has the standard D25 socket for RS232 communication, at baud rates from 300 to 9600. Because transmission-time is not defined by baud-rate (you knew that), what matters most is that S3 will receive a file at 9600,N,8,1 at full speed without handshaking.

Remote Control by Computer

Every feature of S3's keyboard also works by remote control via the serial interface. The big screen computer display can be useful – for example, when you are comparing PROMS with many differences. Batch files can be used for repetitive tasks. Any comms or terminal software will work.

ROM Emulation

As a ROM Emulator S3 has no equal. S3 is a ROM emulator with PROM blowing and editing facilities too, and will emulate any 25 or 27 series PROM up to 27512. It has an *EmuLead:* a couple of feet of ribbon cable terminated by a 24 or 28 pin plug, which can take the place of a PROM in-circuit. A feature you will not find in other ROM-Emulators is *RAM-Emulation*. Because ROMS do not have a write-input, S3 is provided with a separate *write-lead* which can be clipped to the microprocessor's write-pin. This opens new possibilities – the target system can now write into S3. All RAM data can be inspected and modified. You can put the *system stack* and *variables* into the same area as the *program*. You can write your own *breakpoint routine*, adjust variables when testing and so on.

Microsystem Development

Assemblers generate object files which can be downloaded to S3, in INTELHEX, MOTOROLA, TEKHEX, BINARY – or just plain ASCII. Using the *EmuLead*, the code can be tried out in the system under development. When the code works, it can be transferred immediately to PROM. S3 is particularly suitable for the "piggy-back" type of microcontroller. We offer an excellent Editor/Assembler/Comms software package which, although developed *for* us, not *by* us, we endorse because we use it and believe in it. It's fast, convenient and crammed with powerful features. A single keystroke will assemble, link and down-load your code. If an error is encountered it will pick-up the source-file and put the cursor in the error-line. Who needs an unfriendly environment when they're struggling with microsystem development?

S3 itself is Programmable

S3 is all-CMOS, all-SMT. It has a 4K-bytes of BIOS in masked ROM, which handles the INS and OUTS and loads the working program. The Transient Program Area is a further 8K-bytes of RAM, separate from the 64K-bytes of User RAM, and also battery-supported whether S3 is ON or OFF. When S3 is supplied the TPA contains the latest version of the working program – and you get a copy in a backup PROM. The program in the TPA is permanent, until you decide to change it.

To load new software into the TPA, you put the PROM in the socket and key an instruction; the change can be accomplished in only three seconds.

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Price List

S3 PROM Programmer/Emulator includes Backup PROM, EmuLead, Write-Lead, Manual & Charger	£495
Editor/Assembler most microprocessors are covered – send for a list	£195
Developer's Package Used for modifying S3's working program. Contains Editor/Assembler for NEC µCOM87, Circuit Diagram, BIOS calls and SOURCE CODE.	£195
32 Pin EPROM Module 32 pin EPROMS, 1 meg and up	£75
40 Pin EPROM Module 40 pin EPROMS, 1 meg and up	£75
8748/8749/8741/8742 Module –	£125
XICOR 2212 -	£45
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Note – modules plug into S3.
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Circle 74 on Reader Service Card

Easy Reading

TrueScan and OmniPage offer page-recognition capabilities for the Mac or AT

Phillip Robinson

Personal computers may be marvelous at 'rithmetic and 'riting, but they've been embarrassingly dim-witted when it comes to the third "r": reading. Desktop optical character recognition (OCR) has suffered from restricted font intelligence and an inability to read mixed text and graphics. That's changing with the use of 32-bit processors and new algorithms.

Instead of simply reading dot-matrix printer documents back into ASCII files, the goal now is to capture all the text, graphics, and formatting complete with position, type style, and other attributes. The result is stored in a variety of formats for use with word processors, spreadsheets, and page-layout programs.

Calera Recognition Systems (formerly Palantir) and Caere Corp. have both developed page-recognition systems for the IBM PC AT and compatibles. Built around Motorola's 68020 accelerator, Calera's TrueScan and Caere's OmniPage both consist of a full-length add-in board, 2 to 4 megabytes of RAM, and software. Caere also offers a software-only version for the Macintosh SE and II.

The two systems present somewhat different approaches to page recognition and have different strengths. Each works with a wide range of optical scanners. I tested the systems on a 10-MHz AT clone with 640K bytes of RAM, a 40-megabyte hard disk drive, and a VGA adapter and monitor. I used an AppleScanner and an HP ScanJet and ScanJet interface card.

Important factors for page recognition include accuracy, speed, and ease of use. Accuracy concerns the types of text that the system can read and what structures and formatting it recognizes. Both systems recognize such items as subscripts, superscripts, tables with tabs, centering, justification, word wrap, and attributes such as italics and boldface, and they preserve them as control functions in Microsoft Word and other file formats. Speed depends on the scanner used, the efficiency of the recognition process, and the time it takes to convert the data to a particular format.

TrueScan

TrueScan 1.1 provides drivers for over a dozen scanners; can translate TIFF files and fax image files from GammaLink, SpectraFAX, Datacopy, and AT&T fax boards; and converts the results to ASCII, Excel, Lotus 1-2-3, and a variety of word processing file formats (including DCA, DisplayWrite, Word, MultiMate, OfficeWriter, PFS:Write, Samna, Volkswriter, WordPerfect, WordStar, and XyWrite). It saves images as PC Paintbrush, TIFF (uncompressed, modified Group 3, or packbits), CCITT Group 4 compressed fax, or Ventura Publisher files.

TrueScan recognizes typewritten, typeset, laser-printed, and dot-matrix fonts from 6 points to 28 points in monospace or proportional spacing. It recognizes variable-width, multicolumn text, including tables created with tabs. It also knows to enter a hard carriage return only after the last sentence in each paragraph. TrueScan can scan for text, graphics, or both, producing separate text and image files from a single pass.

I tested Calera's standard (S) and extended (E) versions of the TrueScan board. The $3995 Model E has 4 megabytes of RAM and three custom ICs; the Model S ($2745) has 2 megabytes of RAM and two custom ICs. Calera claims that the Model E reads up to 100 characters per second versus 75 cps for the Model S. The Model E also handles landscape page orientation.

You plug the TrueScan board into a 16-bit, full-length slot and run a batch installation file. The software eats up a little over 3.5 megabytes on your hard disk. Initially, I had trouble finding a free address for the board, but the software's memory-map utility helped in my search for free memory.

SCANTEXT reads the text and saves it in the default text format. SCANIMG scans the page as an image and saves it in the default graphics format. SCANBOTH performs both scans in one pass. SCANFILE analyzes text from an image file saved on disk. TRUESCAN brings up the main menu, from which you set the default formats and scanner settings.

During a scan, an on-screen clock indicates start and end times and reports the total time taken to read the document. When the analysis is complete, you tell TrueScan to save the file to disk in the preselected format. This conversion process takes 3 to 15 seconds. You can't see the results, however, until the scan is complete, saved as a file, and loaded into the appropriate application. You can save scanned pages as separate files or store multiple pages in one file.

Software-controlled scanner settings include contrast, text type, page orientation, document source (scanner or disk file), and scan type (image, text, or both). You choose scanning boundaries by entering inch measurements for the four edges, and you can select scanning format (binary, 16 gray scales, or four different dither patterns) and resolution (from 48 dots per inch to 600 dpi).

TrueScan flags characters it doesn't recognize with an asterisk and displays its best guess as to what the character or word should be. You can change the flag character or turn it off.

continued

OmniPage 1.0

Type
Page-recognition board and software

Company
Caere Corp.
100 Cooper Court
Los Gatos, CA 95030
(408) 395-7000

Features
AT version: Full-length board with 68020 accelerator and 2 megabytes of RAM
Mac version: Software only
Both versions: Text recognition at 40 cps to 150 cps; real-time viewing of text during processing; ability to read fonts from 6 points to 28 points; basic text editing

Hardware Needed
AT version: IBM AT or compatible with 20-megabyte hard disk drive, 640K bytes of RAM, graphics adapter, monitor, and mouse; HP ScanJet, Canon, or any scanner that supports uncompressed TIFF files
Mac version: Mac II or SE (with 68020 accelerator); 4 megabytes of RAM (5 megabytes if used with MultiFinder); AppleScanner

Software Needed
AT version: DOS 3.1 or higher
Mac version: System 4.2 or higher

Documentation
User's manual

Price
AT version: $2495
Mac version: $795

Inquiry 855.

TrueScan 1.1 Model E

Type
Page-recognition board and software

Company
Calera Recognition Systems, Inc.
2500 Augustine Dr.
Santa Clara, CA 95054
(408) 986-8006

Features
Full-length board with 68020 accelerator and 4 megabytes of RAM (2 megabytes on Model S); text recognition of 8- to 72-point text at 100 cps (75 cps on Model S); landscape or portrait scanning; simultaneous image and text capture

Hardware Needed
IBM AT or compatible with 512K bytes of RAM, a 20-megabyte hard disk drive, a monochrome monitor, and a scanner

Software Needed
DOS 3.1

Documentation
User's manual

Price
Model E: $3995
Model S: $2745
Model E upgrade: $1495

Inquiry 856.

TrueScan's proprietary recognition algorithm set first performs topological feature extraction to identify characters, looking at the existence and position of bays (open concavities), lakes (closed-in areas), curves, and lines. Then, to break deadlocks between possible character choices, it relies on a dictionary. This helps it make intelligent guesses about word spellings and letter pairings. For example, TrueScan might avoid "truu" in favor of "true" and flag the word.

OmniPage

OmniPage 1.0 for the IBM AT ($2495) includes software and a board with a 68020 accelerator, 2 megabytes of RAM, and its own multitasking operating system. The software includes a run-time version of Microsoft Windows. Under Windows 286 or Windows/386, OmniPage can operate in the background. The AT version includes drivers for the HP ScanJet and Canon scanners.

At $795, the Macintosh version of OmniPage is much less expensive, but it doesn't include a board—this package is software only. It uses the CPU in your Mac SE or II and requires 4 megabytes of RAM (I recommend at least 5 megabytes). While its capabilities are identical to those of the AT version, the Mac version offers fewer file-saving formats (TIFF, ASCII, MacWrite, and Excel) and a driver only for the AppleScanner.

Caere claims a speed of 40 cps to 150 cps for both Mac and PC versions. The OmniPage algorithm starts by defining the dense areas of each page. Next, it checks for the presence of columns, checks for the empty areas between lines and paragraphs, and then finds the horizontal and vertical alleyways between characters. OmniPage compares text against a variable-size character matrix. The software doesn't try to guess unknown characters or correct misspellings; it marks each unreadable character's position with a tilde.

OmniPage recognizes all nonstylized fonts from 8 points to 72 points. It can handle variable-width columns; various type styles; typeset, proportional, and kerned text; partial pages and forms; and graphics.

As with the TrueScan, I had trouble finding a free address for the OmniPage board, but once I found the right switch combination, the installation went smoothly. Using OmniPage was a matter of getting into Windows and starting the program. By contrast, the Mac version was relatively easy to install; it only had card addresses to worry about and a quick SCSI connection to the AppleScanner. Settings and commands appear in pull-down menus. The program includes a tutorial with examples, menu explanations, and a glossary.

The software is more graphically oriented than TrueScan's; on the AT version, it displays each letter that it's reading in a small window as the scan progresses (the Mac version lacks this feature). It also deposits the scanned image or recognized text in a transitional editor window where you can view it before saving to disk. The transitional editor also offers zoom in and out options for graphics, as well as cut, copy, paste, and search and replace functions for text.

OmniPage can handle mixed graphics and text on a page, but it can't save both a recognized-text file and a graphics image file from a single scan. It can save graphics scans as TIFF or uncompressed TIFF files, and it recognizes text in a wide variety of word processor and spreadsheet formats, including Microsoft Word, WordPerfect, MultiMate, Excel, and Lotus 1-2-3. OmniPage can also recognize text stored in TIFF files and in fax files saved as uncompressed TIFF files.

From an initial window in OmniPage, you can choose to scan text or graphics at the default settings, or move to the main program window. There, you can choose your own scanner, text, and graphics settings. These include resolution (200 dpi to 300 dpi), tone (line art, halftone fatting, or halftone Bayer), contrast, image type, and document size. Halftone Bayer dithering is useful when image resolution is more important than its contrast. Halftone fatting is for continuous tone

continued

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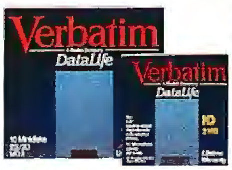

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Table 1: *Processing times, flags, and actual errors produced by TrueScan and OmniPage on nine sample documents. Times are totals for document scanning and recognition. TrueScan times do not include initial software downloading to the board, which takes 10 seconds. (All times are in seconds; N/A = not applicable.)*

	OmniPage AT			OmniPage Mac			TrueScan Model E			TrueScan Model S		
Document	**Time**	**Flags**	**Errors**	**Time**	**Flags**	**Errors**	**Time**	**Flags**	**Errors**	**Time**	**Flags**	**Errors**
Press release	202	17	8	197	14	20	169	107	10	167	103	10
Microbytes	178	2	7	203	18	25	255	115	14	317	116	12
Adobe fonts	310	111	>100	271	40	>100	208	170	>100	255	185	>100
Spec sheet	217	50	>100	283	>250	>250	134	135	>100	182	163	>150
Dot-matrix printout	167	37	>50	147	N/A	>75	58	N/A	7	58	N/A	3
Income statement	97	7	18	210	N/A	>50	128	N/A	4	188	N/A	50
Legal contract	124	14	45	245	>100	>200	144	23	20	219	85	>100
Newspaper story	203	16	30	86	4	15	196	62	25	247	56	30
Newspaper table	135	3	4	182	N/A	>75	101	N/A	5	121	N/A	15

images, for good contrast and resolution.

Text settings include input and output page layout, document page length, scan area, and output file format. You can finely adjust the scan area; zooming lets you inspect the image pixel by pixel. A Statistics function counts recognized and unrecognized characters, gives the recognition percentage, and appends the information to the end of the file.

The Auto Galley function decolumnizes text on each page and puts it into the proper sequence in the output file. Unlike TrueScan, OmniPage also offers a Manual Galley feature that lets you choose the appropriate sequence for decolumnized text. This is useful for pages where text doesn't flow logically from one column to the next. Auto Paste-Up preserves the columnar format, for word processors that support snaking columns. The Financial Forms setting preserves decimal tabs in the text.

When you begin a scan, you see the scanner's progress on the display. First, OmniPage locates areas of text and graphics on the page. Next, the software draws boxes around regions within the text and art, and it labels each box in numerical order; each paragraph and graphical component is a new area. Then the software processes the contents of each area, and, in the AT version, a window on the left side of the screen shows magnified images of the characters that OmniPage is analyzing.

On the AT, the software doesn't time the process, nor does it automatically save a file in a preselected format. That's done by a batch file that kicks in when you leave Windows. If you forget to leave Windows before turning off your machine, you'll lose the data.

After performing multiple scans, sometimes the batch file converts only a single saved .TMP file into the appropriate target format. Also, where TrueScan saves Excel files, for instance, with formatting, OmniPage saves only the values.

OmniPage 1.1 should be available by the time you read this. It offers several improvements over version 1.0, including better format conversions for MultiMate and WordStar, and drivers for the DEST and Microtek scanners. The Macintosh version adds the character window and fixes some bugs running under System 6.02.

Face-Off

To compare TrueScan and OmniPage, I scanned a variety of documents and then saved them in TIFF, Word, and Excel formats on the AT and in ASCII and Excel formats on the Mac. I logged the time to scan and recognize each document and checked the accuracy of each scan by looking at the file in the appropriate application (e.g., Excel or Word). I looked for both flagged and unflagged errors. The results appear in table 1.

While all the flags that OmniPage set indicated read errors, TrueScan marked unfamiliar or misspelled words, so not all flags pointed to actual errors. Because of the different hardware, performance times aren't directly comparable between the Mac and AT products.

I scanned nine documents, starting with a press release with three pages of single-column text on a gray background. The second scan was from the Microbytes section of BYTE (see figure 1). Four columns of text, plus several stories per page with white and yellow backgrounds, made this more challenging. Then came a page of 16 Adobe font samples, typeset, from Palatino and Helvetica Condensed Light to Park Avenue, Bodoni, and Sonata. The fourth scan was the back of a spec sheet for a laptop computer, sporting two columns of red and black type on a white, glossy surface.

The fifth and sixth scans were tabular, and so were aimed at the spreadsheet formats. The fifth was a photocopy of a dot-matrix printout with 5 columns and 20 rows of database report information. The sixth was a bank statement of income, printed in brown type on a white background. This included lengthy labels on the left side of the page and several columns of figures on the right.

The final text scans included the first page of a legal contract (scanned at letter size due to scanner limitations); a clipped, three-column newspaper story; and a table from the same newspaper.

The TrueScan Model E was usually—but not always—faster than the Model S. On the first test, it virtually tied with the Model S, but on the second and third it was 20 percent to 25 percent faster. It also recorded fewer mistakes on some of the more complicated scans, such as the Adobe fonts. Sometimes the difference was impressive: A scan that was pedestrian for the Model E and the OmniPage—the bank statement—was a disaster for the Model S. But, comparing the $1495 cost of an upgrade from the Model S to the Model E to the $1250 difference in their initial prices, I might pick the Model S first and see if it met my needs.

The Mac version of OmniPage was usually slower than its AT counterpart. The legal contract, however, was 2.5 times faster on the Mac. The Mac version was also less accurate than the AT version, but this might be due to the different scanners used. The Mac results were

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sometimes dramatically improved by adjusting the contrast and other parameters.

On the press release, the TrueScan Models E and S were slightly faster than the OmniPage, with similar accuracy. On the Microbytes page, the OmniPage products were significantly faster, though its Mac version made more mistakes. Many of the errors made by both systems were missing spaces rather than misspellings (see figure 2).

• Despite ongoing—well, rampant—speculation about a new **laptop from Apple** Computer, Apple's John Sculley says the company's plans for a laptop are still hampered by **inadequate screen technology**. "I wish we had it now," Sculley said recently, but he added that a laptop is not a big part of Apple's plans for 1989. Sculley said the main

continued

12 BYTE • FEBRUARY 1989

Figure 1: *The sample Microbytes text as originally input.*

On the third and fourth scans (the Adobe fonts and the laptop specs), the TrueScan models were faster. However, neither product produced acceptable output. Accuracy was poor, and although the labels fared less well than the numbers on the spec sheet, it would probably take longer to clean them up than to type them in from scratch.

The TrueScan systems were the clear winners on the multicolumn dot-matrix printout. On the income statement, the AT version of OmniPage finished first, though it made a few more mistakes than the TrueScan. The Mac OmniPage was the slowest and least accurate; the Model S also performed inadequately.

The legal contract and the three-column story produced some odd results. The AT version of OmniPage was the fastest on the contract, yet at the back of the pack on the news story. Finally, on the table, the Mac version of OmniPage fell apart in both time and accuracy. Again, some of this may have been attributable to the different scanners used.

(a)

• Despite ongoing— well, rampant—specula- tion about a new laptop from Apple Computer, Apple's John Sculley says the company's plans for a laptop are still hampered by inadequate screen technology. "I wish we had it now," Sculley said recently, but he added that a laptop is not a big part of Apple's plans for 1989. Sculley said the main (f)n~inu~d 12 B Y T E • FEBRUARY 1989 MICROBYTES ~

(b)

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    ± Despite ongoing-well, rampant--speculation about a new laptop
from Apple Computer, Apple's John Sculley says the company's plans for
a laptop are still hampered by inadequate screen technology. "I wish
we had it now," Sculley said recently, but he added that a laptop is
not a big part of Apple's plans for 1989. Sculley said the main
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12 B Y T E ± FEBRUARY 1989
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(c)

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*6 Despite *ongoingwell, *rampant-specula*tion about a new *laptop
from Apple Computer, Apple's John *Sculley says the company's
plans for a *laptop are still hampered by inadequate screen
technology. "I wish we had it now," *Sculley said recently, but he
added that a *laptop is not a big part of
Apple's plans for 1989.
*Sculley said the main
continued
*I

12 *B Y T E *- FEBRUARY 1989
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Figure 2: *The sample Microbytes text as output by the Mac OmniPage* **(a)**, *AT OmniPage* **(b)**, *and the TrueScan Model E* **(c)**.

The Last Word

The nod for fastest performance was between the Model E and the AT version of OmniPage. The results depended on the particular page, although, overall, the TrueScan did better on spreadsheets and dot-matrix printouts. The Mac OmniPage might do much better with new drivers for the AppleScanner, which should be available now. Fiddling with scanner settings also helped.

Regarding ease of use, the OmniPage's reliance on Windows makes for a neatly visual interface during a scan, and I like the transitional editor, which lets you quickly see what you've scanned. But I found the TrueScan's menu system faster to use, although its inability to view scanned text was inconvenient. TrueScan's on-screen timer is also handy, and the Model E's ability to read documents in landscape orientation makes some tasks simpler.

OmniPage has the graphics command for choosing a partial-page area for scanning, the ability to read larger type, and the sophisticated Manual Galley command for dictating page layout. However, I was frustrated by its dependence on batch-mode formatting and conversion of documents in the AT version, and by the limited file formats available in the Mac version. Also, the accuracy of the Mac OmniPage/AppleScanner combination was less reliable.

None of the reviewed systems can efficiently handle pages with lots of fonts and odd-colored backgrounds, but all can do well on press releases and simple magazine clippings. My favorite is the TrueScan because of its accuracy, quick interface, landscape option, simultaneous image and text capture, and its many application file formats. I liked OmniPage's graphical depiction of work in progress, as well as its on-line tutorial.

Is this page recognition? Not exactly. Realistically, these products have just moved OCR into the age of clipping recognition. I still wouldn't trust the accuracy of poorly printed documents, important spreadsheets, or complex, small-type contracts to these systems, although they could help you grab chunks of text that you could then carefully check for spelling and logic. But both TrueScan and OmniPage represent a substantial leap forward toward complex document recognition. For grabbing clippings for desktop publishing, they are definitely practical. ■

Phillip Robinson, an editor for Virtual Information *(Sausalito, CA), researches and analyzes trends in the computer industry. He is a contributing editor for BYTE and can be reached on BIX as "robinson."*

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Mac Goes Fax

With fax modems for the Mac, sometimes the more you pay, the less you get

Don Crabb

Fax machines were once primarily tools that big businesses used to send a hard copy of important documents abroad via telephone lines. The units cost more than $2000 and were often finicky and unreliable. But the CCITT's Group 3 standard for fax communications has largely changed all that. Today, fax machines have become so popular and so inexpensive that even lifestyle vendors like The Sharper Image are carrying them in their catalogs. You can now buy a good-quality stand-alone fax machine for less than $800.

The next step in this fax revolution would seem to be the personal computer fax modem. Fax modems strip off the scanning and printing hardware of a stand-alone fax machine, along with the phone handset and other phone hardware, reducing a fax machine to its bare essentials. Functions such as telephone dialing and management are handled by software that also prepares a document for transmission. Because personal computer fax modems eliminate some of a fax machine's hardware, they're generally cheaper to buy and easier to set up.

While fax modems for the IBM PC have been around for some time, reliable units for the Mac have appeared only recently. I tested three external units for this review: Abaton's InterFax, Apple Computer's AppleFax, and the FaxSTF from STF Technologies. I also looked at BackFax, a replacement program for the AppleFax software that adds background-mode operation to the unit's capabilities (see the text box "AppleFax Extender" on page 208F).

Fax: Who Needs It?

When I first started looking at fax modems for the Macintosh, I was unimpressed. Fax modems seemed to be a product in search of a need. The devices aren't a viable replacement for full-fledged fax machines, since they lack both a scanner and a printer. If you want to turn your Mac into a fax workstation capable of the same kinds of operations that a stand-alone fax machine provides, you must have a scanner capable of at least 200 by 100 pixels per inch (that's considered standard resolution by Group 3 standards—high resolution is 200 by 200 pixels) and a printer capable of printing at that resolution.

If you add the price of a medium-resolution flatbed scanner ($600 to $1000) and the price of a 24-pin dot-matrix printer (like the Apple Imagewriter LQ at $1300) or a low-priced laser printer (like the Apple LaserWriter IISC at $2900) to the price of a fax modem ($495 to $699), you're talking about a fax workstation that costs $2395 to $4599, not including the cost of the Mac. That's well above the cost of a stand-alone fax machine ($799 to $1600).

The comparison becomes more odious when you consider that of the three modems I tested for this article, only one, the Abaton InterFax, came with software that allowed unattended transmission and receipt of faxes in the background.

On the other hand, fax modems let you store an image electronically for editing with a paint program. You also get better-quality output, for two reasons. Most stand-alone units generate printouts on low-quality thermal paper that can't compete with a laser printer's. And unlike stand-alone machines, fax modems don't require printing a file and scanning it

continued

Name	InterFax	AppleFax	FaxSTF
Type	Fax/data modem	Fax modem	Fax modem
Company	Abaton 48431 Milmont Dr. Fremont, CA 94538 (800) 444-5321	Apple Computer, Inc. 20525 Mariani Ave. Cupertino, CA 95014 (408) 996-1010	STF Technologies, Inc. 1817 Main St. P.O. Box 247 Higginsville, MO 64037 (800) 426-1679
Features	Transmits CCITT Group 3 fax at 4800 and 2400 bps, CCITT V.22 (1200 bps), V.21 (300 bps), and Bell 103 (0-300 bps) and 212A (1200 bps); command-compatible with Hayes Smartmodem; sends and receives in background mode; supports Group 3 polling	Transmits CCITT Group 3 fax at 9600, 7200, 4800, and 2400 bps; also supports CCITT Group 2 fax; transmits binary and text files between AppleFax units at 9600 bps via proprietary file transfer scheme; polls other AppleFaxes	Supports CCITT Group 3 fax at 4800 and 2400 bps; has background-receive capability
Size	5¾ × 8 × 1¼ inches	7⅞ × 4¾ × 2 inches	6 × 3½ × 1 inches
Hardware Needed	Mac Plus or higher; 1 megabyte of RAM	Mac Plus or higher; 1 megabyte of RAM	Mac Plus or higher; 1 megabyte of RAM
Software Needed	System and Finder 5.0 or higher	System and Finder 5.0 or higher	System and Finder 5.0 or higher
Documentation	147-page hardware manual; 141-page software manual	191-page user's guide	73-page user's manual
Warranty	1 year parts and labor	90 days parts and labor	90 days parts and labor
Price	$495	$699	$695
	Inquiry 851.	**Inquiry 852.**	**Inquiry 857.**

before transmitting it. Finally, fax modems are convenient. You don't have to walk down the hall and wait in line for the fax machine or babysit multipage documents that might get stuck in the feeder.

After spending a month testing fax modems, I think they're best suited for offices that have already invested in a Mac, a laser printer, and perhaps a scanner, and that send and receive a lot of hard-copy fax materials that have been created on the Mac. If all you want to do is send hard-copy faxes, a fax modem system is overkill. And for many electronic files, a standard data modem may be sufficient.

A Quick Rundown

None of the fax modems I tested are cheap, but the Abaton unit, at $495, is the least expensive of the group. Next comes the FaxSTF at $695, followed closely by the AppleFax at $699. The prices include the power supplies, serial connection cables, twisted-pair flat phone wire, and software. The FaxSTF also includes a handy, zippered, nylon carrying case.

The AppleFax modem transmits fax images at up to 9600 bps, considerably faster than the InterFax and FaxSTF units, which are limited to 4800 bps. But the InterFax also includes a 1200-bps Hayes-compatible data modem. Apple has developed a proprietary scheme that lets you use the AppleFax's 9600-bps half-duplex fax modem to transmit binary and text files, but it works only with other AppleFax modems. The FaxSTF doesn't offer any standard data communications capability.

While all three devices let you store incoming faxes in a proprietary format or to the Clipboard for use with paint programs, none supports MacDraw PICT, Encapsulated PostScript, resource PICT, or other popular file formats, and none provides any image editing or manipulation capabilities.

Each unit comes with a fax-mail application that lets you create, preview, send, receive, review, and manage fax documents. All the applications let you create fax documents from within another application, since they provide Chooser resources that allow the application to be printed to the fax modem or saved to disk and previewed.

The Abaton InterFax includes a control-panel resource. This controls the sending and receiving of faxes in background mode and lets you send a fax during a voice-initiated call and then resume your conversation when the transmission finishes. The InterFax's background send/receive does not require MultiFinder, although it's MultiFinder-friendly. The FaxSTF can receive background faxes but not send them.

The AppleFax software doesn't allow either background sends or receives unless you buy Solutions' BackFax program. Neither the AppleFax nor the FaxSTF supports fax transmission during voice-initiated calls.

One handy feature of the InterFax is polling. When you set polling on, the InterFax will query the receiving fax machine or fax modem to determine if any faxes are waiting to be sent to you. If so, it permits them to be sent immediately, saving time for both the sender and the receiver. The AppleFax has a modified version of polling that works only with other AppleFax modems (not with stand-alone fax machines). The FaxSTF doesn't support polling.

Each fax application includes fairly extensive management facilities for the

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AppleFax Extender

One of the biggest omissions in the AppleFax software is the lack of a background sending and receiving capability. Fortunately, Solutions' BackFax program has addressed the problem. Solutions has a reputation for quality software, like SuperGlue, SmartScrap, The Clipper, and Glue. In the limited tests that I made, BackFax lived up to that reputation.

BackFax is written strictly for the AppleFax modem, transforming an AppleFax-equipped Mac into an automated fax station that will send and receive Group 3 faxes while letting the Mac do other work in the foreground. BackFax replaces the AppleFax software that Apple supplied with the modem. Like Abaton's InterFax software, BackFax can work in the background without MultiFinder.

With BackFax, you also can create special cover pages for any fax message or group of messages you're sending (this is something none of the other packages offers). These cover pages can include information that identifies the sender, the time and date of the transmission, the number of pages in the fax, the subject of the fax, and any special delivery instructions. Because the cover page is a fax document itself, it can also include graphical information to help distinguish it from other faxes that you receive.

BackFax also includes fax message and phone management capabilities similar to those in the AppleFax software that it replaces. The program includes its own Chooser resource, `MailSaver`, which converts documents to fax format and can send your documents once they're converted. `MailSaver`'s send screen looks like the `Font/DA Mover` and is easy to learn.

If you already have an AppleFax, BackFax is worth the extra $245. Otherwise, the Abaton InterFax is a better buy. For $495, it includes background/receive software that supports message and phone management facilities like those in BackFax. In contrast, the AppleFax/BackFax combination costs $944, comparable to the price of many stand-alone fax machines.

BackFax is published by Solutions International, under license from Solutions, Inc. The company can be reached at 30 Commerce St., Williston, VT 05495, (802) 658-5506.

faxes that you send and receive, along with phone capabilities that control the dialing of remote faxes, the use of pulse or tone phones, and the management of on-line phone directories. None of the programs is superior at fax and phone management, although I did find the Abaton software marginally easier to learn and use.

Technical Details

I've summarized the specifications and features of each fax modem in the table on page 208D. Unfortunately, the more technical information was available only from Apple; little additional information was available for the Abaton or STF units.

The AppleFax modem includes an 8-bit 65C112 microprocessor that uses a 1.8432-MHz clock. The modem uses the processor to direct and control logic flow, configure operating modes (fax or data), decode and execute host instructions, and direct and buffer data between the host and the modem's serial channel controller (SCC). The processor addresses 8K bytes by 8 bits of RAM that's contained in a single IC and is used as a data buffer between the host and the device (fax or another Mac) to which it's connected.

In addition to the RAM, the AppleFax also includes 32K bytes of 8-bit ROM that contains control firmware used by the processor to execute AppleFax modem routines. The AppleFax's SCC is also controlled by the 65C112 microprocessor. The SCC converts data from serial to parallel and from parallel to serial, depending on memory needs. The SCC contains two bit-oriented serial ports. One port is an asynchronous one to the programmable array logic in the AppleFax; the other is a synchronous port to the AppleFax's internal data pump.

The AppleFax includes two external interface ports. One is used by the host computer when the AppleFax is under host control; the other is a pass-through port that lets you connect other serial devices (e.g., a data modem) to your Mac. This additional serial port means that you don't have to give up your Mac's modem port to use the AppleFax modem. It also saves you from purchasing a serial switch box if you already have both Mac serial ports in use.

The back panels of all three modems include RJ-11 telephone jacks for connection to your telephone line and your phone handset. Each modem also includes a back-panel power socket for connection to the supplied transformer/power supplies and an on/off switch. The FaxSTF, however, does not have a power switch; plugging in the unit turns it on.

The front panels are devoted to standard modem status lights for the InterFax, modified status lights for the FaxSTF, and green and yellow power and mode lights for the AppleFax. The AppleFax also includes a mode-select switch in the front for toggling between normal fax/modem mode and pass-through mode (enabling the pass-through serial port). The AppleFax provides a sliding speaker-volume control on the side; the other two modems lack this feature.

The power transformers for the InterFax and the FaxSTF are modest, but the Apple transformer is a large brick that's almost as big as the modem itself. Whether or not its size indicates a more robust power supply is hard to tell, but the transformer makes the unit heavy, which may be a factor if you plan on transporting the device.

Put to the Test

I tested each modem by connecting it to two different kinds of systems: 8-megabyte color Mac IIs and 2-megabyte Mac SEs. I used System 6.0.2, Finder 6.1, and the other system software from the 6.0.2 System Tools during testing. During my first round of testing, I kept only the desk accessories, fonts, INITs, and cdevs supplied with the Apple System.

Each modem comes with its own start-up document (INIT) that's installed into the System Folder. Once I established that all the basic software accessories wouldn't cause any problems with the modem INITs or software, I reinstalled my usual mix of multiple cdevs, fonts, and desk accessories, controlled by `MasterJuggler`. But when I retested each modem with this system software, I ran into two problems with the InterFax and its INIT: The Abaton INIT was incompatible with two other INITs in my usual system mix: the `AutoMac III` macro system and the `MenuClock 101` menu bar clock.

Other than these incompatibilities, I was able to install and use the start-up documents of each fax modem in my normally crowded System Folder without a

continued

hitch. I removed AutoMac III and MenuClock 101 for the duration of my second-round tests.

The AppleFax and InterFax software functioned properly during my tests. But I encountered intermittent problems with the FaxSTF software, especially when I used it with MultiFinder. The error dialogues ranged from Error ID = 7 ("A Facsimile error has occurred. The FaxSTF modem could not be found.") to a problem in which the program quit without explanation and returned to the Finder. These errors occurred randomly with the FaxSTF application, with both my bare-bones test System and my cdev/INIT/desk accessory-loaded System.

Font Problems

One of the tricks of sending clear faxes through the Mac is to have the appropriate fonts. The rule to remember is the 3-times rule. Faxes that are converted from documents with 12-point type must have that same typeface's 36-point size installed in the System, or the fax conversion will take place with a scaled version of the 12-point font—with less than impressive results. Each document that you prepare for faxing must have at least two versions of a font installed in the System: the actual screen font, and a font three times that size (the 3-times rule). As long as you have the larger fonts installed, your faxed documents will be received at their highest possible resolution.

Apple solves the 3-times-rule font problem by including letter-quality fonts in sizes up to 72 points for the Symbol, Times, Helvetica, and Courier fonts. Since Apple no longer licenses these letter-quality fonts to other vendors, that can be a problem for users of the InterFax and FaxSTF. Abaton came up with a decent solution by offering two non-Apple fonts, SWA Swiss and SWA Dutch (which are roughly comparable to Helvetica and Times, respectively), in sizes from 9 to 72 points. If you use these fonts for your fax documents, the resulting resolution is much greater.

Before Apple's licensing changes, the FaxSTF included the Apple letter-quality fonts. Unfortunately, STF Technologies has not included substitutes for these missing letter-quality fonts, so documents sent using 12-point Helvetica, for example, will be faxed as a scaled 36-point Helvetica, with considerably less resolution than if the 36-point font size were installed in the System.

Performance Testing

I ran some informal performance tests with these three modems. The tests consisted of sending and receiving three different documents: a scanned page from the AppleFax manual, a MacPaint screen shot of ParcPlace's Smalltalk-80 system, and a text document created using Ashton-Tate's FullWrite Professional. None of the modems had any problems converting these files into standard- and high-resolution fax images, and none of the modems had any problems sending or receiving the images.

I am convinced that these products have a legitimate niche alongside stand-alone fax machines.

There were some differences in the times necessary to send and receive documents, however. The best performance was from AppleFax to AppleFax, which was 30 percent faster than the other units. I then tested the modems by sending these same documents to a local 9600-bps Sharp Group 3 stand-alone fax machine and to the same model fax machine located in San Francisco. Again, the AppleFax was 25 percent to 30 percent faster than the other units.

But while I expected the 9600-bps AppleFax to be consistently faster in all the tests, that wasn't the case. Often, line noise caused the AppleFax to fall back to 4800 bps, negating its speed advantage. However, you wouldn't know this unless you timed the transmission, since none of the modems provides any indication of the speed at which it's transmitting. If my tests are any indication, you probably shouldn't let claims of speed influence your decision to buy a fax modem. Price, flexibility, and good software are more important.

Recommendations

After working with these products, I'm convinced that they have a legitimate niche alongside stand-alone fax machines. Of the three units, I rate the Abaton InterFax the highest. It costs the least at $495, and it also provides a fine 1200-bps Hayes-compatible data modem capability. Although it was slower than the AppleFax in some tests, it's as fast as the FaxSTF. Also, its software is marginally the best for managing incoming and outgoing faxes.

The InterFax also includes the ability to send and receive faxes in the background (without the need for MultiFinder), so you don't lose your machine while faxing (neither the AppleFax nor the FaxSTF could both send and receive in background mode). And Abaton includes two letter-quality fonts, in sizes up to 72 points, that look nice when received by stand-alone fax machines.

The AppleFax is a good fax modem, but it suffers from substandard software that doesn't allow background sending and receiving. You can buy BackFax to add background capability to the AppleFax, but that brings the total cost to $944. For $699, the AppleFax should include that software as part of the package, especially since the manual touts the modem's role in the AppleFax workstation.

The AppleFax does have the added utility of exchanging Mac text and binary files with other AppleFaxes at 9600 bps. Apple also includes the Imagewriter letter-quality fonts in sizes to 72 points, for sharp-looking faxes.

Unfortunately, the AppleFax has also had its share of hardware problems. At press time, Apple had temporarily suspended shipment of the AppleFax due to a ROM problem that reportedly kept the device from working with some private branch exchanges and older Group 3 fax machines. The unit I tested seemed to function fine.

The FaxSTF isn't a polished product; it lacks several important details that would make it substantially better. The manual is almost impossible to read because the typeface is so minuscule, and it's missing substantive details about the fax hardware. The foot-long serial cable is too short. The modem doesn't have any letter-quality fonts. And the software has the weakest management capabilities of the three units and doesn't allow background sends. On top of all that, at $695, the FaxSTF is also expensive. The unit's saving grace is its size. It's the smallest and lightest fax modem I tested, which may make it a good companion to a Mac laptop when one arrives. ■

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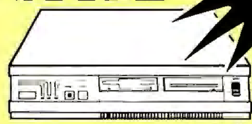

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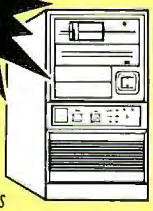

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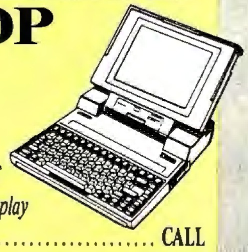

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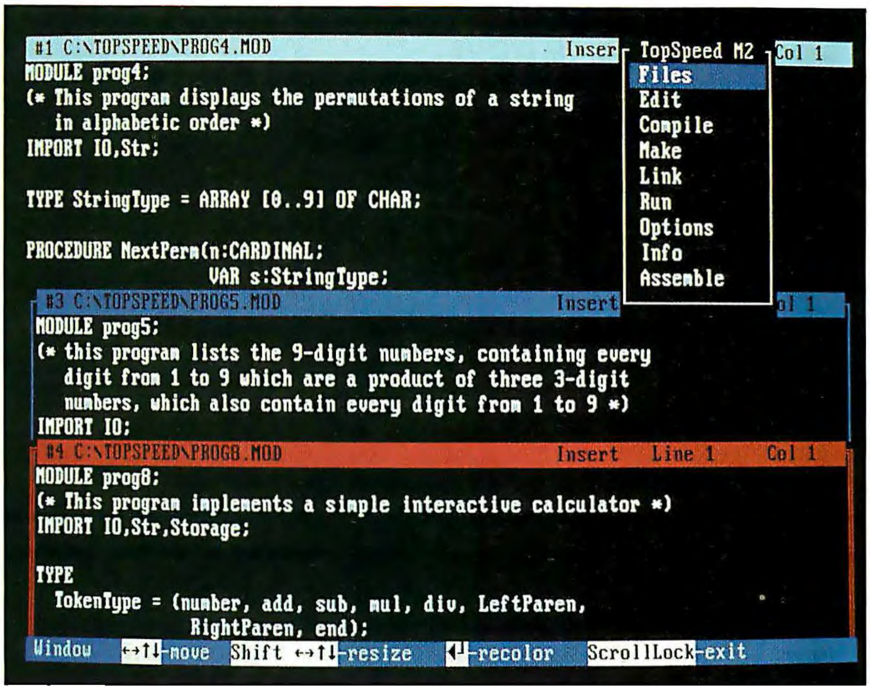
TopSpeed Modula-2

An integrated programming environment that produces efficient code

Barry Nance



There's been a growing curiosity in Modula-2. And TopSpeed Modula-2 for the IBM PC from Jensen & Partners International (JPI) is going to catch the attention of many programmers. Its integrated environment is slick, and its optimizing compiler is fast and efficient.

TopSpeed Modula-2 1.15 ($99.95) works with an IBM PC or compatible with 512K bytes of RAM, two floppy disk drives, and DOS 2.1 or higher.

A Closer Look

The integrated development environment is similar to that of Borland's language products. It provides file-selection operations, an integral editor, a "smart" Make facility, a built-in linker, and a means to run tests of your programs from within the environment. It has a context-sensitive help facility that includes summary information on each of the options in the menu system and library routines.

TopSpeed's menu structure is file-driven and therefore completely configurable. It's easy to customize the default M2.MNU file to suit your personal tastes and development style. You can change the size, position, color, and even the contents of each of the menus. You can integrate other programmer tools and programs (such as the optional TechKit and the TopSpeed full-screen debugger, VID) into the TopSpeed menus.

You're not, however, chained to the integrated environment. If you are more comfortable with a command-line interface, you can invoke the compiler and the linker directly from the DOS prompt.

You can edit up to four files simultaneously in the multiwindow, built-in editor. You can resize, move, recolor, and zoom each window. You indicate which one of the windows is the main module and all the compile and make commands that apply to it. Switching from window to window is quick and easy.

The M2.MNU configuration file establishes the keystrokes for the editor commands, and you change it to set up the editor to your tastes. The default commands are WordStar-like, and pull-down menus are available for users who don't use the short-cut keystrokes.

Turning On the Make Utility

The Make utility is highly integrated with the Modula-2 language and TopSpeed environment. If you give it a main-module name, it automatically figures out what needs to be recompiled to have an up-to-date executable file. If the compiler detects errors in a source file, you can drop immediately into the editor to fix them and then resume Make.

The .OBJ files emitted by the TopSpeed compiler are in standard Microsoft/Intel format, so you could use the Microsoft linker. But you probably won't want to. JPI's linker is faster, and it's smart enough to link in only the code that the program actually references.

You can specify various settings within the TopSpeed environment through a menu option. For example, you can set compiler directives to prepare the code for use with the debugger or set linker directives according to the sort of .MAP file you want to create. You can set directives to enter a command line for a program running inside the environment.

continued

TopSpeed Modula-2 comes with a set of main library routines that differ from the procedures suggested in version 3 of Nicklaus Wirth's Modula-2 definition. For purists, standard library modules are supplied as an alternative.

Checking the Code

The compiler can work quickly. Depending on the complexity of the source code, it will typically handle between 6000 and 10,000 lines per minute. The compiler always recompiles the visible portion of any imported modules (the .DEF files), which slows down the compiler somewhat, but this means there are no restrictions on the ordering of the modules.

Of course, fast compilation speed and an integrated environment aren't everything. What really matters is the ability of the compiler to emit tight, fast, and correct machine code. Code generation is where TopSpeed Modula-2 shines.

I discovered this by looking at the actual machine code for common-language constructs emitted by the compiler. For example, consider the Modula-2 code to initialize an array [1..1700] of characters (see listing 1a). The resulting machine code (see listing 1b) shows that the compiler is smart enough to recognize that the entire array is being initialized. The compiler sets up and then executes a single instruction (the REP STOSW) to perform initialization in-line, without calling a library routine and without initializing each byte separately.

A simple Modula-2 string assignment (see listing 2a) was also handled well by the compiler. The resulting machine code (see listing 2b) demonstrates that the TopSpeed compiler generated the string-assignment code in-line, and that it's smart enough to move 101 bytes as a 50-word move followed by a single-byte move.

I also tried another common program construct, the case statement (see listing 3a). Here, the TopSpeed compiler protects the program from crashing if the value of the control variable in the case statement is not within bounds (see listing 3b).

Special Features

TopSpeed Modula-2 comes with several special features. Among them is a time-slice process scheduler that you can use to create peer-to-peer, concurrently executing threads within a single program. It's easy to launch one or more threads, and you can control each thread's priority, interthread communications (i.e., accessing common variables), and process scheduling. In addition, JPI says that it is working on a version of TopSpeed Modula-2 that will take advantage of OS/2's multitasking features.

A special mechanism supports interrupt handlers, including compiler directives to cause procedures to save/restore registers and to end with an IRET instruction. But you can't place return values in registers, nor can you set the flag register within such a procedure. I had to resort to a separate assembler module to do what I wanted.

TopSpeed Modula-2 also comes with text-windowing facilities that are easy—even fun—to use. When you open a window, you can specify a window title, whether or not it has a frame, the characters (if any) that make up the frame, the row and column of the window, the attributes (colors) that you use, whether you want a visible cursor, and how you want the text in the window displayed. You can manage several windows at once and resize, move, retitle, and hide them. With-

Listing 1: (a) *A TopSpeed Modula-2 routine that initializes an array [1..1700] of characters is compiled* **(b)** *to perform initialization in-line, without calling a library routine and without initializing each byte separately.*

(a)

```
FOR i := 1 TO SIZE(ch_array) DO
    ch_array[i] := '0';
    END;
```

(b)

```
MOV     AX, 48              ; '0' is decimal 48
MOV     ES, CS:DataAreaSeg
MOV     CX, Offset ch_array ; set up addresses
MOV     DI, CX
MOV     AH, AL              ; turn '0' into a word of '00'
MOV     CX, 1700 / 2        ; count of words
REP     STOSW               ; store 850 words of '00'
                            ; with "repeat-store-string-word"
```

Listing 2: (a) *When it compiles a simple string assignment, TopSpeed Modula-2* **(b)** *moves 101 bytes as a 50-word move followed by a single-byte move.*

(a)

```
s1 := "This is a string";
s2 := s1;
```

(b)

```
; s1 := "This is a string";

     MOV     ES, CS:DataAreaSeg   ; 1st assignment...set up addresses
     MOV     DI, Offset s1        ; (ES:DI is destination)
     MOV     SI, Offset str_constant
     PUSH    CS                   ; constants are stored in code seg,
     POP     DS                   ; so move is from CS:SI
     MOV     CX, 8                ; word (not byte) count to move
     REP     MOVSW                ; move 16 bytes (DS:SI to ES:DI)
     MOVSB                        ; do 17th byte

; s2 := s1;

     MOV     DS, CS:DataAreaSeg   ; begin 2nd assignment
     MOV     ES, CS:DataAreaSeg   ; set up addresses
     MOV     DI, Offset s2        ; destination
     MOV     SI, Offset s1        ; source
     MOV     CX, 50               ; string is 101 bytes, so
     REP     MOVSW                ; do 1st 100 (as 50 words),
     MOVSB                        ; then do last (101st) byte
```

in a window, you can place text in a variety of ways (including direct screen writes), and you can insert and delete text lines.

However, TopSpeed Modula-2 is relatively weak in graphics support. After initializing your program for a specific video adapter (there is no auto-detect), you can use TopSpeed's procedures for entering or exiting graphics mode; drawing dots; and drawing lines, circles, ellipses, and polygons. It supports CGA, EGA, VGA, Hercules, and AT&T graphics adapters. No special fonts come with the compiler (à la Borland's BGI), and there are no provisions for setting line widths or fill patterns.

For me, though, one of the best features of TopSpeed Modula-2 is that the library routines come in both object and source forms. Even if you never customize them, just having the code for reference purposes is invaluable.

A Case to Switch

If you are new to Modula-2, you will be happy to know that TopSpeed Modula-2 comes with a language tutorial and a

continued

Listing 3: (a) *The TopSpeed Modula-2 compiler protects the case statement from crashing if* **(b)** *the value of the control variable is not within bounds.*

(a)

```
CASE i OF                   (* if i is:   set j to: *)
  | 0 : j := 0;             (*    0          0      *)
  | 1 : j := 1;             (*    1          1      *)
  | 2 : j := 2;             (*    2          2      *)
  END;
```

Note: *i* was declared as a signed integer.

(b)

```
      MOV    DS, CS:DataAreaSeg
      MOV    AX, i            ; get value of i
      MOV    BX, AX
      SHL    BX, 1            ; set up index for jump (i * 2)
      CMP    AX, 3            ; if i greater than or equal to 3,
      JGE    NSI              ; just go to next stmt after the case
      CMP    AX, 0            ; do the same if i < 0
      JL     NSI
      JMP    CS: [BX+Tbl]     ; go to Tbl+0, Tbl+2, or Tbl+4
Tbl:  SUB    AX, AX           ; set AX to 0
      JMP    Store
      MOV    AX, 1            ; set AX to 1
      JMP    Store
      MOV    AX, 2            ; set AX to 2
Store: MOV   j, AX            ; store AX in j
NSI:
```

TopSpeed Modula-2 version 1.15

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user's manual. The language tutorial is a version of the book *Modula-2: A Complete Guide* by K. N. King (Lexington, MA: D.C. Heath, 1988), condensed and adapted specifically to the TopSpeed Modula-2 system. You will find it thorough and helpful, and it will likely save you from having to buy "helper" textbooks.

The user's manual explains TopSpeed Modula-2 with examples and formal definitions, including the definitions for each of the library modules. The library modules are grouped by category instead of in alphabetical order. I personally would have preferred them in simple alphabetical order.

TopSpeed Modula-2 is tempting. It generates tight, fast machine code—better code than some leading C compilers. And it comes with a wealth of features and tools. I think it might even tempt those who have never used Modula-2 into switching languages. ■

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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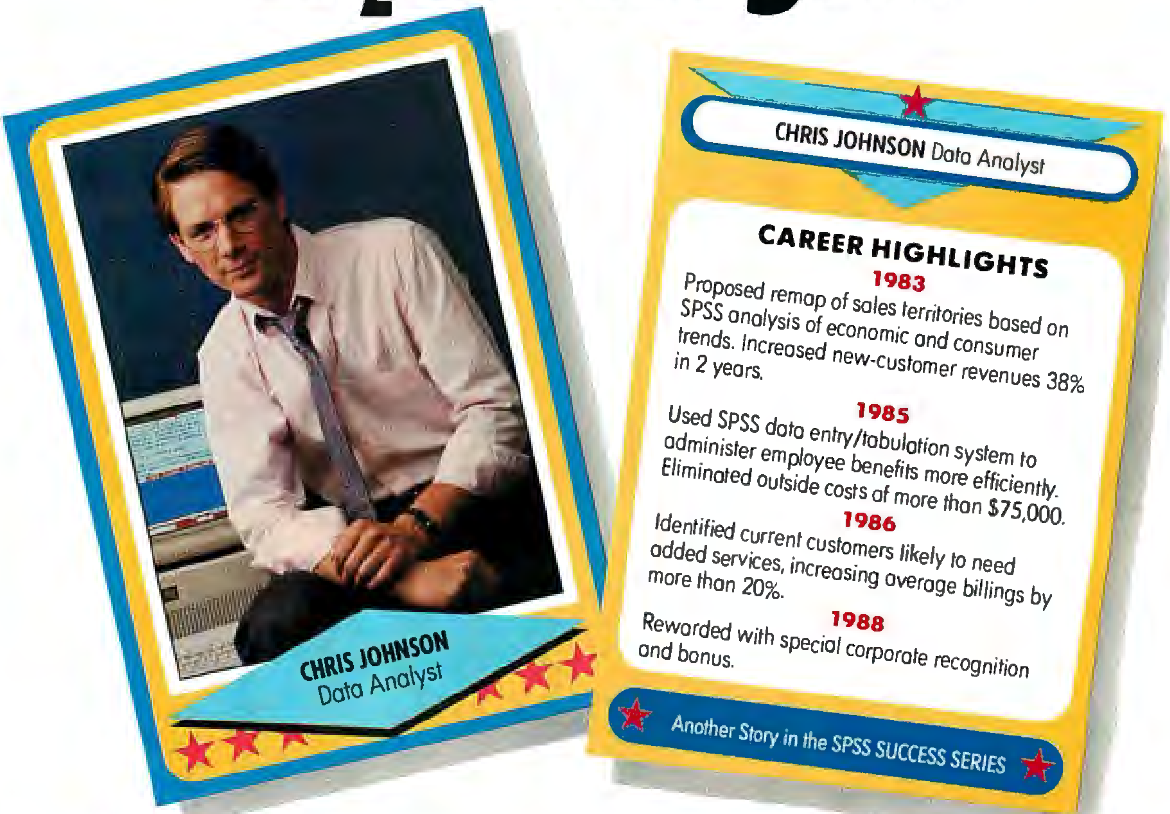

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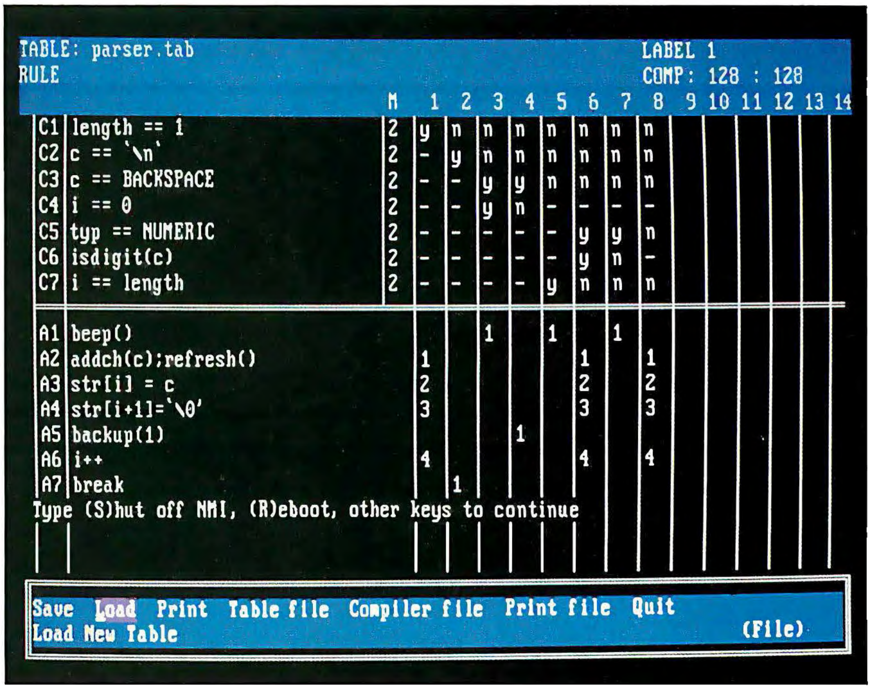
Circle 251 on Reader Service Card

A Different Kind of CASE Tool

Logic Gem might change the way you look at programming

Andrew Schulman



Associating the word *logic* with programming suggests AI. But Sterling Castle's Logic Gem isn't an AI program. It is a tool that you use to explore program logic by means of decision tables.

Listing 1 shows a snippet of C code. In Logic Gem, items like (argc > 2) and the return value from DosOpen() are *conditions*, and items like the command exit() or setting the variable cflag to 1 are *actions*. A decision table is a matrix associating a series of conditions with a set of actions. The basic decision table consists of four sections: condition stub, condition entries, action stub, and action entries.

A decision table equivalent to the code example might look like table 1. The number 2 on lines C1 and C2 indicates that these are simple Boolean operators that can be either yes (y) or no (n). A set of two such two-way conditions presents four possible combinations of values or rules: both true (y/y), the first true and the second false (y/n), the second true and the first false (n/y), and both false (n/n). These combinations appear in the upper right corner of the decision table. In this example, y/y is a more concise way of saying:

```
if ((argc > 2) && (DosOpen
  (argv[2], &cfile,...)))
```

Each combination of conditions carries with it one or more actions. If both conditions C1 and C2 are true, then actions A3 and A4 are invoked: Call fprintf() and then exit(). The numbers 1 and 2 in the lower right corner indicate the order in which to carry out A3 and A4. On the other hand, if neither C1 nor C2 is true (n/n), then the decision table shows that A2 should be triggered.

The Logic Editor

A decision table, then, is a logical spreadsheet, and the Logic Editor portion of Logic Gem helps construct such tables. After opening a fresh table, you type in your conditions and actions on the left side of the screen and then use the Logic Gem Missing command to fill in the missing rules. In the case of a series of simple two-way conditions, Logic Gem supplies a complete set of y/n combinations. You specify which actions are triggered by each y/n combination. In my example, the combination (C1 && C2) triggers A3 and A4, and the combination (C1 && !C2) triggers A1.

Logic Gem evaluates the matrix and can detect inconsistencies. For example, in table 1, the combinations n/y and n/n produce the same result. The program's Reduce command eliminates this redundancy, as shown in table 2. If C1 fails, there is no point in testing C2; thus, table 2 is more concise and more accurate than table 1. Logic Gem happened to remove this error while reducing the table, but applying strict Venn diagram–type logic to the world of programming does present a problem: Side effects are often disguised as logical tests. For example, the command DosOpen is a side effect that is in no way reflected in the table. It just shows a return value "yes," meaning that DosOpen failed.

Logic Gem replaces the n/y/A2 and n/n/A2 decisions with a single n/-/A2 decision. The hyphen indicates "don't care" and plays a crucial role in decision

continued

tables. When a Logic Gem condition is marked with a 2 to indicate Boolean two-way logic, the condition can take on three values: y, n, or -. Likewise, a Logic Gem condition marked with a 3 can take four values: a, b, c, or -.

Logic Gem can also detect and eliminate ambiguities. Adding a rule such as n/n/A1 to table 2, which contains the rule n/-/A2, would be ambiguous. Logic Gem "disambiguates" a table by eliminating rules. In this case, Logic Gem would eliminate n/n/A1, because rules with a hyphen contain more information than rules without it.

Sometimes Logic Gem's Disambiguate command eliminates rules that are indeed ambiguous but that you still may want to keep. And its Reduce command ruthlessly eliminates rules for which you have not yet specified an action. For this reason, the Undo command is important, even though it backs up only one level; it is primitive, consisting of .BAK files on disk. A Readme file on disk uses a Logic Gem decision table to document the situations under which the program creates .BAK files.

All Logic Gem commands are available through a pop-up menu that you access with the forward slash (/) key (confusingly called the right backslash key in the Logic Gem manual). All major logic-editing functions appear in the Table menu, but not in the best order. For example, important commands like Reduce and Missing appear in a submenu called More. Sterling Castle promises a more logical menu structure in future releases.

Listing 1: *Sample C code used to illustrate Logic Gem functions.*

```
if (argc > 2)
    if (DosOpen(argv[2], &cfile, &act, 0L, 0, 0x12, 0x0022, 0L))
        { fprintf(stderr, "\nErr: %s\n", argv[2]);
        exit(1); }
    else
        cflag = 1;
else
    cflag = 0;
```

Table 1: *The Logic Gem decision table from the C code in listing 1.*

```
C1 argc > 2                          2  y  y  n  n
C2 DosOpen(argv[2],&cfile,...)       2  y  n  y  n

A1 cflag = 1                               1
A2 cflag = 0                                  1  1
A3 fprintf(stderr,"\nErr: %s\n",...)    1
A4 exit(1)                              2
```

Table 2: *The decision table after executing the Logic Gem* Reduce *command.*

```
C1 argc > 2                          2  y  y  n
C2 DosOpen(argv[2],&cfile,...)       2  y  n  -

A1 cflag = 1                               1
A2 cflag = 0                                  1
A3 fprintf(stderr,"\nErr: %s\n",...)    1
A4 exit(1)                              2
```

Listing 2: *Sample C code that Logic Gem converts back to C from a decision table.*

```
dosopen.tab()
{
    if (argc > 2) {
        if (DosOpen(argv[2],&cfile,&act,0L,0,0x12,0x0022,0L)) {
            /* rule 1 */
            fprintf(stderr, "\nErr: %s\n", argv[2]);
            exit(1);
        }
        else {
            /* rule 2 */
            cflag = 1;
        }
    }
    else {
        /* rule 3 */
        cflag = 0;
    }
}
```

New Programming Perspectives

Why transform IF . . . THEN logic into a decision table? Logic Gem can verify that all possible states have corresponding actions so that program logic is complete. This increases your confidence in the program and, in addition, verifies its correctness.

Seeing program logic in the form of y/n/- patterns provides new and interesting perspectives. Many of these are stock patterns (e.g., the "upside-down staircase" in the Logic Gem manual), and a future version of Logic Gem might construct these archetypal logic diagrams automatically. In any event, the ability to picture a large block of code as a tiny table of rules, which often conforms to some standard pattern, is one of the great benefits of Logic Gem.

It is also a major drawback. On a standard PC screen, you can usually see an entire table without scrolling. This is a restriction with Logic Gem because you can specify only nine conditions. While it's true that 2^9 is 512, the use of the don't-care symbol reduces the number of combinations to something manageable, if not limiting.

The reason for the nine-condition limit is that a larger number would require two digits, chewing up valuable screen real estate. You could argue that this is a reasonable trade-off; it lets you view entire tables at once, and you will probably never need to exceed the program's limit, anyway.

Associating patterns with program logic may do for many people what flowcharts never could. The ability to associate a set of condition-action rules with a pattern puts Logic Gem halfway between a simple textual description and a graphical flowchart.

The Code Generator

Logic Gem is also a code generator. From a decision table, Logic Gem can generate code in C, Pascal, line-numbered or structured BASIC, FORTRAN, or dBASE III Plus. Surprisingly, neither LISP nor Prolog is included. It would have been better if, rather than hard-wiring specific languages into Logic Gem, the program author had provided a meta-language or template format that would describe the form of the code generator's output.

Logic Gem does a reasonable job of transforming a decision table into compilable code, converting the decision table created from the sample C code from BYTE back to C, as shown in listing 2. The result is straight IF...ELSE code. Logic Gem cannot yet generate case/switch statements, jump/dispatch tables, or state-machine tables. The company says that a future version of Logic Gem will generate case/switch statements.

Note that the Logic Gem-generated C function is called `dosopen.tab()`. The program got this illegal function name from the decision table filename. While the code refers to variables like `cflag` and `act`, these are neither declared as local variables nor passed on as arguments. Because the condition and action stubs are just passed through to the code generator, Logic Gem knows nothing about your code. The result is that you will have to add your own variable declarations. This is no big deal and is unavoidable, but it isn't true that Logic Gem-generated code compiles the first time, as the manual implies.

Logic Gem-generated code tends to fall off the right side of the page, because it generates IF...ELSE code and defaults to eight-character-wide tab stops. You can change Logic Gem's defaults by modifying the file LGCONFIG.

continued

Logic Gem 1.0 (Programmer's Edition)

Type
Decision-table editor, code generator, and logic interpreter

Company
Sterling Castle
702 Washington St., Suite 174
Marina del Rey, CA 90292
(213) 306-3020

Format
One 5¼-inch floppy disk and one 3½-inch floppy disk

Hardware Needed
IBM PC, PS/2, or compatible with 640K bytes of RAM, DOS 2.0 or higher, and a monochrome monitor

Documentation
User's guide and reference guide

Price
$198

Inquiry 881.

The Logic Gem code generator can guarantee a minimum number of tests. It recursively decomposes a decision table into subtables, printing condition stubs as it discards rows, and printing actions as isolated rules. Sorting rules govern the walk down the tree of subtables. A submenu lets you control which sorting rule the code generator uses.

The more interesting sorting rules involve frequency and cost. At the bottom of each y/n/- combination, you can indicate the expected frequency with which this decision occurs and estimate the cost associated with it. Within the context of minimizing the number of comparisons used in isolating a rule, Logic Gem can sort frequent rules first or costly rules last, or it can use a heuristic collation method.

The Logic Interpreter

Logic Gem can serve as a logic interpreter as well. For instance, running the DosOpen() decision table under the interpreter might yield the following scenario:

```
argc > 2 :
y> Yes
n> No
y

DosOpen(argv[2],&cfile,...) :
y> Yes
n> No
n

RULE 2
cflag = 1
```

In addition to executing your decision table in expert-system form, the Logic Interpreter is also a language. Actions or conditions can call subtables; actions can return values to calling tables or set the value for a condition; and actions or conditions can execute DOS commands or display files. When a condition calls a subtable or executes a DOS command, the value of the condition is picked up from the subtable or from a file that Logic Gem uses to communicate with other programs.

All this is done with a tiny instruction set: CC (condition call), CD (condition display), CE (condition execute), AC (action call), AD (action display), AE (action execute), AI (action include), AL (action loop), AP (action proceed), AR (action return), AS (action set). For instance, the action AS 2 n would loop back to the top of the decision table, setting condition 2 to no. You will find this very useful for simulating state machines.

Unfortunately, these commands have no meaning in the other components of Logic Gem. In particular, interpreter commands that chain to another table or loop back to the beginning of the current table are ignored by other parts of the program. So, outside the interpreter, Logic Gem is not suited for handling logic that involves WHILE rather than IF conditions.

What is great about Logic Gem is the way it reveals unsuspected patterns in your code. The program could use a smoother user interface and a more logical menu structure. But for programmers who already use decision tables or would like to use them, Logic Gem should prove to be a valuable tool. ■

Andrew Schulman is a software engineer living in Cambridge, Massachusetts. He can be reached on BIX c/o "editors."

A Window on Word Processing

Ami brings affordable word processing and desktop publishing to Microsoft Windows

Lamont Wood

In the PC world, you generally have a choice of either word processing or desktop publishing. With the new Ami word processor from Samna Corp., you can have a little of both. Depending on your needs, it may be enough—and it's certainly more than you might expect for $199.

Ami is a Microsoft Windows–based word processor that combines on-screen graphics, some WYSIWYG, font control, layout control, and other desktop publishing features with traditional word processing features, such as spell checking, cut-and-paste, and search-and-replace functions.

However, it is not as thorough as some high-powered and usually expensive word processing or desktop publishing packages—although this may not matter to most users. Also, you cannot use Ami on an IBM PC or XT. In fact, it is shipped on high-density floppy disks, precluding its use on a PC (although you can get 360K-byte disks by arrangement). Ami requires an IBM PC AT, PS/2, or compatible with Hercules, EGA, or VGA graphics, 640K bytes of memory, and about 2.4 megabytes of available hard disk space.

Ami joins a nearly empty field of Windows-based word processors. Previously, there was Windows Write, a rudimentary notepad facility bundled with Microsoft Windows, and NBI Legend, a full-blown word processing, desktop publishing package that costs $698. Actually, you don't have to buy Windows to run Ami, since it comes with a Windows run-time package. Using Windows, however, lets you transfer text and graphics between Ami and other Windows applications using the Windows Clipboard function.

The Two Modes

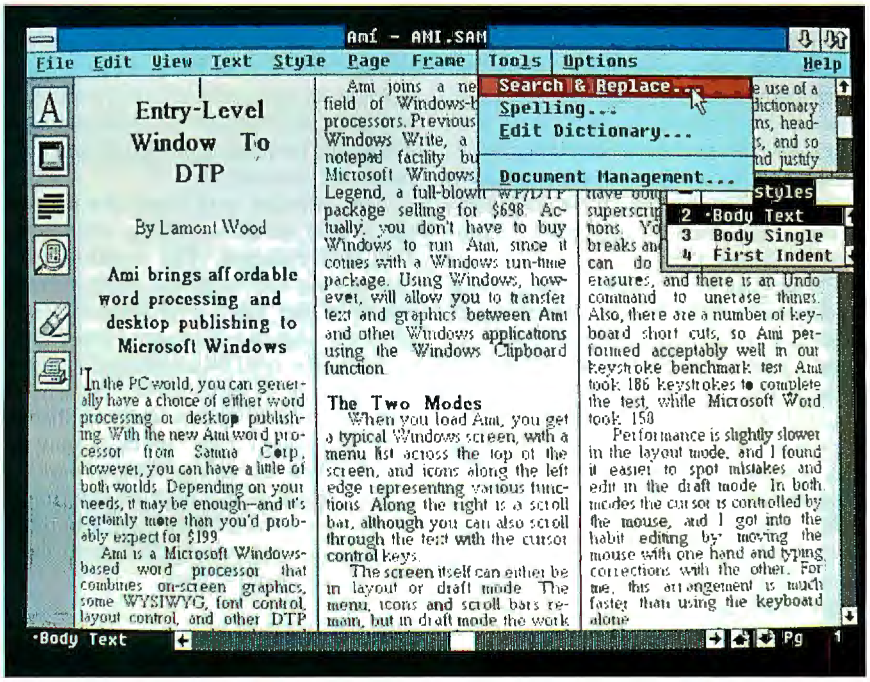
When you load Ami, you get a typical Windows screen, with a menu list across the top and icons along the left edge representing various functions. Along the right side of the screen is a scroll bar, although you can also scroll through the text with the cursor-control keys.

The screen itself can be in either layout or draft mode. In draft mode, the menu, icons, and scroll bars remain, but the work area contains only monospaced text, like any word processor you'd have seen five years ago. You can apply attributes for centering, boldfacing, and so forth in the draft mode, but, in most cases, there is no change in how the text is displayed—it remains left-justified, monospaced text. Even the margins aren't displayed.

You can then toggle into the layout mode, and suddenly you're in another world. The text now shows all the assigned attributes. If you've used a proportional font, the text will look about the same as it does when printed. Right margins are adjusted automatically for different type sizes. What you see is, roughly, what you get—including the margins, which are shaded.

You can compose text in either layout or draft mode and perform all the word processing functions. These include use of a 130,000-word spelling dictionary and control over margins, headers, footers, tab settings, and so on. You can align and justify text in various ways, and you

continued



Ami

Type
Word processor with desktop publishing features

Company
Samna Corp.
5600 Glenridge Dr.
Atlanta, GA 30342
(404) 851-0007

Format
Four 5¼-inch high-density floppy disks

Hardware Needed
IBM PC AT, PS/2, or compatible with 640K bytes of RAM; one floppy disk drive; hard disk drive with 2.4 megabytes of free space; Hercules, EGA, or VGA graphics

Software Needed
DOS 3.0 or higher

Documentation
User's guide, style-sheet guide, Microsoft Windows guide

Price
$199

Inquiry 882.

can choose from boldface, italic, underline, superscript, and subscript options. The program also lets you control page breaks and page numbering, move and erase blocks of text, and use the Undo command to restore the text. Ami provides several keyboard shortcuts, so it performed acceptably in our keystroke benchmark test. Ami took 186 keystrokes to complete the test, while Microsoft Word took 158.

Performance is slightly slower in the layout mode, and I found it easier to spot mistakes and edit in the draft mode. In both modes, you control the cursor by using a mouse. I got into the habit of editing with the mouse in one hand and typing corrections with the other. For me, this arrangement is much faster than using the keyboard alone.

You cannot, however, perform desktop publishing functions while in draft mode. If you add a frame and import a graphics image, there is no evidence of it when you toggle to draft mode. All you can view in the draft mode is the raw text.

Ami's Desktop Publishing

Ami's approach to desktop publishing can be likened to a stripped-down, mass-market version of the approach used by Xerox's Ventura Publisher, a leading desktop publishing package. Ventura Publisher's approach centers around style sheets, paragraph tagging, and frames.

Style sheets are a combination of margin, tab, alignment, and other settings, along with a list of named style tags. As in Ventura Publisher, each of Ami's style sheets resides in a separate file and can be attached to one or more documents, with those documents having full use of the features it defines. Unlike Ventura Publisher, Ami's style sheets can be restricted to one document so that changes to that sheet won't affect other documents that happen to use it.

An individual style tag would concern itself with an individual text element on a page. Consider, for instance, the address field on a business memo. It would start out with a left-justified "TO:" followed by a tab setting. You might also want to use italics and a left margin to place it under your letterhead logo. You could define elements through Ami's Style menu and then give it a name. You can apply a style by simply clicking on it with the mouse.

You can create and save style tags together as a new style sheet. Ami comes with 25 canned style sheets, whose tags you can easily modify. Ami also provides excellent facilities for creating style tags, with windows showing what a selected font and paragraph look like with a choice of indents, line spacing, ruling lines, and so forth. You can have as many as eight columns on a page, and you can select the size of the intercolumn gutter and how heavy a rule you want between the columns.

Ami provides four views of a page in the layout mode: working, standard, full, and enlarged. The working view displays the full width and about half the length of the page. The standard view shows a somewhat closer view that's standard for most Windows applications. The full-page view shows the entire page, with body text reduced to shaded bars, although larger typefaces may be legible. And the enlarged view shows a portion of the page magnified two times. I found the standard view easiest to read, but it has a shortcoming: It cannot show the full width of the page.

Near WYSIWYG

What you see in these layout views may or may not be what you get. That is because Ami can use downloadable laser-printer soft fonts but does not automatically generate matching screen fonts. The only printer font it comes with is Courier, a monospaced imitation of typewriter output. If you need other fonts, you will have to acquire them elsewhere.

For instance, I was able to load some Hewlett-Packard LaserJet soft fonts previously created for a Ventura Publisher system. Ami's Fonts facility let me direct Ami to the subdirectory containing the Ventura Publisher fonts. The program immediately listed by name and size the fonts that it recognized there. I highlighted the ones I wanted, and Ami then copied them to a special subdirectory that it created.

From then on, I could use those fonts in Ami whenever I wanted. However, the fonts that Ami was showing on the screen were selected from its list of canned screen fonts. It comes with eight screen fonts, including Courier, Helvetica, Times Roman, and Script. If you type in layout mode, the lines will wrap and the letters will space themselves. Then, as you leave a paragraph, or about 10 seconds after you stop typing, the program will suddenly reformat the lines and spaces.

The reformatting takes place because Ami knows the letter spacings of the selected printer font even if it is not using them on the screen as you type. The spacing is read from the font files when you select them. As you type, Ami uses the spacings of the screen font. After you stop, it applies the printer font spacings to what you've typed. The result may not look perfectly aesthetic on the screen, but the hard copy you print will look fine. And the line breaks appear in the same places on the screen as they do on the printout.

Also, because Ami has only a few canned screen fonts, the typeface it shows on the screen may not resemble the printer fonts. For example, I loaded a novelty printer typeface called Broadway. Ami did not have a matching screen font, so it simply displayed Times Roman. However, Ami did use the correct spacing for Broadway, so I could judge what the printout would look like.

Frames and Graphics

As with Ventura Publisher, you can add frames to a page. A frame is an enclosure whose contents are separate from the rest of the page. It is used for things such as positioning sidebars in a newsletter, importing graphics, and placing special elements, like logos.

In layout mode, you simply select the frame icon and then stretch out a rectangle. The rectangle is now the new frame, and you can resize or reposition it at will. The text on the page can either wrap around the frame on both sides, not wrap at all and resume below the frame, or continue behind it. The frame can be opaque or transparent. You can set the internal margin of the frame and the kind of borders you want, if any.

You can type text into a frame or import it from another file. (Text can similarly be imported into the document as a whole, in either ASCII, Samna Word, AdvanceWrite, WordStar 2000 versions 1.01 and 3.0, and WordPerfect 5.0 formats.) Material in a frame does not appear at all when you go to draft mode—there is no indication there that the frame exists, unless, of course, the frame was selected (highlighted) before going to draft mode. Then all you see in draft mode is the text that the frame contains.

You can also import graphics images into a frame if they are in either the TIFF or PCX (PC Paintbrush) formats. In fact, importing into a frame is the only way you can use graphics. You can copy the graphic to your Ami document, which allows faster processing, or leave it uncopied, so that any further editing you do to the picture with graphics software will be reflected in your Ami document. You cannot have text and graphics in the same frame, but you can overlap frames with text and graphics to get the same result.

Once the image has been loaded into the frame, you can resize it either to a custom measurement that you specify or automatically to fit the frame. Ami will maintain the aspect ratio of the original if you so specify, or it can be left in its original size within the frame. I found that it was important to have some idea of what size the image should be; otherwise, you could flounder forever trying to get it just right. Things also go more smoothly if the original image does not have a lot of white space around the borders. If the image is larger than the frame, you can "slide" it around within the frame until it's positioned to your liking.

A Few Drawbacks

These are all powerful features, akin to what you would expect to find in a leading desktop publishing program. However, the problem begins when you start using these marvels: Ami can be very slow.

For instance, I created a page with a few paragraphs of text in 12-point Times Roman and made up sample headlines in five other font sizes. There was also a 2-by 2-inch frame containing a PCX image. Ami took 8 minutes and 34 seconds to print this using an 80386-based AT compatible (slowed to 8 MHz to avoid overrunning the printer) and a Quadram QuadLaser emulating a Hewlett-Packard LaserJet Plus.

Printing a page with the same elements from Ventura Publisher, using the same hardware at the same speed, took 2 minutes and 10 seconds. Admittedly, Ami returned control and continued outputting in background mode after the first 3 minutes.

Simply scrolling down the page can run into 10-second delays, especially if you have to scroll onto the screen a graphics image that wasn't copied. (Things go more smoothly if the images are copied into the frame, but then you can't edit it elsewhere.) On the positive side, Ami did perform standard word processing functions at a comfortable speed.

Comparing Checklists

Beyond standard word processing features, Ami falls a little short. Among the missing word processing features are a thesaurus, periodic automatic file saving in the background, multiple windows, redlining, mail-merge, section numbering, footnotes, tables, hidden notes, and numeric tables. These are all features that most high-end word processors—participants in the so-called "check-list marketing wars"—try to have. Such packages usually cost about $500.

In desktop publishing, Ami lacks the precise controls and adjustments that layout and graphic artists would demand. For instance, there is no kerning (the ability to adjust the gaps between letters); you can't make text flow around irregular foreground objects; and you can't draw free-form graphics on the page. Typographic options have to be selected from a list rather than defined in detail.

But the bigger issue is whether you really need all those features. Maybe not, unless you're a professional writer or graphic artist. I believe that Ami offers average users all the desktop publishing they need, and at a price they can appreciate. ■

Lamont Wood is a freelance writer in the computer and electronics fields and lives in San Antonio, Texas. He has been using word processors professionally for more than 10 years. He can be reached on BIX as "lwood."

 Circle 233 on Reader Service Card (DEALERS: 234)

Unix

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Circle 242 on Reader Service Card

IN DEPTH

Unix

With all the attention Unix is getting, you'd think it was a new product. It's not. It's been around for years. In fact, BYTE had an entire section devoted to Unix in October 1983. The attention it's getting now is due more to hardware than to software. In the 80386 and 68030, we finally have the hardware that makes using the Unix operating system on a microcomputer realistic.

Unix is not, however, just another operating system. It broadens the capabilities of the microcomputer to include the power of mainframes and minicomputers by using the very operating system that they use. However, if you decide to change to Unix, there are some things that you should keep in mind.

For one thing, Unix is a multiuser system. Whether you are one user on a small dedicated Unix system, or one of many on a huge Unix system, you must learn to think like a multiuser. This is not a problem. It's merely a mind-set. If you can learn to think like a multiuser, you'll open the doors to the capabilities of a multiuser system, whether or not you actually have one.

One element of this mind-set is the language used in discussing Unix: for example, *terminals*. We all understand what terminals are—many of us use them every day—we just don't tend to think of our own microcomputers as being terminals unless they're hooked up to a minicomputer or mainframe.

Another example is the use of *standard input* and *standard output*. On a large multiuser system, these definitions are extremely important; there must be a default location for input and output for control information on large systems. On a typical microcomputer, however, you can simply substitute keyboard and display screen, respectively.

There are other elements to this mind-set as well, and you'll discover many of them in this month's special In Depth coverage of Unix. We begin with "Future Imperfect" by David Fiedler, which shows how Unix began, what it is now, and where it's going. This article includes the text box "OSF/Motif" by John Paul, which gives an overview of this new graphical user interface from the Open Systems Foundation.

Next, in "One Man's Experience," John Unger describes the trials and tribulations—and rewards—of switching from DOS to Unix. In "The Unix Connection," Ben Smith describes various networking capabilities available to all Unix users, from the Usenet network to the UUCP tools to the NetNews BBS.

In "Safe and Secure?" Patrick Wood describes the pluses and minuses of the security features available on Unix. Then, in "Interrupts Aren't Always Best," George E. Pajari discusses when to use interrupts and when to use polling in designing device drivers.

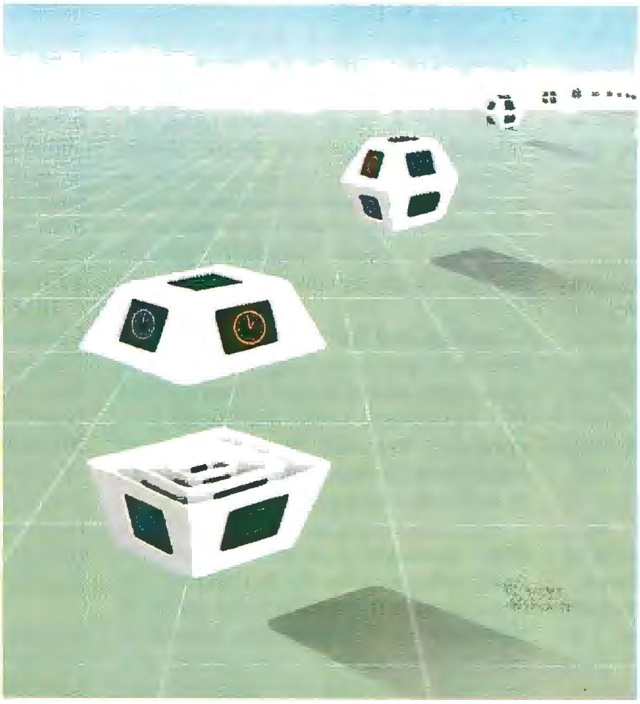
The more you look at Unix, the more you realize that it deserves all the attention it's getting. A real Unix revival has occurred—at least in the microcomputer world. Makes you wonder what other revivals might be just around the corner.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth

Future Imperfect

All the various Unixes are merging into one—but will it run on a microcomputer?

David Fiedler



Time flies when you're having fun. It seems like just yesterday that BYTE ran its first in-depth coverage of the Unix operating system. Back then (in 1983), the hardware state of the art was represented by the Motorola 68000 CPU, Unix System III was the current standard, and CP/M was still going strong.

While a great deal has happened since then, much of the technology has been evolutionary. The real surprises have been—and will probably continue to be—in the ways that people and companies interact with the technology, providing new platforms for others to build on.

Recent History: Hardware

The CPU that has most influenced the Unix system is unquestionably the Intel 80386. With this one chip, Intel has bridged the gap between DOS and Unix, as well as the gap between microprocessors and minicomputers. The ability of the 80386 to run PC-DOS programs while maintaining simultaneous respectable throughput under Unix has made 80386-based machines one of the fastest growing segments of the market. (Naturally, some 80386-based machines are being used for DOS applications alone, but it seems almost a waste of CPU cycles.) Once the 80386 became readily available to the personal computer user, it virtually took over the low end of the Unix hardware market.

Among other classical architecture machines, the leader is the Motorola 68030, a very fast chip whose impact is just being felt in the Unix market. Certainly the effect of all its predecessors (the 68020, 68010, and the venerable 68000) has been great, especially in the scientific workstation market. And just as the Intel design has its followers in the IBM PC and compatible world, so the Motorola chips have been used to good advantage by Apple in the Macintosh line.

The biggest fad in chip design these days is RISC. What surprised most of the old-line companies is that RISC can deliver what it promises: higher speed of execution in exchange for slightly larger executables. The idea is that you restrict the instructions that a CPU can execute to the most common ones. By having a smaller instruction set, less time is spent in the processor's operations decision tree, and throughput is increased.

While the concept isn't new (remember Forth?), it pays off in a big way when applied to the eternal problem of putting a lot of CPU on a little piece of silicon. Innovative companies like Pyramid Technology, MIPS Computer Systems, and Sun Microsystems with its SPARC design (actually, even IBM's RT PC is

continued

RISC-based) led the way with undeniable proof that RISC was viable. Digital Equipment Corporation (DEC), AT&T, IBM, and Data General are now also committed to the RISC concept, as are traditional chip manufacturers Intel (the 80860) and Motorola (88000 CPU). The fad is becoming the norm.

Software

Despite the many protestations to the contrary, whatever is the current AT&T version of Unix becomes the standard to which all other systems are compared. Presently, that is Unix System V release 3.2. Its features include demand paging, shared libraries, STREAMS (a generalized network-interface facility), and RFS (for Remote File System, which is similar to Berkeley's Network File System). SVR3.2 for the Intel 80386 CPU merges Unix and Xenix functionality for the first time, enabling 80386 Unix application software to be sold as a commodity item, as MS-DOS programs are.

However, BSD Unix, based on a modification of Unix made at the University of California at Berkeley, makes up a large portion of the Unix market. Berkeley releases are generally numbered 4.1, 4.2, or 4.3 (the most recent). The SunOS system is based on Berkeley 4.3 Unix. Berkeley brought many innovations to Unix, such as symbolic links, the Fast File System, and NFS. Due to its availability, it has become a de facto standard in the academic community.

Xenix is the third main division of Unix. Created originally by Microsoft as a commercial product for microcomputers, Xenix itself has been ported to machines ranging from large minicomputers, such as the DEC VAX-11/780, to the IBM PC. Xenix has been aggressively marketed and supported by The Santa Cruz Operation and has gained a well-deserved reputation as a solid base on which to put application software. Most of today's Xenix systems are running on the IBM PC AT or 80386-based clones.

For years, computer industry pundits have been raising a lot of dust with predictions about whether PC-DOS or Unix will be the leading operating system. Even to ask the question is silly, since DOS and Unix have been almost mutually exclusive: DOS is for single-user PCs based on the 8088, 80286, or 80386 CPUs, while Unix is a multitasking, multiuser system that runs on virtually any CPU architecture up to a Cray supercomputer (imagine porting DOS to a Cray if you still don't think it's a silly question).

Although DOS and Unix aren't potential competitors in the market, OS/2 and Unix are (although OS/2 is still limited to Intel architecture). One of the advantages of OS/2 will be its upward compatibility from DOS. While relatively few people are working with OS/2 in the office environment right now, there are many happy DOS users on Unix and Xenix systems.

These users are happy because they're running their DOS applications—using the virtual 8086 capabilities of the 80386 CPU (via VP/ix or Merge 386) or using software emulators or converters (Soft PC or XDOS) on other CPUs—and they're doing it without leaving the Unix environment. This gives them the ability to move files between DOS and Unix, use the greater power of Unix for other tasks, and simplify system administration and backup. In many cases, their programs actually run faster than they would under native DOS. This upward compatibility is of a higher order than you usually expect.

If you're a Mac fan, all this talk about DOS probably leaves you cold. Apple, noticing the success that Sun and others are having in the higher-education market with workstations, decided to combine the Mac's ease of use with the popularity of Unix in the Mac II running A/UX. A/UX, while still undergoing development and growing pains, should eventually allow many Mac programs to migrate to the Unix environment while still retaining their Mac flavor and interface, and it should, hopefully, provide the Mac flavor to many Unix tools.

Graphics and Networks

Now that there is no longer a scarcity of Unix application software (counting IBM PC, Macintosh, Unix, and Xenix programs all together, there's no longer much room for argument here), I'll turn to some other topics of interest.

MIT, in cooperation with DEC and IBM, developed a graphics-based software package called the X Window System and made it available to the public. X Windows (as it is generally known) is analogous to the Unix system in that it is reasonably standard and portable, very well written, and serves as a base for other software. While not an entire user interface on its own, X Windows allows you to write applications that can interface with any computer supporting X Windows by simply recompiling.

Due to its availability, X Windows has spread widely and is now the de facto standard in the Unix workstation market. It has also been ported to the IBM PC under DOS and 80386 PCs running Unix and Xenix (Xsight from Locus), as well as DEC machines running VMS. Acer has produced a graphics terminal with X Windows server code embedded in the ROM, obviating the need for a separate computer or workstation for the users of X Windows applications.

But X Windows isn't just graphics. It's also a networking package that allows you to run application programs, possibly located on different computer architectures on the same network, from one bit-mapped display. X Windows manages your display, keyboard, and mouse while transparently sending data via TCP/IP protocols to the other machines or programs as needed.

Another popular graphics and networking package is NeWS (Network Extensible Window System) from Sun. NeWS is based around the PostScript language, which means that less data can be moved across a network for the same graphical results. Sun is making NeWS compatible with X Windows.

Berkeley Unix introduced the Network File System concept. Using NFS allows file systems located on separate networked machines to appear as though they're all on one much larger computer. NFS, due to its availability, has become the de facto standard for networking—not only on Unix, but on workstations and larger systems (such as DEC's VMS) in general. It has become common to have IBM PCs networked to Unix systems using NFS; the PCs can then be used as terminals, or the Unix system as a file server, or both.

IBM has introduced the Transparent Computing Facility, developed by Locus Computing, for its AIX operating system. TCF goes a step further than NFS (while still retaining compatibility with it). TCF will actually run your programs on other networked computers, automatically finding the fastest or least-loaded machine, transferring files, and redirecting I/O as necessary. This is the beginning of true distributed computing.

Standards

As Unix has become ubiquitous, people have found the existence of multiple versions a barrier, especially for program development. Standards, such as SVID, POSIX, and X/Open, attempt to define certain characteristics a system should have, as a minimum, to be considered conforming. This would enable a developer relying only on these system requirements to be assured that the program will run properly on a Unix, Berkeley, Xenix, or any other POSIX-

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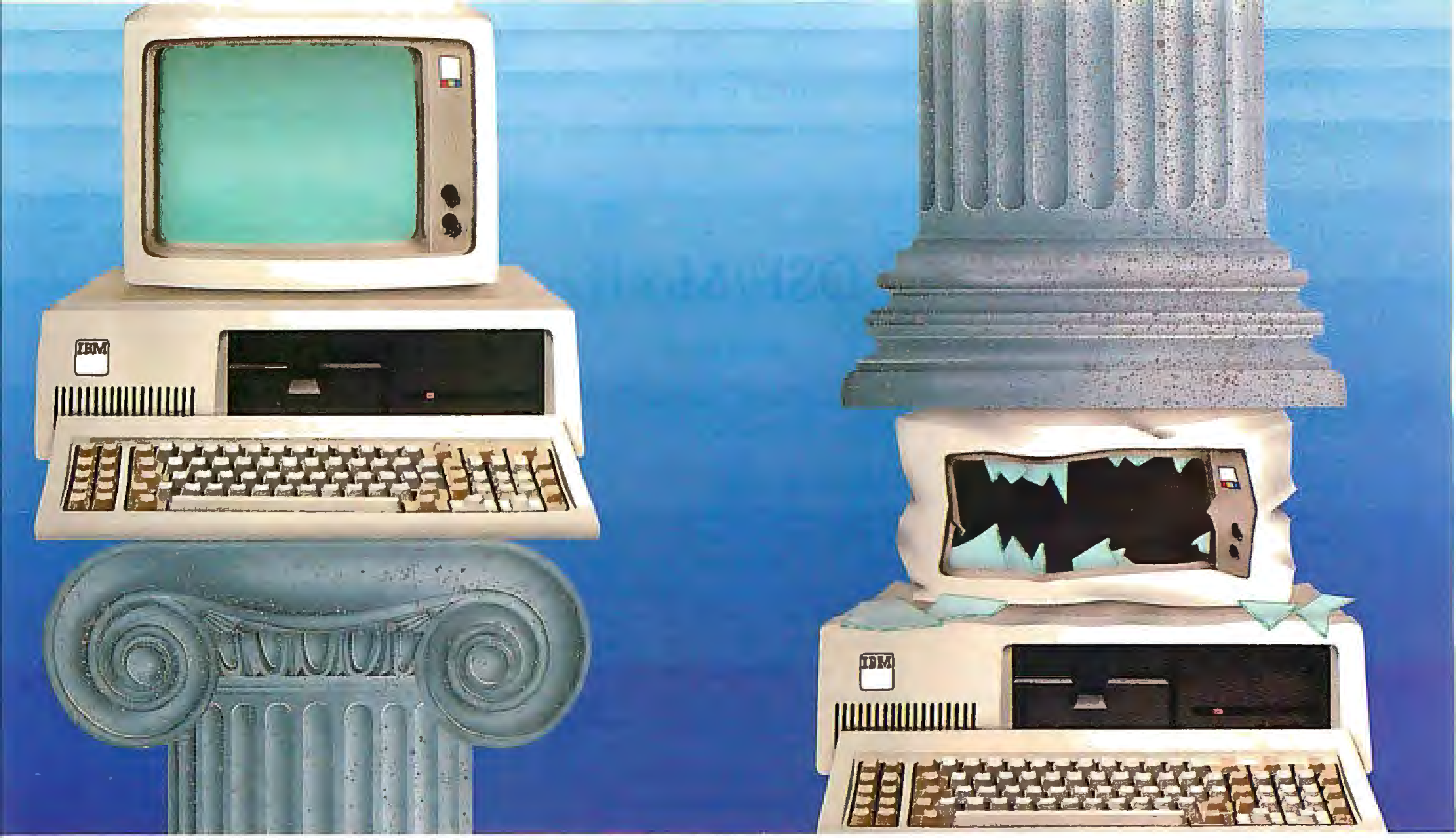

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OSF/Motif

John Paul

A consistent graphical interface has been one of the industry's most obvious and controversial problems—until now. The Open Software Foundation (Cambridge, MA) recently announced OSF/Motif, its first product offering.

OSF/Motif is a graphical user-interface toolkit, window manager, style guide, and user-interface language. It lets you create consistent graphics-based applications on both open and proprietary systems. The various elements that constitute Motif were chosen from vendor submissions to OSF.

Motif's interface behavior is compatible with Presentation Manager's behavior. Thus, if you're familiar with PM on personal computers, you can use Motif-based applications without learning a different user interface.

X Marks the Spot

Motif's graphical interface is based on the X Window System from MIT. This underlying technology provides you with a network-based graphical user interface. X Windows has a server-client architecture. The actual application runs on the client side and can be anywhere in the network—on a Cray, a VAX, a specialized database processor, an Apollo workstation, and so on. The server runs locally on the workstation, personal computer, or X terminal.

Using the X protocol, the client and server communicate, making it possible to run a simulation on a Cray in the network while all user interaction and graphical presentation appear on your workstation or personal computer.

Motif is composed of a style guide, window manager, interface toolkit, presentation description language and compiler, user documentation, application programmer documentation, and test applications.

• *Style guide.* The success of the Macintosh is attributed largely to the consistent look and feel of the applications that run on it. This consistency is what OSF, through Motif, hopes to bring to applications written by the rest of the computer industry.

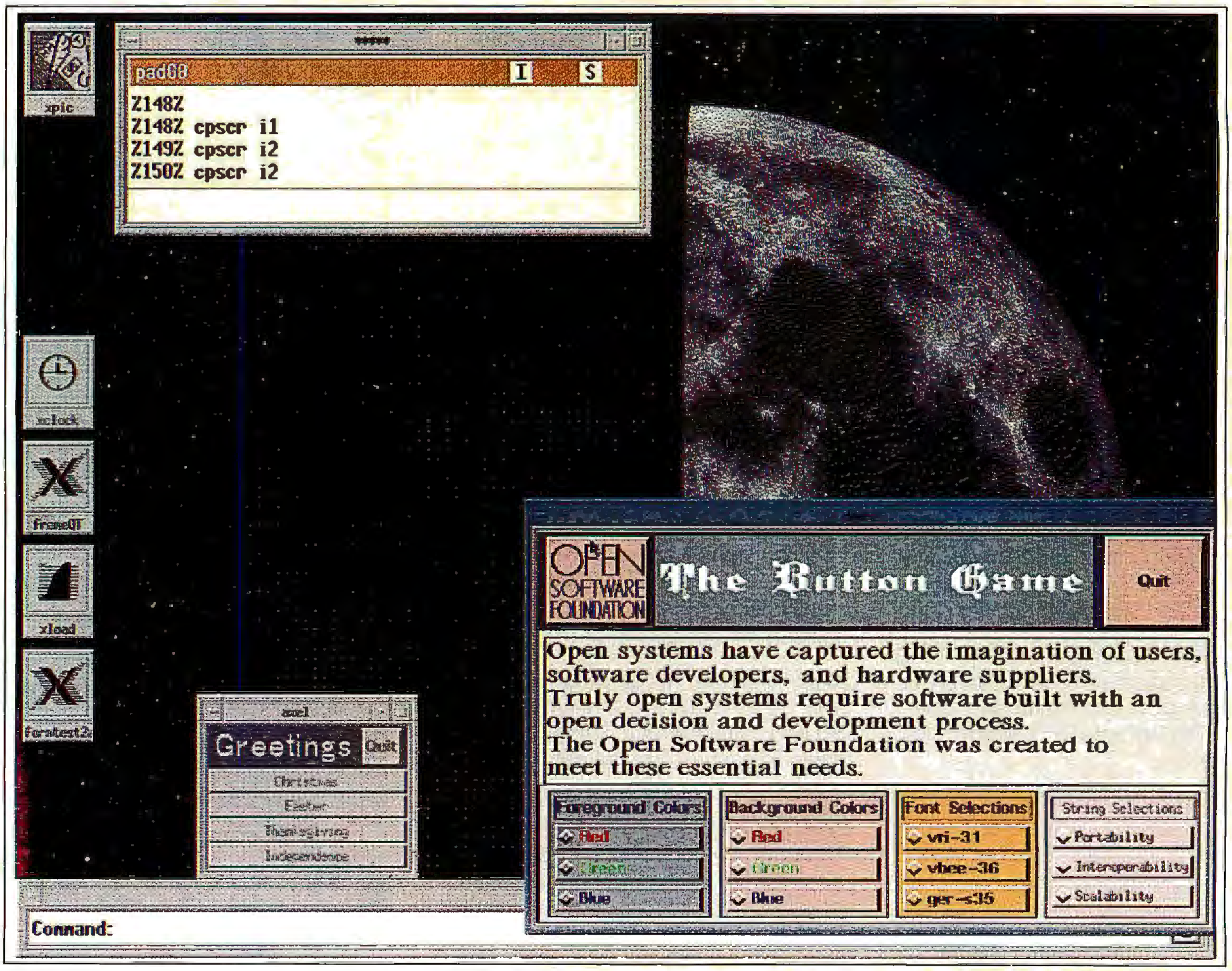

Photo 1: *An example of an OSF/Motif display. OSF/Motif combines the utility of DEC's XUI with the familiar look of Microsoft PM and the elegance of Hewlett-Packard's New Wave. (Photo courtesy of Kee Hinkley and Apollo Computer.)*

The style guide, a joint Hewlett-Packard/Microsoft submission, describes a standard behavior and a set of conventions for applications, to ensure a consistent feel on multiple applications. It is compatible with Microsoft PM, which is already familiar to many PC users. The style guide includes extensions for powerful network-based workstations. Its "look" is based on the HP three-dimensional screen-button appearance (see photo 1).

• *Window manager.* An HP submission, the window manager lets you manipulate multiple applications on the screen and plays a principal role in enforcing the style guide. Although it provides standard PM behavior, the window manager is highly customizable; it lets you redefine the contents of the window-manager menus and alter other aspects of window-related interactions.

• *Interface toolkit.* The OSF/Motif toolkit, a DEC submission, is based on the X Windows intrinsics, a toolkit framework provided with MIT's X Window System. The intrinsics use an object-oriented model to create graphical objects known as *widgets* or *gadgets*. The specified widgets maintain consistency between applications.

DEC's toolkit (XUI) will be extended to support the three-dimensional appearance and PM behavior of the HP/Microsoft submission. It will be upwardly compatible with the current Digital Application Programmer Interface so that applications written today on XUI will move easily to OSF/Motif.

• *Presentation description language.* This language, using DEC's User Interface Language (UIL) compiler and resource manager, enables application developers to describe the presentation characteristics of the application interface independent of the actual application code. The separation between application and interface lets you make many changes to the overall appearance and layout of an application without having to modify, recompile, or relink the application itself.

Open Systems

OSF/Motif supports the major goals of the OSF by providing an interoperable, scalable, and portable application environment. Let's look at these features.

Interoperable systems are more than just networked computers sharing CPU cycles, memory, disk space, and I/O devices. In addition to sharing computer resources, users need to move freely between applications running on different computers and operating systems without having to learn a new user interface.

Many people believe that computing in the future will be dominated by personal computers on the desktop and Unix-based systems in the network. A typical user will run PM-based applications and network-based applications through an X server on the same personal computer at the same time. OSF/Motif, with its PM behavior, will let you do this without confusion—a major step toward linking the personal computer and open-systems communities.

Scalability allows both users and applications to run on a wide range of hardware, from personal computers to supercomputers. Today, when your application outgrows your computer's architecture and you move to a larger system, you usually need to relearn your application. In fact, you may not be able to use it at all. Motif is the first step toward allowing you and your application to scale to a more powerful, yet still familiar, environment.

Motif is built on standards such as POSIX, ANSI C, and X Windows, so it is portable to many different architectures. For example, within one day of receiving the DEC and HP code, the OSF had the software running on three different hardware platforms.

A Joint Effort

OSF chose to build Motif from two technologies. This decision allows Motif to have PM behavior and an advanced three-dimensional look implemented on the best toolkit available.

A joint team of OSF, DEC, and HP engineers is combining the two technologies. Motif's release is scheduled for this summer.

John Paul was recently made president of Nixdorf Computer Engineering Corp. From May 1988 to January, he was interim director of development for the Open Software Foundation. He can be reached on Usenet as "uunet!xait!emacs!jpaul" or on BIX c/o "editors."

conforming system. While X/Open is more international in scope than POSIX (a U.S. national standard sponsored by the IEEE), both enjoy plenty of support from manufacturers and are not exclusive of each other.

More controversial in some corporate circles is the concern that AT&T is in too powerful a position with regard to Unix. Even though AT&T licenses Unix source and binary code to its direct competitors, they claim that the control of Unix is too important to be left to one company and that Unix development should be an open process. Part of the controversy is due to the fact that several companies making this claim have historically made their money with proprietary operating systems that weren't open to anyone.

In any case, these companies have formed a consortium, the Open Software Foundation (OSF), and have been working on an operating system and user interface that will be available this year for anyone who wishes it. It is interesting to speculate on what impact the OSF will have on the industry at large. In the long run, the effect will certainly be fewer separate flavors of Unix. Its system, OSF/1, will be based on IBM's AIX and yet will still conform to Unix System V, POSIX, and X/Open standards. The promise of openness has brought the OSF many new members; this may, in time, dilute the original anti-AT&T posture.

Supporters of AT&T have come up with their own organization, Unix International, Inc. (UII), whose charter is to provide feedback to AT&T on software development, features, and licensing issues, although AT&T will always have the final say. Several companies have joined both UII and the OSF; their chief executives should be considered as potential political candidates.

Free Software

The purest of open systems philosophy is exemplified by the Free Software Foundation and the GNU Project. Richard Stallman (the originator of the popular EMACS editor) is the principal exponent of the movement to eliminate restrictions on copying, redistributing, and general distribution of information and source code for computer programs. Working principally off devotion to the project and grants from Hewlett-Packard and the OSF, the Free Software Foundation has produced some of the best compilers, editors, and utilities for Unix. As X Windows demonstrates, excellence and availability are the prime ingredients for de facto standardization.

continued

Future History—Hardware

Let's look a few years ahead. Predictably, we'll have the Intel 80486 64-bit CPU, which will likely run at speeds of up to 40 MHz or more and have companion specialty chips to drive SCSI, graphics, and other devices at high speeds. These chips will be similar to mainframe channel controllers; perhaps one will appear to the bus like a bank of 80286 CPUs, for DOS compatibility requirements. The Motorola 68040 will be a leading competitor to the 80486, with similar specifications. Both CPUs will retain compatibility with earlier designs.

The new generation of RISC chips will bring extensions to both ends of the current spectrum. RISC technology will appear in lower-priced computers, while much larger machines will be made up of parallel high-throughput RISC processors. Parallel architecture will be more popular in general, with special on-chip logic signals to support synchronization between CPUs. One cabinet will hold a closely coupled network of processors, and your program might be executed on one or all of them (think of IBM's TCF in miniature).

Digital signal processor (DSP) chips will continue to grow in importance. In the Unix workstation market, they will be the key to driving voice I/O, as speech recognition emerges from the laboratory. But as they become more familiar to system designers, DSPs will be used in other interesting ways, since they are basically very fast floating-point RISC machines. Adaptive digital communications is one interesting idea to watch here.

Probably the best look you can get at the future of Unix systems is the visionary NeXT machine (see "The NeXT Computer" by Tom Thompson and Nick Baran, November 1988 BYTE). It's certainly ahead of its time (unavailable to business users, though, and currently only in limited distribution in its market of higher education) and will be used as a model from which future software and hardware developers can start.

The state of the art this year for Unix dial-up communications is the Telebit Trailblazer Plus modem, which has become a de facto standard due to its availability and features. It implements the UUCP protocol (and a few others such as Kermit, XMODEM, and YMODEM) and data compression in firmware, for real-world throughput of well over 1000 bytes per second.

Other high-speed modems using hardware data compression algorithms that automatically switch between fax mode and data mode are on the horizon. In the future, these will all likely be supplanted by ISDN telephone service at 56 kbps. If ISDN is not priced carefully by telephone companies, look for intelligent radio (not cellular) modems that can pass information at high speeds over relatively short distances, using Unix systems as store-and-forward servers as is currently done with Usenet news.

Software

What most people are waiting for now is the release of AT&T's new Unix System V release 4.0. SVR4 will merge current Unix System V, SunOS, Berkeley 4.3, and Xenix system calls and commands in the most ambitious attempt ever to combine all major versions of Unix into one. SVR4 will include both NFS and RFS; STREAMS and Sockets; ASCII character and Open Look graphical interfaces; and X Windows 11 and NeWS. It will provide for real-time process scheduling, support for full international (multiple bytes per character) character sets, ANSI C, and dynamic linking, plus new system administration and security enhancements. Application Binary Interfaces (ABI) will mean that any program written for any 80386, SPARC, or other ABI machine running SVR4 will run properly.

Farther into the future, there will be a standard for electronic documents that combines sound (voice), graphics, and text in E-mail for every popular computer architecture. Such heavy communications traffic loads will require multitasking (and probably multiprocessor) systems and will make single-tasking systems such as MS-DOS and the Macintosh operating system all but obsolete.

User Interface

It's not inconceivable that, in the foreseeable future, nonintuitive interfaces will disappear altogether. Those of us who have grown up with computers in the last 25 years or so may think that the standard shell-type interface is intuitive, but it isn't. Most people can relate to pictures better than to letters and numbers. Graphics is the wave of the future, and there's a big interest in portable graphical interfaces for Unix.

OSF/Motif, the graphical interface selected by the OSF (see the text box "OSF/Motif" by John Paul on page 230), combines offerings from DEC, Hewlett-Packard, and Microsoft. It has the look and feel of Microsoft's OS/2 Presentation Manager and MS-DOS Windows, with the three-dimensional appearance

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developed for HP's Window Manager. All this runs on top of X Windows. Its reasonable licensing terms, extensibility, and wide availability should make OSF/Motif a very important product in the next few years.

In the other camp, AT&T has been demonstrating its Open Look interface, which runs on top of either X Windows or NeWS. Developed with Sun and licensed, in part, from Xerox, Open Look will be the standard graphical interface from AT&T and followers for Unix SVR4. This alone makes it an important force in the market, even though direct support for Open Look has not been as forthcoming as support for OSF/Motif.

NeXT's NextStep is the graphical interface on the NeXT machine. It is object-oriented and has a three-dimensional appearance, and it also supports Display PostScript. While it isn't being offered in the same way as the other products mentioned, NextStep's wide distribution on campuses will influence users' experience. IBM has licensed NextStep as a possible new interface for AIX.

The ultimate choice of a graphical interface for Unix is an important one, but the choice must be made soon, lest "look and feel" lawsuits choke off all progress toward standardization.

A Word on Standards

As noted, many products have become market leaders or de facto standards because they were quickly made available to a wide spectrum of machines. This kind of migration is the real impetus behind open systems. When external organizations attempt to impose standards, they generally succeed in direct proportion to how well they follow what the market is already demanding (remember Esperanto?).

We can hope that once all the various Unixes are merged into one "ultimate" standard version, the result will not be so cumbersome that a supercomputer will be needed to run it (unless, of course, supercomputer chips cost only $50 each by that time).

One Final Glimpse into the Future

What does the future hold? I can imagine this clipping from BYTElines, April 1996:

"Unix System XII release 9.01, from AT&T/Trump Software, is soon to be released. It promises to merge the leading versions of Unix from the U.S., Japan, and the Soviet Union. Controversy arises over whether the kernel (written in C+++++++) should be smaller than 16 megabytes, to allow use on older systems. Computer tabloids argue whether Unix will ever be accepted in the marketplace, since there are only 6.02×10^{23} application programs available for it and it's still not DOS compatible.

"Critics of AT&T/Trump complain that the new release is not open enough and that it won't be available to the public for a full 52 minutes after internal certification (and then only by slow 100-megabyte-per-second network feeds). Richard Stallman, AT&T/Trump Vice President of Software Social Responsibility, disagreed on worldwide digital television and was supported by a majority vote on Usenet 27 seconds later." ■

David Fiedler (alias the "dragon" of InfoPro Systems, Rescue, CA) is the publisher of the Unix newsletters UNIQUE *and* ROOT, *and coauthor of the book* Unix System Administration. *He can be reached on the UUCP network as "infopro!david" or on BIX c/o "editors."*

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One Man's Experience

The trials and tribulations of switching from MS-DOS to Unix

John Unger

About 18 months ago, I decided I would have to bite the bullet and trade in my trusty IBM PC AT for a Unix workstation. It was not an easy decision to make.

During the past seven years, I had progressed from CP/M through MS-DOS and had gradually weaned myself away from larger computers almost completely. I was doing the bulk of my scientific programming and number crunching on my AT using programs I had written in C. When I needed a larger computer, I used terminal-emulation software on the AT that made it work like a DEC VT-100 or a Tektronix graphics terminal, and then I logged onto the nearest minicomputer. But I was coming to an impasse.

First, I had to have more computing horsepower on my desktop, specifically to run larger programs that use high-resolution color graphics. Second, I needed to run commercial software that either was not available for MS-DOS computers, ran too slowly on them, or was crippled in the MS-DOS environment. Also, I wanted to be able to network transparently with the new powerful Unix file-and-compute servers that we planned to acquire where I work. I needed a workstation.

Making a Choice

When I actually sat down to figure out what hardware to buy, two factors became obvious: The workstation had to have a Unix operating system and some sort of MS-DOS emulation. I chose Unix because it has become the de facto standard for scientific and engineering workstations and for the software that runs on them, and because I wanted my workstation to be able to communicate over a local Ethernet network with large Unix computers as easily as possible. However, because I do much of my work at home on my Dell System 200 80286 MS-DOS machine, I still had to interface with that environment and had to be able to move files back and forth between Unix and DOS.

I finally decided on a Sun-3/110, which runs SunOS, a version of Unix very much like BSD 4.2, and SunView, a windowing environment that enhances multitasking in Unix and makes the system a little more user-friendly. I ordered my computer with one of Sun's interprocess communications (IPC) AT-emulation boards installed in its backplane to give me MS-DOS compatibility through a DOS window in the SunView environment.

Although I was experienced with C, all my programming had been on CP/M and MS-DOS microcomputers and non-Unix minicomputers; I had never been either a user or a programmer on a Unix

continued

Table 1: *A list of some of the more common DOS commands and their Unix counterparts. Notice that while some Unix commands are virtually identical to the DOS commands, others give different results and, in general, have the option of using command-line arguments to enhance their power and versatility.*

DOS command	Unix command	Description
DIR	`ls -al`	Directory listing with file data, such as creation date and size
DIR/W	`ls`	Simple list of filenames arranged in columns across the screen
DIR/P	`ls -al	more`	List of filenames, one screen at a time
DEL	`rm`	Delete files
TYPE	`cat`	Display contents of an ASCII file on the screen
COPY	`cp`	Copy files
RENAME	`mv`	Rename files or (Unix only) move file to a different directory
MKDIR (MD)	`mkdir`	Make a new directory or subdirectory
RMDIR (RD)	`rmdir`	Delete an empty directory or subdirectory
CHDIR (CD)	`cd`	Change the working directory
FIND	`grep`	Locate ASCII strings in a file

system. So, to prepare myself for the change, I read books about using Unix—an exercise that was largely a waste of time until I got my machine. I found it extremely difficult to learn without doing; I needed to sit in front of a Unix computer to learn Unix. The books did, however, acquaint me with the structure of the operating system, and when I received my computer, I could recognize some of the more common Unix commands, if not use them intelligently and elegantly.

A more reasonable, inexpensive alternative for getting acquainted with Unix while working on your DOS machine is to use a Unix shell program. The best example I've found is the MKS Toolkit from Mortice Kern Systems (Waterloo, Ontario, Canada). It includes an operating-system shell program and a set of about 130 utility commands that almost perfectly mimic AT&T Unix System V.3.

The MKS Toolkit is not a Unix operating system like Xenix for your 80x86 microcomputer; it won't let you do multitasking or have a multiuser environment. The MKS Toolkit only adds some new commands to DOS and replaces MS-DOS's COMMAND.COM with a command-processor program that looks and acts much like a Unix "Korn" shell interface. With this package you can actually use the common Unix commands and become familiar with the Unix environment while still sitting in front of your comfortable MS-DOS microcomputer with DOS only a keystroke or two away.

Unfortunately, I wasn't aware of the MKS Toolkit when I was making the transition from DOS over to Unix. My changeover would have been considerably smoother and easier if I had been using this sort of software on my AT while waiting for my Sun to arrive. I have also found that by using MKS Toolkit on my 80286 MS-DOS machine at home, I don't have to shift gears from Unix to DOS commands and syntax every time I sit down at my home computer. Of course, the rest of the family can just run MS-DOS on the computer without the Unix shell.

Delivery Day

The big day finally arrived, and my system was delivered. Now, I am no neophyte when it comes to installing microcomputer hardware and software (I've been a BYTE hardware reviewer for the past five years), but I wasn't prepared for the task that lay ahead. First, I found that I had over 2½ cubic feet of documentation to digest (I still haven't removed the plastic from some of the more exotic manuals). Then, it began to dawn on me that I would have to become a system manager for a *real* computer.

I shouldn't have been so surprised. After all, this desktop workstation is as powerful as the VAX minicomputer that I had occasionally logged onto with my AT, and that computer had required a full-time system administrator and professional monthly maintenance to keep it healthy. I obviously had a difficult job ahead. I was going to have to learn more about the nuts and bolts of the Unix operating system than the average user does.

This situation is, I suspect, more the exception than the rule for the majority of new Unix users. Many Unix workstations are used as stand-alone systems or as single-user systems networked into an Ethernet LAN, which means you'd have to be concerned with the nitty-gritty chores of setting up your system and keeping the operating-system software properly maintained and backed up.

Fortunately, Sun has a toll-free number for free software and hardware support during the warranty period, and it is accustomed to helping people like me through the process of getting a system up and running. Still, I spent two full days getting the hardware connected and configured properly and the operating-system software loaded. In all fairness, I should admit that I spent a good part of this time reading the Sun system-installation and maintenance manuals.

Finally, I flipped the power switch, logged onto my new computer for the first time, and was greeted by the notoriously user-*unfriendly* Unix prompt. At this point, real panic set in; the extent of my knowledge of Unix, gained from skimming some Unix books, didn't go much beyond `cat` and `ls`.

Who's in Command?

It appeared that my productivity on the new workstation was going to be very low until I learned more about the Unix operating system, what its terse commands did, and how to use software like `vi`—the ubiquitous Unix editor. It's easy to be intimidated by Unix and its commands. Where MS-DOS has 50 or 60 commands and utility programs, Unix, depending on the version you use, has between 150 and 250 specific commands.

Fortunately, you don't have to learn all of those commands at once (even if you could) to get the feel of Unix. One of the first things I did was experiment with the Unix commands that seemed closest to or functionally equivalent to the commands that I most commonly used in the DOS world. To help me understand these commands better, I made a short list of the DOS commands and their Unix counterparts (see table 1).

There are some slight but important differences between the pairs of commands. For example, you can use the Unix `mv` command to move a file to a different directory as well as to give it another name in the same directory.

One distinction between DOS and Unix that bugs me is that Unix uses the slash as a delimiter, as in

continued

```
cd /usr/junger/byte/unix_dos.rev
```

while DOS uses the backslash character for the same purpose:

```
cd c:\junger\byte\unix_dos.rev
```

Another major difference to keep in mind is that Unix's command-line parser is case-sensitive; in other words, the commands `DIR`, `Dir`, and `dir` would all be different in Unix.

In many cases, the Unix commands can take arguments that extend their meanings and give them more power and flexibility than their DOS counterparts. For example, in Unix, `rm -i` *`filename`* deletes the file only after you respond with a `y` to a prompt asking you to confirm the deletion (much like DOS does when you use the command DEL *.*).

Beware the powerful Unix command `rm -r` *`directory`*, which recursively deletes the directory given in the argument and all the files and subdirectories in that directory. Use this with great care.

Also, Unix's `grep` and DOS's FIND are superficially similar utility programs, but you can extend and fine-tune `grep` with an entire suite of arguments and regular expressions.

The wild-card characters * and ? have almost the same meanings in DOS and Unix, but there are subtle differences. For example, the DOS commands DEL * and DEL T* will delete the file TEST, but neither one will delete TEST.DOC. In Unix, either `rm *` or `rm t*` will delete both `test` and `test.doc` files. In the logic of Unix filenames, the "." character is just like any other character; it is not a special delimiter used between a filename and its extension, as in DOS.

Weaning Yourself

One option that may help with the DOS-to-Unix transition is Unix's `alias` command; it lets you give an additional name to any Unix command-line string. This command takes two character strings as arguments. In its simplest form, the first argument is the new command you want to define, and the second is the normal Unix command or series of commands that the first string will mimic.

As an example, you can enter `alias dir ls -al` to define a new Unix command, `dir`, to produce the same listing of files that the command `ls -al` does. Your Unix system will now understand the `dir` command. But eventually you will want to master the Unix utilities themselves to use Unix to its best effect. Thus, as soon as it's feasible, you should wean yourself away from crutches like DOS-type aliases.

Because I had installed the Sun IPC board, I could still work in the MS-DOS environment on my new Unix workstation much the same as I had on my AT. I had loaded all my old familiar software onto the MS-DOS partition of my Unix system, and I could happily work away in the DOS window of the Unix SunView environment with WordPerfect, BRIEF, Quattro, Turbo C, and all my favorite DOS utilities. But I was relying on the DOS window and the DOS software to do many of the tasks I could have done better and faster in Unix.

Gradually, I realized that trying to do everything in the MS-DOS window was a mistake. The only way to learn about Unix is to use it as much as possible. Looking back, I can see that I used the MS-DOS capabilities of my system as a crutch, so it took me longer than neces-

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sary to become familiar with Unix. There are no shortcuts: To learn how to use software as powerful and complex as Unix, you have to practice.

Unfortunately, throughout this learning process—which is still going on, by the way—I didn't have that most important Unix resource: a local Unix guru. So, I had to look elsewhere. My first instinct turned out to be a good one: I reread the introductory manuals that had come with my system. (You know how it is—when all else fails, read the documentation.) Sun Microsystems' introductory Unix manuals are excellent.

I also went back to the books I had looked over before I actually received my system. First, you have to separate the wheat from the chaff—and when it comes to books on Unix, there's a lot of chaff.

If you are responsible for taking care of a Unix system, *Unix System Administration* (Hayden Books, 1986) by David Fiedler and Bruce H. Hunter is excellent. It is clearly written and logically organized, and it has been an invaluable aid. Two other books that I found especially good for learning the basics are *The Unix Operating System* (second edition, John Wiley & Sons, 1988) by Kaare Christian and *Introducing the Unix System* (McGraw-Hill, 1983) by Henry McGilton and Rachel Morgan.

One thing you should keep in mind is that two major flavors or dialects of Unix exist in the computer world today: AT&T System V.3 and the University of California at Berkeley–derived BSD 4.2 (and BSD 4.3). These two versions share many of the same commands, but each has its own set of utilities and peculiarities not found in the other's repertoire.

Remember to choose a book that addresses either both versions of Unix or the version running on your machine. The three books I have mentioned are slanted toward System V but do address some of the differences between System V and BSD. The book by Christian is especially good in this respect.

A Tough Climb, but I Made It

This approach to learning Unix got me started in the right direction. But I made real progress only when I forced myself to choose Unix tools to do a particular task rather than using the familiar DOS tools—even though it meant doing things a lot more slowly at first as I waded through the terse Unix commands manual. Basically, I had a tough climb up the initial slope of the Unix learning curve.

Another important resource that I used to get my questions answered was the Unix conference on BIX. On BIX, you can find real Unix gurus to answer your questions almost 24 hours a day; chances are, if you can't get your questions answered there, they won't be answered anywhere. The moderators and members of the Unix conference can give you prompt answers to most questions—sometimes you get more information than you bargained for. I still use BIX as an important resource.

It's been a little over a year since I made the switch from DOS to Unix, and the trials I've discussed occurred in the first few months. During that initiation period, my use of Unix versus DOS was about 20 to 80. Today, that ratio is more like 95 to 5.

I think the real breakthrough came for me after I had acquired a critical-mass knowledge of Unix commands and tools. One thing that helped me become more

continued

fluent in Unix was realizing that conventions, such as the syntax of command-line arguments, regular expressions, the use of single and double quotes, and wild cards, are used consistently throughout virtually all Unix commands.

Once you learn how to use `sed`, for instance, you can transfer that knowledge to the use of `grep`, the line editor `ex`, or even that most versatile of Unix commands, `find`. With this background, I could appreciate how the Unix and SunView environments work as a whole.

I now have enough experience that I actually think first of using the best and most efficient Unix tool, rather than searching around for a DOS program that might do almost the same task but do it more slowly. Today, I use the Sun's MS-DOS window almost exclusively for transferring text and data files from DOS to Unix and back again, because I still use my 80286 DOS system at home for much of my work. I rarely run DOS software on the Sun.

20/20 Hindsight

My decision was the right one. The Unix software programs I needed for data analysis and display run well on my workstation. I can do all my programming and data management tasks more quickly and effectively in the Unix environment. And new, DOS-type software, such as WordPerfect, is becoming available for Unix machines, which helps make Unix more friendly. I have the best of both worlds.

If I faced the same decision today, I would still choose a *real* Unix workstation like a Sun over the new high-speed 80386 DOS machines available now. First, I am a complete convert to being able to do true multitasking in a windowing environment, a Unix capability that is especially easy to use in SunView. Second, I must be able to use high-resolution color graphics with large programs that process large data sets (i.e., a computer with virtual memory) to carry out my research.

If I still had to keep one foot in the MS-DOS world, I'd choose a hybrid DOS/Unix computer like the new Sun386i workstation rather than a Sun-3 or Sun-4 workstation with added MS-DOS compatibility, as I did a year ago. Such machines do a better job of DOS emulation than the 68020 or SPARC machines do (see "The Sun386i," December 1988 BYTE, and "Sun's Newest Workstation: the Sun386i" by Tom Thompson, July 1988 BYTE). However, for compatibility with the bulk of Unix software available for Sun computers, a Sun-3 or Sun-4 is the better choice.

In addition, the version of SunOS 4.0 that runs on the Sun386i has a friendlier window-based operating-system shell—for Unix, that is—than the versions of SunOS 4.0 and SunView that run on the Sun-3 and Sun-4 systems, so the Sun386i is easier at the start. Finally, while waiting for my new Unix workstation to arrive, I would definitely use software like the MKS Toolkit to help acquaint me with Unix while I was still working in my comfortable MS-DOS environment. ■

John Unger is a geophysicist for the U.S. government and lives in Hamilton, Virginia. He writes graphics software and uses computers to study the earth's crust. He can be reached on Usenet as "sun!.gd.usgs.gov!junger," or as "junger" on BIX, where he moderates the sun conference.

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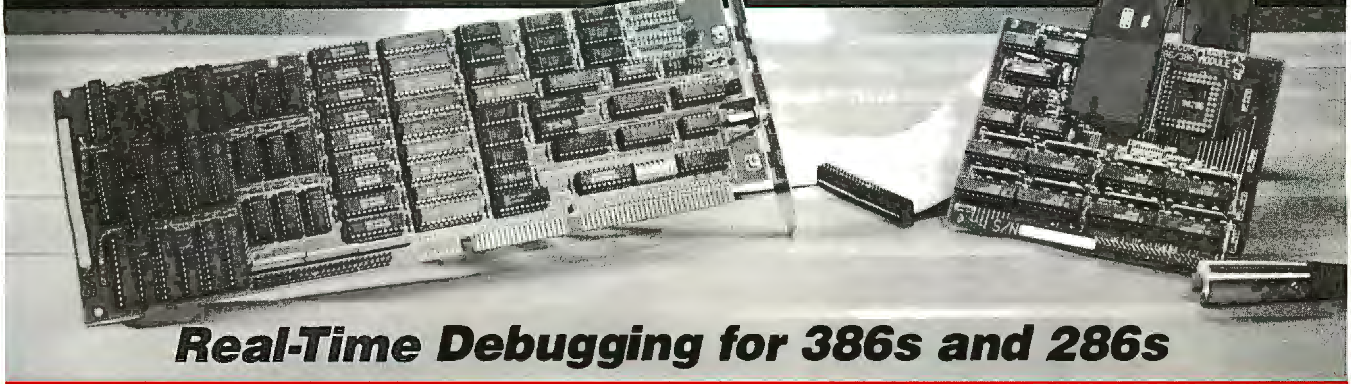

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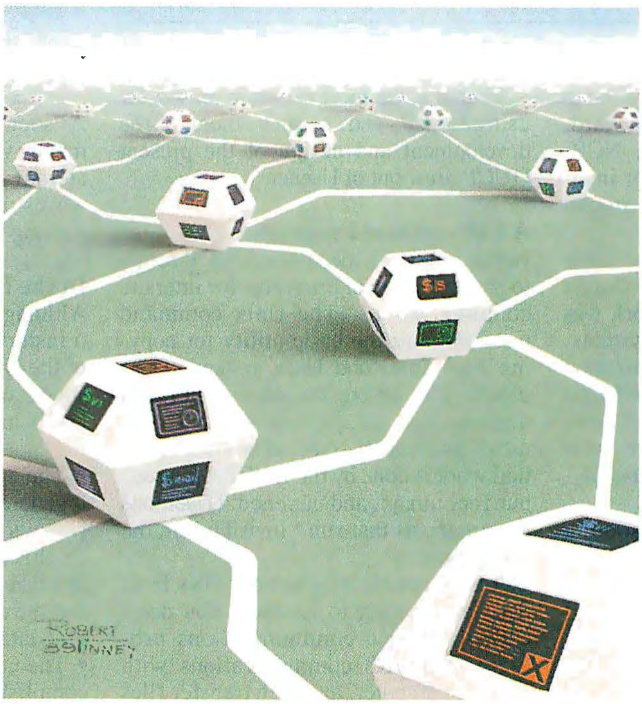
The Unix Connection

Usenet, UUCP, and NetNews give Unix worldwide communications power

Ben Smith



Unix has always implied connectivity, and UUCP (Unix-to-Unix copy) is the collection of programs that traditionally provides it. While all Unix licenses include the UUCP tools, many small systems never take advantage of them, nor of the worldwide network of computers that the tools connect. Many Unix E-mail users have no idea that they are using UUCP when they send E-mail to users at other sites. The beauty of it is that they don't have to know.

NetNews is Unix's BBS. It is the largest electronic BBS in the world, and, like many Unix operating-system utility extensions, its programs are in the public domain. However, unlike many other public domain programs, NetNews programs are usually created and maintained by professional programming teams.

The common element between UUCP and NetNews is the network, Usenet, so I'll begin there.

A Distributed Network

Although it's common to have your Unix machine as part of a small network of machines, perhaps within a university system or a company, few people want to pass up the opportunity to connect to "the net," or Usenet.

Although Usenet is an informal organization, more often than not controlled by de facto standards and traditions, it comprises the largest worldwide network of computers. Thousands of minicomputers, mainframes, and now even high-end microcomputers connect an estimated 1 million users. Rather than being configured as a central site with which all remote sites communicate (the configuration of BIX and CompuServe), Usenet is a distributed network.

Sites designated as *backbone* sites have well-defined responsibilities of collecting and forwarding messages to other regions (see figure 1). *Branch* sites have the less-defined responsibilities of passing information to other branch sites and to *leaf* sites. Leaf sites need only be polite and not burden their *feeds* with frivolous news and requests.

In 1979, Tom Truscott and James Ellis wrote a set of Unix shell scripts (using the more primitive operations of UUCP) to facilitate moving local news files between Duke University and the University of North Carolina. Steve Daniel, with the help of Truscott, rewrote the routines in C. Their work was presented as NetNews Release A at the 1980 USENIX conference.

As with many Unix enhancements, programmers at the University of California at Berkeley developed a version with many features that appealed to the

continued

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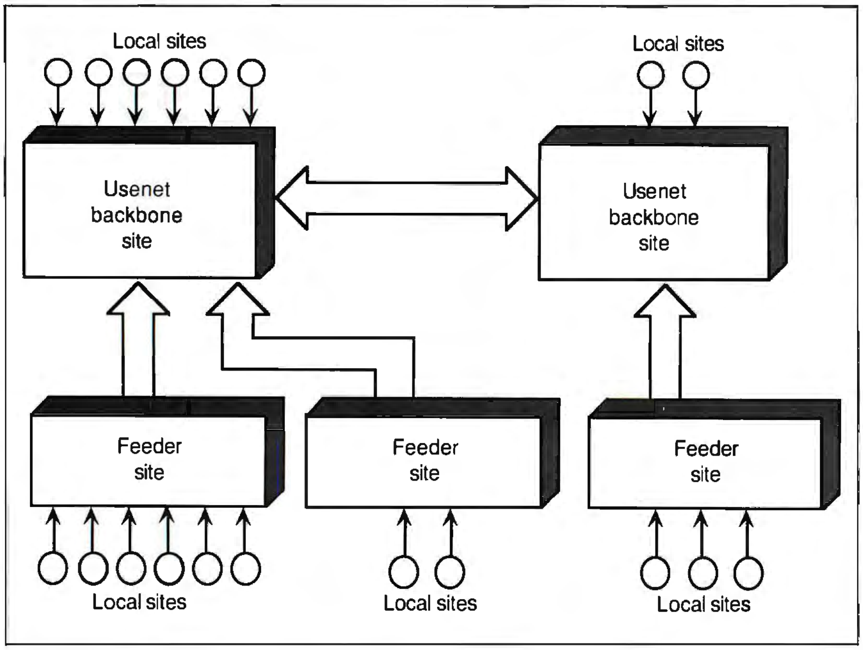

Figure 1: *The relationship between the local site and the backbone site. Mail-routing functions exist between backbone-site machines. By consulting a map of all the intermediate sites and most of the leaf sites, UUCP can figure out a path for your message.*

growing numbers of Unix users. Since then, NetNews and Usenet have been adopted by Bell Labs, Hewlett-Packard, Digital Equipment Corp., IBM, NCR, Motorola, Unisys, and many other institutions of industry and education around the world.

As the number of Unix sites and users grew, so did the traffic on Usenet. Until a few years ago, joining the network was difficult for users of new Unix systems, because there was no real organization through which to apply. You had to find a site that would let you get a feed from them. Since resources are never free, many people are reluctant to let just anyone tie in through their machine.

In 1987, the USENIX organization, a Unix users group, funded an experimental public site, UUNET, organized by Rick Adams. New Unix systems could subscribe to network service from this single site for a fixed monthly fee. The experiment generated enough revenue and interest that UUNET has become a real entity, owning its own equipment and paying its own bills.

The new UUNET machine is a Sequent S81 with four processors and almost 2 gigabytes of disk space. Because of the computer's modularity of parallel processing, it can be expanded to 30 processors and virtually unlimited disk space. The machine contains the sources for many of today's Unix standards, including TEX and X Windows.

Usenet is the most common reason for using UUCP, and, as such, much of the development and design of the present UUCP grew out of Usenet.

A Collection of Programs

In the lingo of Unix users, UUCP refers to the collection of programs for intersite communications. The Unix command `uucp` initiates the basic utility for copying files from one Unix system to another. The entire collection includes `uucico`, `uux`, `uuxqt`, `uustat`, `uuclean`, `uuto`, and `uupick` (see table 1). The actual work is done by the UUCP *daemons*: `uucico`, `uuxqt`, and `uusched`. (Daemons are programs that run "invisibly" in the background.)

It is incredibly easy to copy files from one Unix system to another. You don't have to enter a communications program, establish communications with another computer, and then transfer files using upload or send-file commands. All you have to do is enter `uucp` *`source-files destination`*. The only real difference between using this utility and copying files from one subdirectory to another within the same system is that the source file or the destination can contain site names or addresses.

For example, if I want to copy the source for the Notesfile system (the filename is `Notes.tar.Z`) from the UUNET machine in Virginia to the `Notes` subdirectory on my machine in New Hampshire, I would issue the following command:

```
uucp uunet!/usr/spool/ftp/news/
 Notes.tar.Z /usr/users/ben/Notes
```

The only complexity in this command is the directory path to the file. The ! is appended to site names to distinguish them from subdirectory names. (Unix uses the forward slash [/] to delimit subdirectory names where MS-DOS uses the backslash [\].)

You can abbreviate directory paths by using the tilde (~) to represent the home directory of a log-in. The home directory for `uucp` is the public file-exchange area; in this case, `/usr/spool/ftp`. More often than not, however, it is `/usr/spool/uucppublic`. My home directory (log-in `ben`) is `/usr/users/ben`; it might be `/usr/ben` on another machine. The use of the tilde abbreviation resolves these site-specific differences. The simplified command with abbreviated pathnames then becomes

```
uucp  uunet!~uucp/news/Notes.tar.Z
 ~/Notes
```

As soon as you have issued the `uucp` command, you can continue with other work at your terminal or workstation. UUCP works in the background, without interrupting you or slowing you down.

In the Background

Although generating the request for a file transfer is simple, the actual operations of the UUCP daemons are not. Figure 2 shows what happens in the background and behind the scenes.

- The `uucp` utility is a *spooling* program. It generates a list of work to be done with files and prepares the files for processing (in this case, it makes a copy of the files in a directory set aside for this purpose). But the daemon `uucico` performs the actual data transfer.
- The `uucp` utility invokes `uucico` to accomplish the data transfer. The `uucico` daemon places the call to the remote system (usually through another program, `dial`), starts the companion `uucico` on the remote site, reaches an agreement with it on a data transfer protocol, and begins sending control files and the data files.
- The `uucico` daemon on the remote machine has assumed the slave role. The originating site—the master—controls it.
- After the originating site has sent all

its requests, uucico reverses the roles of master and slave. It gives the remote site a chance to send anything it might have spooled. Once the transfers are complete, both machines agree to break the connection.

- As a last task, each uucico invokes uuxqt to move the files to the requested subdirectory and to process any other tasks that were requested.
- Throughout the whole process, uucico updates logs of its activities so you can see the progress of your requests (by using uustat), and the system administrator can keep tabs on communication inefficiencies and security threats from other systems.

Unix Mail

When you send mail to someone on another system, you use mail (or mailx), just as if that person were on your local system. In other words, the user interface is the same whether you send mail to someone local, on your LAN, or across the world. The difference lies in how you address the mail. You prefix the recipient's name with his or her address. The address consists of a list of machines through which to route the mail, with each site name appended with a bang (!).

If I wanted to send mail to George Bond on the bixpb computer, I would issue the command mail bixpb!gbond (or uunet!bixpb!gbond, if my local computer connects to bixpb through uunet). I would compose the mail message in the usual way. George would find it on his machine just as if someone local had sent it to him. He could reply to it

continued

Table 1: *The Unix utility commands and daemons.*

Name	Category	Description
cron	daemon	Processes repeated events on Unix systems. It uses tables created by crontab.
crontab	command	Schedules repetitive events on Unix systems.
mail	command	A program for sending, reading, and managing E-mail.
mailx	command	A more complex version of the E-mail program.
postnews	command	Posts new articles to NetNews.
readnews	command	Simple, line-oriented method of reading messages from NetNews.
rmail	daemon	Delivers mail to a user on a remote site.
rn	command	A flexible and complex program for reading and managing NetNews messages. You can create macros and totally automate your news with this program.
rnews	daemon	Processes incoming NetNews articles.
uucico	daemon	Processes requests for file transfers and remote commands, both on the originating site and on the destination site.
uuclean	command	Cleans up and deletes unwanted UUCP requests.
uucp	command	Spools requests for copying files to and from other systems.
uupick	command	Requests a remote system to send a file from the public spooling area of a remote site.
uusched	daemon	Schedules UUCP connections.
uusend	command	Requests a file to be sent out through a series of remote sites.
uustat	command	Views the status of and deletes UUCP requests.
uuto	command	Requests a file to be sent to the public spooling area on a remote site.
uux	command	Spools requests for commands to be run on remote sites.
uuxqt	daemon	Processes remote requests for programs to be executed locally.
vnews	command	A slightly more complex, screen-oriented program for reading messages from NetNews.

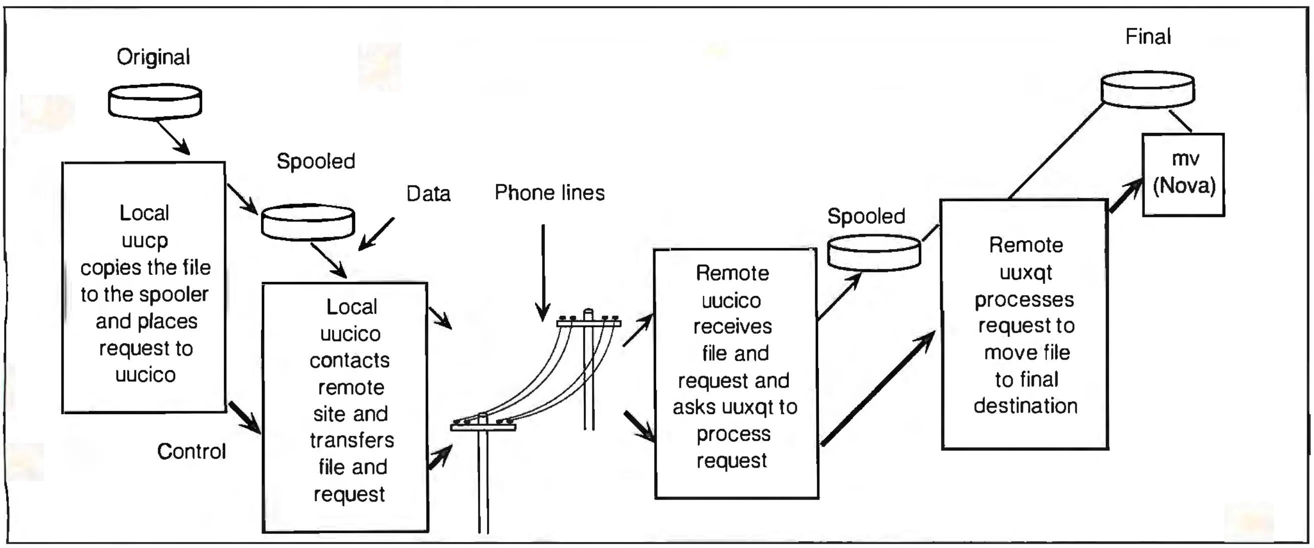

Figure 2: *The UUCP background operations for copying a file. Although it is simple to generate the request for a file transfer, the actual operations of the UUCP daemons are more complex.*

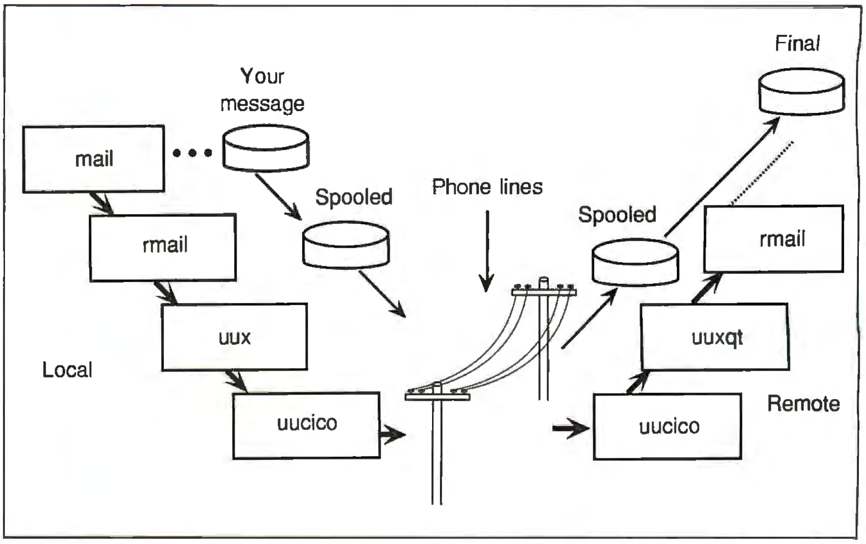

Figure 3: *How mail is delivered to remote sites. UUCP recognizes when the mail recipient is on another system. Instead of putting the mail-delivery request in the local mail spooler, UUCP passes it to* `uux` *to deliver at the remote site with* `rmail`.

without worrying about where it came from, since the mail header has my address. His machine would send the response back in the same way my machine sent the original message. If there were any intermediate machines, the address string would include the machine names.

It's possible to contact anyone who has access to a machine that links to Usenet. There are direct links to ARPANET, the Center for Mathematic and Computer Science in Amsterdam, which acts as the common node between Usenet and the EUnet (the European Unix network), New Zealand, Bangkok, Seoul, Toronto, and hundreds of other sites around the world. Unix users often give their Usenet addresses whenever they give out their regular mail address and phone number.

Because of the complexity of Usenet, some of these addresses can become ridiculously long:

```
bixpb!uunet!lll-winken!lll-ncis!
  helios.ee.lbl.gov!pasteur!
  ucbvax!agate!bionet!
  csd4.milw.wisc.edu!uxc!
  uxc.cso.uiuc.edu!m.cs.uiucedu!
  aguest.
```

This address was probably generated by a very inefficient mail-routing routine. The message would originate in New Hampshire, go to Virginia, work its way to California, go back to Wisconsin, and eventually end up on the appropriate machine. The sites that have long names broken by dots are LANs; each subname is a node on the LAN.

As with most tedious and error-prone tasks that you encounter on Unix machines, there are quick and efficient ways to generate addresses. First, the UUCP system has aliases for long addresses. That is, you can address mail with a nickname; a table supplies the full address path and the real name.

Second, there are mail-routing functions on backbone-site machines. UUCP on these machines consults a map of all the intermediate sites and most of the leaf machines, and it can figure out a path for your message. All you supply is the path to the backbone site and the name of the destination machine. Thus, you can reduce the monstrous address above to

```
bixpb!uunet!m.cs.uicuc.edu!
  aguest
```

If I communicated with this account more than once, I would create a nickname for it.

Behind the Scenes

What is happening with mail delivery "behind the scenes" is more complex (see figure 3). The mail program can recognize when the recipient of the mail is on another system. Instead of putting it in the local mail spooler, it passes the mail-delivery request to `uux` to deliver at the remote site with `rmail`, the remote mail utility. The `uux` utility executes programs at remote sites. Like `uucp`, you can use `uux` alone for specific tasks; however, it is restricted to commands in a UUCP control file at the remote site.

The `uux` utility passes the rest of the work, including the mail file and the

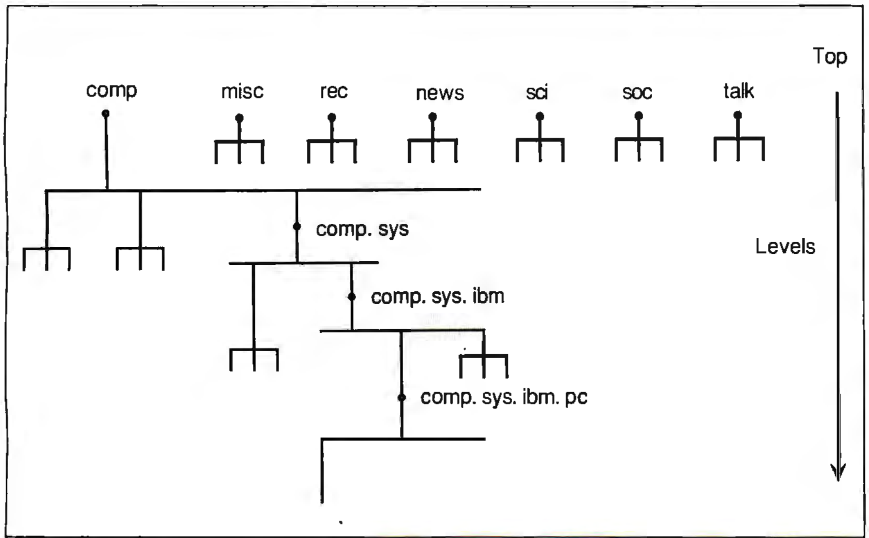

Figure 4: *The hierarchical organization of newsgroups. Each major newsgroup has several sub-newsgroups, which in turn may have their own sub-newsgroups, and so on, sometimes to four levels. This organization makes it easier to find special newsgroups and provides the file structure for the actual messages.*

`rmail` commands for its delivery, to `uucico`, which calls the remote system. The mail system maintains a mailbox for each user. The mail-administration program appends new mail messages to the file. When you read your mail, the mail program deletes those messages from your mailbox in the mail-spooler subdirectory. (You can save a copy in your home directory if you wish.)

Files and process requests are transmitted in both directions during each connection. Letting a remote site start a process on the local site can be a real threat to system security. In addition, uncontrolled communications over the phone system can be very costly.

Control and Scheduling

If a lot of local users send messages to remote systems, the local system will be dialing up other systems all day, and the phone bill will be astronomical. To keep communications as efficient as possible, several built-in controls to the UUCP utilities also affect the remote mail transfers and NetNews transfers.

Sites usually connect only a few times a day. (Direct connections and LANs are obvious exceptions.) Instead of having the mail system and other UUCP requests initiate the `uucico` daemon, `cron` (the system scheduling daemon) invokes `uucico`.

The `cron` program continuously runs in the background of Unix systems. It works like the timer clocks that turn your house lights on and off when you leave on vacation. Once a minute, `cron` checks the `crontab` tables to see if there's any task that needs to be done.

It's customary to create a `crontab` table that invokes `uucico` for each remote site once or twice a day (or even once an hour if a faster turnaround is required). When two sites make a connection, data and request transfers are bidirectional. It doesn't matter which site initiates the call; therefore, it is of little value for your machine to call sites that are scheduled to call you.

Your machine may call some remote systems only once a day, perhaps at 1:00 a.m. when phone rates are the lowest. Although this slows down communication turnaround, it dramatically reduces operating costs.

Security

System security is more sophisticated for UUCP than for the typical user-log-in process. When you log onto a Unix system, it screens you only by checking your password with your user ID. Once you are onto the system, you are only restricted by your group ID. It's fairly simple to keep track of what you, as an individual, have done while on the system. But UUCP log-ins have the potential of giving thousands of users access to your system. Although access is vicarious, the danger is real.

Usually, UUCP accounts are limited to copying files to and from the UUCP spool directory, and they cannot access anything else. In addition, the UUCP can run only `uucico`, `rmail`, and `rnews`

continued

(restricted news posting). Some people allow remote UUCP log-ins to run `who` and `lc`, but these utilities weaken security by providing information for system infiltrators to make logical guesses about passwords.

A more sophisticated version of UUCP is the HoneyDanBer UUCP, or BNU (basic networking utilities) UUCP. This version and others based on it have tables that provide much more finely grained control over access by other systems. For example, instead of having one set of restricted commands for all remote systems, the BNU system provides different levels of access for each remote site. In addition, it can restrict what information local users request from remote sites.

Many of us already suffer from severe information indigestion.

In general, the UUCP files contain information about which remote systems are available and how UUCP logs onto them; which requests for file transfers are pending, in progress, and complete; which operations remote sites can start on the local site; and flags to lock ports that are in use. These control files contain sensitive material, and therefore only the system administrator is allowed to read them.

The largest amount of communication on Usenet is not E-mail, however; it's NetNews, Unix's electronic bulletin-board activity. NetNews is the biggest reason for control and the largest source of traffic.

NetNews

NetNews is not a news service along the lines of United Press International. It is the actual activity of the developers and users of high technology. The messages are not journalism; they are the source of journalism. This is active conferencing, like you would find on BIX.

Three commonly used programs exist to read and respond to the news: `readnews`, `vnews`, and `rn`. If you are new to reading news, use `readnews`. It's the simplest. However, if you need the power of macros and the flexibility to customize the system, you will want the flexibility of `rn`. All three programs let you respond to messages, reply to the author directly with E-mail, file messages, and save messages. They use lists in your home directory to keep track of what subjects you are interested in reading and which messages you have already read.

Messages are organized as separate articles within *newsgroups*. Newsgroups are organized in hierarchical structure with only a few at the top of the structure. Each major newsgroup has several sub-newsgroups. Each of these may have its own sub-newsgroups, and so on, sometimes to four levels of organization (see figure 4). For example, you can find the messages relating to bug fixes for BSD 4 Unix in `comp.bugs.4bsd.ucb-fixes`. This organization not only facilitates finding special newsgroups, it also provides the file structure for the actual messages.

In many ways, sending news is like sending mail, but instead of sending the message to an individual, you send it to a newsgroup. Reading the news can be a big task, not because it's more complicated than reading and replying to mail but because of the sheer volume of news on the system. You select which articles you want to read from the list of article headers. Discussions within a newsgroup are tied together by the subject in the article headers. You can follow an entire conversation within a newsgroup before going on to read another conversation within that same group.

Or you can mark a subject for rejection. For instance, if you are interested in Atari ST computers, you might join the newsgroup `comp.sys.atari.st`. If there were a conversation about MIDI programs and devices and you had no interest in them, you could automatically kill all new articles with the keywords *MIDI* and *music*. Similarly, you might be interested in data acquisition and analysis, and you could automatically save all articles with these keywords.

Unlike BIX, all news messages are copied onto the local machine. You and other local users peruse them without connecting to a remote machine. A NetNews message has a header that describes the E-mail address of its originator, which newsgroups the message belongs to, its subject matter, the date it was posted, and a unique message ID.

A Little More Complex

NetNews operations are far more involved than Unix mail operations. The basic data transfer is the same, using `uucico` and `uuxqt`. But managing the news is more complex, from the time a message is posted to the time it is read by perhaps hundreds of thousands of users.

When you post a news message, it is immediately added to the news on your local machine. The news-posting program gives the message the next article number in that newsgroup. Everyone on your local machine can now read that item. Users have private files showing which articles they have read and which newsgroups they subscribe to. The news-reading programs take care of things from there—for the local users.

For the network, things are more complex. A site may send and receive news at the same time that several other sites do. This information exchange doesn't occur over a simple single-direction pipeline. If all the newly received messages are passed on to all the other sites, the same messages would be received and sent over and over, as many times as there are possible paths from one site to another.

The communications load would be beyond the limits of imagination. A network of just six sites can provide up to 64 possible paths, a network of 10 sites provides many millions of possible paths, and Usenet is composed of many thousands of nodes—how many possible paths would that be?

The problem of controlling news flow used to be solved by trading news the same way people trade baseball cards. Each site must end up with only one copy of every available message. The conversation between NetNews sites would go like this: "I have. You have? I don't have these, but you do. I have these that you don't. I'll give you these, and you give me those." The key to the process is the unique message ID that is created for each message. It is composed of the site name and the value of the message counter at that site.

Today, other methods are used as well. For instance, if one of the connecting sites' names appears in the `Path:` field of the message header, you can assume that the site has already seen the message.

A full news feed can take up as much as 4 megabytes a day. No one has enough disk space to accumulate data at that rate for very long, so messages more than two weeks old are usually discarded. Their message IDs are kept to prevent reacceptance of any copies that might still be bouncing around the network. The communications load is further reduced by data-compression programs that are part of the news sharing and batching.

Information Overload

Computers and communications lines can handle this load, but can we? Are we doomed to information overload? Many of us already suffer from severe information indigestion. Using these "free" Unix communications and news utilities is very appealing, but the amount of information can be overwhelming.

Since the UUCP programs open our machines to oceans of new information, it's best to start with a little at a time. The most useful facility is the ability to send E-mail through Usenet. You may also need to send and receive documents with other Unix sites.

If you decide to become involved in NetNews, start by subscribing to just one newsgroup, such as "comp" or "rec." Learn to use the news-reading program of your choice. Don't let your appetite for the network's information exceed your capacity to digest it.

However, NetNews is as pure an example of "social networking" as you will find. It's great fun to meet and talk with others about your interests without having to join a club or a society. If you are doing research or are looking for help with some problem, an electronic BBS, such as NetNews or BIX, can provide answers in hours to questions that might otherwise take months or years to find answers to. ■

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basename	ex	ls	strip
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break	exit	more	switch
c	expand	mv	sync
cal	export	nl	tail
case	expr	nm	tee
cat	false	od	test
cd	fc	pack	[
chdir	fg	passwd	time
chmod	file	paste	times
cmp	find	pcat	touch
: (colon)	fmt	pg	tr
comm	fold	pr	trap
compress	for	print	true
continue	function	prof	tty
cp	getopt	ps	type
cpio	glob	pwd	typeset
crypt	egrep	r	ulimit
ctags	fgrep	read	unalias
cut	grep	readonly	uname
date	gres	return	uncompress
dd	hash	rev	unexpand
deroff	head	rm	uniq
dev	help	rmdir	unpack
df	history	rsh	unset
diff	if	sed	unstrip
diff3	init	set	until
diffh	integer	sh	vi
dirname	jobs	shift	wc
. (dot)	join	size	whence
du	kill	sleep	which
echo	lc	spell	while
			who

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Safe and Secure?

Unix comes with a lot of security features— but it's up to you to turn them on and use them

Patrick Wood

Unix security. To some computer people, these two words are mutually exclusive; to others, they refer to secure operating-system products for the Department of Defense (DoD). But what do they mean to you?

As general-purpose operating systems go, Unix has reasonably robust security. The problem is that most Unix systems are distributed with many of the security features turned off, and many administrators and users ignore security practices.

Many operating systems impose a default level of security that you can't circumvent. Unix, however, lets you set your own security standards. This is compatible with the Unix philosophy that the system shouldn't "get in the way"; anything you can turn on, you should also be able to turn off.

This philosophy goes back to the early days of Unix when dial-up lines were uncommon, hackers were just people who stayed up late at night playing computer games, and users were mostly interested in sharing data, not protecting it.

Unix was developed in a research-oriented environment at AT&T Bell Labs and, later, at various universities, so security wasn't the first concern. For example, in an early version of `passwd`, the Unix password-changing program, you could set passwords to NULL and log in without having your password checked. Later versions of the program fixed that but still allowed very short passwords.

The current version of `passwd` on many Berkeley Unix systems asks you to use a longer password if you enter fewer than five characters. However, if you insist by continuing to provide a short one, the program will relent and let you use it. The Unix versions based on AT&T's System V require a six-character password, and you can't get away with anything less.

Unix receives fairly high marks for its implementation of the four basic areas of computer security (see the text box "A Secure Base" on page 254), but some things do fall through the cracks.

The Crack in the Network

Unix is very compatible with networking: Many networks run on Unix systems, and a lot of networking software exists for them. A network constitutes an access path into the system, and some networking software and hardware aren't particularly good at preventing unauthorized access or compromise.

For example, Ethernet is a broadcast network, so all data that goes from one system to another is visible on the network. It's possible to have a system claim that it's another system. Most Unix networking software for Ethernet assumes that the network addresses are correct, so if you have a network test system, it's

continued

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A Secure Base

You can divide computer security into four major areas: preventing unauthorized access, preventing compromise of data, preventing denial of service, and preserving system integrity. I'll consider them one at a time.

• *Preventing unauthorized access.* This is perhaps the most important part of any system's security: keeping the "bad guys" off the system. Most multiuser systems require that you go through a validation process before gaining access. This usually entails signing onto the system with a unique name that identifies who you are and then entering a password (in theory, unique and known only to you and to the system) that proves you are who you say you are. The Unix mechanism that handles this validation is called `login`.

Some systems have several validation levels: They may request an extra password when you call in to the system over the public telephone network, or you may need a special password to access privileged information or a network. Special modems can keep a list of users and their telephone numbers. Thus, when you call in, the modem gets your user name, hangs up, and calls you back at a preprogrammed number. Such dial-back systems prevent attacks from any but a few known numbers.

• *Preventing data compromise.* Once on the system, even authorized users shouldn't be able to delete, modify, or even look at other users' files without permission. Most systems implement some form of protection for users' files, although, surprisingly enough, not all do. Some multiuser systems require a separate add-on package to implement file protection.

Unix has a built-in protection scheme that lets you protect files against reading, writing, and/or executing by everyone else on the system, a predefined group, or even yourself. Other systems allow even finer control over file access: They let you permit or deny access on a per-user basis (e.g., joe_t and mary_b can read this file, or everyone can read this file except bill_s).

• *Preventing service denial.* You shouldn't be able to prevent others on the system from doing their work, accessing their files, and otherwise using the system's resources. For example, a runaway program that grabs the CPU shouldn't be allowed to tie up the entire system, nor should a database program be allowed to use up all the free space on the system's disk.

Different systems handle these kinds of problems in different ways, and few can handle all possible scenarios. If you know a lot about the internal organization of a particular system, you can usually figure out how to run it "hard," Unix included. In particular, Unix isn't very good at preventing disk overuse.

• *Preserving system integrity.* You shouldn't be able to crash the system consistently; there should be no conditions under which an unprivileged user's program can overwrite system tables or otherwise corrupt the system. In other words, a system shouldn't be reliably unreliable.

Most systems are structured so that you don't share memory with the system, and the operating system's memory is protected from your programs. Similarly, user programs are usually protected from each other. This scheme tends to depend on hardware support for protected memory. Systems designed around older microprocessors, like the Intel 8086, simply are not able to provide this form of protection. However, most modern-day implementations of Unix do separate the users from the system.

When the system does crash—and it will—it should maintain data integrity. Files shouldn't be corrupted or lost for more than a few seconds or minutes prior to the crash. Although this isn't strictly a security issue, it is related to system integrity and is, therefore, usually bundled in.

easy to masquerade as someone else.

These test systems used to be very expensive (about $50,000); now you can get software for a few hundred dollars that turns your microcomputer into a network monitor. About the only way to guard data in this situation is to encrypt it with specialized hardware.

Some networking software puts blind trust in the network, accepting any data that comes over the network as valid data and not garbage. Obviously, this is a disaster waiting to happen.

In general, a network of any kind has so many potential security problems that you should think of it as a single system whose security is only as strong as its weakest link.

The Worms Crawl In . . .

Perhaps the most publicized computer security breach to date occurred last November and affected about 7000 Unix systems. First billed as a virus, but technically a worm, it received front-page newspaper and national TV-news coverage. The worm program replicated itself across thousands of systems overnight. A bug in its design prevented it from spreading slowly, as its author had intended; instead, it spread like wildfire across the Internet network from system to system. It worked by exploiting several flaws in Unix security and the Unix networking code.

One of the worm's easiest routes into a system on the network was through debugging code left in some E-mail software to allow system administrators to test the system remotely. This code allowed someone from another system to tell it to "do this," and the program would do it without checking first to see what it was.

The worm could also look at files on the local system to figure out which remote systems the users could access from the local system without a password. (This is fairly easy for a user to set up with the Berkeley Unix networking utilities.) The worm would then masquerade as any of those users and run a copy of itself on the remote system.

Another path was to try to crack the remote systems' passwords by testing a short dictionary against them. The worm would also try to gain access by sending a carefully constructed "garbage" message to a remote network-monitoring program. The program, compiled with a fixed-size array for incoming data, simply didn't limit the data it read. This allowed the worm to selectively overwrite parts of the program's memory, forcing it to perform actions it wasn't designed to do—like copying and running the worm.

All in all, the worm proved harmless, except for lost time and aggravation, but it provided good lessons in security: Never put code into production that contains a back door into the system; don't use short, easy passwords—they are too easy to guess; check all input to a privileged program that receives data from an

continued

uncontrollable source; beware of networking software that allows you to access systems without some form of authentication. None of the loopholes the worm used are deficiencies in Unix per se; they are due to poor programming or user practices.

A Nasty Virus

There is an important distinction between a worm and a virus. A worm spreads around a network by copying itself from system to system, but it doesn't necessarily alter the systems in any way. A virus, on the other hand, spreads by attaching itself to another program; when you run that program, the virus attaches itself to more programs. Over time, a virus can "infect" all the programs on your system. A worm is self-contained; it doesn't infect anything.

If a virus-infected program moves around a network or if files are accessible across a network, the virus can infect the entire network and any system attached to it. Unix viruses have been created and are very difficult to prevent. You can also have a hybrid worm that is a cross between a worm and a virus. The hybrid worm injects its virus into each system it enters. When the Internet worm first appeared, the main concern of those affected was that it might be a hybrid.

The most publicized viruses to date have been on MS-DOS microcomputers and Macintoshes. A virus is designed for a particular piece of hardware and/or operating system. There are more MS-DOS microcomputers and Macs than any one specific Unix box, and thus the epidemic has hit them hardest. (The Internet worm was restricted to Sun workstations and DEC VAXes running Berkeley Unix.)

The Trojan Horse

A Trojan horse is an old security trick: It's a program that appears to do something useful; however, it also does something harmful, such as deleting random files or creating a `setuid` program (one that always runs with owner permission).

A Trojan horse can be made to look like a system command and then placed in a directory where you'll run it instead of the actual command. Since Unix lets you specify the PATH (a list of directories to search when you enter a command), if the current directory is farther up the list than the system directories, you'll run the horse. Most of the older Unix versions and some of the current ones use a default search PATH that lists the current directory first.

You can think of a virus as a Trojan horse with an infection. When you run an infected program, it does something useful and something nefarious: It infects other programs.

Mail Bombs

A mail bomb is a mail message that makes use of a dangerous feature of many "smart" terminals: It contains an escape sequence that causes the terminal to send data on the screen back to the host system. For example, a mail bomb might print `cd $HOME; rm -rf * &` on the screen followed by a "retransmit" escape sequence. This line will silently delete all your files. And if the bomb is clever, it will then delete the line from the screen using another escape sequence.

Fortunately, mail bombs are hardware-specific and manufacturer-specific, so a mail bomb designed for a Hewlett-Packard terminal won't work on a DEC VT-220, and vice versa; however, considering the current volume of E-mail traffic (multimegabytes per day), mail bombs could pose a serious threat.

Permission, Please

The file permissions on Unix are an obvious way to prevent compromising data. If your file permissions are correct, nobody knows your password, the system administrator isn't snooping in your data, and no one has broken the system's security, your files are safe. Many users, however, don't know what file permissions are, let alone how to use them.

On most Unix systems, new users are all added to the same group if the system administrator selects the default settings. Even on systems with fairly secure default permissions, users in your group can usually read your files, and on many systems they can read and *write to* your files. Thus, users who shouldn't share data end up doing so without knowing it.

Just Who's Running This Program?

Perhaps one of the biggest cracks in Unix security is one of its best features: the `setuid` capability. An executable binary file can have its permissions set so that it always runs with the owner's permissions, *no matter who executes it*. When it runs, it runs as if the owner of the program were running it. This feature can allow anyone to execute programs that access restricted files. The capability assumes that such a program performs some kind of checking when it is run.

For example, the `passwd` program allows you to change your password. Passwords are stored in an encrypted form in the file `/etc/passwd`. For `passwd` to change your password, it must be able to write to `/etc/passwd`. There

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is no special system call for modifying /etc/passwd; the passwd program must do it using standard Unix reading and writing routines. But if you look at the program file /bin/passwd, you'll see that it has a special file permission set: the setuid permission.

The superuser (root) also owns passwd, and when it runs, it has full access to the system and can overwrite any file it wants to, including /etc/passwd. The passwd program is designed to change your password only after you have entered your old password, identifying yourself as that user. Only then can you enter a new password.

So, if setuid programs are well designed, why the fuss? Unfortunately, most setuid programs aren't well designed. Some of them have some glaring holes that allow regular users to become the superuser with little effort. The problem isn't with the setuid concept per se; it's with the overuse and misuse of it. In principle, you should use setuid only when there is no other way to accomplish a particular function. In practice, it's used whenever it's the easiest way.

The Orange Book

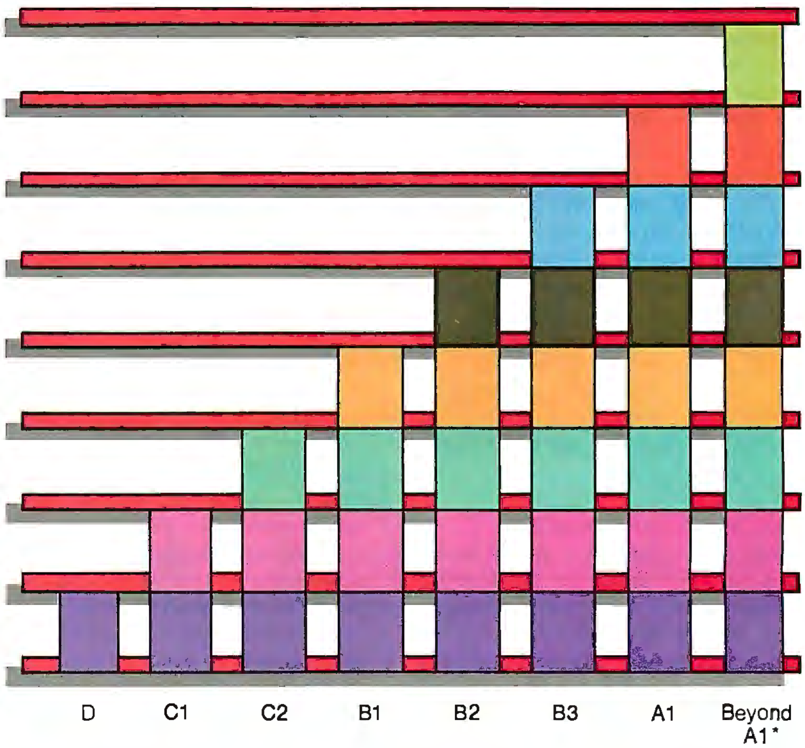
The National Computer Security Center, a part of the DoD, published a document at the end of 1985 called the "Department of Defense Trusted Computer System Evaluation Criteria." Known as the Criteria, or just the Orange Book (due to its bright orange cover), this document has had far-reaching effects on the computer-security industry. It sets the standards and requirements for the secure systems that the DoD will purchase. If the NCSC prevails, over the next few years, most, if not all, systems purchased by the U.S. government will have to meet some minimum level of security as specified in the Orange Book.

The Orange Book divides computer security into four broad divisions:

- Division D: minimal protection (i.e., any system that fails to pass in divisions A, B, or C).
- Division C: discretionary protection (i.e., you decide what protections to enforce, like the Unix file permissions).
- Division B: mandatory protection (i.e., the system enforces some form of protection that is not under your control).
- Division A: verifiable protection (i.e., you must prove that the security model and/or the implementation are secure).

continued

Table 1: *The Orange Book's seven classes of security and beyond.*



Minimal security

Security controls much like Unix's, including:
Log-in verification
Discretionary controls for users and groups
Documentation of security features and their implementation

Audit trails of security violations
Stricter log-in controls
Resource separation and strict object (disk and memory) reuse policy

Mandatory access controls
"Labeling" of objects (like permissions but more comprehensive)
Labeling of output and "exported-data" tapes

Formal security policy for the operating system (a model)
Greater use of labels
Separation of operator and administrator functions

Ability to specify permissions on a per-user and per-group basis
Security administrator log-in with special privileges
"Modular design" of security system
Trusted recovery (restore after crash or reload of operating system)

Security algorithms must be formally verified

Proven correctness of hardware and firmware
Proven correctness of development tools
Formal verification of source code

* Beyond A1 isn't possible with current software and hardware technology.

The divisions are hierarchical—each higher division assumes all the requirements of the lower ones. Thus, Division B must have the discretionary protection from Division C as well as its own mandatory protection. The divisions themselves are divided into seven levels. Security increases as the numbers go up within a division (see table 1).

Unix fits into this alphabet soup at about C1. NCSC observers believe that with auditing capabilities System V would probably be at C2. Most people involved in implementing secure Unix systems think that the highest level Unix can reach without a total redesign of the kernel is B2 and that B2 would require 25 to 50 person-years of effort to implement. Companies are devoting resources toward this goal because the DoD wants Unix—a *secure* Unix.

The Future of Unix Security

For now, secure Unix systems (à la the Orange Book) are expensive because the companies that implement these systems have to recover development costs. As more products appear and companies get more experience with secure systems, costs will come down, but secure Unix systems are sure to remain more expensive than those that are not secure.

Fortunately, products that improve Unix security are available. Some of them are USECURE from Unitech Software (Vienna, VA), SysAdmin from UniSolutions Associates (Culver City, CA), PassPort from Sytek (Mountain View, CA), SafeWord from Enigma Logic (Concord, CA), and Kerberos from MIT's Project Athena (Cambridge, MA). ■

Editor's note: *Security programs from* Unix System Security *(Howard W. Sams, 1985) are available as security-.shar in the "listings" topic of the unix conference on BIX. See page 3 for details.*

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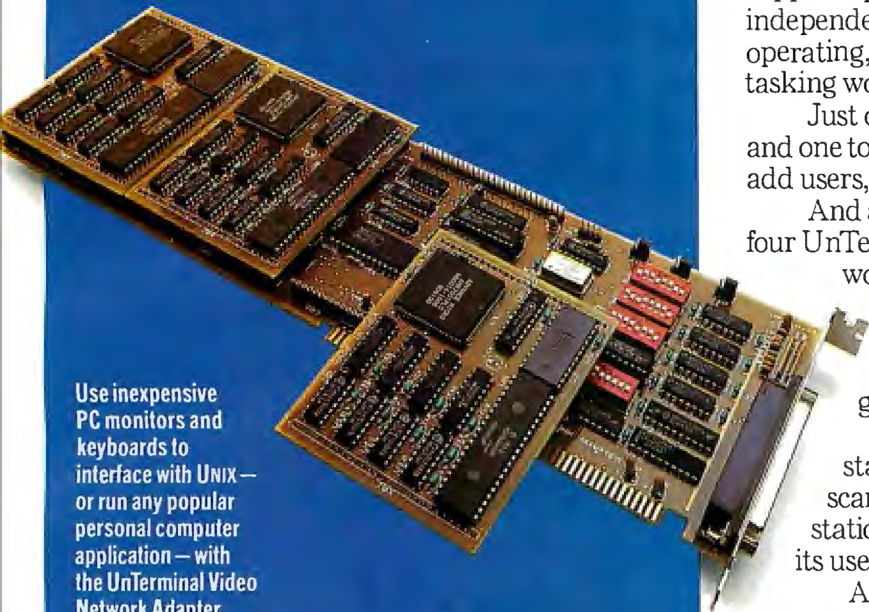

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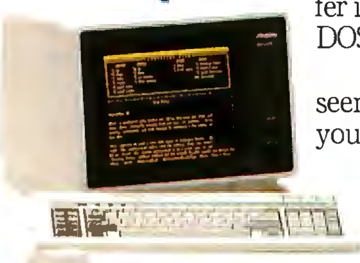

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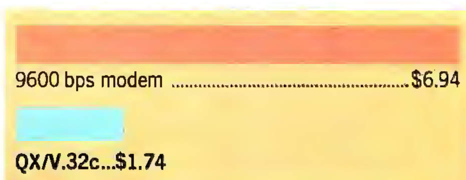

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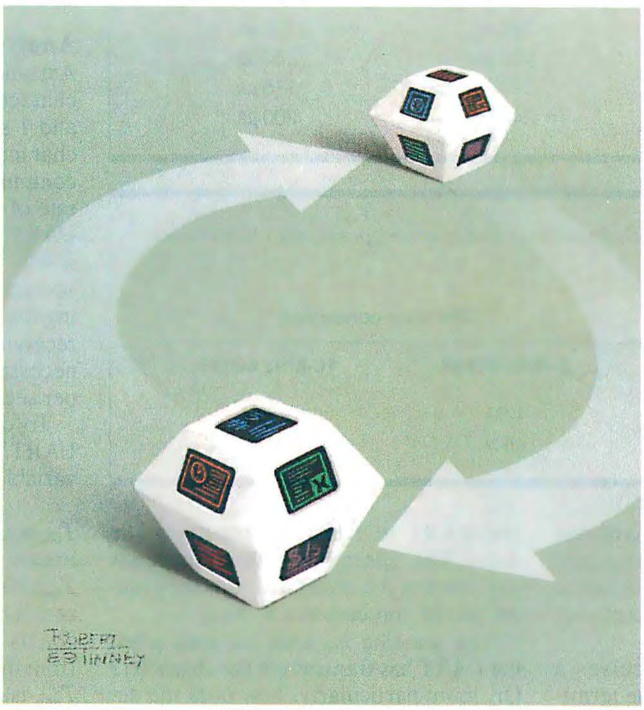
Interrupts Aren't Always Best

The choice between interrupts and polling in a Unix device driver can significantly affect performance

George E. Pajari



The communications controller that connects users' terminals to the central system is a critical component in a Unix multiuser system. In fact, since processing the byte stream to and from a single user's terminal can consume over 50 percent of a CPU's time, communications is a surprisingly CPU-intensive activity. If half the CPU time is consumed in servicing a single terminal, the throughput of the system for the other users drops dramatically.

It is usually assumed that interrupts are the best way for serial devices to use CPU resources, but for a high-performance communications controller and its associated device driver, the interrupt system is not always best. Polling can frequently result in higher performance.

Before examining in detail the operation of Unix communications controllers and the related issues, I want to look at what a device driver is, the function of a Unix communications controller, what interrupts are, and what polling is.

Device Drivers

A device driver is a request translator. As figure 1 illustrates, the device sits between an operating system (in this case, Unix) and the hardware. The operating system issues a request (e.g., "Read hard disk sector 10991"), and the device driver translates that into the appropriate commands for the particular hard disk controller (e.g., "Read 1024 bytes starting at sector 9, head 5, cylinder 101; transfer data to the buffer at physical address 18C400; then interrupt the CPU").

The advantage of having device drivers is that the operating system can issue *generic* requests to devices without having to know about the details about each controller. Should a controller change, you need only change the driver. You can install new devices on the system without changing the operating system proper.

Serial Communications

In Unix systems, the method used to connect individual terminals to the central host is usually an asynchronous serial-communications line. The interface on the host computer handles communications between the host and one or more terminals (or modems). This serial-communications board is responsible for transmitting data to the terminals and receiving data intended for the host.

The device driver for the serial-communications interface accepts requests from the operating system to transmit characters to a user, as well as requests to provide data received from a user.

Assume that you have a normal PC COM1: port. This communications interface is little more than a single chip

continued

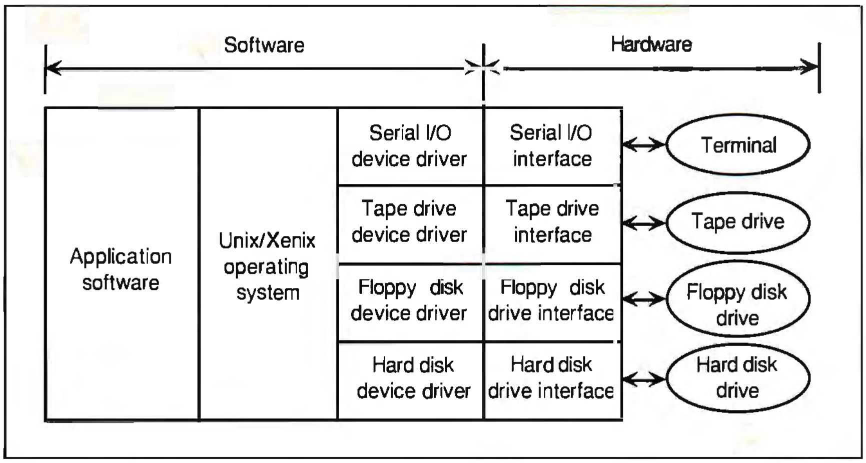


Figure 1: *Device drivers (the big picture). The device driver sits between the operating system and the hardware.*

Table 1: *Timings for basic operations.* T_{int}*: CPU time to handle an interrupt;* $T_{syscall}$*: time spent handling a request;* $T_{p\to u}$*: time to copy and handle a byte from the process to the UART;* $T_{u\to p}$*: time to copy and handle a byte from the UART to the process.*

Variable	8-MHz 80286	16-MHz 80386
T_{int}	220 μs	110 μs
$T_{syscall}$	550 μs	280 μs
$T_{p\to u}$	210 μs	175 μs
$T_{u\to p}$	240 μs	200 μs

Table 2: *Overhead for nonpolled transmit and receive operations (continuous operation at 9600 bps).*

Operation	CPU time consumed	
	8-MHz 80286	16-MHz 80386
Transmitting	42%	28%
Receiving	45%	30%

that receives bytes of data and converts them into serial asynchronous data (and vice versa). This chip is usually referred to as the UART (universal asynchronous receiver/transmitter).

When the device driver receives a string of characters to send to the terminal, it copies them into an internal buffer and then performs the necessary processing on the string (e.g., converting new lines into carriage return/new-line pairs, and so on). Next, it takes the first character to be transmitted and writes it to the *transmit data* register on the UART. The UART transmits this byte 1 bit at a time (e.g., 9600 bits per second). Meanwhile, the device driver informs the operating system that it is waiting for the UART to finish transmitting the data. The operating system suspends execution of the driver and runs the highest-priority process that is ready.

The question is, what happens when the UART has transmitted the character? Or, more particularly, how does the device driver know that the UART is ready for the next character?

The Purpose of Interrupts

Interrupts are one method of signaling the CPU that something has happened. In this case, the UART signals an interrupt when it has completed transmitting data and is ready to receive more data.

When a CPU receives an interrupt, it checks to see if the interrupt has been enabled. If it has not, the interrupt is ignored. If it has been enabled, the CPU stops what it's doing, saves some information in a designated area of memory so that the interrupted work can be resumed, and starts executing a part of the device driver known as the *interrupt handler*. The interrupt handler checks to see if there is more work to be done (i.e., bytes waiting to be transmitted) and, if so, places the next byte in the UART's transmit register. And so it goes. Write a byte to the UART. Transmit the byte. Interrupt the CPU. Run the interrupt handler. Repeat.

The process is much the same for incoming data. In this case, the UART receives a byte from the user's terminal a bit at a time and assembles it into a byte. When the entire byte has been received (5, 6, 7, 8, or 9 bits, depending on the coding scheme and parity), it interrupts the CPU. The interrupt handler takes the assembled byte from the UART's receive register and places it in an internal buffer. This internal buffer can then satisfy requests from the operating system for data from the user.

Analysis of Interrupts

Assume that the UART is handling 7-bit characters with 1 parity bit, 1 stop bit, and 1 start bit, for a total of 10 bits per character. If you also assume 9600-bps communications, you have an effective rate of 960 characters per second. If the UART is continuously busy transmitting, it will be generating 960 interrupts per second. Similarly, if the UART is receiving data at the capacity of the line (e.g., receiving a file using Kermit), it will necessarily be generating 960 interrupts per second.

To express the CPU overhead of the UART's operation, I have defined some variables:

T_{int} is the CPU time needed to handle an interrupt.
$T_{syscall}$ is the time spent handling a process's request to a device driver.
$T_{p\to u}$ is the time needed to handle a byte from the process to the UART.
$T_{u\to p}$ is the time needed to handle a byte from the UART to the process.

Then, the time required to transmit a line of data (say 64 bytes) is expressed as

$$T_{transmit-64} = T_{syscall} + 64 \times (T_{p\to u} + T_{int})$$

Similarly, the time required to receive a line of data is

$$T_{receive-64} = T_{syscall} + 64 \times (T_{u\to p} + T_{int})$$

Table 1 shows typical values for all these variables. Timings are from an 8-MHz IBM PC AT compatible and a 16-MHz 80386 machine, both running SCO Xenix. Table 2 shows the results of placing these values into the foregoing equations and converting the values to CPU overhead (assuming continuous 9600-bps operation).

As you can see, half of the 80286's time is consumed by the overhead of a single 9600-bps line. Even on a 16-MHz 80386 (which can usually handle 16 to 32 users), a single 9600-bps line can consume almost a third of the system. There must be a better way, and there is.

Polling

How would you design the device driver if you had a UART that could store data? And what would the performance be?

For starters, you would stop the UART from generating an interrupt every time it transmitted or received a character. When transmitting a string of data, you would write the entire string (up to the capacity of the UART's buffer) at one shot. The UART would then simply transmit data until it emptied its buffer, at which point it would interrupt the CPU. The interrupt handler would fill the UART's buffer again, and off the UART would go. Obviously, the CPU would be interrupted much less frequently. In fact, the overhead of handling a single line of data becomes

$$T_{buffered\text{-}transmit\text{-}64} = T_{syscall} + T_{int} + 64 \times T_{p \to u}$$

In the case of the receiver, however, you have to be more ingenious. Even if the UART can store incoming data in its own buffer, you can't just ask it to interrupt only when its buffer is full. If the UART has a 64-character buffer, the device driver wouldn't be interrupted until 64 bytes had arrived. And until it was interrupted, the driver wouldn't know that there was any data to pass along to the operating system (and ultimately to the application). What would happen? You would see a response from the system only after typing 64 characters. If your command could be typed with fewer than 64 characters, it would just sit in the UART's buffer. Not until the UART's buffer was full would the UART interrupt. Clearly, this won't work.

What you must do is periodically check the UART to see if data is present even if the UART's buffer is not full. The device driver asks the operating system to notify the driver every 1/20 of a second. (If you were to check less frequently, the echoing of characters to the terminal wouldn't take place quickly enough, and the delay would become noticeable and distracting.)

Table 3: *Time to poll and check the UART.*

Variable	8-MHz 80286	16-MHz 80386
T_{poll}	285 µs	125 µs

Table 4: *Overhead for polled transmit and receive operations (continuous operation at 9600 bps).*

Operation	CPU time consumed	
	8-MHz 80286	16-MHz 80386
Transmitting	14%	12%
Receiving	24%	20%

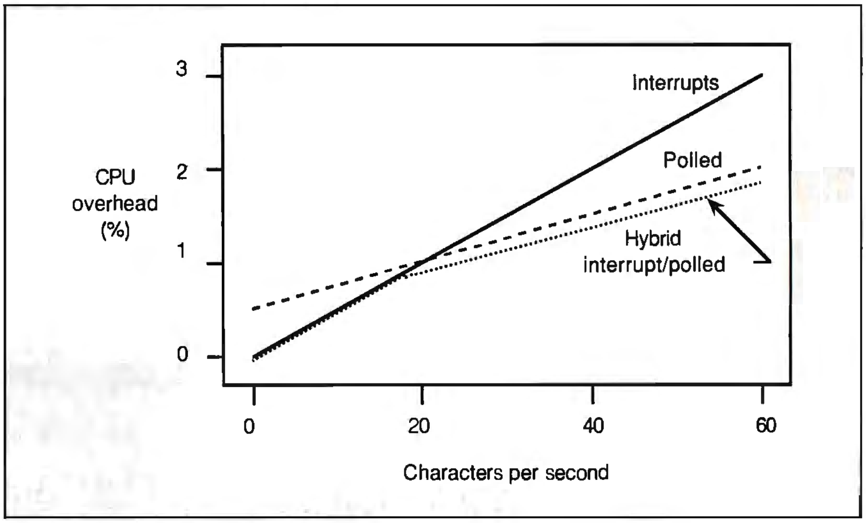


Figure 2: *Comparison of device and driver performance for interrupts, polling, and hybrid interrupt/polling.*

When the driver is notified, it checks the UART and transfers whatever is in the UART's buffer into the driver's buffer. In this way, no character is left in the UART's buffer for more than 50 milliseconds. Thus, you reduce the worst-case number of interrupts (from 960 per second for a 9600-bps connection to 20 per second) and yet avoid problems of stale data in the UART's buffer.

But how do you analyze the overhead? Well, you need one more variable in the analysis: T_{poll} is the CPU time needed to check (poll) the UART's receiver buffer. Using this variable, the overhead of an idle (receiving) line is expressed as

$$T_{poll\text{-}receive\text{-}idle} = 20 \times T_{poll}$$

whereas the overhead of handling a saturated line for 1 second (running at 9600 bps with lines averaging 64 characters) is approximately

$$T_{poll\text{-}receive\text{-}max} = 15 \times T_{syscall} + 20 \times T_{poll} + 960 \times T_{u \to p}$$

In 1 second, 960 characters arrive, 20 polls occur, and fifteen 64-character lines are passed to the application.

Table 3 gives the value for T_{poll} and table 4 calculates the overhead for polled operation. Compare this table with table 2. Polling has cut the overhead roughly in half when running 9600-bps lines continuously.

Light Loads

But what about light loads? If the port is idle, the interrupt approach generates no

continued

load (since no interrupts are occurring). The polled approach, however, still generates 20 interrupts per second. Yet at higher rates, polling is better. What's the answer?

The solution is to put some additional intelligence into the communications interface. By changing the design of the device itself so that it uses interrupts at low rates and polling at higher rates, you can take advantage of both worlds.

One approach would be an interface that generated an interrupt only if one or more characters had been received but not read after 50 ms. At low traffic rates (below 20 cps), the overhead of this device would be the same as that of the interrupt-driven UART. At higher rates, it would be similar to that of the polled UART. The resulting performance would be the best of both worlds.

Figure 2 compares the performance of the three approaches: interrupts, polling, and hybrid interrupt/polling. Note that the hybrid approach is even better than polling at higher data rates, since device interrupts require less CPU time to handle than requesting (and receiving) scheduled clock interrupts.

Is There One Best Way?

Neither interrupts nor polling is always best. By closely examining the performance of each system, I have shown the strengths of each and, in the final step, developed a design to exploit each one. The result is a design for a serial-communications interface that has low overhead at low loads and an overhead that does not increase substantially at much higher loads.

The analysis does not have to stop here. Most of the better communications boards and device drivers have been designed after much more extensive analysis of the question of overhead. This analysis shows that additional performance can be gained (1) by migrating some of Unix's character processing to a CPU on the communications board itself, (2) by taking advantage of multiple UARTs on the same board to perform work on multiple ports at each interrupt, and (3) by processing packets of characters rather than individual characters whenever possible.

There are always important design issues in Unix serial communications that require careful analysis during the design process. Assumptions such as "We'll use interrupts; all our other device drivers do" cannot lead to optimal design.

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ACKNOWLEDGMENT
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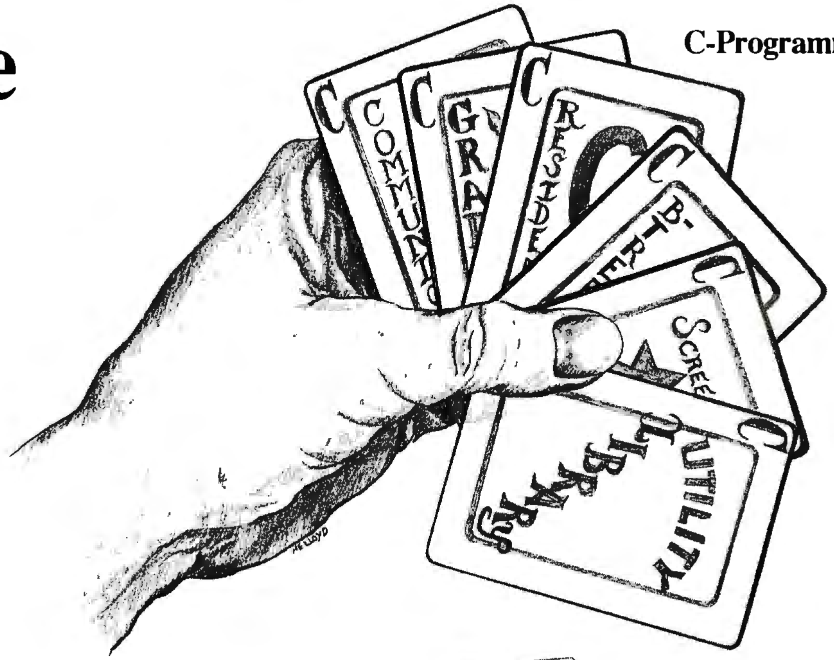

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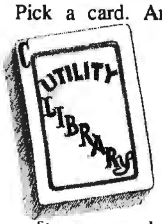

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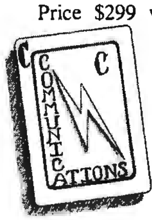

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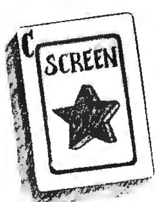

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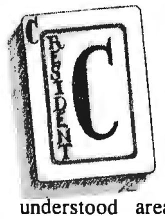

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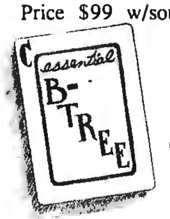

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THE QUEST FOR THE MOLECULAR COMPUTER

Computer components are already microscopic. How much smaller can they get?

Mark A. Clarkson

In the past four decades, computers have shrunk from room-filling behemoths to fingernail-size wafers and have gone from fast to almost unbelievably fast. It seems reasonable to ask how much further this evolution can go. What is the lower limit on size? What is the upper limit on speed?

Scientists are working to design and build computing circuits that work at these limits—orders of magnitude smaller than current circuits and too fast to measure.

The quest for the molecular computer—a computer with components the size of molecules—is about raw power, pure and simple. As anyone who works with computers knows, the one thing you can always use is more speed. Complex simulations and graphics processing require massive computational power. Molecular circuits will be 100,000 times faster than the ones in the PC on your desk.

As the components shrink, so do the computers. As microprocessors have shown us, smallness can be a power all its own, bringing with it the ability to put computers into places that are far too small for today's devices. A computer with molecular gates and circuits might be too small to see—small enough to fit within a human cell. Much smaller than neurons, such computers might be hooked together in parallel, more densely and complexly than the brain.

In the book *Engines of Creation* (Doubleday, 1987), Stanford University scholar K. Eric Drexler explored the idea of artificial molecule-scale machines, including computers, but it is certainly not a new idea. In 1959, the late Nobel-laureate physicist Dr. Richard Feynman gave a talk entitled "There's Plenty of Room at the Bottom," in which he discussed "maneuvering things atom by atom" to build devices on a molecular scale. "It is not," he said, "an attempt to violate any laws; it is something. . .that can be done. It has not been done because we are too big."

After almost 30 years, we have now begun to direct the construction of new proteins, to view and manipulate individual atoms and molecules. Feynman's vision may finally be at hand. If we could arrange things atom by atom, or at least molecule by molecule, then we could build computers that are very small, and very fast, indeed—so small and fast that I need to define some words to use in talking about them.

A millimeter is one-thousandth of a meter; a silicon chip, without its package, can be measured in millimeters. Smaller still is the micron (μ)—one-millionth of a meter. Individual transistors on that silicon chip are measured in microns. A nanometer (nm) is one-billionth of a meter; molecules are measured in nanometers.

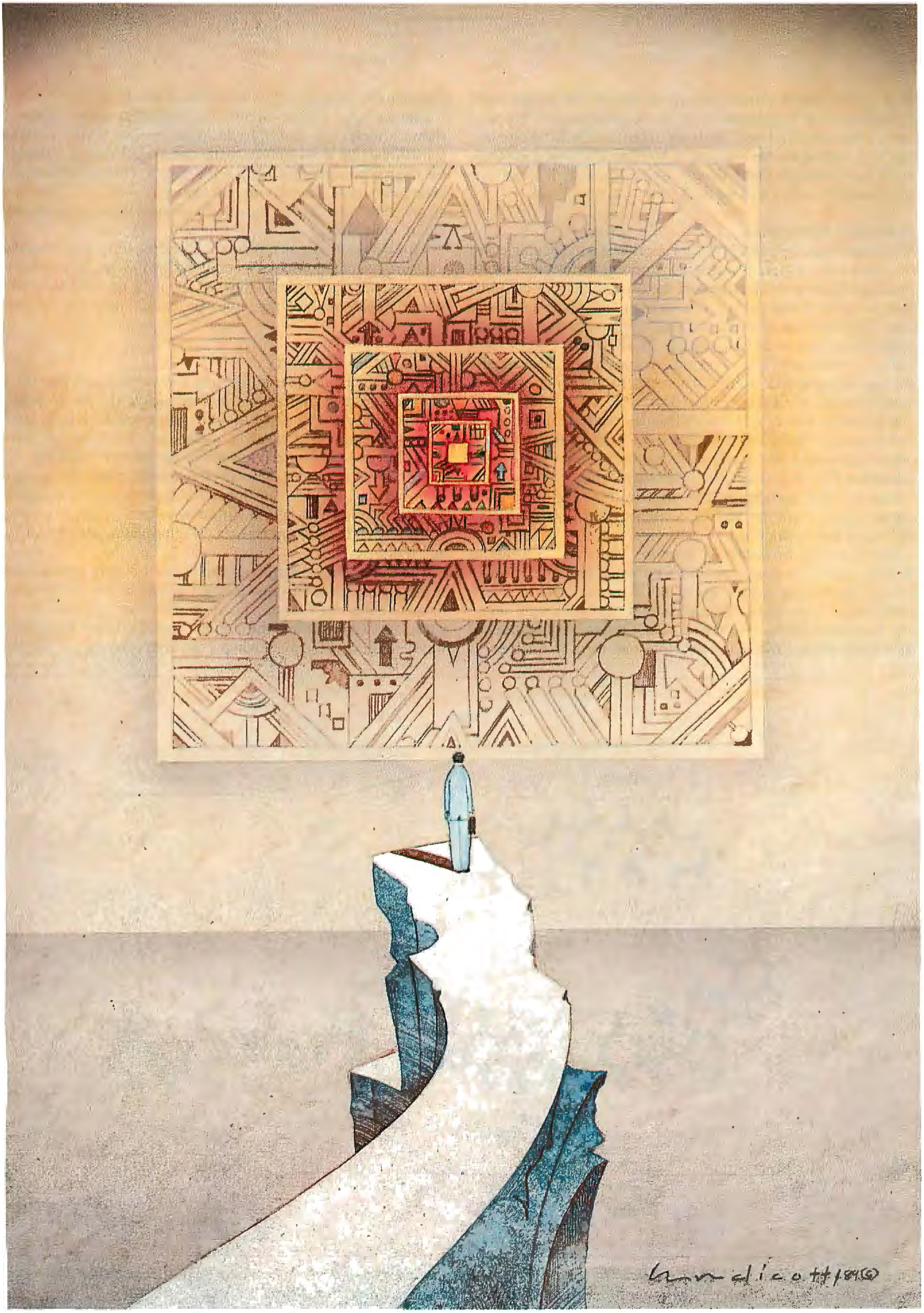
Similarly, a microsecond is one-millionth of a second; a nanosecond (ns) is one-billionth of a second. Light travels the length of this page in a nanosecond. One-trillionth of a second is a picosecond (ps), the time it takes light to travel the width of the period at the end of this sentence. A femtosecond is one-thousandth of that.

A current, high-density silicon IC might pack 50,000 transistors into a square millimeter, with a spacing between components on the order of 1 μ to 2 μ. Improved manufacturing technology and new materials could eventually reduce this by 90 percent, but current thinking says that semiconductors can't get any smaller than that.

As size decreases and density increases, components cannot shed heat as easily, and overheating becomes a problem. Reliable manufacture of objects so small becomes much more difficult. Additionally, at about $^1/_{10}\,\mu$, the space between individual components becomes so small that electrons begin to *tunnel*, jumping unpredictably from one place to another, thus creating spontaneous short circuits.

The dividing line between the microscopic and the molecular is 1 μ. Below that, the difference is no longer merely a matter of scale, it is a matter of domain as well. At the microscopic level, electronics as we know it still functions. Below this level, we enter the realm of quantum physics, where electronics ceases to function; electricity no longer exists as a mass phenomenon, and electrons must be treated as quirky individuals. At this

continued



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level, everything is fundamentally different; we cannot build molecular-scale transistors in the traditional manner. We need new components and new methods to build submicron circuits. The U.S. and Japan are working to build a molecular computer, but if semiconductor technology, as we know it, will not suffice to build it, what will we use?

Molecular Electronics

If electronics as we know it won't function at a molecular scale, electronics of a different sort will. Atoms and molecules trade, share, and transport electrons all the time. Electrons can shift from an atom in one part of a molecule to an atom somewhere else. The shifting of electrons can change the fundamental properties of the molecule, such as its ability to conduct electricity or to absorb light of a certain wavelength. Researchers are beginning to use these phenomena in the construction of molecular electronic devices (MEDs).

Richard Potember and his colleagues at the Johns Hopkins University Applied Physics Lab have developed a switch built of copper atoms and an organic molecule called tetracyanoquinodimethane (TCNQ) combined into a thin film. Pulses of high voltage or laser light applied to the film bind and unbind the copper atoms from the TCNQ, switching the film from conducting to nonconducting.

The Syracuse University Center for Molecular Electronics (CME), under the direction of Dr. Robert Birge, is in the process of developing a high-speed RAM based on a molecule called bacteriorhodopsin. It is a bacterial form of a light-sensitive pigment found in the retina of the human eye. Pulses of laser light change the molecule from one form to another. It functions as a toggle with a switching time of 3 ps.

Can we build a logic circuit on a molecular scale? Figure *1* shows a molecular NAND gate developed at CME, looking something like a wishbone, with two "legs" and a "neck." Each leg is an input; the neck is the output. (A NAND gate is a logic gate whose output is on if either input is off.) The gate is a single complex molecule only 4 nm across—the size of a hemoglobin molecule.

This gate is as fast as it is small. Its firing time is too short to measure—subfemtosecond—and it cycles in 3 ps. By comparison, gate speeds inside a Cray are about 12 ns—10,000 times slower. Inside your average microprocessor, they are 20 times slower still.

The Contact Problem

One of the fundamental hurdles on the way to molecular electronics is termed the *contact problem*: How do you interface with such a tiny thing? Molecular wires could be built from strands of electron-conducting molecules, but since the wires are as large as the device in question, the problem remains.

Perhaps a more elegant answer is optical coupling: using a laser beam as a "wire" of light. The laser is versatile, and its beam can be as fine as the finest wire and as quick as even CME's NAND gate. Optical coupling provides other benefits, as I'll discuss later.

The electronic molecular gate in figure 1 is only 4 nm across. It is optically coupled—that is, data is read in and out via laser beams rather than wires. Each of the three sections of the gate—the two inputs and the output—absorbs light of a different wavelength. Input is made via pulsed lasers shown on the gate.

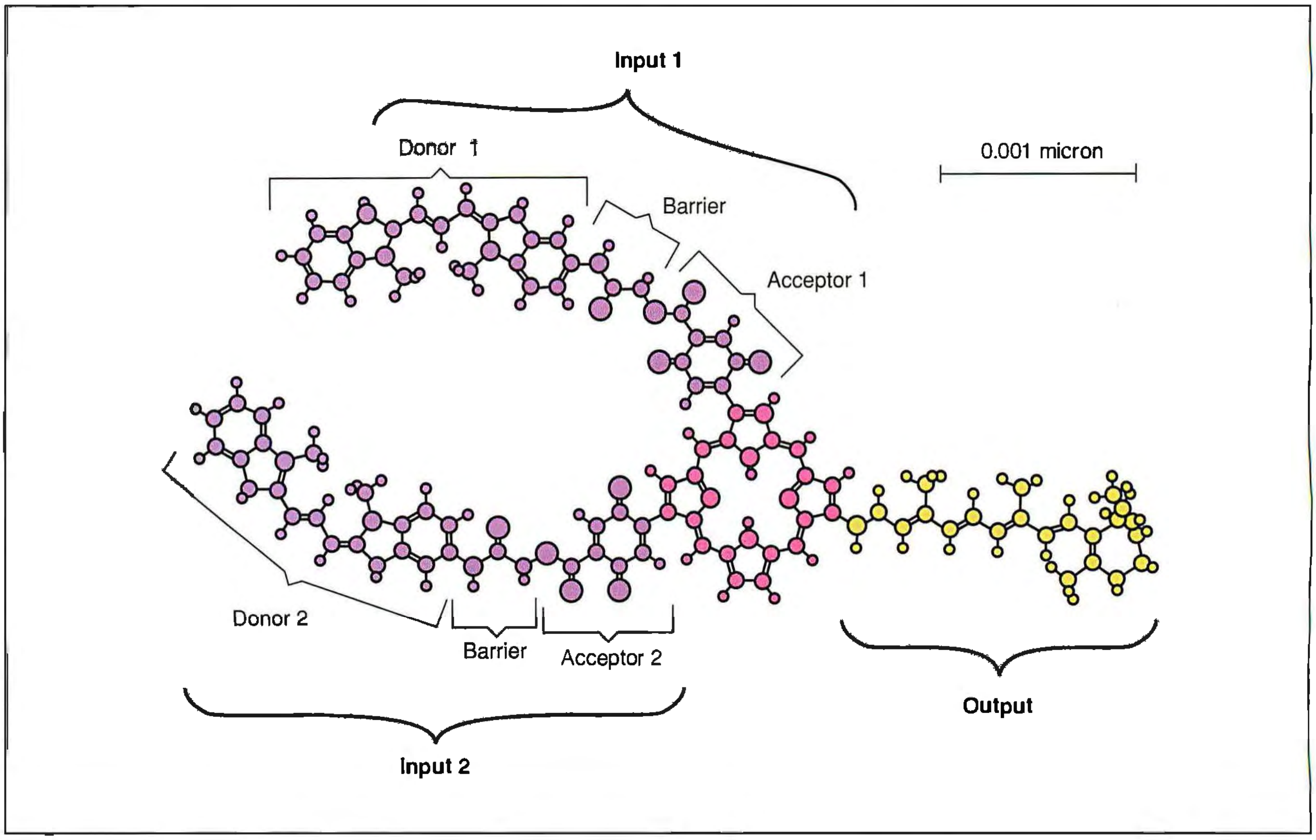


Figure 1: *A molecular NAND gate, driven by laser light. It is four-billionths of a meter across and 10,000 times faster than similar silicon gates. (Source: Center for Molecular Electronics, Syracuse University, Syracuse, NY)*

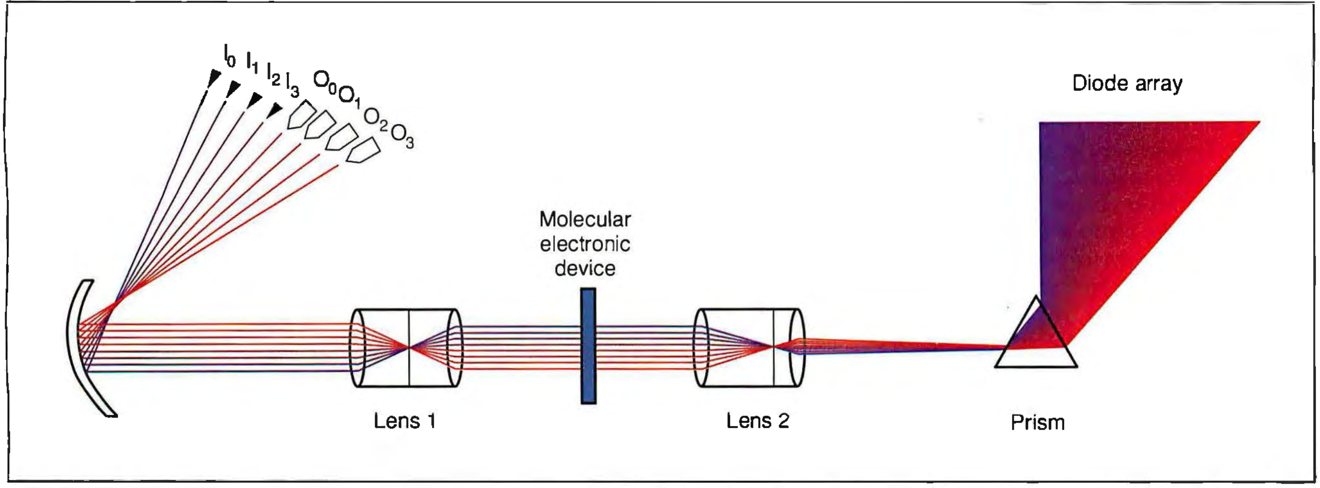


Figure 2: *Eight frequencies of laser light (representing the four input and four output channels) are passed through the molecular electronic device, and the emerging light is read via the diode array (DA). Components in the MED can block the output frequencies of light or let them pass through. (Source: Center for Molecular Electronics, Syracuse University, Syracuse, NY)*

Output is read via a third laser shown through the gate; if its light passes through, the output signal is on; otherwise, it is off.

Each input leg of the gate consists of an acceptor and a donor separated by a barrier. With no input applied to the gate, each donor has transferred an electron to its acceptor. The behavior of the output section is altered by the presence of these two extra electrons in its neighborhood. When an input is struck by laser light of the proper wavelength, the electron is transferred back from acceptor to donor. If both inputs fire, both electrons are transferred away from the output section simultaneously, making its environment unstable. As a result, the absorption band of the output (the wavelength of light that it absorbs) shifts into the range of the output laser, blocking its light.

The lasers need not be focused directly on an input or output; in fact, the entire gate is smaller than the beam. The address of the gate is defined optically with different wavelengths of light, rather than spatially with different wires. As a result, the gate can be placed anywhere within a given MED, and the individual inputs and outputs can be placed within the molecule however it is convenient.

Figure 2 shows an optically coupled 4-bit MED with four input and four output lasers. Each I/O channel is represented by a laser on a different wavelength. Input is provided by the four pulsed lasers (I_0 through I_3). Output is provided by the four continuous lasers (O_0 through O_3). The output is read by an array of light-sensitive diodes (DA). Lens 1 combines the different beams and spreads the resulting light over the entire MED. Lens 2 refocuses the exiting beam, and the prism splits it into its component parts again. The lasers affect only the I/O portions of the MED.

Probability and Proteins

Molecular gates dissipate little heat and can be packed much more densely than can silicon gates. They are, however, still vulnerable to manufacturing defects and to quantum phenomena, such as the unpredictability of individual electrons.

An obvious way to compensate is with simple redundancy: Use an ensemble of thousands of identical gates, operating in parallel as a single component. The output is averaged, filtering out statistical perturbations and component malfunctions. (In the arena of molecular electronics, the use of thousands of molecules in one device is called *bulk technology*.)

Optical coupling makes this parallel operation and ensemble averaging convenient. A laser can illuminate 1000 molecules as easily as one—more easily, in fact—and since our NAND gates block laser light when they fire, our ensemble of NAND gates would produce a measurable drop in output laser light, even if only 90 percent of the gates worked properly.

Starting with such small components gives us some elbow room: 100,000 molecular NAND gates would still fit comfortably within a square micron. Even so, some argue that the need for such large-scale redundancy eliminates the size advantage of molecular circuits over semiconductors.

Robert Birge doesn't think that's the point. In fact, he thinks lasers and ensemble processing may make the supercomputers of 10 years from now *bigger*. "Molecular electronics is not going to make a small computer," he says, "it's going to make a fast computer." Speed, he thinks, is a worthy goal in itself.

But not everyone is willing to give up on the molecular-scale computer, or *nanocomputer*. In a move of quantum jujitsu, Robert Bate of Texas Instruments has transformed electron tunneling from the problem into the solution. He is building a device in which the tunneling of electrons can be switched on and off. By harnessing quantum phenomena such as electron tunneling, Bate believes he can build molecular electronics that are more reliable and less "noisy" than semiconductors. (See the article "The Quantum Transistor" on page 275.) These electronics could also make possible a million-fold increase in component density, with a corresponding increase in speed.

Babbage Revisited

In 1833, Charles Babbage began work on an "analytical engine"—a mechanical digital computer, powered by steam and driven by rods and gears. He never completed it.

Now, 150 years later, Drexler is proposing a similar computer, but on a nanometer scale.

In what he terms "a really conservative argument," Drexler has avoided many of the sticky questions of quantum physics by designing a computer similar to Babbage's that would send signals by pushing and pulling on atom-wide rods of carbon.

Drexler believes that the highest-performing nanocomputers will use molecular electronics. The appeal of the mechanical nanocomputer, on the other hand, is that it is easier to design

continued

Rods and Knobs

The mechanical molecular computer designed by K. Eric Drexler uses logic circuits based on the movement of rods rather than electronics. The rods are studded with two types of knobs, called *gate knobs* and *probe knobs* (see figure A). The knobs are specially designed not to react with each other when they come into contact.

The rods intersect each other at right angles. A gate knob at an intersection will block a corresponding probe knob from being pushed through. In figure B1, the gate knob on rod *y* blocks the probe on rod *z*, preventing the probe from being pushed left. As a result, the knob on the output rod can move up. In figure B2, rod *z* is free to slide left, blocking the output rod.

To drive the gate, all the probe gates are drawn back (down or right), and then the input rods *x* and *y* are set in the desired on and off positions. Lastly, the rods with probe knobs are pushed. If no gate knobs block the intersections, the rods move. The new positions of the rods affect other rods in other gates in the circuit.

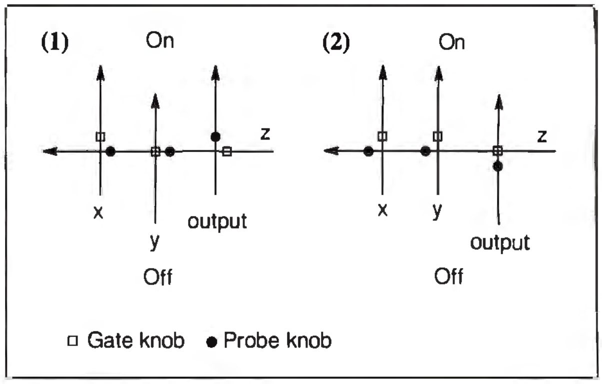


Figure B: **(1)** *Schematic of a rod logic NAND gate. As long as the gate knob on either the* x *or* y *input blocks the intersection, the output rod is free to slide.* **(2)** *If* x *and* y *are both on, rod* z *is free to slide, blocking the output rod.*

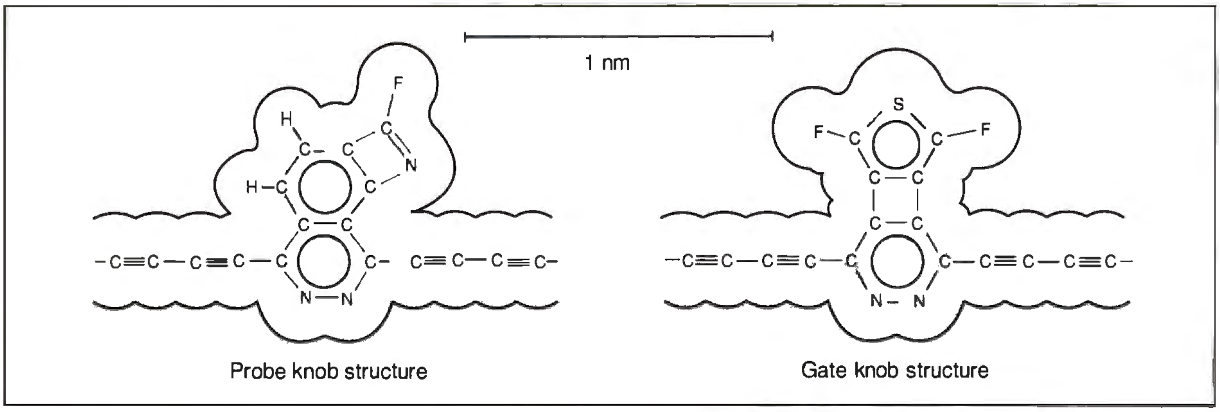


Figure A: *The rods are atoms of carbon strung end-to-end. The knobs are specifically designed not to interact with each other. (Source: K. Eric Drexler, Foresight Institute, Palo Alto, CA)*

and understand. Drexler sees it as a worst-case analysis of molecular computing: We will be able to do at least *this* well.

The rods in Drexler's nanocomputer would be chains of carbon atoms, joined single-file into strands one atom wide and a fraction of a micron long. The rods are studded with knobs, one every few nanometers, and fitted tightly together in an interlocking three-dimensional matrix. They slide back and forth in channels within a rigid framework, intersecting each other at right angles, like a fantastically complex puzzle. Where the rods meet, a knob on one can block the intersection, keeping the corresponding knob on another rod from being pulled through. (See the text box "Rods and Knobs" above.)

Drexler estimates that a rod-logic nanocomputer that is functionally equivalent to a simple microprocessor would be less than 100 nm across. While it would be orders of magnitude slower than a comparable molecular electronic device, it would still be faster than a Cray. Though the rods would move at less than 10 meters per second, they would need to move only a few nanometers, yielding subnanosecond gate speeds.

For high-speed RAM, Drexler suggests a block of mechanical memory cells with sliding rods and tabs that encode data by clamping some rods and leaving others free to move. 64K bytes of this RAM would be about 70 nm on a side.

For mass storage, the computers might use long polyethylene molecules as tape, storing data in carbon atoms. This kind of tape would be over 100 times denser than the high-speed mechanical RAM. A 64K-byte device, including tape, reel, drive, and read/write apparatus, would measure about 10 nm across.

For the most part, Drexler's solution to the contact problem is to have no contact. Rather than using nanocomputers as minuscule PCs and interacting with them directly via keyboard and screen, he prefers to give them tasks better suited to their size. He sees his nanocomputers as autonomous agents that could fit inside human cells to supervise machinery repairing damage and disease or that could direct molecular assemblers in the building of more nanocomputers.

By avoiding electronics, Drexler's computers avoid the worst of the uncertainties associated with electrons. Like their molecular counterparts, these computers would dissipate little heat, and their components could be packed together quite densely. Drexler thinks that the technologies that give us nanocomputers will eliminate manufacturing defects almost completely.

Building the Nanocomputer

Much, if not most, of the work of building nanocomputers today is being done by chemists, which might seem strange until you realize that chemists have been building molecules on the nanometer scale for decades. Building molecules is a chemist's business. Chemistry and its close cousin genetic engineering both provide paths to the construction of the nanocomputer.

Molecular gates could be brewed in test tubes through chemical reactions or built up, a few molecules at a time, into thin films. Genetic-engineering techniques allow very complex molecules to be built one fragment at a time. These methods are used to build today's simple MEDs, such as NAND gates.

Genetic engineers can produce custom proteins that bind together selected molecules. These "designer" proteins might build tomorrow's MEDs, reading instructions and assembling the component parts much as the ribosomes in cells read genetic code and assemble proteins themselves. Molecular circuits could thus self-assemble out of solutions in test tubes.

In addition to being fantastically inexpensive, this method would be almost perfectly reliable because the selective binding of individual molecules would assure proper assembly. Many researchers believe that full-scale manufacturing of molecular circuits will require such biological systems.

Another route to the nanocomputer is direct manipulation. A device known as the Scanning Tunneling Electron Microscope (STEM) uses electron tunneling to produce images of individual atoms. In addition, by regulating the current in a needle held a few nanometers above a surface, scientists can sometimes grab individual molecules and atoms and then move them or break them apart. Control is still poor, but it is improving. In time, we might handle molecules like Tinkertoys, placing them together to make tiny circuits and wires or rods and gears.

STEM technology, or something like it, might also form the basis for a data-storage system. Bits could be represented by altered patches of atoms on the surface of the storage medium. If a bit were a patch 10 atoms on a side, a square centimeter would hold 100 trillion bytes. Every book ever written would fit in a space 20 centimeters square.

If It Were to Happen

If we are to build molecular computers, molecular gates and switches will eventually have to be combined into complex circuits. Little work is currently being done to this end—the gates themselves are usually far from reliable. No one is presently working to build a mechanical computer such as Drexler's. The molecular devices described in this article are all still basic research; it may be 10 or 15 years before we see products based on molecular electronics appearing on the market. In the meantime, through more conventional means, computers will continue to get smaller and faster.

Microprocessors have changed our lives. My $30 wristwatch has a tiny chip that tells time, does math, and keeps my phone book and appointment calender. The molecular equivalent of an IBM PC, meeting Drexler's worst-case standards for size, would fit by the thousands of billions into a teaspoon.

Molecular computers coupled with light-emitting dyes could form displays as good as real life. With sufficiently small parts, we could model the human brain, neuron by neuron. And if the submicroscopic computer continues to elude us, we will still have an increase in power and speed of three or four orders of magnitude by using molecular computing technology. ■

Mark A. Clarkson is a freelance writer living in Wichita, Kansas. He has been a computer consultant and analyst for eight years. He can be reached on BIX c/o "editors."

THE QUANTUM TRANSISTOR

The rules of semiconductor physics are dramatically different when you are working at the level of quantum mechanics

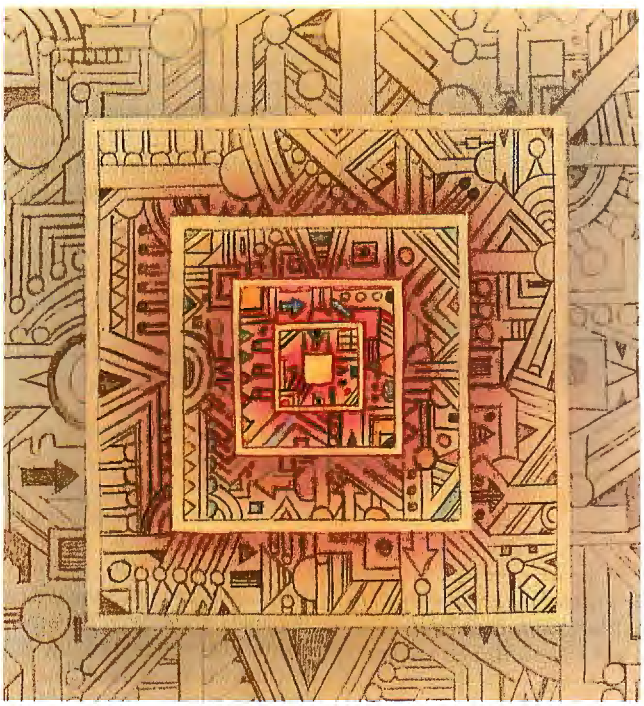
Mark Reed

Until the 1950s, vacuum tubes were the key ingredient of electronic systems. The discovery of the transistor effect by Bardeen, Brattain, and Shockley was the culmination of a technology based in atomic physics and material science. However, the true impact of semiconductor technology was not felt until the IC came into widespread use.

We now stand on the threshold of a new technology for electronic components, one that promises device densities 100 times greater and switching speeds 1000 times faster than what is currently possible. This technology is based on quantum effects, the very nature of matter and energy itself.

As George Heilmeier, chief technical officer of Texas Instruments, has said, "Comparing quantum-effect devices with today's semiconductors is like comparing semiconductors with vacuum tubes." (See "TI's Prototype Transistor Takes a Quantum Leap," Microbytes, March BYTE.)

[Editor's note: *This article contains terms that will be unfamiliar to those with little background in physics. These terms are explained in the glossary on page 280*].



Scaling Down

The IC was the revolutionary enabler for relatively compact, efficient, and inexpensive digital computers. The IC generation was followed by a long period of evolutionary progress. Much of this progress was due to downscaling.

In their seminal paper on the subject, Robert Dennard and coworkers at IBM proposed a scaling concept for silicon MOSFETs (metal-oxide-semiconductor field effect transistors) that is still valid today. The principle of scaling is to reduce all the dimensions of the device by a constant factor while reducing all applied voltages accordingly to keep the potential gradients the same as in the unscaled device.

This evolutionary concept has produced an exponential decrease in minimum feature sizes with concurrent decreases in power, cost, and delay times. The exponential growth of the worldwide electronics market, especially in computer technology, is largely due to this progress.

Engineers and scientists have always known that the downscaling process could not continue indefinitely. Pallab Chatterjee and his colleagues at Texas Instruments had previously placed a diminishing-returns limit of 0.5 micron on ICs. More recent analysis indicates that the limit is more like 0.3 micron. ICs less than 0.1 micron are unlikely because electrons are capable of *tunneling* through the thin (less than 40 angstroms) silicon dioxide *gate dielectric*. The implication is that traditional semi-

continued

conductor technology will reach its limits in the mid to late 1990s.

What basic physical phenomena are reasonable candidates for a post-VLSI revolution? Molecular electronics (see "The Quest for the Molecular Computer" by Mark A. Clarkson on page 268), hybrid biological-electronic devices with nontrivial architectures, superconducting electronics, and all-optical devices make up the list. However, the outstanding candidate, both in promise and demonstrated results, is quantum effects in semiconductors.

It appears that traditional semiconductor technology will reach its limits in the mid to late 1990s.

Nanoregions

Quantum effects occur in any system when the wave nature of the particles of the system becomes important. In semiconductors, whenever conditions allow, the wave nature of electrons and holes becomes important. This generally happens when we try to confine these particles to regions smaller in dimension than their quantum mechanical wavelength.

In free space, the quantum mechanical wavelength of an electron is called the de Broglie wavelength and is dependent on the energy of the electron. This is the so-called wave-particle duality: Under the right conditions, particles clearly exhibit a wave nature. Likewise, electromagnetic waves (such as visible light) have an associated particle-like nature (photons). An idea associated with this is that a particle cannot be confined inside a dimension less than its wavelength. In other words, the exact location of the particle is uncertain (Heisenberg's uncertainty principle).

The world in which these effects are dominant is on the scale of atoms and molecules, so we cannot see, touch, or taste these effects. To observe them, we must either construct special experiments that make these effects dominant over all others on the macroscopic scale or reduce our experiments to the microscopic scale (called the *nanoscale*, based on the nanometer, which is a billionth of a meter). We have called the possible next generation of electronic devices in this regime *nanoelectronics*.

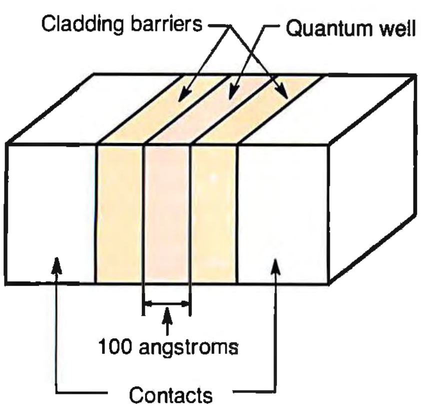


Figure 1: *The underlying principle crucial to the development of the quantum transistor is the quantum well, created by sandwiching an ultrathin film between two walls of a second semiconductor material.*

Quantum Wells

In the late 1960s, Leo Esaki and Leroy Chang at IBM and Nick Holonyak at the University of Illinois began investigating the properties of electrons confined in *quantum wells*, semiconductor films only a hundred or so angstroms thick sandwiched between high confining walls made of a second semiconductor material (see figure 1). As I mentioned earlier, quantum effects become important when the characteristic wavelength of electrons is about the same size as the confinement region. For conduction electrons in semiconductors, this corresponding distance is called the Bloch wavelength (which can be an order of magnitude larger than the de Broglie wavelength for the same energy); for silicon at room temperature, it is about 0.01 micrometer (10 nanometers or 100 angstroms).

During this time, researchers John Arthur and Al Cho at Bell Labs were working on ultrathin-film crystal growth techniques that could butt two different crystals together in a commensurate fashion; that is, a heterojunction. This work was mostly with gallium arsenide (GaAs) and related III-V compound semiconductors, by molecular beam epitaxy (MBE).

Esaki and Holonyak realized that thin-film technology could be used to create quantum wells. Because the confining region is about the same size as the electron and hole wavelength, it is the solid-state analogy of an atom; the electrons in the well occupy a ladder of discrete, well-defined energetic values (subbands) analogous to atomic orbitals. The intriguing difference here is that the energy levels of the wells are sensitive to the height of the confining barriers and to the thickness of the well, dimensions that can be controlled.

Initial optical and electrical experiments on quantum wells quickly verified the discrete energy-ladder structure that is predicted by quantum mechanics. Though the electrical experiments were very convincing from a basic physics standpoint, they were not very impressive as devices, due to the poor quality of materials that could be produced at that time (the electrical experiments demanded material perfection). So, research was diverted to another, seemingly more fruitful, area, that of two-dimensional electron systems.

In the 1960s, workers at IBM verified that the electrons in the conducting channel of a silicon MOSFET constituted a two-dimensional electron gas (2DEG). This stimulated important research on 2DEGs, laying the groundwork for later developments in many areas of quantized systems. The developing quantum-well technology found an ideal application here in that many parameters that were fixed in the silicon 2DEG technology could now be varied by MBE.

Raymond Dingle, Arthur Gossard, and Horst Störmer of Bell Labs developed the idea of spatial modulation of electronic dopants (*modulation doping*), which thereby removes annoying scattering centers from the 2DEG conducting layer. The ability to enhance the conductance of a quantum well or accumulation layer by doping the neighboring higher band-gap layer is the major innovation in this development.

Though the nature of the quantized states is important in the 2DEGs, these devices are distinct from quantum devices because the electron does not travel through the system "coherently." Coherent transport means that the wave nature of the electron coming into the system has some, if not all, of the original wave character of the electron preserved when it exits the system. In conventional transistors and the 2DEG devices, the electron has bounced off so many things by the time it gets across the device that the memory of the original wave is unrecognizably scrambled; thus, the electronic transport through the device is classical, not quantum, mechanical.

Resonant Tunneling Diodes

The first real quantum device was proposed and demonstrated by Chang, Esaki, and Raymond Tsu at IBM. The device is called a *resonant tunneling diode* and is shown in figure 2. The center of the device is a quantum well, with a spectrum of energy levels determined by the growth parameters. The wavelength of the confined electrons is about the size of the quantum well. If there were no other extenuating circumstances, electrons dropped into the well would sit there occupying those different energy levels. However, we have modified the situation by making the cladding barriers very thin, about the size of an electron wavelength.

Now, remember that the uncertainty principle states that the electron cannot be confined to a dimension less than its wavelength; thus, there exists some finite probability that the electron dropped inside the well might suddenly appear outside the well. This is the phenomenon of quantum-mechanical tunneling and has no classical-mechanical equivalent. It would be like throwing a baseball at a solid wall and having it pop out the other side. The dimensions at which this actually happens are typically about 50 angstroms, so we do not see this sort of phenomenon occur in the macroscopic world; the thicker the barrier, the less probability of the baseball tunneling through the wall. The probability may be very, very small, but it is *never* zero; the baseball actually has a finite probability of popping out the other side. True, it is much more probable that the universe will end first before we see the baseball on the other side of the wall.

Now, if an electron is thrown against the barrier wall of the resonant tunneling structure, it has a finite probability of either tunneling through or bouncing off. In more exact terms, it can tunnel through because the Bloch-wave functions of conduction-band electrons can have a finite amplitude in the *forbidden gap* of a semiconductor. The probability is tremendously enhanced when the energy (i.e., the wavelength) of the input electron matches that of the quantum well. When this resonant energy is reached, the tunneling probability is enhanced. (This is similar to the resonating effect provided by the reflecting mirrors in the cavity of a laser.)

In a resonant tunneling diode, we cannot control the electron energy, but we do have control over the potential difference applied across the device (see figure 2). We can bring the state of the quantum well into resonance with the electrons that are available at the point of injection; these can then tunnel through the double barrier formed by the cladding of the single quantum well. The crucial idea is that resonance (and thereby, high current) is achieved only when the quantum level lines up with the contact when a voltage is applied. If the quantum-well state is *not* in resonance, then the tunneling current is low.

This gives rise to a nonlinear current-voltage characteristic with peaks occurring when the quantum well reaches a reso-

continued

nant condition (see the right side of figure 2). (A similar structure, called the *tunnel diode*, has a tunneling barrier formed by a macroscopic depletion layer between n-type and p-type regions. However, other than the use of tunneling, there is no similarity between the two devices; the resonant tunneling diode utilizes quantum confinement, which is controlled by the band-gap engineer.)

The coherency of the electron Bloch wave as it travels through the structure is important. In structures like the resonant tunneling diode, the quantum wells have dimensions that are typically less than the coherence length of the Bloch wave involved. The structure then "resonates" in response to the constructive interference of forward and backward Bloch waves, and the steady-state tunneling current is substantially amplified, like the sound from a resonating organ pipe. These interference and resonance concepts are key in the creation of quantum devices.

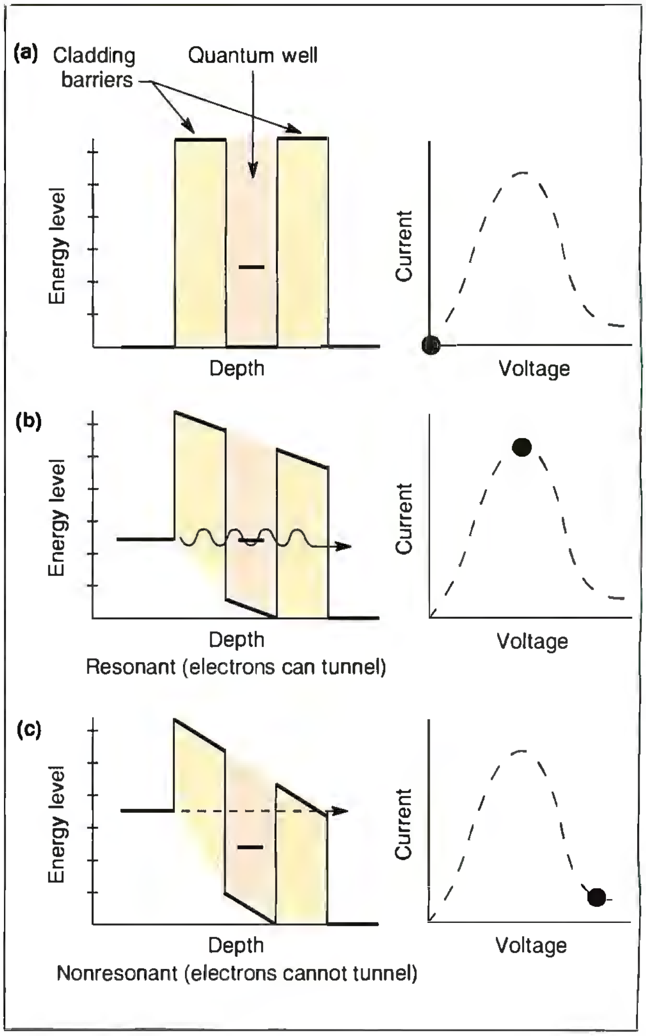


Figure 2: *The different states of a resonant tunneling diode: energy level versus depth (left) and the corresponding voltage versus current (right).* **(a)** *When the energy level of the source contact is below the quantum state within the well, there is no tunneling.* **(b)** *When the source contact level is raised to match that within the well, tunneling occurs.* **(c)** *If the source contact level is raised even further, tunneling ceases since the level inside the well no longer matches that of the source.*

A Conceptual Quantum Device

To clarify this concept of interference/resonance amplification, let's build a hypothetical quantum device (see figure 3). Let's inject into the device an electron wave packet, which then splits in half and travels down two identical channels. These two electron wave packets are thus coherent—that is, in phase.

Now, let the two wave packets enter boxes A and B, which have the following simple properties:

- If the control switch on the box is set at 0, then the wave packet propagates through the box undisturbed.
- If the control switch is set at 1, the phase of the propagating wave is shifted a half-wavelength (π), making it out-of-phase with the other wave packet.

Now let the two wave packets recombine.

- If the controls A and B were set the same (both 0 or 1), the final electron wave packet is just the same as the initial wave packet: *constructive interference.*
- If the controls A and B are in different states (i.e., A=0 and B=1, or visa versa), the output is zero: The recombined wave packets have destructive interference, and there is no output current.

This is an exclusive-NOR (XNOR) logic function, a basic logic building block. An entire set of complex functions can be designed, on paper at least, and is surprisingly akin to microwave waveguide circuits.

The exciting fact is that such phenomena have recently been demonstrated in microfabricated electronic structures. Though the device described above is far from being realized, wave-function interference and the "electron waveguide" analogy have been clearly demonstrated. Device physicists, such as Greg Timp and coworkers at AT&T, have microfabricated tiny waveguide structures and found that the system was indeed coherent. The waveguide analogy is very good—perturbations in one part of the system affected the wavefunction of the electron in all other parts of the system. This poses a problem when you try to put contacts onto the structure to measure the electrical properties—the contacts are part of the system and can dramatically affect the measurement. The measurement and isolation of a quantum wavefunction interference device is a major unsolved problem. We presently know more about the quantum devices themselves than how to make contacts to them.

Making Contacts in the Quantum World

To illustrate the problems of making macroscopic contacts to nanoscale quantum devices, let us consider making a quantum tunneling transistor. Starting with the (two-terminal) resonant tunneling diode, how do we make a three-terminal transistor out of a structure whose center region is typically 20 atoms across? The simplistic approach is to manipulate the potential of the quantum well by connecting it to a voltage, like any other transistor. But since the controlling electrons being put into the quantum well also tunnel out along with the current-carrying electrons, it becomes impossible to distinguish between the controlling (base) electrons and current-carrying (emitter-collector) electrons. The formidable problem of soldering to a 50-angstrom-thin layer is beside the point, since it wouldn't do you any good even if you could.

The solution to the problem is easy once the real problem is realized; use a narrower-band-gap quantum-well layer to hide the lowest-lying control electrons' state from the overhead tunneling electrons. The ability to grab hold of and modulate the potential of a quantum well is a major milestone on the path to creating quantum devices. This solution to the not-so-obvious problem shows that the difficulties in creating quantum devices are often more conceptual than physical.

Quantum Wires and Quantum Dots

The device structures emphasized so far employ quantization in only the vertical direction—that is, in the thin epitaxial direction. I mentioned previously that the thin quantum well was the solid-state analogy of an atom. The atom analogy, however, is good only in the thin epitaxial direction; the other dimensions are unconstrained and thus have no quantum confinement.

The remarkable advances in nanofabrication technology in the last few years have changed this situation. Researchers around the world have demonstrated that they can impose quantum confinement in one or both of the remaining two dimensions; that is, laterally create structures that approach the thin epitaxial dimensions. If an already-confined quantum well is confined in another dimension, it is called a *quantum wire*; if all three dimensions are confined, it is called a *quantum dot*, and it is here that the solid-state atom analogy is exact (see fig-

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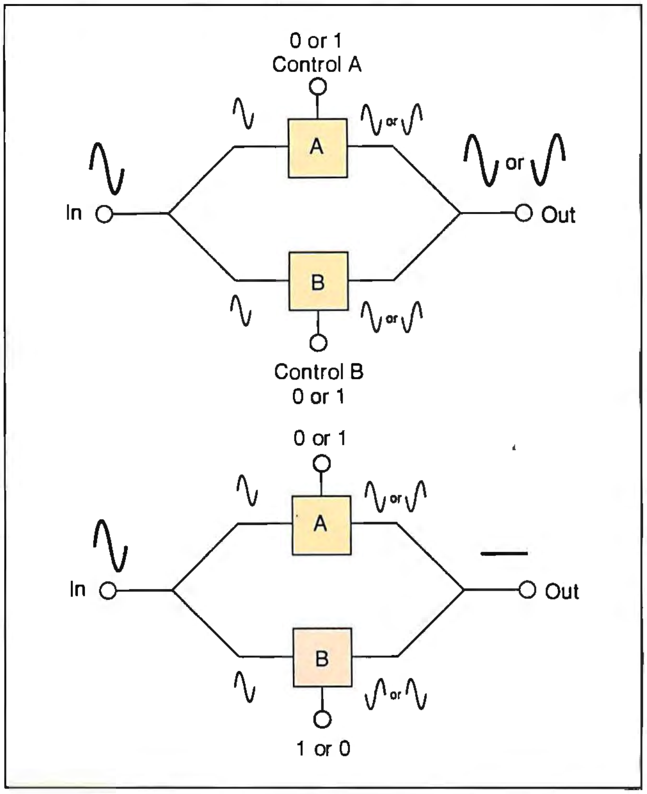

Figure 3: *A hypothetical quantum device, into which an electron wave packet is injected. The packet then splits in two and travels down two identical channels toward control boxes. A 0 in a control box indicates that the wave packet propagates through the box undisturbed; a 1 indicates a shift of a half-wavelength in the phase of the propagating wave. If A and B are the same (above), the two wave packets recombine into a wave packet that is unchanged from the original. If A and B are different (below), the recombined wave packets have destructive interference, and there is no output current. Thus, the device forms the basis for the exclusive-NOR (XNOR) logic function, a basic building block for electronic components.*

Glossary

band gap The difference between the energy levels of electrons bound to their nuclei (valence electrons) and the energy levels that allow electrons to migrate freely (conduction electrons). The band gap is sensitive to the spacing of atoms in a material.

Bloch wavelength The effective wavelength of electrons in a semiconductor crystal. (See de Broglie wavelength.) A Bloch wavelength is sometimes called an *electron wave packet* or a *wave function*. It can be an order of magnitude larger than the de Broglie wavelength for the same energy.

cladding barrier The higher-band gap material encasing a lower-band gap material that defines the walls of the quantum well.

coherence length The typical distance an electron can travel before it runs into a defect or impurity.

conduction electrons In a conductor or n-doped semiconductor, some of the atom's outer-shell electrons are bound so loosely that they can roam freely throughout the solid. Since the electrons are mobile, the material can conduct electricity.

de Broglie wavelength A particle's wavelength, based on Prince Louis Victor de Broglie's theory that particles exhibit wave-like characteristics.

dopants (n-type and p-type) N-type (negative) dopants, such as phosphorus, come from group V of the periodic table. When added to silicon (from group IV), n-type dopants create a material that contains conduction electrons. P-type (positive) dopants, such as boron, come from group III and result in *holes*.

doping The process of creating semiconductor materials by adding tiny amounts of chemicals to pure crystals of silicon, germanium, or gallium arsenide.

epitaxial layer An added layer of crystal that takes on the same crystalline orientation as the substrate.

forbidden gap Electrons bound to an atom acquire and release energy in discrete amounts. When atoms of a conductor or semiconductor are placed in a solid, there is a fixed energy level that a given electron must acquire to release it from its parent atom and allow it to become a conduction electron. Since this energy is a fixed amount, it defines a forbidden gap. Electrons cannot exist at energy levels in this gap. They are either below it (and bound to an atom) or above it (and able to move freely).

holes Take an imaginary crystal composed entirely of atoms with four electrons in the outer shell. These are the valence electrons, which take part in chemical reactions. Each atom will form bonds with its neighbors so that its nucleus will be surrounded by four electron pairs. Now remove one atom and replace it with an atom possessing only three valence electrons (a group III element). You've just created a hole—the absence of an electron. It is an amazing fact of nature that this hole exhibits properties of a real particle.

interference (destructive and constructive) When two waves of the same frequency are combined, they can either cancel each other (destructive) or build on each other (constructive). Waves that are out of phase have destructive interference.

molecular beam epitaxy (MBE) Growing thin crystal layers by directing beams of atoms or molecules at the semiconductor. The process takes place in a high vacuum, and the thin layers are crystals aligned with the crystal substrate.

potential gradients The difference in voltage per unit of distance in a conductor or semiconductor material.

quantized states Discrete levels of energy due to the quantum-mechanical properties of the material.

scattering centers The necessary impurities (dopants) in semiconductors cause the electrons flowing through the semiconductor to scatter. This is not a problem for the operation of traditional semiconductor devices. However, when designing quantum devices, the electron-wave properties must remain coherent.

silicon dioxide gate dielectric A dielectric is a material that resists the flow of electrons. In the process of making semiconductor devices, the silicon is oxidized to form silicon dioxide (a dielectric). This material is used as an electrical insulator. Most of it is eventually etched away, but some is left in patterns on the device to create necessary electrical separation of the elemental components (gates) of the device.

III-V compounds The columns in the periodic table of elements are called groups. Elements in a group have similar chemical properties. Elements from a different group than that of the host material can be used in semiconductors. Gallium, for example, is a group III element and arsenide is from group V, making GaAs a III-V compound.

tunneling The quantum-mechanical process that demonstrates the wave nature of particles. The term is applied to the ability of electrons to penetrate a barrier that would be impenetrable by classical physics. The invention of the tunnel diode in 1957 moved tunneling from a theoretical concept to a practical reality in semiconductor devices.

two-dimensional electron gas (2DEG) In an electron gas, the electrons move around without apparent restriction. The behavior of electrons in conducting metals (such as copper) is an example of a three-dimensional electron gas (3DEG). In a 2DEG, motion is restricted to a single plane (two dimensions).

waveguide Because of the behavior of microwaves, tubes (rather than wires or free space) are used to channel them. The size and shape of the tube influence the transmission, propagation, and filtering of microwaves. These specialized tubes are called waveguides.

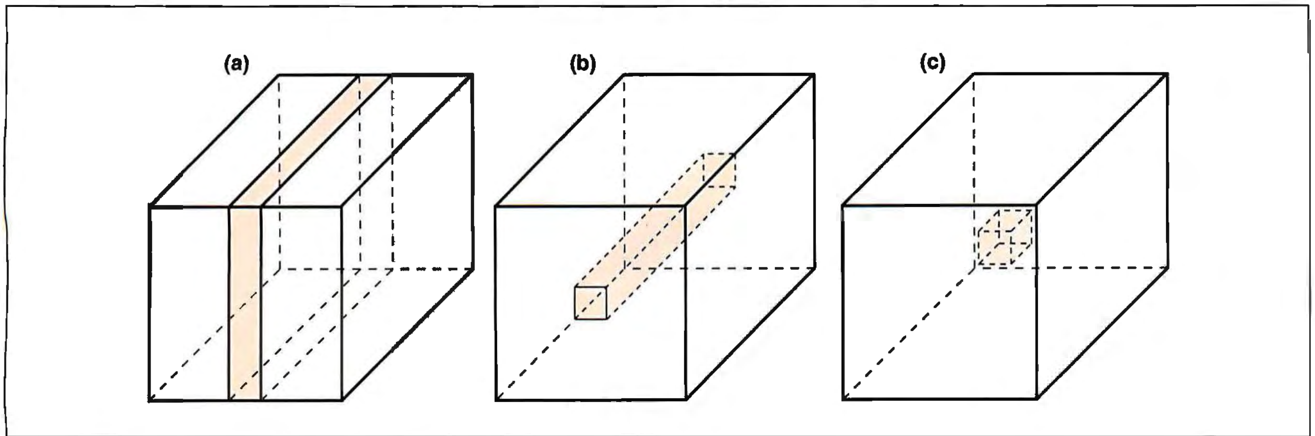

Figure 4: **(a)** *Restriction by one dimension results in a quantum well;* **(b)** *restriction by two dimensions produces a wire;* **(c)** *restriction by three dimensions produces a dot.*

ure 4). Precise control of this quantum confinement and the resulting electron energy structure are the second key ingredients in the creation of quantum devices.

Research into quantum wires began in the early 1980s, mostly in metal systems. Researchers discovered the importance of relevant scattering and coherence lengths and realized that the effects would be much larger in semiconductor systems. Today, many university and industrial laboratories throughout the world use quantum-wire technology. Daily, there are new achievements in the basic physics of quantum-wire electronics (i.e., quantum waveguides) and in the properties of enhanced devices using this technology.

However, the development of quantum dots has been significantly slower. Only within the last year, when we at Texas Instruments implemented a method for putting tunnel barriers and contacts onto the sides of a quantum dot, was anyone able to see the first evidence for the creation of totally quantum-confined states. Now, researchers are using these "atoms" to explore the fundamentals of quantum-confined states.

Now that we can make "atoms," the next step is to build "molecules." Consider two quantum dots, patterned in close proximity with a tunnel barrier between them. If the two dots are different sizes, the energy levels will not line up, and electrons in one of the dots cannot resonantly tunnel into the other. However, if a bias is applied to make the energy levels line up, electrons can resonantly tunnel from one dot to the other.

Bob Bate of Texas Instruments pioneered this new genre of quantum devices. He showed that it is easy to construct multiterminal transistors and any possible logic function from similar structures. Here, the quantum dot is of particular interest because the total absence of states at energies intermediate between the quantum levels (i.e., no unconstrained dimension) means that electrons only tunnel between dots that have equivalent energy levels. This development is important for digital switching applications, where the ideal is to be able to hold off the supply voltage with minimal leakage current and to use a third terminal to create a nearly instantaneous switching into a highly conductive state.

The Future of Quantum Devices

To envision how quantum devices will be used, first realize that the limitations of present VLSI technology are due not only to device degradation but also to a multitude of problems: interconnection overhead, system noise, and alpha particle events, among others. In essence, simply replacing today's devices one-for-one with nanoscale quantum devices does not solve the scaling limit problem. The implication is that quantum devices must be used in designs with noise tolerance. But this research is not even as far along as research in device technology. Researchers have identified a number of strong candidate architectures, such as cellular automata. Before we can use quantum devices in complex functions, we need to do more work on quantum device coupling and contact effects.

If these devices are only tens of nanometers across and operate by the tunneling of only a few electrons, how are we to bring signals in and out of these tiny structures? This problem turns out to be much less daunting than we initially thought.

Researchers at Bell Labs, Cornell, and Texas Instruments have discovered that quantum wires are excellent amplifiers. At the quantum level, electrons are like tiny wave packets; in a quantum wire, they travel straight through the wire without bouncing to either side. We have found out that if we put a small charge, even a single electron, in the middle of a quantum wire, there is tremendous blockage. In large structures that are not quantum wires, the wave packets can bounce to the side and go around. However, in a quantum wire, the wave packets are restricted to two directions—forward or backward. The wave packets are simply a substantial electrical current, and a single electron in the quantum wire can produce a phenomenal amplification of 10^{11} per second per electron. Alhough we are still working on developing a method for coupling the single-electron output of one quantum device to quantum-wire amplifiers, this will soon be a reality.

The creation of quantum wires and dots, phase-coherent structures, controllable tunneling, and single-electron output amplifiers are all key steps toward a complete quantum-device technology. We still need to develop a method of controllably defining the locality of nanoscale contacts, and we still need to completely define a workable architecture. The pursuit of a revolutionary (rather than evolutionary) semiconductor technology is inherently risky, but the alternative is hardly acceptable, and the anticipated rewards are enticing. ■

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DIGITAL VIDEO INTERACTIVE

Digital audio, video, still pictures, and computer graphics come together in a personal computer environment

Imagine touring the jungles of the Yucatán peninsula from your easy chair. Using a joystick and your computer's screen, you "walk" through ancient Mayan ruins, zooming in to take a closer look at artifacts and wildlife. Sounds of water, insects, and jungle animals surround you, realistically shifting their relative positions as you slowly turn 360 degrees to get a full, seamless view of your surroundings. You explore the underground maze of a Mayan palace, track your progress on a map of the site, enter a rain forest, and watch birds and monkeys in the trees overhead. All along the way, the voice of an expert archaeologist describes important features of what you see.

You then enter a video "museum," with theme rooms containing more information about the site. Using the joystick to select icons and objects, you view pictures of Mayan ruins as they looked before and after restoration, piece together the fragments of an ancient glyph, listen to the voices of howler monkeys, and piece together your own "jungle symphony" from a selection of sound clips.

I took this very "tour" in January—and the first commercial systems may be available by this summer, thanks to an ingenious marriage of digital technologies known as *digital video interactive*.

The DVI technology combines motion video, still pictures, multitrack audio, and computer graphics in a single integrated environment controlled by a personal computer. Implemented by boards and chips soon to be manufactured in quantity by Intel, DVI provides all the facilities necessary to produce truly exciting interactive-video presentations.

An All-Digital Approach

Already, a few systems provide interactive audio, video, and computer graphics. For instance, the popular arcade game Dragon's Lair lets you move about a dungeon, fighting monsters in a quest for a beautiful princess. Also, the U.S. Army uses a system called EIDS for interactive training. These systems use videodisks as the source of video and audio material; as you make choices, the head jumps to a different track, which contains a simulation of the result.

This approach, while practical for some applications, has three main drawbacks. First, you can make only a limited number of choices, and only those that were "expected" by the system's designers. Second, there are usually marked, and often annoying, interruptions in the video and audio as the laser-disk head moves to a new location. Finally, computer-generated text or graphics, if desired, must be superimposed on the video image after the fact. Usually, this requires additional computer graphics hardware and complex genlock circuitry to synchronize the video from the two sources.

A key goal of DVI is to eliminate the expense, complexity, and awkwardness of a part-analog/part-digital system by storing and processing everything as digital data. DVI uses a single storage device and a single set of chips to produce live-action video, synthetic video, and audio, all under the direct control of a personal computer. The result is a system that is far more interactive and sheer fun to use than anything that has come before.

Video Compression

The first—and most exciting—component of DVI is advanced video data compression. Extremely good compression, especially of video, is necessary because an uncompressed video image takes up large amounts of memory. One demonstration I watched showed gymnasts and figure skaters performing at high speed. The image consisted of 256 pixels by 240 pixels, with 24 bits per pixel (8 bits each for red, green, and blue).

At this resolution and a standard television rate of 30 frames per second, it would have taken only 96 seconds' worth of uncompressed data to fill up a standard half-gigabyte CD-ROM disk. And, since a CD-ROM can transfer data at only 150K bytes per second, there's no way the disk could have kept up with the demand for data.

DVI addresses this problem by providing extremely efficient compression and fast decompression of video information. Since the greater part of a video image doesn't change from frame to frame, only the differences between successive frames are recorded. Special hardware to handle compression mechanisms like a CLUT (color lookup table) and *chrominance subsampling* (see the text box "Chrominance Subsampling" on page 284) is built into the DVI chip set. Additional proprietary techniques pack the information still further.

The compression algorithms take into account the fact that only decompression must be done in real time, shifting as much of the computational burden as possible to the device that compresses the video. The final result is more than an hour of full-screen motion video and multichannel audio on a single CD-ROM disk—all of which can be played back in real time.

Currently, the practical minimum size of a compressed video frame is about 5K bytes; more compression usually introduces undesirable artifacts. However, because the DVI hardware is easily reprogrammed, none of the compression algorithms are fixed in stone. This flexibility will let DVI grow as the state of the

continued

art advances, while allowing new systems to be downward-compatible with materials produced for older ones.

The DVI hardware can also compress and decompress still images with compression ratios of up to 25-to-1. Exact reproductions of detailed graphics and medical illustrations can be done at ratios between 2-to-1 and 3-to-1 (see "Chrominance Subsampling").

Audio Compression

The compression of audio information poses different, but equally challenging, problems. Audio doesn't exhibit as much regularity as video, so it's not as easy to interpolate future waveforms from earlier ones. Also, audio must be contiguous. Most of us are used to video sequences that jump from take to take, but discontinuity in an audio signal can be jarring.

DVI provides audio compression via an ADPCM (for adaptive differential pulse code modulation) algorithm and uses special buffering techniques to prevent discontinuities in the sound, even during the long step times of CD-ROM heads. Typically, the compressed audio will take from 4K to 16K bytes per second (more if there are more tracks).

Synthetic Video

Along with the ability to reproduce compressed video sequences, DVI has facilities to create computer-generated images in real time. The hardware supports both bit-mapped graphics and "structured" graphics (in which objects are created from primitive graphics elements like polygons and curves) directly, and there are facilities for bit-mapped (and, potentially, stroked) text fonts.

DVI uses special hardware to perform the *warp* algorithm, which very quickly maps a pattern or texture onto a simulated two-dimensional or three-dimensional surface. The sample application called Design and Decorate (see photo 1) demonstrates this feature by allowing you to "reupholster" sofas and chairs with different fabric patterns in a fraction of a second, then arrange them in a simulated room to see how they'll look. The DVI hardware and software generate realistic shadows and textures, and they let you change vantage points almost instantly.

Another demonstration program, Flight Simulator (see photo 2), shows realistic textured images of buildings as you fly over the landscape—including a billboard with a picture of Nipper, the RCA dog, listening to "His Master's Voice" (a reminder that the DVI development team was originally part of RCA Laboratories; see the text box "A Brief History of DVI" on page 287). Yet another demonstration is a tutorial on Photography (see photo 3): The screen becomes your viewfinder as you frame, focus, and shoot pictures using the joystick. And in the Landscaping demonstration (see photo 4), you can arrange shrubs and trees in your garden and then watch them grow to maturity before your eyes.

The DVI Hardware

At the heart of DVI technology lie two chips—VDP1 and VDP2—that together form the video display processor (see figure 1). The first versions of these two chips, implemented in 2-micron CMOS, were designed using Silicon Compiler Systems' automated chip-design software, and they were built by VLSI Technology.

The use of silicon compilers was an important trade-off: It brought the system to market quickly, but the very nature of silicon compiling limited the speed and complexity of the chip set. Intel is now at work on a fully customized chip design, which is likely to be significantly smaller and faster.

VDP1, or the pixel processor, is a horizontally microcoded microprocessor that runs at 12.5 million operations per second (MOPS). It uses a wide instruction word and has no permanent microcode; all the code it executes is loaded from dual-ported video RAM (VRAM) into an on-chip instruction RAM before being run.

Because the on-chip microcode store is not nearly large enough to hold all the routines that might be used to produce a single scene, VDP1 has the ability to

Chrominance Subsampling

Scientists theorize that it was more important for primal humans (and their evolutionary ancestors) to be able to precisely locate boundaries between light and dark areas than to be able to detect differences in color. For this reason, they say, the color-sensing *cones* of the human retina are distributed more sparsely than the more sensitive but noncolor-sensing *rods*. Digital video interactive, like color television, takes advantage of the resulting trait of the human eye: The spatial resolution of color vision is lower than that of noncolor vision.

In DVI's special 9-bit-per-pixel video-encoding scheme, the colors and brightnesses of pixels are encoded not as RGB components but as Y-C components: luminance, or brightness, plus two values that describe the hue and saturation of the color. The luminance (Y) bit map is used at its full resolution, while the color values (C_1 and C_2) are recorded for only every fourth pixel in each direction. The result is a set of three bit planes, as shown in figure A.

When VDP2 displays images in this mode, it automatically interpolates the colors of each pixel for which no chroma information is available from the colors of its neighbors.

Chroma interpolation works well on images with no sharp borders between saturated colors; however, it will produce bleeding if used with most conventional computer graphics. VDP2 solves this by switching to other display modes—like a 256-color lookup table—on a pixel-by-pixel basis, if necessary.

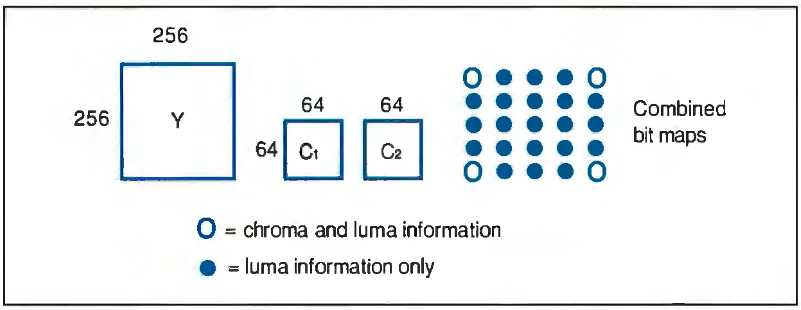

Figure A: *Chrominance subsampling takes advantage of the fact that the eye has less spatial sensitivity to color than to brightness. Three bit planes, two of them at one-quarter resolution, are used to reproduce the image by interpolating colors between the points.*

completely reload that RAM in less than 120 microseconds—the time it takes a standard video monitor to scan two lines. In fact, VDP1 typically reloads microcode several times during every frame of a text/graphics display.

The wide microcode word can cause several operations to occur concurrently within VDP1. Address calculations and pixel processing go on at the same time. Counters for the inner loops of graphics operations increment as the operations happen. Using special hardware, VDP1 can perform the warp algorithm on 500,000 pixels a second—much faster than any general-purpose processor now available.

> *VDP1 can perform the warp algorithm on 500,000 pixels a second.*

Because they expected the DVI architecture to evolve, its developers were careful to make provisions for the format of the microcode word to change with the technology. Instead of storing the microcode in a raw binary format, the system keeps it in a *logical* format on the disk and translates it into *physical* microcode only when moving it into VRAM. This design will make it easy to provide downward compatibility in later versions of the chip set.

In all cases, data must be moved into the on-chip data RAM before it can be manipulated. Because the chip's novel architectural features are the subject of several patent applications, Intel hasn't disclosed the width or organization of the internal data paths. However, Intel has stated that the on-chip data RAM is large

continued

Photo 1: *Design and Decorate, developed by Intel and Videodisk Publishing, lets you move and "reupholster" furniture to achieve a pleasing interior design.*

Photo 2: *The Flight Simulator demonstration puts you in the cockpit of a simulated airplane that flies among realistic landmarks.*

Photo 3: *Photography teaches camera novices how to compose and focus pictures (notice the simulated depth of field in this picture).*

Photo 4: *Landscaping lets you plan a garden and view it as it will look at different stages in the life cycles of shrubs and trees.*

enough to hold some or all of the last video scan line—an important feature for image processing. The designers were careful to match VDP1's requirements to the bandwidth of current VRAMs. Most of the available bandwidth is used, but the processor rarely has to wait for access.

The host system—which is currently an IBM PC AT—controls VDP1 via a bank of 256 16-bit registers. The host can also access the VRAM—up to 16 megabytes of it—via an EMS-like paging scheme. VDP1 can generate interrupts on the host CPU (for itself or on behalf of VDP2) to signal events that occur in either video chip.

A Super CRT Controller

VDP2, or the output display processor, acts as a super CRT controller for the DVI system. It isn't directly accessible via the host system bus; instead, it programs itself by loading values into internal registers from VRAM (much as the copper loads the video registers in the Amiga's custom chip set). The registers are always reloaded at the end of every frame, but they can also be reloaded more often under software control. VDP2 can send signals back to VDP1 via the 4-bit VBUS interface.

VDP2 extracts data from VRAM via a 32-bit-wide multiplexed bus connected to the VRAM serial ports and maps it, via a specially designed *pixel data path*, to a CRT display.

The output to the D/A converters is 32 bits per pixel. Of these, 1 byte is used for luminance (brightness), 2 bytes for chrominance (color), and 1 byte for the *alpha channel*, a special-effects channel that can be used with a video mixer to blend VDP2's output with another video signal. The maximum resolution I saw demonstrated was 768 by 480 pixels, although the technology does allow higher resolutions.

Besides performing the mundane task of CRT control, VDP2 also participates in the decompression of pixel data. The use of chroma interpolation facilitates a smooth construction of images from a luminance bit map that has the same resolution as the screen, and from two subsampled chrominance bit maps that have only one-sixteenth as many pixels—blending the colors to fill in the intervening areas.

When reproducing bit-mapped text, icons, a mouse pointer, or other portions of the screen that contain sharp boundaries between colors, VDP2 can switch on a pixel-by-pixel basis to a CLUT to get precise color information without interpolation. It can also display noncompressed data stored in 16- or 32-bit-per-pixel formats.

VDP2 can also organize the storage of pixels in VRAM during video digitization. In fact, while VDP2 takes care of these logistics, VDP1—which would otherwise sit idle—can work on compressing the digitized images as they arrive.

The combined power of VDP1 and VDP2 is impressive. Intel's Microcode demonstration plays the game of Life in one window, displays full-motion video in another, and pans a third window smoothly about the screen image.

VDP1 and VDP2 sit together with VRAM and interface logic on one of the three boards that currently make up the DVI interface. A single-board implementation is expected to be available by the end of this year. The DVI audio processor and the DVI utility board complete the set.

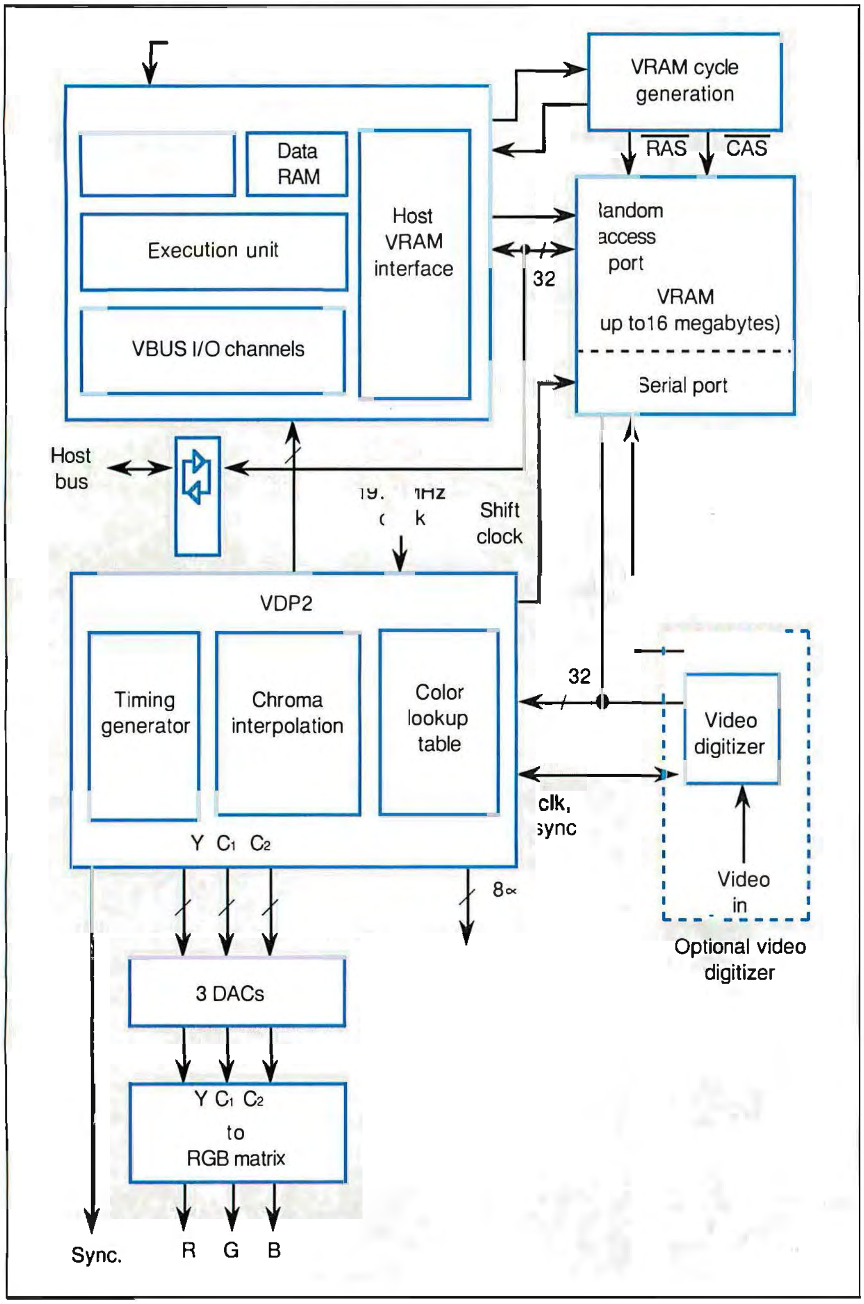

Figure 1: *The digital-video-interactive video subsystem consists of the VDP1 pixel processor, the VDP2 output display processor, video RAM, a host interface, and an optional video digitizer board.*

A Brief History of DVI

Digital video interactive was conceived by Larry Ryan of the David Sarnoff Research Center (then RCA Laboratories) in 1983. At that time, RCA began working on schemes to make its LaserVision analog videodisk system interactive, with unsatisfying results. Ryan suggested an all-digital approach, and he received approval from his boss, Art Kaiman, to test its feasibility. Within one year, they were satisfied that DVI was possible, and Kaiman's entire staff was working fiercely on the project.

The effort continued for six years, while the group weathered numerous budget cuts and changes of management. RCA dropped out of the videodisk and home computer businesses and was acquired by General Electric. To save time, the design moved directly from computer simulations to silicon; no board-level prototype was ever built. Despite a warm reception at the 1987 CD-ROM Conference, the DVI effort didn't mesh with GE's strategic plans, so GE, in turn, donated the Sarnoff Research Center to SRI International (retaining control of the technology). Finally, GE sold the technology to Intel.

The DVI Audio Processor

The DVI audio processor uses a Texas Instruments TMS320C10 digital signal processor to record and decompress audio in real time. Running at a clock rate of 25 MHz, it executes most instructions in four cycles, for a net speed of 6.25 MOPS. The digital signal processor has a small internal data RAM (144 16-bit words) that is supplemented by 16K bytes of dual-ported DRAM (shared with the host) and 8K bytes of high-speed (50-nanosecond) program RAM. An optional audio digitizer attaches as a piggyback board.

The audio processor offers three levels of digitized audio, encoded as 4K, 8K, and 16K bytes per second. The lowest quality, with a bandwidth equivalent to that of AM radio or a telephone connection, is suitable for speech; the highest quality is superior to what you'll hear on a typical FM radio program. It's also possible—at least in theory—to synthesize arbitrary waveforms using the audio processor.

The audio processor is a complete subsystem by itself, and it can be run independently of the other DVI hardware. The software interface to the processor is also defined in such a way that the implementation can be changed (i.e., a different digital signal processor can be used) without changes to DVI applications.

The DVI Utility Board

The utility board provides three functions: a dual joystick interface, 128K bytes of DRAM (to top off the memory of a standard AT at 640K bytes), and a CD-ROM interface with a full sector buffer. (While a CD-ROM disk isn't absolutely necessary to run DVI applications—they run equally well from a hard disk—it's an excellent distribution medium due to its large capacity and low cost.)

Intel hopes to improve data throughput in future systems by providing a direct data path between the CD-ROM interface and the audio and video subsystems: a *DVI bus*. This will free the host system from the arduous task of shuttling data from the utility board to the other boards in real time.

The DVI Software

All activities of the DVI boards are controlled by a layered set of software routines provided by Intel (see figure 2). At the lowest level are the TSR drivers for VDP1, VDP2, the audio processor, and the utility board. There is also MS-CDEX (Microsoft CD-ROM extension), which allows access to the CD-ROMs through DOS. (This driver is necessary only if a CD-ROM disk is used as the DVI storage medium.)

On the next two levels, provided by linkable object code libraries, are driver interface modules, which give the programmer direct low-level control of each DVI subsystem, and the graphics and AVSS (audiovisual subsystem) libraries, which provide complex functions involving more than one subsystem. At the top of the hierarchy is the DVI application.

Two key parts of the DVI software are RTX (real-time executive), which performs real-time multitasking on the AT, and AVSS, which allows DVI applications to issue high-level commands like, "Play back this audio/video sequence now." These subsystems hide much of the complexity of real-time I/O control, letting the developer concentrate on the creative aspects of the application.

The Compression Process

All the video and audio, as well as most of the still images and other information

continued

CD-ROM, CD-I, and DVI

What are the differences between CD-ROM, compact disk-interactive, and digital video interactive?

CD-ROM, as defined by the Philips/Sony *Yellow Book* and the International Organization for Standardization 9660 standard, is merely a way of encoding data files on a CD-ROM disk. It doesn't say anything about what's in the files or how they are used.

CD-I, as defined by the Philips/Sony *Green Book*, is a specification for a complete hardware/software product that includes a CD-ROM player, a Motorola 68000-family CPU, and special audio- and video-processing hardware. Intended for the consumer market, it's designed for price-sensitive applications; keyboards and read-write storage media are options. CD-I has a wide range of capabilities, including CD-quality audio (which DVI does not have), but it cannot display continuous full-screen, full-motion video, and it cannot run on hardware that doesn't precisely conform to the specification.

DVI is a more generalized technology that does not require specific hardware other than the DVI chip set. Unlike CD-I, it's suited for use with forms of mass storage other than CDs, like WORM (write once, read many times) disks and magneto-optical disks. Also, it can work as a peripheral of many different kinds of computers. (It's possible, at least in theory, to run windowing environments like X Windows, NeWS, and Presentation Manager on or through the DVI hardware.) DVI can display full-screen, full-motion video, and the internal graphics CPU—as well as the host CPU—can be programmed to execute new special effects and data decompression algorithms.

found in a DVI application, must be compressed to fit on a CD-ROM disk or other reasonably priced personal computer storage medium. The operation is highly computation-intensive; Intel currently performs video compression on a Meico array processor with 64 INMOS transputers working in parallel. Even with this much horsepower, each video frame takes 13 seconds to compress—400 times slower than it will actually run (ongoing research, as well as more transputers, is likely to reduce this figure).

In Intel's current compression process, it first transfers the video material from tape to a high-speed disk at the full frame rate, then backs it up onto WORM (write once, read many times) disks and compresses it on the array processor. After the initial compression pass, Intel examines the images for artifacts and makes some final touch-ups, if necessary, before returning the resulting compressed video to the customer (usually on cartridge or 9-track tape).

The quality of the video input is vitally important to the compression process. Any form of distortion or noise present in the source material is likely to be amplified by the compression process, and this may also reduce its efficiency. Thus, Intel currently accepts material only on 1-inch videotape (though it may accept other formats of similar quality in the future). Some images compress better than others. Images with saturated colors, for instance, are likely to bleed due to the chrominance-subsampling techniques used in the video subsystem.

Intel is currently the only vendor of video and audio compression services, but this will change.

At this writing, Intel is the only vendor of compression services, but this will change. Third parties will be granted licenses to use Intel's software on their own hardware to satisfy customers' compression needs.

Authoring a DVI Application

How do you author your own DVI application? In the early days of DVI, when the initial demonstration programs were created, there was little in the way of authoring tools. The Palenque demonstration, created by Intel in conjunction with the Bank Street College of Eduation, was largely coded by hand using the evolving run-time libraries, C, assembly language, and VDP1 microcode. Video and audio had to be edited prior to digitization and compressed by a mainframe computer before they could be viewed.

Fortunately, better authoring tools are

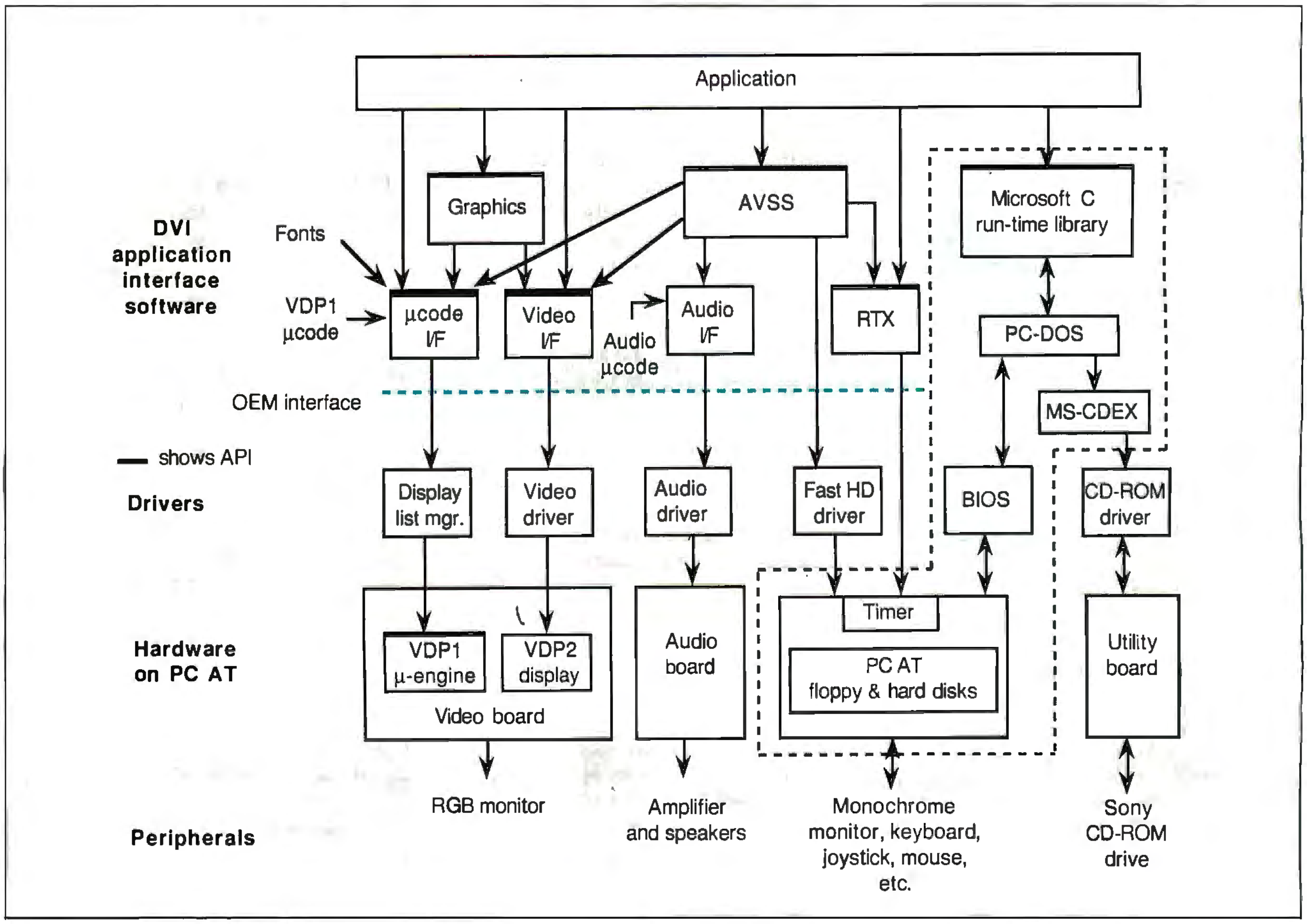

Figure 2: *The digital-video-interactive run-time software is layered and modular. The low-level device drivers are implemented as TSR programs; the higher-level software is packaged as run-time libraries for the C language. There are facilities to directly execute custom microcode on VDP1.*

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now in place, and by the third quarter of this year, Intel will release utilities that will eliminate most or all of the need to program in C, assembly language, or microcode when writing DVI applications (though it will certainly still be possible to do so). Contemplating a wide variety of possible applications, Intel has rejected the notion of a "standard user interface" for DVI, but it will provide the software tools required for application developers to create their own.

Intel's most significant breakthrough in the area of authoring tools is Edit Level Video, a facility that lets the developer digitize and compress video in real time using just the DVI board set. While the quality isn't as good as that done by a large computer and may produce some visual artifacts, ELV provides a digitized version of the video that the author can edit directly on the DVI system and then use to develop an application.

During editing, the authoring software compiles an *edit decision list*—a list of the Society of Motion Picture and Television Engineers time codes where each video sequence starts and stops. This list, together with a high-quality master tape of the video, is fed to the "production" compression system to create high-quality (Presentation Level) video. The steps that you go through to produce a complete application are roughly as follows:

1. Digitize the video footage using ELV.
2. Digitize the audio.
3. Use editing tools to select the desired video and audio sequences.
4. Add the programming, computer graphics, menus, icons, and still images.
5. Send the original videotapes and the edit decision list to a vendor for compression.
6. Replace the ELV with Presentation Level Video (the standard DVI routines let this be done without recompilation of the DVI application).

How much does it cost to produce a DVI application? This figure can vary greatly depending on the nature of the material involved. A demonstration program called Words in the Neighborhood, created in conjunction with the Children's Television Workshop, tapped a library of 20 years' worth of high-quality video material developed for the television show *Sesame Street*; all that was necessary was to pick the sequences and add a user interface.

A similar application created from scratch, however, would incur the same production costs as an equivalent video presentation: Actors, camera crews, editing, lighting, and scripting will likely account for the bulk of the cost. Programming costs may also become significant if sophisticated computer graphics, custom user interfaces, or custom microcode are required.

Once the application is developed, the rest of the process is relatively inexpensive. Presentation Level Video compression costs roughly $300 per finished minute of full-screen images; mastering and pressing a CD-ROM costs anywhere from $2000 to $8000. (For some applications—especially those that won't be mass-marketed—it's possible to skip both of these steps and distribute applications with ELV on high-capacity tape cartridges or hard disks.)

An Interactive Future

Intel's marketing plans call for the first DVI-based systems to be available in June. In keeping with its traditional marketing approach, Intel will offer products on all levels: Chips, boards, systems, driver software, development tools, and compression services will all be available. While the names of the companies working with Intel to produce end-user products are still under wraps, you can expect to see announcements about that time.

The introduction of DVI heralds the beginning of an age of truly interactive audiovisual media. The demonstration programs, although impressive, only scratch the surface of what's possible. DVI's potential as a tool for marketing, teaching, entertainment, simulation, animation, and special effects is bound to keep creative minds busy for many years to come. ■

ACKNOWLEDGMENTS

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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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Today's microcomputers are more and more powerful and sophisticated. So, too, are the professionals who use, buy, sell, manage, and plan exactly how to make these computers integral and productive parts of their businesses. For these professionals--for those who have come to be known as volume buyers--there is one great way to stay on top of the explosion in microcomputer technology: PC EXPO in New York.

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The extraordinary breadth and depth of the PC EXPO exhibitor list confirms the show's stature as "the industry standard." Martin Hansen, MIS director for an international financial investment firm, sums up the expectations of the show's 50,000 volume buyers, "I know if it's something I need to see, I can see it at PC EXPO," he says. "And if it's not at PC EXPO, I probably don't need to see it."

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Part 1

DIRECTORY ASSISTANCE

The directory: the single most important data structure in your computer

You've heard it called many names—most often, the *directory*. Die-hard Apple II users usually call it the *catalog*. In Unix camps, the term is more likely *filesystem* or *filestore*. It's an organic entity whose internals are forever falling into disorder and fouling things up.

Its inner parts get corrupted: "Your FAT's been corrupted," the in-house computer whiz tells you, and you wonder if you should modify your diet. Or you're walking past a couple of the system managers for your company's Unix network and one remarks that he's "running out of i-nodes," and you think you should stop and recommend your family's physician.

Whatever you call it, it's the data structure on your disk (hard or floppy) that holds your files in its care. And whether you're aware of it or not, the directory (I'll settle on "directory" for the remainder of this article) is possibly the single most important data structure in your computer system. Its inefficiencies hamper your operations, its limitations set the boundaries on your disk-storage real estate, and its death marks the end of your workday. Your directory is your constant companion; it's a good idea to acquaint yourself with this company.

In this two-part discussion, I'll take a close look at the directory structure of some of the most popular microcomputer-based operating systems. I'll discuss the directories according to their family line, level of complexity (loosely defined, I'll admit), and the order in which they were introduced. I'll begin with DOS 3.3.

DOS 3.3

First, don't confuse this DOS 3.3 with the DOS 3.3 for the IBM PC; I'm discussing Apple's DOS 3.3 for the Apple II line. Although it was first released in August 1980, DOS 3.3 is still very much alive today. Many entertainment and educational packages are still released on DOS 3.3-formatted disks (or at least DOS 3.3 variants; software developers generate variants of DOS 3.3 that have been modified to be copy-protected).

The prevailing mass storage device for DOS 3.3 is the famous Apple Disk II. This drive supports a 5¼-inch floppy disk, single-sided, with 35 tracks of 16 sectors. Each sector holds 256 bytes of data. Consequently, a single Disk II disk can hold about 144K bytes of information. The actual space available to files is somewhat less, thanks to the sectors given over to the boot image and the directory.

Apple placed the disk's directory information at track 17, smack in the middle of the floppy disk. At first glance—and if a Disk II were all DOS would ever be used on—this makes perfect sense. Since you can assume that a disk's directory will be accessed more than any other section of the drive, placing the directory in the middle keeps the average head movement to a minimum. However, if you want to use DOS 3.3 on something other than a 35-track drive and you want to keep things optimal, you're faced with having to modify the operating system to alter its procedure for allocating directory sectors.

The format of DOS 3.3's primary catalog structure is shown in table 1. This is known as the volume table of contents (VTOC). An appropriate name: It is the table of contents (where the system goes first to look for requested files) for the volume (the contents of the disk).

In DOS 3.3, the VTOC has three jobs:

1. It holds the pointer to the volume's catalog—where the actual filenames and their associated information are kept.

2. It contains data that defines the structure of the disk: how many tracks it has, the number of sectors per track, the number of bytes per sector, and so on. This allows you to create a DOS 3.3 volume on a non-Disk II drive, because DOS 3.3 can deduce the drive's structure from this information.

3. It carries the volume's bit map. This is a block of 200 bytes whose contents indicate the status of every sector on the volume. Each bit in the bit map corresponds to a sector on the volume. If that bit is a 1, its corresponding sector is available for use; if the bit is a 0, the sector has been claimed by some file (or, possibly, by DOS itself as a sector used to hold directory information).

The catalog (see table 2) is a singly linked list of sectors pointed to by the VTOC. Each sector holds information for up to seven files. Notice that there's no mention of subdirectories, or even directories. There are none—DOS 3.3 is a "flat" file system.

Within each file entry of the catalog, you'll find space for the filename (a generous 30 characters), the file type (whether the file is an Applesoft BASIC file, a text file, and so on), and a pointer to yet another singly linked list: the file's track/sector list (T/S list).

The T/S list keeps track of where the file's pieces are. Since it is unlikely that you have large amounts of contiguous space always available on the volume, the first sector of a file may be on one track, the next near the middle of the disk, and the next out on the other end of the disk. The T/S list is the system's index to where the file's components have been placed.

I've shown the layout of a T/S list sector in table 3. Each T/S list entry can keep track of up to 122 file sectors, or about 31.5K bytes. To show you how everything fits together, in figure 1 I've

continued

diagrammed a road map of all the pointers DOS 3.3 has to follow to locate the sectors of an imaginary file named BOB.

Have you noticed the DOS 3.3 file-system's most distinguishing feature? Everything's a singly linked list (although you could argue that entries on the T/S list are tables). DOS 3.3 makes no attempt to maintain the filenames in any sorted fashion other than the order in which the files were created on the disk. This means that if you fill the volume with lots of filenames, the system has to scan linearly through the catalog when responding to a request for a file. Also, each time a file grows another 31.5K bytes, the system must add another entry to that file's T/S list. The number of disk accesses for reading bytes increases toward the end of file.

To be sure, these delays become apparent only as the contents of a given volume grow. And given that a Disk II–formatted floppy disk can hold only up to about 126,000 bytes of file data, it's rare that a catalog becomes so full or a file so long that any degradation becomes apparent. It's also true that the Disk II is not the world's fastest floppy disk drive system to begin with. For many applications, however, DOS 3.3 is entirely adequate.

But that isn't what Apple thought.

Table 1: *The VTOC (volume table of contents), always located at the start of track 17 on an Apple DOS 3.3 disk.*

VTOC format

Byte offset	Description
0	Unused.
1	First catalog sector's track (byte).
2	First catalog sector's sector (byte).
3	Release version of DOS.
4-5	Unused.
6	Volume number (byte).
7-38	Unused.
39	Number of T/S pairs in a T/S list sector—equals 122 for a Disk II disk (byte).
40-47	Unused.
48	Last allocated track (byte).
49	Track allocation direction (byte).
50-51	Unused.
52	Number of tracks per disk (byte).
53	Number of sectors per track (byte).
54-55	Number of bytes per sector (word).
56-59	Bit map for track 0 (4 bytes).
60-255	Rest of bit map—4 bytes per track.

Table 2: *DOS 3.3's catalog sector, a singly linked list of sectors pointed to by the VTOC.*

Catalog format

Byte offset	Description
0	Unused.
1	Next catalog sector's track (byte).
2	Next catalog sector's sector (byte).
3-10	Unused.
	First file entry.
11	Track number of first sector on this file's T/S list (byte). If 0, this entry is empty.
12	Sector number of first sector on this file's T/S list (byte).
13	File type and lock flag (byte). If highest bit is set, the file is locked (cannot be deleted). Some of the more common file types are: 0 = Text file 1 = Integer BASIC file 2 = Applesoft BASIC file 4 = Binary file
14-43	File name (30 bytes).
44-45	Length of file in sectors (word).
46-80	Second file entry (35 bytes).
81-255	Remaining file entries; 3 through 7 (35 bytes each).

ProDOS

ProDOS appeared in January 1984 as a replacement for Apple's DOS. Strictly speaking, the version of ProDOS released was ProDOS 8, targeted for Apple's II+, IIe, and IIc machines. With the introduction of the IIGS, Apple released ProDOS 16 to take advantage of the 65816's internal 16-bit registers (among other things). However, ProDOS 8 and 16 use identical file-systems, and since that's what I'm discussing here, I'll simply refer to the operating system as ProDOS. As you'll see, ProDOS's directory structure was not an upgrade of the DOS directory structure—it was a complete redesign. (Historical note: The ProDOS directory structure is virtually identical to that of SOS, the operating system of Apple's ill-fated Apple III.)

One of the major differences between ProDOS and DOS 3.3 is in the way the two operating systems view a disk. Recall that DOS 3.3 sees any disk as tracks made up of sectors; DOS 3.3 locates a given sector by that sector's track/sector coordinates. (This may make you wonder how DOS 3.3 handles multiheaded drives. You have to trick it: I have an old Konan hard disk system on my Apple II that came with its own driver software for two-headed 5-megabyte hard disk drives. It maps all even-numbered tracks to head 0 and all odd-numbered tracks to head 1. So DOS tracks 0 and 1 are on cylinder 1, DOS tracks 2 and 3 are on cylinder 2, and so forth).

ProDOS, however, sees a disk as a collection of 512-byte *blocks*, starting with block 0 and continuing on up to the number of blocks that are on the drive. Consequently, ProDOS is much more flexible; it isn't concerned with the physical geometry of the disk—tracks, sectors, and heads. That's left up to disk driver routines. And ProDOS provides well-defined "hooks" for attaching your disk driver routines to the operating system.

Another improvement is the added sophistication of ProDOS's directory structure. Often, added complexity can translate to added headaches; in this case, thankfully, the added sophistication buys increased performance. Where the DOS directory structure was a singly linked list, the ProDOS structure is doubly linked. Table 4 shows the format of a ProDOS directory block, and figure 2 gives a graphical view of how the structure works. Can you see the added component? And yes, ProDOS allows subdirectories.

In ProDOS, the VTOC is replaced by the volume directory key block, always found on block 2 of the device. The volume header of the key block carries information that you've already seen in DOS 3.3, such as the volume name (rather than just a number), the number of entries, and the block number of the bit map. But it also carries information that you didn't see in DOS 3.3, such as creation date and time information, and access permissions (e.g., read, write, and format). The improvements continue: For example, one bit in the access-privi-

continued

Table 3: *Format of a sector from the track/sector list. This is how DOS 3.3 knows where the scattered parts of a file are.*

T/S list sector

Byte offset	Description
0	Unused.
1	Next T/S list entry's track (byte); 0 if no more entries.
2	Next T/S list entry's sector (byte).
3-4	Unused.
5-6	Physical-to-logical sector mapping word. The first sector pointed to at offset 12 maps to this logical sector in the file.
7-11	Unused.
12-13	Track (byte at 12) and sector (byte at 13) of file's first data sector. If this pointer is 0, it is assumed empty.
14-15	Track/sector of second data sector.
16-255	120 more track/sector pointers.

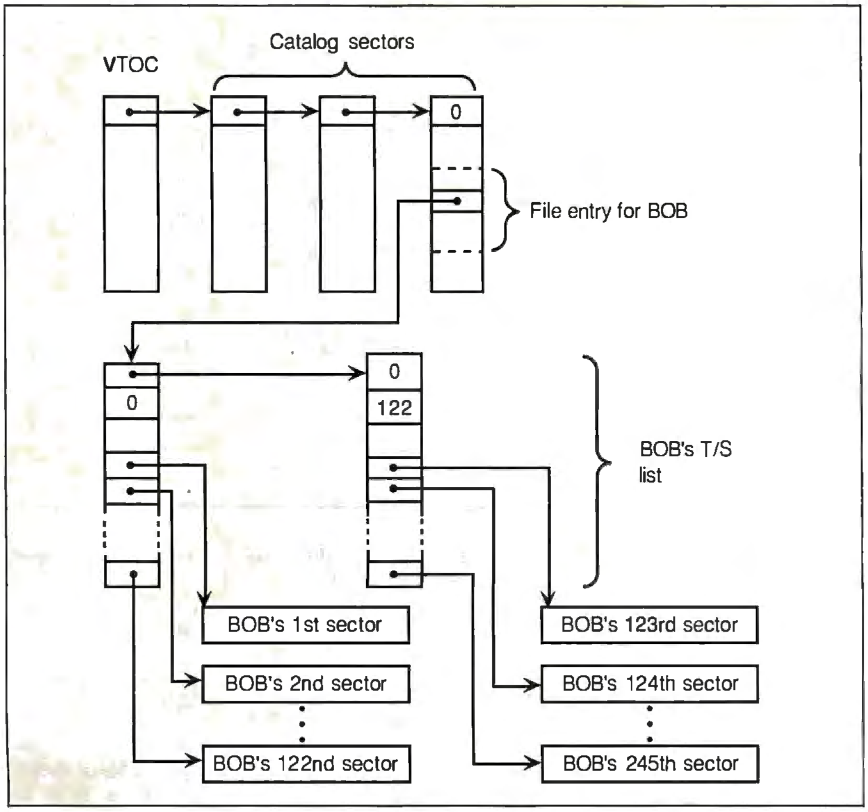

Figure 1: *On the trail of file BOB. DOS 3.3 begins with the VTOC, searches through the catalog sectors, and then goes on through the track/sector list sectors.*

Table 4: (a) *The ProDOS directory block. Specifically, this is the format for the volume directory key block, whose first entry holds information pertaining to the entire disk (volume).* **(b)** *Fields different for a subdirectory key header's entry.*

ProDOS directory block

(a) Byte offset	Description
0-1	Previous block pointer (word).
2-3	Next block pointer (word).
4	Type and name length (byte). The high nibble indicates what type of entry this is. The low nibble is the length of the entry's name.
5-19	Volume name (15 bytes).
20-27	Unused.
28-31	Creation data/time (4 bytes).
32	ProDOS version number (1 byte).
33	Minimum version of ProDOS that can access this volume (1 byte).
34	Access privileges (1 byte). Bit 0 = Volume may be read. Bit 1 = Volume may be written. Bit 5 = Volume's directory has been modified since last backup. Bit 6 = Volume may be renamed. Bit 7 = Volume may be destroyed.
35	Length of each file entry in the volume table, usually set to 39 (1 byte).
36	Number of entries in each volume block, usually set to 13 (1 byte).
37-38	Number of active entries in the volume table; includes subdirectories, but does not include the header (word).
39-40	Starting block of volume bit map (word).
41-42	Total number of blocks on this volume (word).
	First file entry.
43	Type and name length (byte). High nibble is entry type; low nibble is name length. 0 = Delete entry. 1 = Seedling file. 2 = Sapling file. 3 = Tree file. D = Subdirectory file. E = Subdirectory header entry. F = Volume header entry.
44-58	Entry name
59	File type (1 byte). Some of the more common types are: 1 = Bad blocks file 2 = Text file 3 = Binary file 25-27 = Appleworks files 252 = Applesoft BASIC program file 255 = ProDOS system file
60-61	Tree pointer (word); points to the file's index tree. If this entry is a subdirectory, this is the first block of the subdirectory's catalog.
62-63	Total number of blocks used by the file, including index blocks (word). If this entry is a subdirectory, this is the number of blocks in the subdirectory's catalog.
64-65	Creation date and time (4 bytes).
66	ProDOS version (1 byte).
67	Minimum ProDOS version that can access this entry (1 byte).
68	Access privileges (1 byte). Bit 0 = File may be read. Bit 1 = File may be written. Bit 5 = File has been modified since last backup. Bit 6 = File may be renamed. Bit 7 = File may be destroyed.
69-70	Auxiliary field (word). This field depends on the entry type. For text files, this holds the record length. For binary files, this holds the load address.
71-74	Date and time when the file was last modified (4 bytes).
75-76	Block number of this file's directory (word).
77-511	Remaining file entries. For the volume key block, there is room for 11 more entries; for all other blocks, there is room for 12 more entries.

For subdirectory key headers, the format is the same as for a volume key header except for the last 6 bytes, which look like the following:

(b) Byte offset	Description
37-38	Number of active entries in the subdirectory (word).
39-40	Pointer to the parent directory's key block (word).
41	This subdirectory's entry number in the parent directory (byte). The parent directory's entry counts as 0.
42	The length of entries in the parent directory—usually 27h (byte).

leges byte can be used by disk backup software to determine whether or not the volume has been modified since the last backup.

Following the volume header on the key block—and on the remaining blocks of the directory chain—are the file and subdirectory entries. Though shorter, these entries are similar to the volume header entry: They carry creation date and time, access flags, and modification date and time (a must for software development using a make utility). A subdirectory entry points to the head of a directory list whose structure is virtually identical to the master directory list.

The structure of files is also much improved under ProDOS. Recall that DOS 3.3 keeps track of a file's physical sectors via a singly linked T/S list. In ProDOS, the structure of a file's housekeeping information actually changes as the file grows. If you look back at figure 2, you'll see that I've shown a 1-block file named BOB as a member of the master directory. In ProDOS terminology, BOB is a *seedling* file; BOB has 512 or fewer bytes of data.

As BOB grows past the 512-byte barrier, it becomes a "sapling" file (see figure 3). Where the pointer in BOB's directory entry (the tree pointer) once led to a single block of data, it now leads to an index block. Pointers in the index block—there can be up to 256 of them—point to the data blocks. Now BOB can hold up to 128K bytes of data.

If BOB continues to grow past 128K

continued

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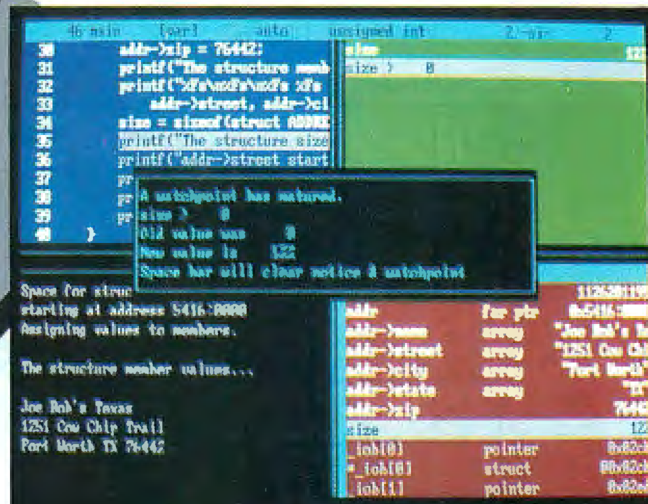

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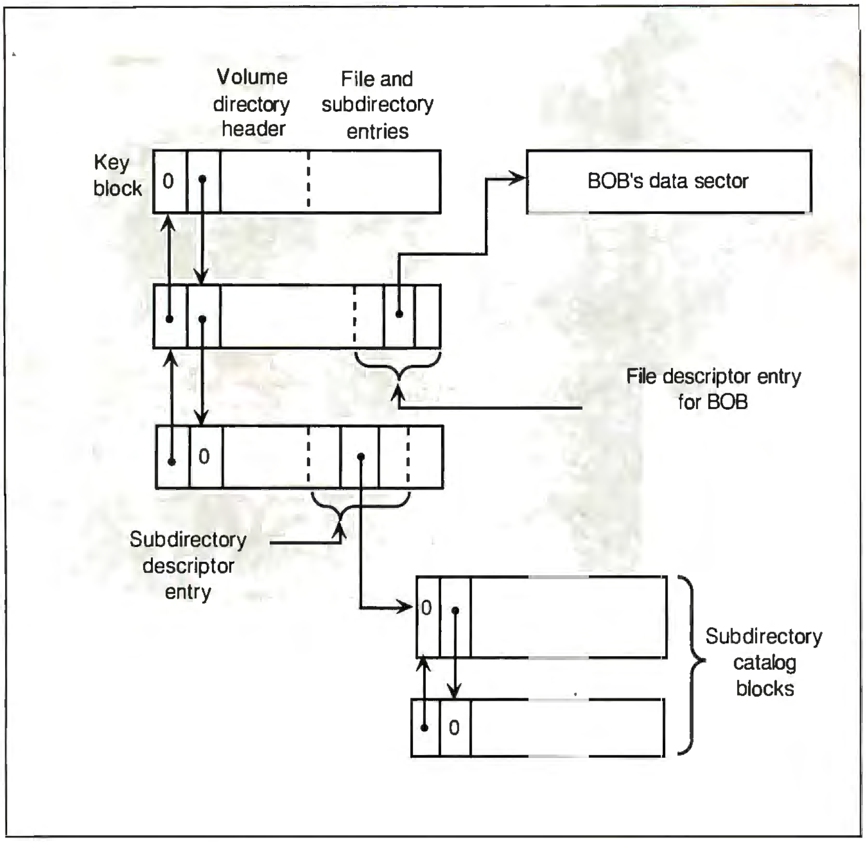

Figure 2: *The ProDOS directory structure. Notice that lists are doubly linked. (Not shown is the subdirectory's return link to its father's key block.)*

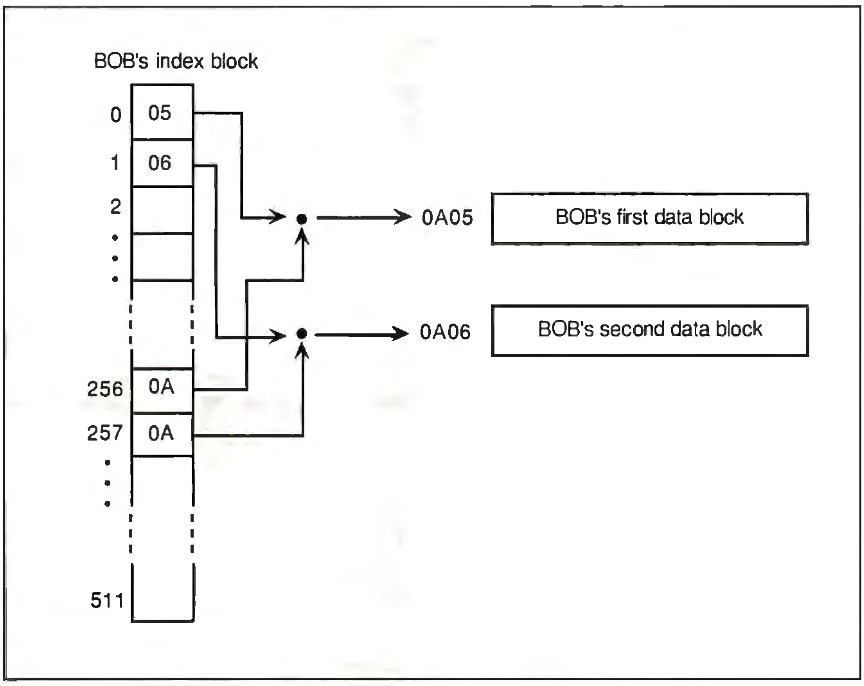

Figure 3: *Structure of a ProDOS sapling file. The pointer in BOB's directory entry now leads to an index block. Notice that the word-wide block number of BOB's data blocks is formed by concatenating low and high bytes from opposite halves of the index block.*

bytes, the file adds another index level and becomes a *tree* file (see figure 4). Now BOB's tree pointer leads to a master index block, whose elements point to index blocks, whose elements (finally) point to the actual data. A tree file can contain up to 16 megabytes of data, and this is as big as a file can get under ProDOS.

The beauty of this file structure is that small files are rapidly accessed, but large files are still taken into account. Plus, even though a file may grow to 16 megabytes, you need at most three disk accesses to retrieve the file's data. Compare this with the singly linked list index structure of DOS 3.3, and you can see the advantages. The ProDOS directory structure is quite respectable in its capabilities, and you'll see that it shares some similarities with the file-systems of larger machines that I'll cover later.

CP/M

In 1979, Digital Research released version 2 of the CP/M operating system. CP/M 2's offspring—CP/M 2.2—followed shortly thereafter and became the premier operating system for the popular 8080- and Z80-based S-100 bus systems. CP/M still enjoys a substantial following, and if imitation is the sincerest form of flattery, then CP/M should be rosy-cheeked: The first version of PC-DOS was more or less a port of CP/M to the 8088 processor.

The good news about the CP/M file system is its adaptability: It can accommodate everything from 5¼-inch single-sided floppy disks to (conceivably) hard disks as big as a gigabyte. The bad news is that this adaptability often demands some complex calculations on the part of some unlucky human—usually whoever gets to install CP/M on a new system.

Space on a CP/M drive is divided into allocation blocks. Files grow in allocation-block-size jumps. Like the ProDOS block, a CP/M allocation block is composed of a number of physical disk sectors. Unlike the ProDOS block, a CP/M allocation block is not the same size for all CP/M disks. Here's where CP/M's flexibility comes in: You can select the optimum allocation block size for your particular disk drive. The data structure within CP/M that describes the geometry of a disk is the disk parameter block (DPB) shown in table 5. Choosing the values for the DPB entries is not a matter of solving a single equation; rather, it involves—as you'll soon see—a trade-off between how many files you anticipate having on your disk and the average size of each file.

From an application's point of view, the CP/M file-system is record-based. Any program will see a file as a collection of 128-byte records. This is a holdover from CP/M's early days, when the physical sector size for a CP/M disk was 128 bytes. Often, you'll hear this referred to as a *standard record*; if you're talking about CP/M, it means 128 bytes. The DPB carries the information needed to calculate the number of standard records per allocation block.

Unlike the Apple-based file-systems I've covered so far, the CP/M directory structure is unlinked. Rather, a disk's directory is kept on a series of contiguous allocation blocks beginning at a specific track on the disk. The location of this starting track of the directory is defined in the DPB as an offset from track 0. This allows you to reserve space for boot tracks on the disk, since allocation blocks that files use for their contents *follow* the directory on the disk.

A contiguous, unlinked directory has advantages and disadvantages. Being contiguous, the records of the directory can be rapidly accessed. However, the number of blocks allocated to the directory is fixed; if you've allotted eight allocation blocks to the directory, it'll take up eight allocation blocks even if there's only one file on the whole disk.

Each standard record of the directory can hold up to four entries (see table 6). Within each entry are fields for the file's name, type, and data map. The data map is a set of pointers that lead you to where the various parts of the file's data are stored. Each pointer references an allocation block, and, depending on the configuration of the disk, each pointer may be 1 or 2 bytes long. If a disk is composed of less than 256 allocation blocks, pointers are byte-wide; word-wide pointers allow CP/M to access disks holding up to 65,535 allocation blocks. Consequently, each directory entry points to a maximum of either 8 or 16 allocation blocks of file data.

Once a file grows so big that a single entry cannot keep track of it, CP/M opens an extent entry. This is a directory entry identical to the first except for the extent byte and the contents of the data map. I've diagrammed the mechanics of this in figure 5. In the figure, the file BOB has grown so that one data map isn't enough. The operating system creates another entry in the directory with the extent byte set to 1. This entry's data map points to BOB's additional allocation blocks. If BOB continues to grow, CP/M will create more and more extents,

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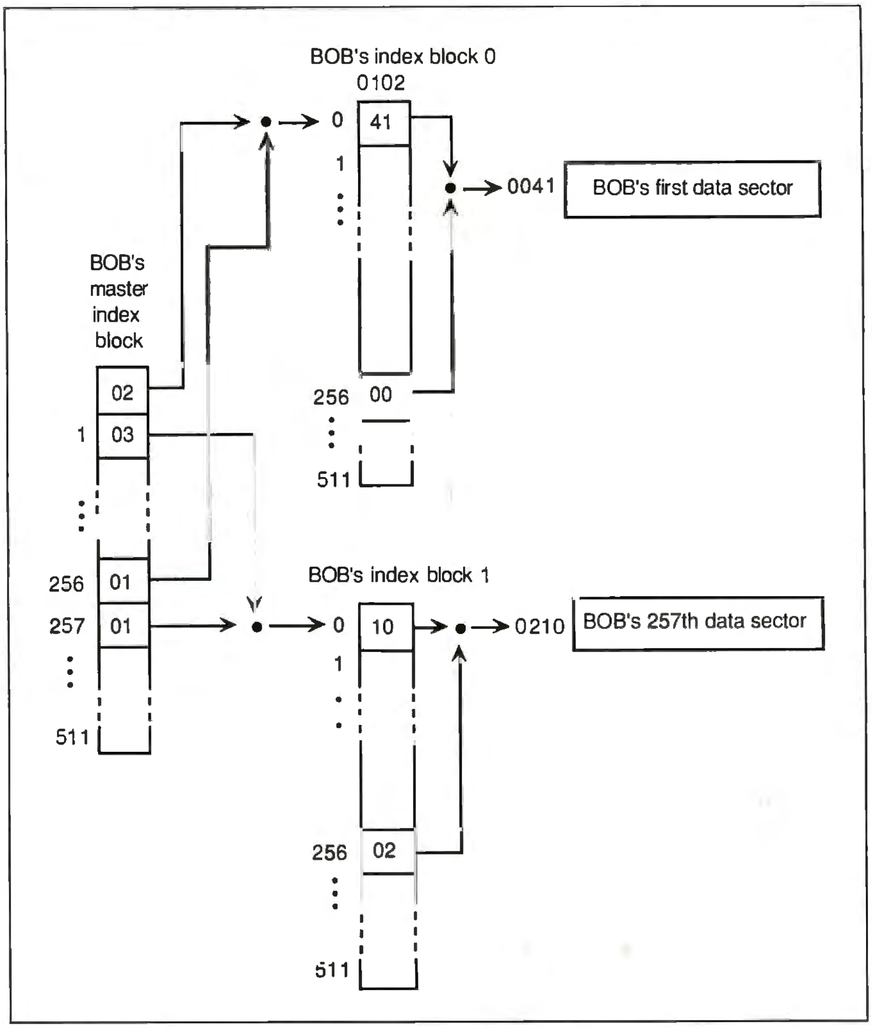

Figure 4: *BOB has become a tree file. Now there are two levels of index blocks.*

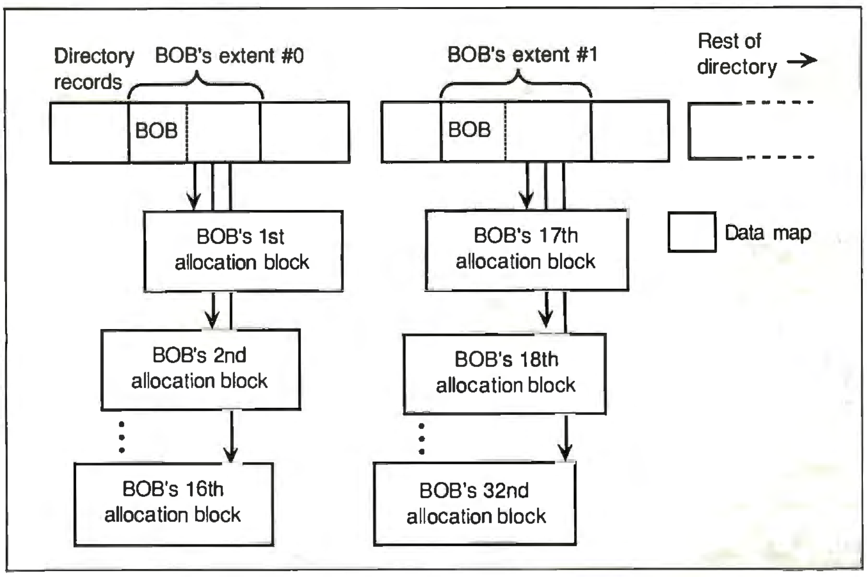

Figure 5: *BOB moves to CP/M. Note that the size of a single allocation block differs from disk to disk and may contain more than one 128-byte record.*

Table 5: *CP/M's disk parameter block. This data structure (kept in memory) enables the operating system to determine the physical parameters of the disk and map logical records to physical disk sectors.*

Byte offset	Description
0-1	Number of 128-byte records per disk track (word).
2	Block shift factor (byte). Number of times a record number must be shifted right to get its allocation block number.
3	Block mask (byte). Perform an AND on this byte with a record number to get that record's offset within its allocation block.
4	Extent mask (byte). Allows you to calculate physical extent from logical record number.
5-6	Highest allocation block number on the drive (word).
7-8	Maximum number of directory entries (word). Note that the first entry is number 0.
9-10	Initial 16 bits of allocation vector (word). Used to preallocate directory blocks when the system creates the allocation vector bit map.
11-12	Size of check area (word). The check area is a region of hash bytes that enable CP/M to determine that a disk has been swapped. This region usually has 1 byte per 128 bytes of directory.
13-14	Initial offset (word). Number of tracks reserved (starting at track 0) for boot or partitioning information.

Table 6: *A CP/M directory entry.*

Byte offset	Description
0	User code (byte).
1-8	Filename (8 bytes).
9-11	File type (3 bytes). The high bit of each of these bytes is reserved as an attribute bit. Byte offset 9; the high bit set represents a read-only file. Byte offset 10; the high bit set represents a system file (not displayed by DIR). Byte offset 11; the high bit set represents a change in this entry (for archive purposes).
12	Extent number (byte).
13	Used by BDOS (byte).
14	Extent overflow (byte).
15	Record count (byte). Indicates the number of 128-byte records described by this entry.
16-31	Data map. This field can either be 16 1-byte entries or eight 2-byte entries (see text).

up to a maximum of 32. (Some releases of CP/M allow for more extents, using the extent overflow byte at offset 14.)

Here's where the tricky part of determining allocation block size comes in. Given that files grow by allocation-block-size leaps, you can assume that, on average, half a file's last allocation block will be empty. This might prompt you to choose a small allocation block size, but to do so would mean that as a file grew larger the system would have to create a multitude of extent entries in the directory for the file. Worse, there's really no mechanism for ensuring that extent entries are stored in ascending order in the directory; more extents mean more disk accesses.

You may notice that a CP/M disk has no bit map. Actually, there is an allocation bit map—called the *allocation vector*—but it isn't kept on the disk drive, it's kept in memory. Whenever the operating system selects a disk, it reads the entire directory to construct the allocation vector in RAM. Of course, as files grow and are deleted, the system updates the allocation vector appropriately.

At first glance, the CP/M directory structure may appear flat. This is partially true; you can't create subdirectories, but you can set up alternate directories on the same disk via the *user code* (at byte offset 0 in each file entry). This byte can take on values ranging from 0 (default) to 31 and thereby serves to partition the files in the directory into 32 "user areas." You move from area to area with the USER command. So, if you enter USER 4, you can see and manipulate only files with user codes set to 4.

Any discussion of CP/M would be incomplete without mentioning ZCPR3, a kind of extension to the CP/M operating system. A full-blown ZCPR3 package includes numerous program tools, but it is germane to point out here ZCPR3's ability to support named directories.

Essentially, ZCPR3 allows you to attach a name to a specific drive and user number, so A15: (drive A, user area 15) might be ROOT, and A7: might be WORDS. You can move through directories using a Unix-like CD (change directory) command, and with some clever programming you can even create the illusion of hierarchical directories. Although at the lowest level the operating system sees a CP/M directory structure, ZCPR3 makes you feel as though you're working with a more sophisticated file-system.

Next Month

I'll continue the promenade through microcomputer file-systems, moving on to MS-DOS, the Macintosh, and Unix. You may be surprised at some of the similarities between what I've covered so far and what you'll see next month. ■

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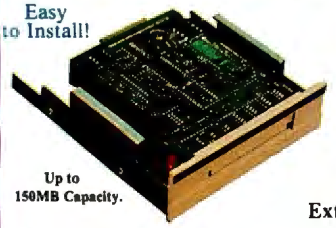

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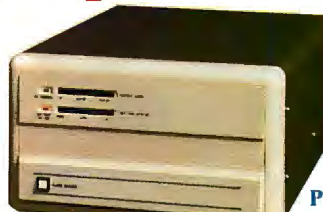

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	42MB MFM 40ms	1549	1829	1709	1969	2129
	65MB RLL 40ms	1649	1929	1809	2069	2229
	122MB RLL 28ms	1949	2229	2109	2369	2529
16MHz 1MB RAM 0 WAIT STATE	32MB RLL 65ms	$1649	$1929	$1809	$2069	$2229
	42MB MFM 40ms	1749	2029	1909	2169	2329
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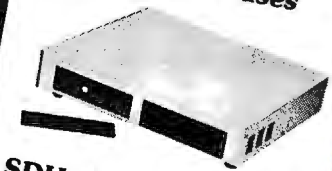

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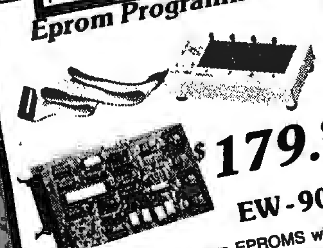

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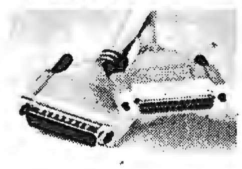

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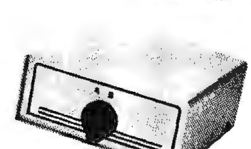

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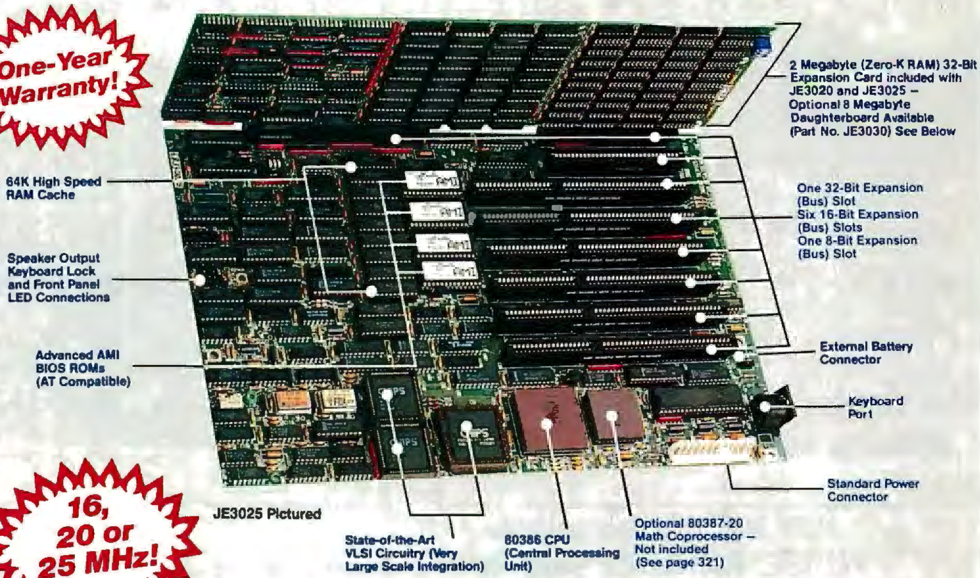
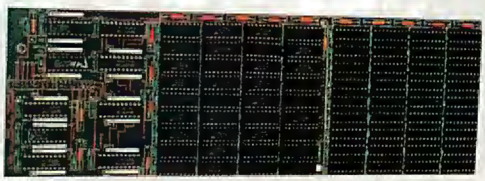


JE3025 Pictured

16, 20 or 25 MHz!

JE3020/JE3025: The AMI 80386 baby motherboards are available in either 16MHz or 20MHz versions. The AMI 80386 motherboards fit into an XT, AT or Baby AT chassis so that the boards deliver 386 power/performance and AT compatibility in an XT footprint size. The motherboards are ideally suited for a variety of applications including Multiuser (Unix, Xenix, PC MOS), Networking (Novell, 3-Com), CAD applications (Autocad) and Multi-tasking (Windows, OS/2, Desqview). The boards feature one 8-bit slot, six 16-bit slots and one 32-bit slot that accommodates the memory card (supplied). Also features 80387-20 math co-processor capability for the JE3025 and 80387-16 for the JE3020. Both motherboards are keyboard switchable between low and high speed and 1 or 0 wait states. The 20MHz board features a Norton SI rating of 24.2 in the 20MHz mode, while the 16MHz board features a Norton SI rating of 18.7 in the 16MHz mode. AMI BIOS ROMs are included. RAM is mounted on a 32-bit expansion card (included) which utilizes (72) 41256-100 256K chips (JE3025) to reach 2 Megabytes (the JE3020 utilizes 41256-120 chips). A daughterboard is available (Part No. JE3030) which accepts (72) 511000P-10 1Meg chips for an additional 8 Megabytes, bringing the total memory of the system to 10 Megabytes. BIOS options include built-in setup and diagnostics. Special features include 64K of high speed (45ns) static cache RAM on the motherboard and Video BIOS Shadow RAM, allowing for exceptionally fast video performance. • Size: 8.5" x 13" • Weight: 3 lbs. • One-Year Warranty

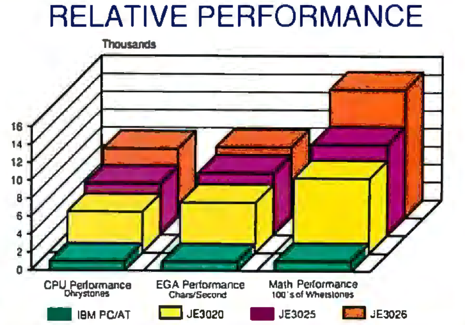
JE3030 - 8 Megabyte Daughterboard Option (Zero-K RAM)



JE3026: This is the new full size 80386 25MHz speed demon from AMI. The JE3026 will fit into the new JE2010 tower case (see page 320F) or full size AT style cases. The board offers the same features as the JE3020/3025 with increased expandability and speed. The JE3026 features a Norton SI rating of 30.3 in the 25MHz mode. Also features 80387-25 or Weitek™ math coprocessor capability. The JE3026 is expandable to a total of 16 Megabytes using the JE3031 (not included – sold separately, see below). The JE3026 can be expanded to 8Mb on-board using (36) 511000P-80 and (4) 91000S-80 1Mb SIMM modules. The JE3031 is a 32-bit plug-in memory card which can be expanded to a total of 8Mb using (72) 511000P-80 1Mb chips for a total of 16Mb of RAM! When 4Mb DRAMs and SIMMs become available, the JE3026 is ready for them, allowing expansion to 32Mb on the motherboard, 48Mb with the JE3030/JE3031 combination • Size: 12" x 13.75" • Weight: 3.25 lbs. • One-Year Warranty

See page 321 for RAMs and Math Coprocessors

RELATIVE PERFORMANCE



Part No.	Description		Price
JE3020	16MHz 80386 AT Compatible Baby Motherboard (Zero-K RAM)	~~$1399.95~~	$1199.95
JE3025	20MHz 80386 AT Compatible Baby Motherboard (Zero-K RAM)	~~$1699.95~~	$1499.95
JE3026	25MHz AT Compatible Full-Size Motherboard (Zero-K RAM)		$2299.95
JE3030	8 Megabyte Daughterboard for JE3020 and JE3025 (Zero-K RAM)	~~$299.95~~	$249.95
JE3031	8 Megabyte 32-bit Plug-In Card for the JE3026 (Zero-K RAM)		$269.95

Jameco ELECTRONICS

IBM PC/XT/AT Compatible Motherboards

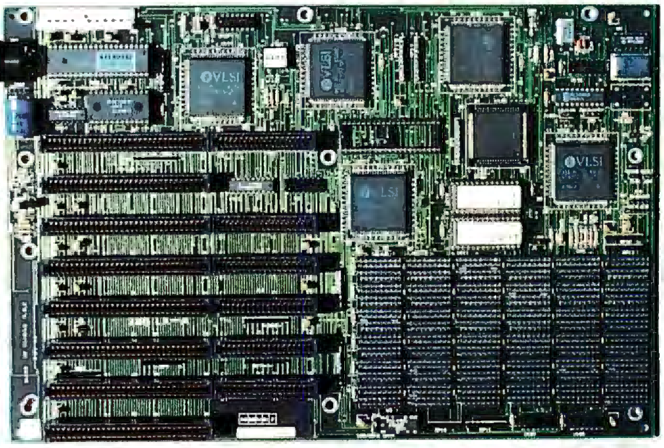
1-YEAR WARRANTY!

SALE

IBM AT Compatible 12MHz 80286 Motherboard

- 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
- Selectable wait states (0 or 1)
- 80287-8 Math Co-processor capability☆
- Norton SI rating of 13.7
- Size: 13" x 8.75"
- Weight: 2.25 lbs.

One Year Warranty!



JE3005 80286 8/12MHz Motherboard . . ~~$329.95~~ **$299.95**

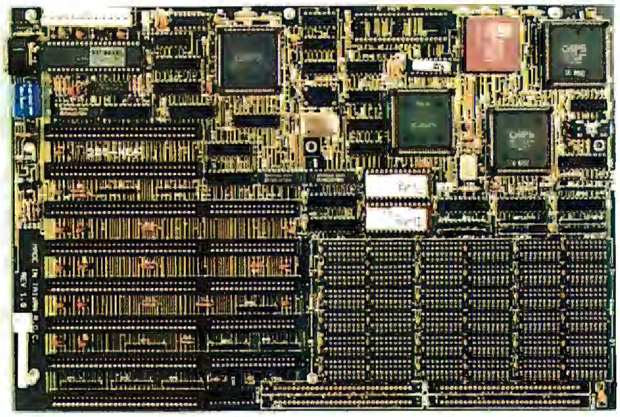
SALE

IBM AT Compatible 16MHz 80286 *NEAT* Motherboard

- 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 hardware or keyboard selectable
- Front panel LED indicators supported
- Five 16-bit and three 8-bit expansion bus slots
- AMI BIOS ROMs included
- Supports all *NEAT* functions including shadow RAM, EMS 4.0, RAM re-mapping, selectable wait states, etc.
- 80287-10 Math Co-processor capability☆
- Norton SI rating of 18.0
- Size: 13" x 8.5"
- Weight: 2.25 lbs.

Latest Technology!

One Year Warranty!



JE3010 80286 8/16MHz *NEAT* Motherboard ~~$469.95~~ **$399.95**

IBM PC/XT Compatible *TURBO* 8MHz Motherboard

- Expandable to 640K RAM using 4164 and 41256, 150ns chips☆
- 4.77 or 8MHz hardware or keyboard selectable operation
- Front panel LED indicators supported
- Eight expansion bus slots
- AMI BIOS ROMs included
- 8087-2 Math Co-processor capability☆
- Performs at an average speed of 75% faster than the original IBM PC/XT
- Norton SI rating of 1.7
- Size: 12" x 8.5"
- Weight: 1.75 lbs.

One Year Warranty!

JE1001 8088 4.77/8MHz Motherboard. **$89.95**

SALE

IBM PC/XT Compatible *TURBO* 10MHz Motherboard

- Expandable to 640K RAM using 4164, 41256 & 41464 120ns chips☆
- 4.77 or 10MHz hardware or keyboard selectable operation
- Front panel LED indicators supported
- Eight expansion bus slots
- AMI BIOS ROMs included
- 8087-1 Math Co-processor capability☆
- Performs at an average speed of 100% faster than the original IBM PC/XT
- Norton SI rating of 2.0
- Size: 12" x 8.5"
- Weight: 1.75 lbs.

One Year Warranty!

JE1002 8088 4.77/10MHz Motherboard . . ~~$109.95~~ **$99.95**

☆ See page 321 for Dynamic RAMs and Math Coprocessors

320B **• FOR COMPLETE PRODUCT LINE, REQUEST JAMECO'S 74-PAGE CATALOG • (415) 592-8097**

Jameco ELECTRONICS

IBM™ COMPATIBLE COMPUTER KITS

DOS AVAILABLE!

Jameco's new 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 (Part No. JETM...$29.95) and DOS (Part No. EZDOS...$49.95 or EZDOSP [EZDOS w/TrueBASIC]...$69.95)***

Please note: JE3008 and JE3013 shipped in 1 box (43 lbs. total) – JE3002 and JE3003 shipped in 2 boxes (55 lbs. total)

IBM AT 12MHz Compatible Kit

- ***Free! QAPLUS Diagnostic Software Included!***
- ***Free! PC Write Word Processing Software Included!***
- ***DOS Available*** *(See Above)*
- ***80286 CPU, Optional 80287-8 Math Co-processor Capability***
- ***512K RAM Included– See description on opposite page for expandability***
- ***8 or 12MHz Keyboard Switchable Operation***
- ***Clock/Calendar***
- ***AMI BIOS ROMs Included***
- ***Save $132.57***

Shown with EGA Option (not included) JE1059 Monitor and Adapter Card $499.95 (See page 320E)

Part No.	Description	Price
JE3005	8/12MHz Baby AT Motherboard (Zero-K RAM – includes AMI BIOS ROMs)	$299.95
JE1016	Enhanced AT Style Keyboard	69.95
JE2019	Baby AT Flip-Top Case	69.95
JE1022	5.25" DSHD Disk Drive (Beige Bezel)	99.95
JE1032	200 Watt Power Supply	89.95
JE1043	360K/720K/1.2MB/1.44MB Floppy Controller	49.95
41256-100	512K RAM (18 chips)	152.82

Save $132.57 SALE! *Regular List* $832.52

JE3008 80286 12MHz Kit. . . . . ~~$799.95~~ **$699.95**

IBM AT 16MHz *NEAT* Compatible Kit

- ***Free! QAPLUS Diagnostic Software Included!***
- ***Free! PC Write Word Processing Software Included!***
- ***DOS Available*** *(See Above)*
- ***80286 CPU, Optional 80287-10 Math Co-processor Capability***
- ***2 Megabyte RAM Included, Expandable to 8 Megabyte***
- ***8 or 16MHz Keyboard Switchable Operation***
- ***Clock/Calendar***
- ***AMI BIOS ROMs Included***
- ***Save $174.85***

Shown with VGA Option (not included) JE2055 Monitor and Adapter Card $599.95 (See page 320E)

Part No.	Description	Price
JE3010	8/16MHz *NEAT* AT Motherboard (Zero-K RAM – includes AMI BIOS ROMs)	$399.95
JE1016	Enhanced AT Style Keyboard	69.95
JE2019	Baby AT Flip-Top Case	69.95
JE1022	5.25" DSHD Disk Drive (Beige Bezel)	99.95
JE1032	200 Watt Power Supply	89.95
JE1043	360K/720K/1.2MB/1.44MB Floppy Controller	49.95
511000P-10	2MB RAM (18 chips)	395.10

Save $174.85 SALE! *Regular List* $1174.80

JE3013 80286 *NEAT* 16MHz Kit . . . ~~$1199.95~~ **$999.95**

IBM PC/XT 8MHz Turbo Compatible Kit

- ***Free! QAPLUS Diagnostic Software Included!***
- ***Free! PC Write Word Processing Software Included!***
- ***DOS Available*** *(See Above)*
- ***256K RAM Included, Expandable to 640K***
- ***4.77 or 8MHz Switchable Operation***
- ***Parallel Printer Port***
- ***AMI BIOS ROM Included***
- ***Save $112.06***

Part No.	Description	Price
JE1001	4.77/8MHz Turbo Motherboard (Zero-K RAM – includes AMI BIOS ROM)	$89.95
JE1010	Flip-Top Case	34.95
JE1015	XT/AT Compatible Keyboard	59.95
JE1020	5.25" DSDD Disk Drive (Black Bezel)	89.95
JE1030	150 Watt Power Supply	59.95
JE1040	360K Floppy Controller	29.95
JE1050	Mono/Graphics Card with Printer Port	59.95
AMBER	12" Monochrome Amber Monitor	99.95
41256-150	256K RAM (9 chips)	67.41

Save $112.06 SALE! *Regular List* $592.01

JE3002 8088 8MHz Turbo Kit . . . ~~$499.95~~ **$479.95**

IBM PC/XT 10MHz Turbo Compatible Kit

- ***Free! QAPLUS Diagnostic Software Included!***
- ***Free! PC Write Word Processing Software Included!***
- ***DOS Available*** *(See Above)*
- ***640K RAM Included***
- ***4.77 or 10MHz Switchable Operation***
- ***AMI BIOS ROM Included***
- ***Multi I/O Card***
- ***Save $148.50***

Part No.	Description	Price
JE1002	4.77/10MHz Turbo Motherboard (Zero-K RAM – includes AMI BIOS ROM)	$ 99.95
JE2014	Turbo Flip-Top Case	69.95
JE1015	XT/AT Compatible Keyboard	59.95
JE1021	5.25" DSDD Disk Drive (Beige Bezel)	89.95
JE1031	Mini 150 Watt Power Supply	69.95
JE1071	Multi I/O with Controller, Graphics and Printer Port	119.95
AMBER	12" Monochrome Amber Monitor	99.95
4164-120	Parity RAM (2 chips)	5.90
41256-120	512K RAM (18 chips)	143.10
41464-12	128K RAM (4 chips)	39.80

Save $148.50 SALE! *Regular List* $798.45

JE3003 8088 10MHz Turbo Kit . . . ~~$699.95~~ **$649.95**

• REFER TO CODE 4038 WHEN ORDERING • SEE PAGE 322 FOR ORDER FORM • (415) 592-8097 320C

Circle 140 on Reader Service Card

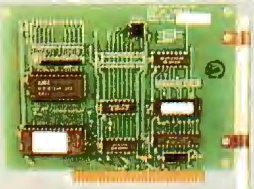
Jameco ELECTRONICS

IBM™ PC/XT/AT COMPATIBLE CARDS

1-YEAR WARRANTY!

Pentagon Systems, Inc.

Security Access Card for IBM PC/XT/AT and Compatible Computers



The "Sergeant" is an access control card that prevents unauthorized access to your computer through user passwords.

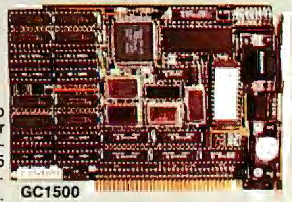
Features: • Allows up to 10 programmable user passwords • Built-in software—no diskettes required for installation; just plug-in and go! • Fully menu-driven—no commands to remember • All resident software is in machine language, encrypted and is protected against intrusion and corruption attempts • Diskette locking capability • Owner/managers can monitor all usage and attempts to gain access • Passwords securely protected and accidental or intentional attempts to get to the passwords further secures them • Designed using EEPROM—requires no battery back-up • "Hacker Proof" because the ROM containing the core firmware is not accessible as it selectively turns itself off and on • Passwords may be assigned from remote locations (e.g. Corporate Headquarters) • Becomes transparent to all machine functions once a correct password has been accepted • Manual included • 1-Year Warranty

SAC1 Security Access Card. **$149.95**

Orchid Technology

VGA Cards for IBM PC/XT/AT & PS/2 Models 25 and 30

ORCHID



GC1500

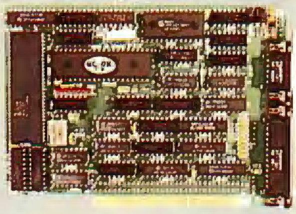
Orchid VGA Cards provide you with the palette to create picture-perfect computer graphics. Ideal for use with VGA single frequency analog and multi-frequency monitors such as the QC1478 and TM5155 (see page 320E). In addition the GC1500 is compatible with monochrome TTL monitors (see page 320E).

GC1500 Features: • 8-bit card • Compatible with Hercules/MDA/MCGA/CGA/EGA and all 17 standard VGA modes plus 8 extended modes • Comes w/256K user upgradeable to 512K • 360 x 480 - 256 colors • Upgradeable to extended modes such as 800 x 600 - 256 colors • VGAspeed utility allows for a 250% increase in speed • Manual included • 4-Year Warranty

GC1501 Features: • Works with 8 or 16-bit computers • Compatible with MCGA/MDA/CGA/EGA and all 17 standard VGA modes • Comes w/256K user upgradeable to 512K • 360 x 480 - 256 colors • Upgradeable to extended modes such as 800 x 600 - 256 colors or 1024 x 768 - 16 colors • Auto mode switch, auto bus sense, auto monitor select and translation ROM included • VGA speed utility allows for a 250% increase in speed • Manual included • 4-Year Warranty

Part No.	Description	Price
GC1500	8-bit VGA Card ***SALE!***	~~$269.95~~ **$249.95**
GC1501	8/16-bit VGA Card ***SALE!***	~~$349.95~~ **$329.95**

Monochrome Graphics Adapter for IBM PC/XT/AT

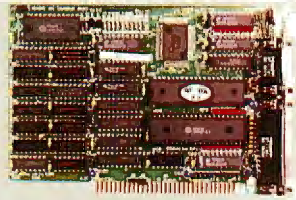


Compatible with IBM Monochrome (MDA) and Hercules Graphics Standards (HGA)

The JE1050 is a monochrome graphics card with parallel printer port and features the following: • Text mode: 80 x 25; Graphics mode: 720 x 348 • Compact half-card • Parallel printer interface with transfer rate of 1000 characters per second • Manual included

JE1050. . . . . **$59.95**

Color Graphics Adapter for IBM PC/XT/AT

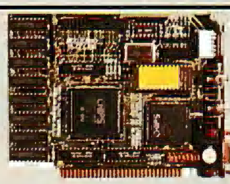


Compatible with IBM Color Graphics Standard (CGA)

The JE1052 is a color graphics adapter card capable of operating with either IBM RGB or composite monochrome monitors and features the following: • Parallel printer port • Text modes: 40 x 25 or 80 x 25; Graphic modes: 320 x 200 or 640 x 200 • Light pen interface • Includes composite video monitor adapter • Manual included

JE1052. . . . . **$49.95**

Enhanced Graphics Adapter for IBM PC/XT/AT

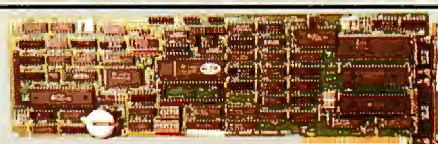


Compatible with IBM Enhanced Graphics Standard (EGA)

The JE1055 is an IBM EGA/CGA/MDA/HGA compatible card featuring the following: • Text mode: 80 x 25; Graphics mode: 720 x 348 • Reserved video jacks and feature connectors • Light pen interface • 256K Video RAM • Dipswitch on back of card allows changing of switch settings without opening case • Displays 16 colors from a palette of 64 • Manual included

JE1055. . . . . **$159.95**

Multi I/O with Controller and Graphics for IBM PC/XT

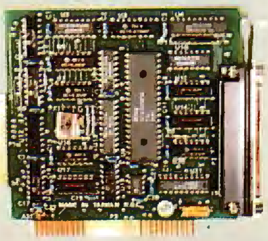


Compatible with IBM Monochrome (MDA) and Hercules Graphics Standards (HGA)

The JE1071 is a multi I/O card with six add-on functions, uses only one slot and features the following: • Text mode: 80x25; Graphics mode: 720x348 • One RS232C serial communication port (expandable to two - use Part No. SSP3) selectable for COM1 thru COM4 • Game port • Real-time clock/calendar with replaceable battery back-up • 5.25" floppy disk drive controller capable of handling up to two 360K drives • Parallel printer port • Print spooler software • Manual and cables included

JE1071. . . . . **$119.95**

Floppy Disk Drive Controller Card for IBM PC/XT and Compatible Computers

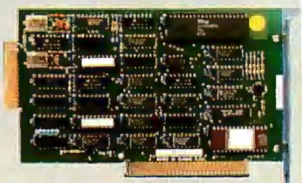


• Run up to four 360KB disk drives • Includes cable for two internal drives • DC37S connector allows for an additional two external drives (external cable not included, use Part No. ECC) • Complete with manual

JE1040. . . . . **$29.95**

360KB/720KB/1.2MB/1.44MB Floppy Disk Drive Controller Cards for IBM PC/XT/AT and Compatible Computers

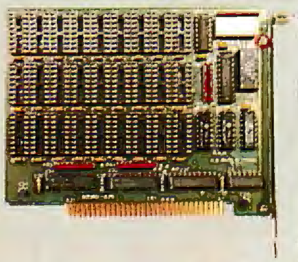
• The JE1043 allows connection of one or two 360KB, 720KB, 1.2MB or 1.44MB floppy disk drives • The JE1049 allows connection of up to four 360KB, 720KB, 1.2MB or 1.44MB floppy disk drives • JE1049 only: To add two external drives use cable Part No. ECC/to add two internal drives use cable Part No. TDC • Both units include cable for two internal disk drives and manual



JE1043

JE1043 2-Drive Controller. **$49.95**
JE1049 4-Drive Controller. **$59.95**

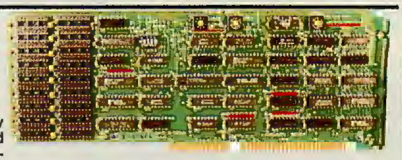
Expansion Memory Half-Card for IBM PC/XT and Compatible Computers



• Expands your system to the maximum 640K (zero-K on-board) • Accepts either 64K memory chips (4164) or 256K chips (41256) • Eight possible memory configurations ranging from 64K to 576K • Fits any slot (except slot 8 on IBM XT) • Recommended for systems running at 4.77MHz • Manual included

JE1080. . . . . **$49.95**

2MB Memory Expansion Cards for IBM AT and Compatible Computers



JE1083

• 2MB (zero-K on board) memory expansion cards for the IBM AT and compatible computers • JE1081 utilizes (72) 41256-120ns chips to reach 2MB • JE1083 utilizes (18) 511000P-10 chips to reach 2MB (JE1083 requires full 2MB for operation) • LIM EMS 4.0 drivers • Both cards offer conventional, expanded and extended memory capabilities • Auto-parity check • RAM disk and Print Spooler software included • Manual included

Part No.	Description	Price
JE1081	2MB Expansion Card - Utilizes 41256-120 Chips (Zero-K)	**$119.95**
JE1083	2MB Expansion Card - Utilizes 511000P-10 Chips (Zero-K)	**$129.95**

320D ***• FOR COMPLETE PRODUCT LINE, REQUEST JAMECO'S 74-PAGE CATALOG • (415) 592-8097***

Jameco ELECTRONICS

IBM COMPATIBLE COMPUTER PRODUCTS

1-Year Warranty!

IBM PC/XT Compatible Flip-Top and Slide Cases

New Slide Version Available!

• Metal housing and chassis • Anti-static coated plastic face plate • Flip-top/Slide models available • Back plate set for 8 expansion card slots and power supply mount • Will hold up to a combination of 4 half-height floppy or hard disk drives • Color: grey • All necessary hardware incl. • Size: 19.5"W x 16.5"D x 5.75"H • Weight: 17 lbs.

JE1010

JE1010 Flip-Top PC/XT Case . **$34.95**
JE1011 Slide PC/XT Case **$39.95**

Baby AT Flip-Top Case

New High Tech Design!

• Metal housing and chassis • Anti-static coated plastic face plate • Back plate with 8 expansion slots and power supply mount • Switches on front for Turbo mode and Reset • Indicator lights for Power, Turbo mode, Hard disk operation • Keyboard lock with 2-key set • Will hold up to a combination of 3 half-height floppy or hard disk drives • All necessary hardware is included • Color: Beige • Size: 17.125"W x 17"D x 6.5"H • Weight: 21 lbs.

JE2019 Baby AT Case **$69.95**

Tower Case with 250 Watt Power Supply

Space and expandability in an attractive floor mount case!

NEW

Case: • Will fit AT/386 Baby or Full (standard) size motherboards • Space saving floor-mount case • Metal housing and chassis • Anti-static coated plastic face plate • Back plate with 8 expansion slots • Switches for Turbo and Reset • Indicator lights for Power, Turbo mode, Hard Disk operation • Keyboard lock with 2-key set • Will hold up to a combination of 6 half-height floppy or hard disk drives • Includes 2-3.5" drive cages • All necessary hardware included • Color: Beige

Power Supply: • 250 Watt • Input: 90-130VAC @ 47-400Hz (110/220V switchable) • Output: +5V @ 26A, +12V @ 9A, −5V @ 0.5A, −12V @ 0.5A • Plug compatible connectors • Built-in fan

Tower Case Unit:
• Size: 7.325"Wx16.75"Dx25.25"H • Weight: 34 lbs.

JE2010 Tower Case w/250W Power Supply ~~$299.95~~ **$279.95**

Baby XT Flip-Top Case

New High Tech Design

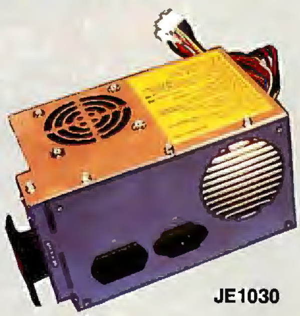
• Metal housing and chassis • Anti-static coated plastic face plate • Back plate with 8 expansion slots and power supply mount • Switches on front for Turbo and Reset • Indicator lights for Power, Turbo mode and Hard Disk operation • Keyboard lock with two key set • Will hold up to a combination of 3 half-height floppy or hard disk drives • All necessary hardware included • Color: Beige • Size: 14.5"W x 17"D x 6.75"H • Weight: 17 lbs.

JE2014 Flip-Top Baby XT Turbo Case **$69.95**

IBM PC/XT Compatible 150 Watt Power Supplies

+5VDC @ 15A
−5VDC @ 0.5A
+12VDC @ 5.5A
−12VDC @ 0.5A

• Input: 90-130VAC @ 47-63Hz (110/220V switchable) • Output: +5V @ 15A, −5V @ 0.5A, +12V @ 5.5A, −12V @ 0.5A • Plug compatible connectors • Built-in fan • Size (JE1030): 5.5"W x 9.5"D x 4.625"H, Wt.: 6 lbs. • Size (JE1031): 6.25"W x 6"D x 6"H, Wt.: 5 lbs. • Spec. included



JE1030

JE1030 PC/XT. **$59.95**
JE1031 Baby PC/XT . . . **$69.95**

IBM AT Compatible 200 Watt and 250 Watt Power Supplies

200 Watt (JE1032):	250 Watt (JE1033):
+5VDC @ 20A	+5VDC @ 26A
−5VDC @ 0.5A	−5VDC @ 0.5A
+12VDC @ 8A	+12VDC @ 9A
−12VDC @ 0.5A	−12VDC @ 0.5A

JE1032

JE1032: • Input: 90-130VAC @ 47-400Hz (110/220V switchable) • Output: +5V @ 20A, −5V @ 0.5A, +12V @ 8A, −12V @ 0.5A • Plug compatible connectors • Built-in fan • Size: 6.5"L x 5.88"W x 6"H • Weight: 6 lbs. • Spec. included

JE1032 200 Watt At Comp. Power Supply **$89.95**

JE1033: • Designed to fit in popular tower cases • Input: 90-130VAC @ 47-400Hz (110/220V switchable) • Output: +5V @ 26A, −5V @ 0.5A, +12V @ 9A, −12V @ 0.5A • Plug compatible connectors • Built-in fan • Size: 8.33"L x 6"W x 5.94"H • Weight: 6.5 lbs. • Spec. included

JE1033

JE1033 250 Watt AT Comp. Power Supply **$119.95**

IBM PC/XT/AT Compatible 101-Key Enhanced Keyboard with Calculator

• Solar powered calculator offers ease and convenience of use • 101-key • Enhanced keyboard layout • Tactile touch keyswitches • 12 function keys • Illuminated LED indicators for Num Lock, Caps Lock and Scroll Lock • Separate cursor pad • Low profile design • Switchable between PC/XT or AT • Manual included • Color: Beige • Size: 19.5"W x 7.625"D x 1.5"H • Weight: 3.6 lbs.

NEW

Solar Powered Calculator!

JE2016 Enhanced PC/XT/AT Keyboard with Calculator **$79.95**

IBM PC/XT/AT Compatible 84-Key Keyboard

• 84-key • AT style layout • Tactile touch keyswitches • Switch selectable between PC/XT or AT • Illuminated LED indicators for Num Lock, Caps Lock and Scroll Lock • Low profile design • Manual included • Color: Beige • Size: 19.5"W x 7.5"D x 1.33"H • Weight: 4.6 lbs.

JE1015. . . . . $59.95

IBM PC/XT/AT Compatible 101-Key Enhanced Keyboard

• 101-key • Enhanced keyboard layout • Tactile touch keyswitches • 12 function keys • Illuminated LED indicators for Num Lock, Caps Lock & Scroll Lock • Separate cursor pad • Low profile design • Automatically switches between PC/XT or AT • Spec. included • Color: Beige • Size: 19"W x 8"D x 1.33"H • Wt: 4.6 lbs.

JE1016. . . . . $69.95

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Seagate HARD DISK DRIVES Seagate

Seagate 20 and 30 Megabyte Half-Height Hard Disk Drives for the IBM PC/XT/AT and Compatible Computers

Seagate Hard Disk Drives provide the IBM PC/XT/AT or compatible computers with 20 and 30 Megabytes of formatted capacity in a shock resistant, half-height package. These drives are easily installed and ideal for applications ranging from rugged industrial use to quiet office and home environments. High reliability is assured through the use of LSI and a single circuit board. The drives may be purchased with or without controller cards. Controller cards are capable of controlling two hard drives. Cables provided for connecting one hard drive only. 1-Year Warranty. Documentation included.

ST225 (20 Megabyte): • Available for PC/XT or AT • Track to track access time: 20 msec. max. • Average access time: 65 msec. • Data transfer rate: 5.0 Megabits/sec. • Tracks: 2,460 • Bytes per track (formatted): 8,704 • Read/Write Heads: 4 • Cylinders: 615 • Size: 5.75"W x 8"D x 1.63"H • Weight: 5 lbs.

Part No.	Description	Price
ST225	20MB Hard Disk Drive Only for IBM PC/XT/AT and compatibles (MFM Controller needed)	$224.95
ST225XT	20MB Hard Disk Drive, MFM Controller and Cables for IBM PC/XT and compatibles	$269.95
ST225AT	20MB Hard Disk Drive, MFM Controller, Software and Cables for IBM AT and compatibles	$339.95

20 Mega-byte!

Seagate ST225XT 20MB Hard Disk Drive Kit

ST238 (30 Megabyte): • Available for PC/XT or AT • Track to track access time: 20 msec. max. • Average access time: 65 msec. • Data transfer rate: 7.5 Megabits/sec. • Tracks: 2,460 • Bytes per track (formatted): 13,312 • Read/Write Heads: 4 • Cylinders: 615 • Size: 5.75"W x 8"D x 1.63"H • Weight: 5 lbs.

Part No.	Description	Price
ST238	30MB Hard Disk Drive Only for IBM PC/XT/AT and compatibles (RLL Controller needed for operation)	$249.95
ST238XT	30MB Hard Disk Drive, RLL Controller and Cables for IBM PC/XT and compatibles	$299.95
ST238AT	30MB Hard Disk Drive, RLL Controller and Cables for IBM AT and compatibles	$389.95

30 Mega-byte!

Seagate ST238XT 30MB Hard Disk Drive Kit

40MB, 60MB and 120MB Hard Disk Drives Available! Call for Information and Pricing.

Jameco ELECTRONICS HARD/FLOPPY CONTROLLER CARDS *NEW!*

Hard Disk/Floppy Controller for IBM PC/XT and Compatible Computers

Connect up to Two Hard and Two Floppy Disk Drives!

The JE1044 is an 8-bit floppy and MFM hard disk controller for the IBM PC/XT and compatible computers. The JE1044 will allow connection of up to two hard disks and two floppy drives (360KB, 720KB, 1.2MB and 1.44MB). Cables are included to allow connection of one hard disk and two floppy disk drives. To connect a second hard disk drive an additional cable will be required (use Part No. HD2)

JE1044 . . . . **$129.95**

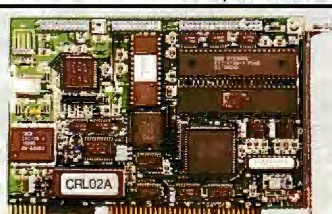
Hard Disk/Floppy Controller for IBM AT and Compatible Computers

The JE1045 is a 16-bit floppy and MFM hard disk controller for the IBM AT and compatible computers. The JE1045 will allow connection of up to two hard disk drives and any combination of two floppy disk drives (360KB, 720KB, 1.2MB and 1.44MB). Cables are included to allow connection of one hard disk and two floppy disk drives. To connect a second hard disk drive an additional cable will be required (use Part No. HD2).

JE1045 . . . . **$149.95**

RLL Hard Disk Controller Cards for IBM PC/XT/AT and Compatible Computers

The JE1042 is an 8-bit RLL hard disk controller card for the IBM PC/XT and compatible computers. The JE1042 should be used with hard disks designed for RLL formatting such as the Seagate 30MB ST238, 60MB ST277 and 120MB ST4144. Cables and documentation included.



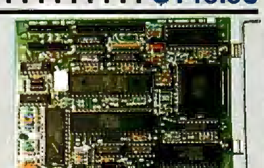
JE1047

JE1042 RLL PC/XT Hard Disk Controller Card . . ~~$99.95~~ **$89.95**

The JE1047 is a 16-bit RLL hard disk controller for the IBM AT and compatible computers. The JE1047 should be used with hard disks designed for RLL formatting such as the Seagate 30MB ST238, 60MB ST277 and 120MB ST4144. Cables and documentation included.

JE1047 RLL AT Hard Disk Controller Card **$189.95**

MFM Hard Disk Controller Cards for IBM PC/XT/AT and Compatible Computers



JE1041

The JE1041 is an 8-bit MFM hard disk controller card for the IBM PC/XT and compatible computers. The JE1041 can be used with many types of hard disk drives including the Seagate 20MB ST225 and 40MB ST251/ST251-1. Cables and documentation included.

JE1041 MFM PC/XT Hard Disk Controller Card. **$79.95**

The JE1046 is a 16-bit MFM hard disk controller for the IBM AT and compatible computers. The JE1046 can be used with many hard disk drives including the Seagate 20MB ST225 and 40MB ST251/ST251-1. Cables and documentation included.

JE1046 MFM AT Hard Disk Controller Card. **$129.95**

• REFER TO CODE 4038 WHEN ORDERING • SEE PAGE 322 FOR ORDER FORM • (415) 592-8097 320G

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The Economical Choice for a High Quality, High Accuracy Digital Multimeter

• 3.5 Digit (.5" High) LCD Readout • Audible Continuity Test • 1-Year Warranty

High Quality, Low Cost!

RANGE	ACCURACY	RESOLUTION
AC VOLTAGE		
200mV	±1.2% of reading	100µV
2V	±0.8% of reading	1mV
20V		10mV
200V		100mV
700V	±1.2% of reading	1V
DC VOLTAGE		
200mV	±0.5% of reading	100µV
2V		1mV
20V		10mV
200V		100mV
1000V		1V

RANGE	ACCURACY	RESOLUTION
AC CURRENT		
20µA	±1.0% of reading	10nA
200µA		100nA
2mA		1µA
20mA		10µA
200mA	±1.8% of reading	100µA
2A		1mA
20A	±3.0% of reading	10mA
DC CURRENT		
20µA	±0.5% of reading	10nA
200µA		100nA
2mA		1µA
20mA		10µA
200mA	±1.2% of reading	100µA
2A		1mA
20A	±2.0% of reading	10mA

RANGE	ACCURACY	RESOLUTION
RESISTANCE		
200Ω	±0.5% of reading	0.1Ω
2KΩ	±0.5% of reading	1Ω
20KΩ		10Ω
200KΩ		100Ω
2MΩ		1KΩ
20MΩ	±1.0% of reading	10KΩ

Unit comes complete with probes, batteries, carrying case & manual. Size: 6.75"H x 3.5"W x 1.25"D

Measures: AC/DC Voltage, AC/DC Current, Resistance, Diodes, Transistor hFE, Audible Continuity Test • Auto Zeroing • Input Impedance: 10MΩ • Overload Protection: 1000VAC/VDC • One-Year Warranty

M3800 3.5 Digit Multimeter. **$39.95**

Handheld Digital Multimeters

NEW, BARGRAPH MODEL!

• Jumbo 3.5 and 4.5 Digit (.7" High) LCD • Audible Continuity Test • Overload Protection • 1 Year Warranty • Ruggedized Case

AC Voltage (for M3610, M3650/B and M4650)

	ACCURACY		RESOLUTION	
RANGE	M3610/M3650/B	M4650	M3610/M3650/B	M4650
200mV	±1.2% of reading	±0.5% of reading	100µV	10µV
2V	±0.8% of reading		1mV	100µV
20V			10mV	1mV
200V			100mV	10mV
750V	±1.2% of reading	±0.8% of reading	1V	100mV

DC Voltage (for M3610, M3650/B and M4650)

	ACCURACY		RESOLUTION	
RANGE	M3610/M3650/B	M4650	M3610/M3650/B	M4650
200mV	±0.3% of reading	±.05% of reading	100µV	10µV
2V			1mV	100µV
20V			10mV	1mV
200V			100mV	10mV
1000V	±0.3% of reading	±0.1% of reading	1V	100mV

Resistance (for M3610, M3650/B and M4650)

	ACCURACY		RESOLUTION	
RANGE	M3610/M3650/B	M4650	M3610/M3650/B	M4650
200Ω	±0.5% of reading	±0.2% of reading	0.1Ω	.01Ω
2KΩ	±0.5% of reading	±0.15% of reading	1Ω	0.10Ω
20KΩ			10Ω	1Ω
200KΩ			100Ω	10Ω
2MΩ			1KΩ	100Ω
20MΩ	±1% of reading	±0.5% of reading	10KΩ	1KΩ

Capacitance (for M3650/B and M4650 only)

	ACCURACY	RESOLUTION	
RANGE	M3650/B/M4650	M3650/B	M4650
2000pf	±2% of reading	1pf	0.1pf
200nf		100pf	10pf
20µf	±3% of reading	10nf	1nf

Frequency (for M3650/B and M4650 only)

	ACCURACY	RESOLUTION	
RANGE	M3650/B/M4650	M3650/B	M4650
20KHz	±2% of reading	10Hz	1Hz
200KHz		100Hz	10Hz

M3650B

4.5 DIGIT FOR UNDER $100!

M4650

All units come complete with probes, batteries, carrying case & manual. Size: 7"H x 3.5"W x 1.5"D

M3610: • Measures: AC/DC Voltage, AC Current (200µA to 20A), DC Current (200µA to 20A), Resistance, Diodes, Transistor hFE, Audible Continuity Test • Auto-Zeroing • Input Impedance: 10MΩ • Overload Protection: 1000VAC/VDC

M3610 3.5 Digit Multimeter. **$49.95**

M3650: • Measures: AC/DC Voltage, AC Current (2mA to 20A), DC Current (200µA to 20A), Resistance, Diodes, Transistor hFE, Audible Continuity Test, Frequency and Capacitance • Auto-Zeroing • Input Impedance: 10MΩ • Overload Protection: 1000VAC/VDC

M3650 3.5 Digit Multimeter with Frequency and Capacitance Measurement. **$69.95**

M3650B: • Same specs as the M3650 (above) except features a 40 *point* bargraph display

M3650B 3.5 Digit Multimeter with 40 point Bar Graph. **$79.95**

M4650: • Measures: AC/DC Voltage, AC Current (2mA to 20A), DC Current (200µA to 20A), Resistance, Diodes, Transistor hFE, Audible Continuity Test, Frequency and Capacitance • Auto-Zeroing • Data Hold Switch • Input Impedance: 10MΩ • Overload Protection: 1000VAC/VDC

M4650 4.5 Digit Multimeter with Frequency/Capacitance Measurement and Data Hold Switch. **$99.95**

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Replace the 8086 or 8088 in Your IBM PC and Increase Its Speed by up to 30%!

Part No.		Price
UPD70108-5	(5MHz) V20 Chip	~~$7.49~~ $ 6.49
UPD70108-8	(8MHz) V20 Chip	~~$9.49~~ $ 7.95
UPD70108-10	(10MHz) V20Chip	~~$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	7485	SALE	.45
7402	.29	.19	7486	SALE	.29
7404	SALE	.15	7489	1.95	1.85
7405	.35	.25	7490	.49	.39
7406	.39	.29	7493	.45	.35
7407	SALE	.25	74121	SALE	.25
7408	.35	.25	74123	SALE	.35
7410	SALE	.15	74125	SALE	.35
7414	SALE	.25	74126	SALE	.35
7416	SALE	.19	74143	SALE	3.95
7417	SALE	.19	74150	SALE	1.10
7420	.29	.19	74154	1.35	1.25
7430	SALE	.15	74158	SALE	1.25
7432	.39	.29	74173	SALE	.59
7438	SALE	.25	74174	SALE	.35
7442	SALE	.29	74175	SALE	.35
7445	SALE	.59	74176	SALE	.49
7446	.89	.79	74181	SALE	1.49
7447	.89	.79	74189	SALE	1.49
7448	1.95	1.85	74193	.79	.69
7472	SALE	.25	74198	SALE	1.25
7473	.39	.29	74221	SALE	.69
7474	SALE	.25	74273	SALE	1.49
7475	.49	.39	74365	SALE	.35
7476	.45	.35	74367	SALE	.35

74LS

74LS00	SALE	.15	74LS165	.75	.65
74LS02	SALE	.15	74LS166	SALE	.69
74LS04	SALE	.16	74LS173	SALE	.25
74LS05	SALE	.16	74LS174	SALE	.25
74LS06	.59	.49	74LS175	SALE	.25
74LS07	.59	.49	74LS189	SALE	2.95
74LS08	.28	.18	74LS191	SALE	.39
74LS10	SALE	.15	74LS193	.69	.59
74LS14	SALE	.29	74LS221	SALE	.49
74LS27	SALE	.19	74LS240	SALE	.45
74LS30	SALE	.15	74LS243	SALE	.45
74LS32	SALE	.19	74LS244	SALE	.49
74LS42	.49	.39	74LS245	SALE	.59
74LS47	.89	.79	74LS259	.99	.89
74LS73	SALE	.25	74LS273	.89	.79
74LS74	SALE	.19	74LS279	.49	.39
74LS75	SALE	.25	74LS322	3.49	3.39
74LS76	.39	.29	74LS365	SALE	.35
74LS85	.59	.49	74LS366	SALE	.35
74LS86	.29	.19	74LS367	SALE	.29
74LS90	SALE	.29	74LS368	SALE	.35
74LS93	SALE	.29	74LS373	SALE	.59
74LS123	SALE	.35	74LS374	SALE	.49
74LS125	.49	.39	74LS393	SALE	.69
74LS138	.49	.39	74LS590	5.95	5.85
74LS139	SALE	.29	74LS624	1.95	1.85
74LS154	1.19	1.09	74LS629	SALE	1.95
74LS157	.45	.35	74LS640	SALE	.89
74LS158	SALE	.25	74LS645	SALE	.89
74LS163	SALE	.35	74LS670	SALE	.79
74LS164	SALE	.35	74LS688	2.39	2.29

74S/PROMS*

74S00	SALE	.19	74S188*		1.49
74S04	SALE	.19	74S189		1.49
74S08	SALE	.19	74S196	SALE	.99
74S10	SALE	.19	74S240		1.39
74S32	SALE	.19	74S244	SALE	.75
74S74	SALE	.19	74S253	SALE	.29
74S85	SALE	.49	74S287*		1.49
74S86	SALE	.19	74S288*		1.49
74S124	SALE	1.25	74S373	SALE	.99
74S174	SALE	.25	74S374	SALE	.99
74S175	SALE	.25	74S472*	SALE	2.49

CD—CMOS

CD4001	.19	CD4076	.59
CD4008	.59	CD4081	.22
CD4011	.19	CD4082	.22
CD4013	.29	CD4093	.35
CD4016	.29	CD4094	.89
CD4017	.49	CD40103	1.49
CD4018	.59	CD40107	.49
CD4020	.59	CD4510	.69
CD4024	.45	CD4511	.69
CD4027	.35	CD4520	.75
CD4030	.35	CD4522	.79
CD4040	.65	CD4538	.79
CD4049	.29	CD4541	.89
CD4050	.29	CD4543	.79
CD4051	.59	CD4553	3.95
CD4052	.59	CD4555	.79
CD4053	.59	CD4559	7.95
CD4063	1.49	CD4566	1.95
CD4066	.29	CD4583	.59
CD4067	1.49	CD4584	.49
CD4069	.19	CD4585	.69
CD4070	.29	MC14411P	7.95
CD4071	.22	MC14490P	4.49
CD4072	.22		

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**	6.95
2864A	8192x8	250ns 5V **Read/Write** (Pin 1, No R/B̄)	13.95
2864A-30	8192x8	300ns 5V **Read/Write** (Pin 1, No R/B̄)	12.95
2865A-30	8192x8	300ns 5V **Read/Write**	9.95
52813	2048x8	350ns (21V) 5V Read Only	1.49

MICROPROCESSOR COMPONENTS

MISCELLANEOUS CHIPS

Part No.	Price
D765AC	~~3.95~~ 2.95
WD9216	3.95
Z80, Z80A, Z80B SERIES	
Z80	1.19
Z80-CTC	~~1.29~~ .99
Z80-PIO	~~1.29~~ .99
Z80A	1.29
Z80A-CTC	1.65
Z80A-DART	~~4.95~~ 3.95
Z80A-PIO	~~1.89~~ 1.49
Z80A-SIO/0	~~3.95~~ 2.95
Z80B	2.75
Z80B-CTC	~~9.95~~ 3.25
Z80B-PIO	3.95
Z8530	4.95
Z8671	7.95
Z868181	8.95
8000 SERIES	
8031	~~9.95~~ 3.49
80C31	~~9.95~~ 8.95
8035	~~1.49~~ 1.25
8039	~~1.95~~ 1.59
8052AHBASIC	24.95
8080A	~~2.25~~ 1.49
8085A	2.49
8086	3.95
8086-2	~~6.95~~ 5.49

8000 SERIES Continued

Part No.	Price
8087(5MHz)	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
8155-2	3.49
8156	2.95
8212	2.29
8224	~~2.25~~ 1.95
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
8253-5	1.95
8254	3.95
8255A-5	2.95
8259-5	~~2.25~~ 1.75
8272	~~9.95~~ 2.95
8279-5	~~2.95~~ 2.75
8741	9.95
8742	~~19.95~~ 17.95
8748 (25V)	7.95

8000 SERIES Continued

Part No.	Price
8748H (HMOS) (21V)	9.95
8749	9.95
8751 (3.5-8MHz)	37.95
8751H (3.5-12MHz)	39.95
8755	~~13.95~~ 12.95
80286-10 LCC	59.95
80287-3 (5MHz)	149.95
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
80387-SX (16MHz)	369.95
82284 (8MHz)	9.49
82288 (8MHz)	9.95
DATA ACQUISITION	
ADC0804LCN	2.79
ADC0808CCN	~~5.95~~ 5.49
ADC0809CCN	~~3.69~~ 3.29
ADC1205CCJ-1	19.95
DAC0808LCN	~~1.75~~ 1.49
DAC1008LCN	5.95
AY-3-1015D	~~4.95~~ 3.95
AY-5-1013A	1.95

STATIC RAMS

Part No.	Function		Price
2016-12	2048x8	120ns	~~3.75~~ 2.95
2018-45	2048x8	45ns 300MIL	6.95
2102	1024x1	350ns	.89
2114N	1024x4	450ns	~~.99~~ .79
2114N-2L	1024x4	200ns Low Power	1.49
21C14	1024x4	200ns (CMOS)	.49
5101	256x4	450ns (CMOS)	~~2.95~~ 2.49
6116P-1	2048x8	100ns (16K) CMOS	~~3.95~~ 3.19
6116P-3	2048x8	150ns (16K) CMOS	~~3.49~~ 2.79
6116LP-1	2048x8	100ns(16K)LP CMOS	~~4.39~~ 3.59
6116LP-3	2048x8	150ns (16K) LP CMOS	~~3.95~~ 3.09
6264P-10	8192x8	100ns (64K) CMOS	~~9.95~~ 9.49
6264P-15	8192x8	150ns (64K) CMOS	~~9.25~~ 7.49
6264LP-10	8192x8	100ns (64K) LP CMOS	~~10.95~~ 10.25
6264LP-12	8192x8	120ns (64K) LPCMOS	~~10.49~~ 8.95
6264LP-15	8192x8	150ns (64K) LPCMOS	~~10.25~~ 7.95
6514	1024x4	350ns (CMOS)	~~3.75~~ 3.49
43256-10L	32,768x8	100ns (256K) LowPower	23.95
43256-15L	32,768x8	150ns (256K) Low Power	22.95
62256LP-85	32,768x8	85ns (256K) LPCMOS	26.95
62256LP-10	32,768x8	100ns (256K) LP CMOS	24.95
62256LP-12	32,768x8	120ns (256K) LP CMOS	24.25

DYNAMIC RAMS

THM91000L-10	1,048,576x9	100ns 1Megx9 SIP	~~399.95~~ 329.95
THM91000S-10	1,048,576x9	100ns 1Megx9 SIM	~~399.95~~ 299.95
THM91000L-80	1,048,576x9	80ns 1Megx9SIP	~~419.95~~ 349.95
THM91000S-80	1,048,576x9	80ns 1Megx9 SIM	~~419.95~~ 339.95
TMS4416-12	16,384x4	120ns	~~6.75~~ 5.95
TMS4416-15	16,384x4	150ns	~~6.25~~ 5.49
4116-15	16,384x1	150ns (MM5290N-2)	~~1.39~~ 1.25
4128-15	131,072x1	150ns (Piggyback)	5.29
4164-100	65,536x1	100ns	3.49
4164-120	65,536x1	120ns	2.95
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41256-60	262,144x1	60ns	~~11.99~~ 10.99
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85227-10PL	262,144x9	100ns 256Kx9 SIP	~~149.95~~ 105.95
85227-10PS	262,144x9	100ns256Kx9SIM	~~149.95~~ 105.95
511000P-10	1,048,576x1	100ns (1 Meg)	~~25.95~~ 21.95
511000P-80	1,048,576x1	80ns (1 Meg)	~~35.95~~ 24.95
511000P-85	1,048,576x1	85ns (1 Meg)	~~30.95~~ 23.95
514256P-10	262,144x4	100ns (1 Meg)	~~34.95~~ 29.95

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TMS2516	2048x8	450ns(25V)	~~6.95~~ 5.95
TMS2532	4096x8	450ns (25V)	~~5.95~~ 4.95
TMS2532A	4096x8	450ns(12.5V)	~~4.49~~ 3.25
TMS2564	8192x8	450ns(25V)	~~6.95~~ 4.95
TMS2716	2048x8	450ns (−5V, +5, +12V)	~~6.95~~ 6.49
1702A	256x8	(1µs)	4.95
2708	1024x8	450ns	6.95
2716	2048x8	450ns (25V)	3.75
2716-1	2048x8	350ns (25V)	~~4.25~~ 3.95
27C16	2048x8	450ns (25V) CMOS	~~4.25~~ 3.75
2732	4096x8	450ns (25V)	3.95
2732A-20	4096x8	200ns (21V)	4.25
2732A-25	4096x8	250ns (21V)	3.95
27C32	4096x8	450ns (25V) CMOS	~~4.95~~ 4.25
2764-20	8192x8	200ns (21V)	4.25
2764-25	8192x8	250ns (21V)	3.59
2764-45	8192x8	450ns (21V)	3.39
2764A-25	8192x8	250ns (12.5V)	3.69
27C64-15	8192x8	150ns (12.5V) CMOS	5.95
27128-20	16,384x8	200ns (21V)	~~6.95~~ 6.49
27128-25	16,384x8	250ns (21V)	5.95
27128A-15	16,384x8	150ns (12.5V)	7.75
27128A-20	16,384x8	200ns (12.5V)	~~5.75~~ 5.25
27128A-25	16,384x8	250ns (12.5V)	~~5.25~~ 4.95
27C128-25	16,384x8	250ns (21V) CMOS	5.95
27256-15	32,768x8	150ns (12.5V)	8.95
27256-20	32,768x8	200ns (12.5V)	6.95 6.25
27256-25	32,768x8	250ns (12.5V)	5.49
27C256-15	32,768x8	150ns (12.5V) CMOS	7.95
27C256-25	32,768x8	250ns (12.5V) CMOS	~~6.25~~ 5.49
27512-20	65,536x8	200ns (12.5V)	10.95
27512-25	65,536x8	250ns (12.5V)	9.95
27C512-25	65,536x8	250ns (12.5V) CMOS	~~10.25~~ 9.49
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6810	~~1.25~~ .99
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6840	~~3.49~~ 2.95
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318019-03	~~12.95~~ 10.95
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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
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74HC125		.49	74HC4049	SALE	.25
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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

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74HCT08	SALE	.15	74HCT175	SALE	.25
74HCT14	SALE	.29	74HCT240	SALE	.59
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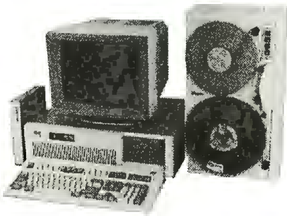

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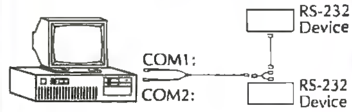

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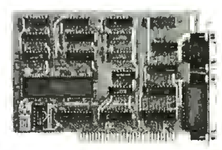

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It used to be difficult and costly to do process control, robotics, data acquisition, monitoring and sensing with your computer. Now the low-cost A-BUS system makes it easy to do almost any project you can imagine.

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An A-BUS system consists of: ▪ An A-BUS adapter plugged into your computer ▪ A cable to connect the adapter to 1 or 2 A-BUS function cards. ▪ The same cable will also fit an A-BUS Motherboard for expansion to up to 25 cards in any combination.

Important

All A-BUS Systems: ♦ Come assembled and tested ♦ Include detailed manuals with schematics and programming examples ♦ Can be used with almost any language (BASIC, Pascal, C assembler, etc.) using simple "IN" and "OUT" commands (PEEK and POKE on some computers ♦ Can grow to 25 cards (in any combination) per adapter ♦ Provide jumper selectable addressing on each card ♦ Require a single low cost unregulated 12V power supply ♦ Are usually shipped from stock. (Overnight service is available.)

About

Founded in 1976 for the purpose of developing low cost I/O devices for personal computers, Alpha has grown to serve over 70000 customers in over 60 countries. A-BUS users include many of the Fortune 500 (IBM, Hewlett-Packard, Tandy, Bell Labs, GM...) as well as most major universities. A-BUS products are U.S. designed, U.S. built, and serviced worldwide.
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Inputs, Outputs, etc.

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Reed Relay Card: 8 reed relays (20mA at 60VDC, SPST). Individually controlled and latched, with status LEDs. **RE-156: $109**

D/A converter: 4 Channel 8 Bit D/A converter with output amplifiers and separate adjustable references. **DA-147: $149**

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Digital Input: 8 optically isolated inputs. Input can be 5 to 100V voltage levels or switch closures. **IN-141: $65**

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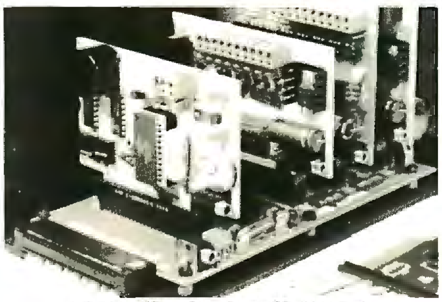
Options: ► 5 amp/phase power booster for 1 motor: **PD-123: $49**
► Remote "teach" keypad for direct motor control: **RC-121: $54**



A large A-BUS system with two Motherboards
Adapter in the foreground plugs into PC,XT,AT type slot.

Stepper Driver Kit: For experimenting with stepper motors. Includes 2 MO-103 motors and a ST-143 dual driver **PA-181: $99**

Stepper Motors: (4 phase, unipolar)
MO-103: 2¼" dia. ¼" shaft, 7.5°/step, 12V, 5 oz-in torque. **$15**
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► Can address 64 ports and control up to 25 A-BUS cards.
► Require one cable, Motherboard required for more than 2 cards.

A-BUS Parallel Adapters for:

IBM PC/XT/AT & compatibles. Uses one short or long slot	**AR-133: $69**
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A-BUS Cable: Necessary to connect any parallel adapter to one A-BUS card or to first motherboard, 50 pin, 3 ft. **CA-163: $24**
Special Cable for two A-BUS cards **CA-162: $34**

Serial Adapter: Connect A-BUS systems to any RS-232 port. Allows up to 500 ft from computer to A-BUS. **SA-129: $149**

Serial Node: To connect additional SA-129/A-BUS systems to a single RS232 serial port (max 16 nodes). **SN-128: $49**

Serial Processor: same as above plus built in BASIC for off-line monitoring, logging, decision making, etc. **SP-127: $189**
Use SA-129 or SP-127 with modems for remote data acquisition.

Motherboard: Holds up to 5 A-BUS cards in sturdy aluminum frame with card guides. A sixth connector allows (using cables CA-161: $12) additional Motherboards to be added. **MB-120: $108**

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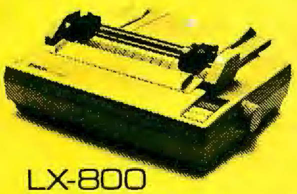

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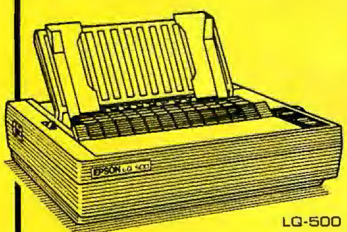

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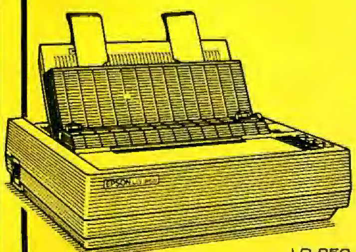

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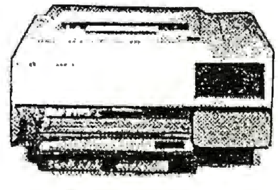

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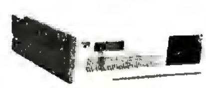

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Mouse w/Paintbrush $98
Mouse w/CAD .... Call
Mouse w/Window .... Call

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Complete FAX 9600 .... $388
Complete Answering Machine .. $248

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3 way ABC $38
4 way ABCD $58
5 way ABCDE $68
Crossover X $68
AutoSwitch 3 way $198
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2400 internal w/software $98
1200 external $88
2400 external $148
2400 PS/2 internal $198
Intel 2400B for PS/2 .... $278

Intel
8087 .... $94
8087-2 .... $138
8087-1 .... $178
80287-6 .... $148
80287-8 .... $218
80287-10 .... $248
80387-SX $348
80387-16 .... $378
30387-20 .... $398
80387-25 .... $528
Above board 286 Plus 512K $418
In board 386 .... $1028

Cables
6' printer $12
10' printer $18
25' printer $28
9' serial $18
25' serial $28
50' serial $38
100' serial $58
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Monitor extender $16
Printer extender $16

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Monographics w/Parallel $48
Color Graphics w/Parallel $48
Jade EGA card $158
Jade VGA+ $238
Jade VGA+ 16 .... $288
Dual game port $19
XT I/0 Par/Ser/Clk/Game $58
AT I/0 Par/Ser/Game $58
360/720K 1.2/1.44 MB FDC $48
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XT Hard Disk controller $58
AST SixPak Plus $118
AST XFormer $578
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Paradise VGA+ $268
Paradise VGA+ 16 .... $318

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S. L. Waber 6 outlet $18
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Isobar 8 outlet $68
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450 Watt UPS $398
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1200 Watt UPS $698

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MicroSpeed PC-Trac Ball $78
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Circle 275 on Reader Service Card

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PART	SIZE	SPEED	Vpp	PRICE
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2716	2048x8	450ns	25V	3.49
2716-1	2048x8	350ns	25V	3.95
2732	4096x8	450ns	25V	3.95
2732A	4096x8	250ns	21V	3.95
27C64	8192x8	250ns	12.5V	4.95
2764	8192x8	450ns	12.5V	3.49
2764-250	8192x8	250ns	12.5V	3.69
2764-200	8192x8	200ns	12.5V	4.25
27128	16384x8	250ns	12.5V	4.95
27128A-200	16384x8	200ns	12.5V	5.95
27C256	32768x8	250ns	12.5V	7.95
27256	32768x8	250ns	12.5V	5.95
27256-200	32768x8	200ns	12.5V	7.95
27512	65536x8	250ns	12.5V	11.95
27C512	65536x8	250ns	12.5V	12.95
27C101-20	131072x8	200ns	12.5V	34.95

■ CALL TO CONFIRM CURRENT PRICES ■

STATIC RAMS

PART	SIZE	SPEED	PRICE
2114	1024x4	450ns	.99
2114L-2	1024x4	200ns	1.49
TC5516	2048x8	250ns	3.95
TMM2016-200	2048x8	200ns	3.25
TMM2016-150	2048x8	150ns	3.29
TMM2016-100	2048x8	100ns	4.29
HM6116-4	2048x8	200ns	4.95
HM6116-3	2048x8	150ns	5.95
HM6116-2	2048x8	120ns	6.45
HM6116LP-4	2048x8	200ns	5.95
HM6116LP-3	2048x8	150ns	6.45
HM6116LP-2	2048x8	120ns	6.95
HM6264LP-15	8192x8	150ns	9.95
HM6264LP-12	8192x8	120ns	10.95
HM43256LP-15	32768x8	150ns	17.95
HM43256LP-12	32768x8	120ns	19.95
HM43256LP-10	32768x8	100ns	24.95

■ CALL TO CONFIRM CURRENT PRICES ■

DYNAMIC RAMS

PART	SIZE	SPEED	PRICE
4116-200	16384x1	200ns	.89
4116-150	16384x1	150ns	.99
4164-150	65536x1	150ns	2.89
4164-120	65536x1	120ns	3.19
4164-100	65536x1	100ns	3.95
TMS4416	16384x4	150ns	8.95
41128-150	131072x1	150ns	5.95
TMS4464-15	65536x4	150ns	14.95
TMS4464-12	65536x4	120ns	15.95
41256-150	262144x1	150ns	7.99
41256-120	262144x1	120ns	8.49
41256-100	262144x1	100ns	8.79
41256-80	262144x1	80ns	9.49
MK4332	32768x1	200ns	6.95
HM51258-100	262144x1	100ns	13.95
1 MB-120	1048576x1	120ns	24.95
1 MB-100	1048576x1	100ns	27.95

■ CALL TO CONFIRM CURRENT PRICES ■

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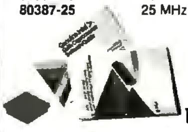
8087-2	8 MHz	139.95
8087-1	10 MHz	189.95
80287	6 MHz	157.96
80287-8	8 MHz	219.95
80287-10	10 MHz	264.95
80387-16	16 MHz	397.95
80387-SX	16 MHz	389.95
80387-20	20 MHz	469.95
80387-25	25 MHz	589.95



intel 5 YEAR WARRANTY

INCLUDES MANUAL & SOFTWARE GUIDE

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■ SHIRT POCKET SIZE! ■ ERASES MOST EPROMS/ EPLD'S IN 3 MINUTES ■ ALL SIZES UP TO 4 AT A TIME

DATARASE II

SPECTRONICS CORPORATION

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PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189
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6502	2.25
6502A	2.69
6502B	4.25
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6522	2.95
6526	13.95
6532	5.95
6551	2.95
6581	14.95

* CMOS

6800

6800	1.95
6802	2.95
68B02	3.95
6803	3.95
6809	2.95
68B09	5.99
6809E	2.95
68B09E	5.49
6808	2.49
6810	1.95
6821	1.25
68B21	1.85
6840	3.95
6845	2.75
6847	4.75
6850	1.95
68B50	1.75
6852	4.95
6883	22.95
68000	9.95
68020	189.95

8000

8031	3.95
8035	1.49
8039	1.95
8052AH BASIC	34.95
8080	2.49
8085	1.95
8085A-2	3.75
8088	5.99
8088-2	7.95
8155	2.49
8155-2	3.95
8156	2.95
8741	9.95
8748	7.95
8749	9.95
8755	14.95

8200

8205	3.29
8212	1.49
8216	1.49
8224	2.25
8228	2.25
8237	3.95
8237-5	4.75
8238	4.49
8243	1.95
8250	6.95
8251	1.29
8251A	1.69
8253	1.59
8253-5	1.95

8200

8254	2.79
8255	1.99
8255-5	2.49
8256	15.95
8259	1.95
8259-5	2.29
8272	4.39
8274	4.95
8275	16.95
8279	2.49
8279-5	2.95
8282	3.95
8283	3.95
8284	2.25
8286	3.95
8287	3.95
8288	4.95

Z-80

Z80-CPU	1.25
Z80A-CPU	1.29
Z80B-CPU	2.75
Z80A-CTC	1.69
Z80B-CTC	4.25
Z80A-DART	5.95
Z80B-DART	6.95
Z80A-DMA	5.95
Z80A-PIO	1.89
Z80B-PIO	4.25
Z80A-SIO/0	5.95
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Z80A-SIO/2	5.95
Z8671BASIC	9.95

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41256A8B-15	256K x 8-BIT	FOR MAC	150ns	$89.00
41256A8B-12	256K x 8-BIT	FOR MAC	120ns	$95.00
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41256A9B-15	256K x 9-BIT	FOR PC	150ns	$94.00
41256A9B-12	256K x 9-BIT	FOR PC	120ns	$99.00
41256A9B-10	256K x 9-BIT	FOR PC	100ns	$109.00
41256A9B-80	256K x 9-BIT	FOR PC	80ns	$119.00
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16R8	2.95	20R6	4.95
16R6	2.95	20R8	4.95
16R4	2.95	20X8	4.95
20L8	4.95		

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7400	.19
7402	.19
7404	.19
7405	.25
7406	.29
7407	.29
7408	.24
7410	.19
7411	.25
7414	.49
7416	.25
7417	.25
7420	.19
7432	.29
7447	.89
7473	.34
7474	.33
7475	.45
7476	.35
7586	.35
7489	2.15
7490	.39
7493	.35
74121	.29
74123	.49
74151	.55
74154	1.49
74157	.55
74166	1.00

74LS00

74LS00	.16
74LS02	.17
74LS03	.18
74LS04	.16
74LS05	.18
74LS08	.18
74LS10	.16
74LS11	.22
74LS14	.39
74LS20	.17
74LS21	.22
74LS27	.23
74LS30	.17
74LS32	.18
74LS38	.26
74LS42	.39
74LS47	.75
74LS51	.17
74LS73	.29
74LS74	.24
74LS75	.29

74LS76	.29
74LS83	.49
74LS85	.49
74LS86	.22
74LS90	.39
74LS92	.49
74LS93	.39
74LS109	.36
74LS112	.29
74LS123	.49
74LS125	.39
74LS132	.39
74LS138	.39
74LS139	.39
74LS151	.39
74LS153	.39
74LS154	1.49
74LS155	.59
74LS156	.49
74LS157	.35
74LS158	.29
74LS161	.39
74LS163	.39
74LS164	.49
74LS165	.65
74LS166	.95
74LS175	.39
74LS192	.69
74LS193	.69
74LS197	.59
74LS221	.59
74LS240	.69
74LS241	.69
74LS244	.69
74LS245	.79
74LS251	.49
74LS257	.39
74LS258	.49
74LS259	1.29
74LS260	.49
74LS273	.79
74LS279	.39
74LS322	3.95
74LS323	2.49
74LS367	.39
74LS373	.79
74LS374	.79
74LS377	.79
74LS393	.79
74LS541	1.49
74LS670	.89
74LS682	3.20
74LS688	2.40

74S

74S00	.29
74S02	.29
74S04	.29
74S74	.49
74S86	.35
74S112	.50
74S287	1.69
74S288	1.69
74S374	1.69
S32	.35
S138	.79
S240	1.49
S244	1.49
S373	1.69

74F

74F00	.35
74F04	.35
74F08	.35
74F32	.35
74F74	.39
74F138	.79
74F244	1.29

74HC

74HC00	.21
74HC04	.25
74HC08	.25
74HC14	.35
74HC32	.35
74HC74	.35
74HC138	.45
74HC139	.45
74HC154	1.09
74HC157	.55
74HC244	.85
74HC245	.85
74HC373	.69
74HC374	.69

74HCT

74HCT00	.25
74HCT04	.27
74HCT08	.25
74HCT32	.27
74HCT138	.35
74HCT240	.89
74HCT244	.89
74HCT245	.99
74HCT373	.99
74HCT374	.99

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TL072	1.09	NE555	.29	LM3900	.49
TL084	1.49	NE556	.49	LM3909	.98
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LM309K	1.25	LM565	.95	IC7760	1.99
LM311	.59	LM567	.79	7805T	.49
LM311K	3.49	NE570	2.95	7808T	.49
LM317T	.69	NE590	2.50	7812T	.49
LM318	1.49	LM723	.49	7815T	.49
LM319	1.25	LM741	.29	7905T	.59
LM323K	3.49	MC1330	1.69	7912T	.59
LM324	.34	MC1350	1.19	7915T	.59
LM334	1.19	LM1458	.35	MAX232	7.95
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LM338K	4.49	LM1489	.49	ICM7207A	5.95
LM339	.59	LM1496	.85	ICM7208	15.95
LF353	.59	ULN2003	.79	75150	1.95
LF356	.99	XR2206	3.95	75154	1.95
LM358	.59	XR2211	2.95	75188	1.25
LM380	.89	CA3046	.89	75189	1.25
LM386	.89	CA3146	1.29	75451	.39
LM393	.45	MC3470	1.95	75452	.39

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ADC0804	2.99
ADC0809	3.85
DAC0800	3.29
DAC0808	1.95
1793	9.95
8272	4.39
COM8116	8.95
UPD765	4.39
1691	6.95
2143	6.95
AY5-3600 PRO	11.95
AY3-1015	4.95
AY5-1013	3.95
MC146818	5.95
MM58167	9.95
MM58174	9.95
MSM5832	2.95
IM6402	3.95
IM6403	9.95
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NS16450	10.95

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32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.4576	1.95
3.579545	1.95
4.0	1.95
5.0688	1.95
6.0	1.95
8.0	1.95
10.0	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
20.0	1.95
22.1184	1.95
24.0	1.95

CRYSTAL OSCILL.

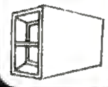
1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
4.0	4.95
5.0688	4.95
8.0	4.95
10.0	4.95
14.31818	1.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

STD. CMOS LOGIC

4001	.19	4050	.29
4011	.19	4051	.69
4013	.35	4060	.69
4015	.29	4066	.29
4016	.29	4069	.19
4017	.49	4093	.49
4024	.49	14411	9.95
4040	.69	4511	.69
4046	.69	4538	.95
4049	.29	4702	9.95

SHORTING BLOCKS

5/$1.00



DISCRETE

1N751	.49	2N3904	.10
IN4004	10/1.00	2N3906	.10
IN4148	25/1.00	2N4401	.25
KBP02	.55	4N26	.69
2N2222	.10	4N35	.89
2N2907	.25	JMBO RED	.10
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.01UF	100/5.00
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Circle 6 on Reader Service Card (DEALERS: 7)

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PS-135 $59.95
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PS-200 $89.95

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- WITH APPLE CONNECTOR
- +5V @ 6A, +12V @ 3A, -5V @ 1A, -12V @ 1A

PS-A $49.95

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- +5V @2.5A, +12V @1.5A
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FR-4 EPOXY GLASS LAMINATE WITH GOLD PLATED EDGECARD FINGERS AND SILK SCREENED LEGENDS

FOR XT

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JDR-PR2 ABOVE WITH I/O DECODING LAYOUT $29.95

FOR AT

JDR-PR10 16 BIT WITH I/O DECODING LAYOUT $34.95
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FOR PS/2

JDR-PR32 32 BIT PROTOTYPE CARD $69.95
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JDR-PR16PK PARTS KIT FOR JDR-PR16 ABOVE $15.95
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JDR INSTRUMENTS—2 YEAR WARRANTY!

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- WIDE BAND WIDTH ■ VARIABLE HOLDOFF

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- TV SYNC FILTER ■ COMPONENTS TESTER

MODEL 2000 $389.95

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- AUTORANGING ■ AC/DC 2V - 500V, RESIS. 2K-2M

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3.5 DIGIT POCKET SIZE DMM
- BASIC DC ACCURACY ±0.5% ■ 14 RANGES

DMM-100 $29.95

3.5 DIGIT FULL FUNCTION DMM
- BASIC DC ACCURACY ±0.25% ■ 22 RANGES

DMM-200 $49.95

THE ULTIMATE 3.5 DIGIT DMM
- BASIC DC ACCURACY ±0.25% ■ 34 RANGES
- TEMP, TRANSISTOR & RESISTANCE FEATURES

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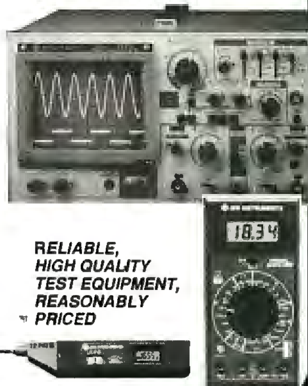
RELIABLE, HIGH QUALITY TEST EQUIPMENT, REASONABLY PRICED



DATA SWITCH BOXES

TYPE	# OF POS.	PARALL.	SERIAL	PRICE
PUSHBTTN.	2-WAY	AB-P	AB-S	39.95
ROTARY	2-WAY	RSP-2	RSS-2	24.95
ROTARY	3-WAY	RSP-3	RSS-3	27.95
ROTARY	4-WAY	RSP-4	RSS-4	29.95

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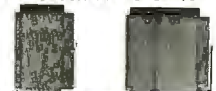
EXT-8088 XT COMPATIBLE $29.95
EXT-80286 AT COMPATIBLE $39.95
EXT-16 MICROCHANNEL 16-BIT $69.95
EXT-32 MICROCHANNEL 32-BIT $99.95



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PDS-300 2390 TIE PTS $24.95
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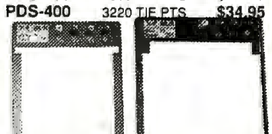

IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS					
		10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	--	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

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FOR TROUBLESHOOTING SERIAL COMMUNICATIONS

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- ACCEPTS UP TO 24 14-PIN ICS
- 1940 TIE POINTS
- EXT FEMALE DB25 D-SUB CONNECT.

PDS-604 $49.95

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS					
			9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	--	.79	2.27	--
	FEMALE	DBxxSR	.55	.75	--	.85	2.49	--
WIREWRAP	MALE	DBxxPWW	1.69	2.56	--	3.89	5.60	--
	FEMALE	DBxxSWW	2.76	4.27	--	6.84	9.95	--
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	--	2.25	4.25	--
	FEMALE	IDBxxS	1.45	2.05	--	2.35	4.49	--
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	--	--
	PLASTIC	HOODxx	.39	.39	--	.39	.69	.75

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE : A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE .59

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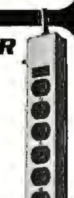
PROTECTS YOUR EQUIPMENT!



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- MOTHERBOARD CONNECTOR
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LONG-LASTING 3V LITHIUM

3V-MHW $1.95
HOLDER $1.49

IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS								
		8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	--	4.95	4.95	--	5.95	--	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	--	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

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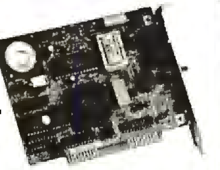

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LMOUSE-BPBL	BUS MOUSE W/PUBLISHER PKG	$129.95
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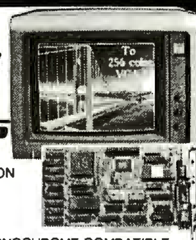

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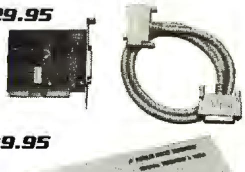

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Circle 6 on Reader Service Card (DEALERS: 7)

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Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

The front of BYTE will feature, as always, Microbytes, What's New, and Short Takes. The June Short Takes, BYTE's hands-on look at new and interesting products in an abbreviated format, will include Dell Computer's 325, Lifetree's Volkswriter 4, Digital Vision's ComputerEyes image digitizer, and DTG's System Sleuth, among others.

How much modem can you get for under $500? In June's **Product Focus**, we examine inexpensive external 2400-bps modems that support V.22bis and MNP 5 data compression.

System reviews begin with a new 80386SX computer: the NCR PC916sx. Apple's new Macintosh SE/30 promises to be an exciting machine. In June, we follow up our February preview coverage with an in-depth review of the system.

Add-in/peripheral reviews look at four high-resolution hand scanners: Logitech's ScanMan, The Complete PC's Complete Hand Scanner, DFEI's HS-3000, and KYE International's Geniescan. We also compare six 16-bit VGA cards: ATI's VGA Wonder, Genoa's Model 5400, Orchid's Prodesigner Plus, STB's VGA EM-16, and Video Seven's V-RAM VGA and FastWrite VGA.

In our **language reviews**, we'll look at Smalltalk/V Mac, a robust and mature product based on object-oriented technology that Digitalk has been developing for years.

Another **review** will cover a tool for constructing skeletal Windows applications. CASE:W is itself a Windows application that manages menus, resource script files, icons, and dialog boxes in a WYSIWYG context.

Application reviews include design and drawing programs. Claris CAD for the Mac looks to be a power-packed two-dimensional CAD program. On the PC side, Corel Systems' Corel Draw is a high-end drawing program that shows promise.

IN DEPTH:

The **security of sensitive data** is a major area of concern in the computer world—one very much in the public eye with the now-famous nationwide network worm. Our coverage will include different methods of securing network access, data encryption, radiation protection, and more. Protective devices will also be discussed.

FEATURES:

Our **Expert Advice columnists** will hold forth at the front of the book: Jerry Pournelle, Ezra Shapiro, Wayne Rash, Mark L. Van Name, Bill Catchings, Tom Thompson, and Mark Minasi. We'll also have our two **Hands On columnists**. In Some Assembly Required, Rick Grehan will continue his tour of operating systems and how they handle file directories. Brett Glass will look Under the Hood at new modem technology.

In our **full-length features**, we'll discuss methods for turning a single-user application into a multiuser application for running on a LAN. Based on an actual case study, the article presents the pitfalls of network programming.

Standard DOS applications are limited to 640K bytes. The LIM/EEMS specification gives computers access to as much as 32 megabytes of additional memory. We'll present a library of C programs that uses the specification to make expanded memory available for data storage.

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Index to Advertisers by Product Category

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READER SERVICE

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Use BYTE's Telephone Inquiry Processing System

Using TIPS can bring product information as much as 10 days earlier.

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1) If you are a new Reader or have lost your I.D. Card, circle #1 on the Reader Service Card. We will immediately send your personal TIPS Reader I.D. Card.

GET PREPARED

2) Write your Reader Number, as printed on your Reader I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: **(413) 637-3170** and wait for voice commands.

ENTER YOUR I.D. AND ISSUE NUMBERS

5) When TIPS says: "Enter Reader Number"
(Enter by pushing the numbers and # – symbols enclosed in the boxes on telephone pad ignoring blank boxes)
Enter □ □ □ □ □ □ □ □ □ □ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 5 9 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. □ □ □ □ # #
2. □ □ □ □ # #
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END SESSION

8) End session by entering # #

9) Hang up after hearing final message
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Title ____________________ Phone (______) ____________

Company ______________________________

Address ______________________________

City ____________________ State ________ Zip ________

A. What is your level of management responsibility?
1 ☐ Senior-level Management
2 ☐ Other Management
3 ☐ Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)
1 ☐ Administration
2 ☐ Accounting/Finance
3 ☐ MIS/DP/Information Center
4 ☐ Product Design and Development
5 ☐ Research and Development
6 ☐ Manufacturing
7 ☐ Sales/Marketing
8 ☐ Purchasing
9 ☐ Personnel
10 ☐ Education/Training
11 ☐ Other: ____________

C. Please indicate your organization's primary business activity: (Check one.)

Computer-Related Businesses:
1 ☐ Manufacturer (Hardware, Software)
2 ☐ Computer Retail Stores
3 ☐ Consultants
4 ☐ Service Bureau/Planning
5 ☐ Distributor/Wholesaler
6 ☐ Systems House/ Integrator/VAR
7 ☐ Other: ____________

Non-Computer-Related Businesses:
8 ☐ Manufacturing
9 ☐ Finance, Insurance, Real Estate
10 ☐ Retail/Wholesale
11 ☐ Education
12 ☐ Government
13 ☐ Military
14 ☐ Professions (Law, Medicine, Engineering, Architecture)
15 ☐ Consulting
16 ☐ Other Business Services
17 ☐ Transportation, Communications, Utilities
18 ☐ Other: ____________

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