

SETTING THE STANDARDS

15
YEARS

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BYTE

FEBRUARY 1990

A MCGRAW-HILL PUBLICATION

Zenith's Amazing EISA

*EISA disk drive controller
promises phenomenal
throughput*

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New Data Storage Ideas**

**Micro Edsels:
Computing's Lead Balloons**

**Multimedia:
What It Is, how you'll use It**

**Plus:
SCSI, Multitasking, Bus Wars**

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Zenith MinisPort
HP IIP LaserJet
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**THE
WORLD'S
BEST
SPREADSHEETS**

Lab tests of 15
state-of-the-art
programs for
DOS, OS/2,
and the Mac



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JNCING DO OFF THE STEM 325.



THE NEW
DELL SYSTEM® 316SX
16 MHz 386SX

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

STANDARD FEATURES:

- Intel 80386SX microprocessor running at 16 MHz.
- Choice of 512 KB, 640 KB, 1 MB or 2 MB* of RAM expandable to 16 MB (8 MB on the system board).
- Page mode interleaved memory architecture.
- LIM 4.0 support for memory over 640 KB.
- Integrated diskette and high performance 16-bit VGA video controller on system board.
- Socket for Intel 80387SX math coprocessor.
- 5.25" 1.2 MB or 3.5" 1.44 MB diskette drive.
- Integrated high performance hard disk interface on system board.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 3 full-sized 16-bit AT expansion slots available.

****Commercial Lease Plan. Lease for as low as \$72/month.**
△ Xerox Extended Service Plan pricing starts at \$187.

20 MB VGA Monochrome System	\$1,899
40 MB VGA Color Plus System	\$2,399
40 MB Super VGA System (800x600)	\$2,499
100 MB Super VGA System (800x600)	\$3,099

Prices reflect 512 KB of RAM. 640 KB versions of the above systems are available for an additional \$50, 1 MB versions for an additional \$150, and 2 MB versions for an additional \$300.



DELL SYSTEM® 210
12.5 MHz 286.

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

STANDARD FEATURES:

- 80286 microprocessor running at 12.5 MHz.
- Choice of 512 KB, 640 KB, 1 MB or 2 MB* of RAM expandable to 16 MB (6 MB on the system board).
- Page mode interleaved memory architecture.
- LIM 4.0 support for memory over 640 KB.
- Integrated diskette and high performance 16-bit VGA video controller on system board.
- Socket for Intel 80287 math coprocessor.
- 5.25" 1.2 MB or 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.
- 3 full-sized 16-bit AT expansion slots available.

****Commercial Lease Plan. Lease for as low as \$61/month.**
△ Xerox Extended Service Plan pricing starts at \$158.

NEW LOW PRICES

20 MB VGA Monochrome System	\$1,599
20 MB VGA Color Plus System	\$1,899
40 MB VGA Monochrome System	\$1,799
40 MB VGA Color Plus System	\$2,099

Prices listed reflect 512 KB of RAM. 640 KB versions of the above systems are available for an additional \$50, 1 MB versions for an additional \$150, and 2 MB versions for an additional \$300. 100 MB hard drive configurations also available.



THE NEW
DELL SYSTEM® 316LT

This new full-featured, battery powered 386SX laptop costs less than most 286 laptops.

STANDARD FEATURES:

- Intel 80386SX microprocessor running at 16 MHz.
- Choice of 1 MB or 2 MB* of RAM expandable to 8 MB (on the system board using 1 MB SIMMs).
- LIM 4.0 support for memory over 1 MB.
- Adjustable and detachable 640 x 480 VGA Liquid Crystal Display.
- One industry standard half-size 8-bit expansion slot.
- Socket for 16 MHz Intel 80387SX math coprocessor.
- 3.5" 1.44 MB diskette drive.
- 83-key keyboard with embedded numeric keypad and 12 function keys.
- 1 parallel, 1 serial, and external VGA monitor port.
- Connector for 101-key keyboard or numeric keypad.
- Removable and rechargeable NiCad battery pack utilizing Dell's "continuous power" battery system (patent pending).
- AC Adapter.

****Commercial Lease Plan. Lease for as low as \$127/month.**
△ Xerox Extended Service Plan pricing starts at \$295.

20 MB, 1 MB RAM	\$3,499
20 MB, 2 MB RAM	\$3,699
40 MB, 1 MB RAM	\$3,799
40 MB, 2 MB RAM	\$3,999

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



THE DELL SYSTEM® 325 25 MHz 386.

An even better value at these low prices.

STANDARD FEATURES:

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

- 200-watt power supply.

• 8 industry standard expansion slots (6 available).
****Commercial Lease Plan. Lease for as low as \$153/month.**
△ Xerox Extended Service Plan pricing starts at \$370.

NEW LOW PRICES.

40 MB VGA Monochrome System	\$4,199
100 MB VGA Color Plus System	\$5,099
100 MB Super VGA Color System (800x600)	\$5,199
150 MB Super VGA Color System (800x600)	\$5,699

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

*Performance Enhancements: Within the first megabyte of memory 128 KB (316SX, 316LT and 210), 384 KB (325) of memory is reserved for use by the system to enhance performance.
 All systems are photographed with optional extras. All prices and specifications are subject to change without notice. Dell cannot be responsible for errors in typography or photography. **Payment based on 36-month, open-end lease. Leasing arranged by Leasing Group, Inc. In Canada, configurations and prices may vary. DELL SYSTEM is a registered trademark of Dell Computer Corporation. Microsoft, MS, MS-DOS and XENIX are registered trademarks of Microsoft Corporation. Intel is a registered trademark, and 386 is a trademark of Intel Corporation. Dell UNIX System V is based on INTERACTIVE Systems Corporation's 386ix. UNIX is a registered trademark of AT&T in the United States and other countries. Other trademarks and trade names are used to identify the entities claiming the marks and names or their products. Dell Computer Corporation disclaims any proprietary interest in trademarks and trade names other than its own. On-site service may not be available in certain remote locations. For information on, and a copy of Dell's 30-day Total Satisfaction Guarantee, limited warranty, or Xerox's service contract, please write to Dell Computer Corporation, 9505 Arboretum Boulevard, Austin, Texas 78739-7299. Attn: Warranty. ©1989 Dell Computer Corporation. All rights reserved.

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

You see, we have an unusual relationship with our customers.

We deal directly with them.

That's why we can custom configure each system for each customer.

That's why we can provide them the most comprehensive service and support in the business.

And, with no retailers, we can actually offer high-end systems like this Dell System® 325 for as low as \$4,199. With other configurations \$2,500 below the comparable IBM or Compaq systems.

Or, a custom configured leasing plan can be designed for any business**

Which explains why Dell has won the last four *PC Week* polls for overall customer satisfaction.

As for the System 325, it's a thoroughbred. And it runs on either Microsoft® MS-DOS®, MS® OS/2, or our Dell UNIX® System V, which is compatible with AT&T System V Interface Definition. As well as XENIX®.

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

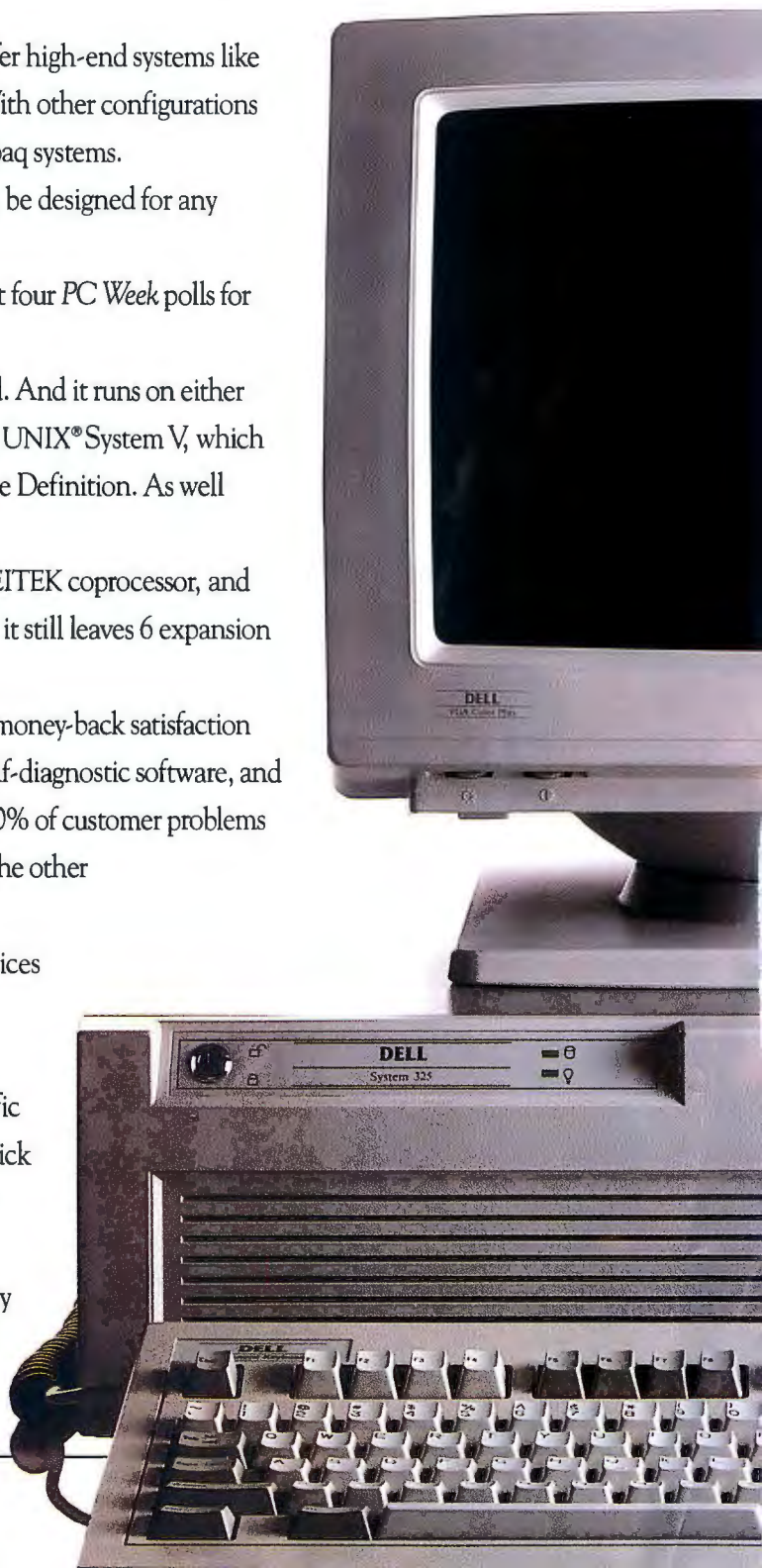
And every Dell system includes a 30-day money-back satisfaction guarantee. As well as a full-year warranty, self-diagnostic software, and toll-free technical support that solves over 90% of customer problems by phone. With next day on-site service for the other 10%, provided by Xerox Corporation^

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

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

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

ANNOUNCEMENT UP TO \$1100 OFF DELL SYSTEMS



**4 OUT OF 5
DELL
CUSTOMERS
WILL BE
COMPLETELY
SATISFIED.**

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

Just keep lowering your prices

(28-30)

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

Reduce Cost

(28-30)

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

Sell them at an even lower price

(28-30)

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

Drop the Price /

(28-30)

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

GIVE THEM AWAY FREE.

(28-30)

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



800-426-5150.

To order, call 800-426-5150. In Canada, call 800-387-5752. In Germany, call 06103/701100. In the U.K., call 0800 414535.



power⁴Cache...The most advanced What else would you expect



PC MAGAZINE, January 1989,
*"In a field of powerhouse machines
there can only be one winner, and
ALR's FlexCache is it."*

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

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

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

More important, PowerCache 4 is the first PC to fully utilize 128-bit burst mode and a "read and write-back" 128KB cache design, providing a better than zero wait state performance as compared to the i386. Furthermore, the ALR PowerCache 4 is 100% IBM® PS/2™ Micro Channel™-compatible supporting bus mastering devices and giving

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



**California Anza-Borrego
Desert State Park**

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

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

you a more efficient system for a variety of multi-user and fileserver applications. Like most ALR computers, the PowerCache 4 is a truly balanced system. The fastest power is achieved by enhancing our PowerCache 4 design with the industry's fastest disk drives and interface. The PowerCache 4 systems come standard with a high-speed 15MHz ESDI and 32 KB hard disk cache on the disk controller. What more could you possibly need.

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PowerCache 4 is the first PC to fully utilize 128-bit burst mode and a "read and write-back" 128KB cache design, providing better than zero wait state performance as compared to the i386.



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For our UK office:
0 635-521 922 FAX: 0 635-521 844
For our Singapore:
(65) 258-1286 FAX: (65) 258-1285

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LANtastic Ethernet Starter Kit,
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Word processing will two pages than it ha

**What you see
is what you get.**

Also known as WYSIWYG, this on-screen editing feature lets you see exactly what your changes are the instant you make them.

**Location, location,
location.**

Use the ruler to make everything flush left, or right. Or centered. Single-spaced. Double-spaced. Anywhere and any way you want it. With one simple click.

It's a wrap.

You can move or resize any positioned object, such as a chart or table, and watch the text automatically wrap the whole thing into a nice, neat package.

**We've got
tables covered.**

This feature makes creating a table as easy as creating a spreadsheet, sending the TAB key the way of carbon paper.

Something happens the first time you look at new Microsoft® Word for Windows.*

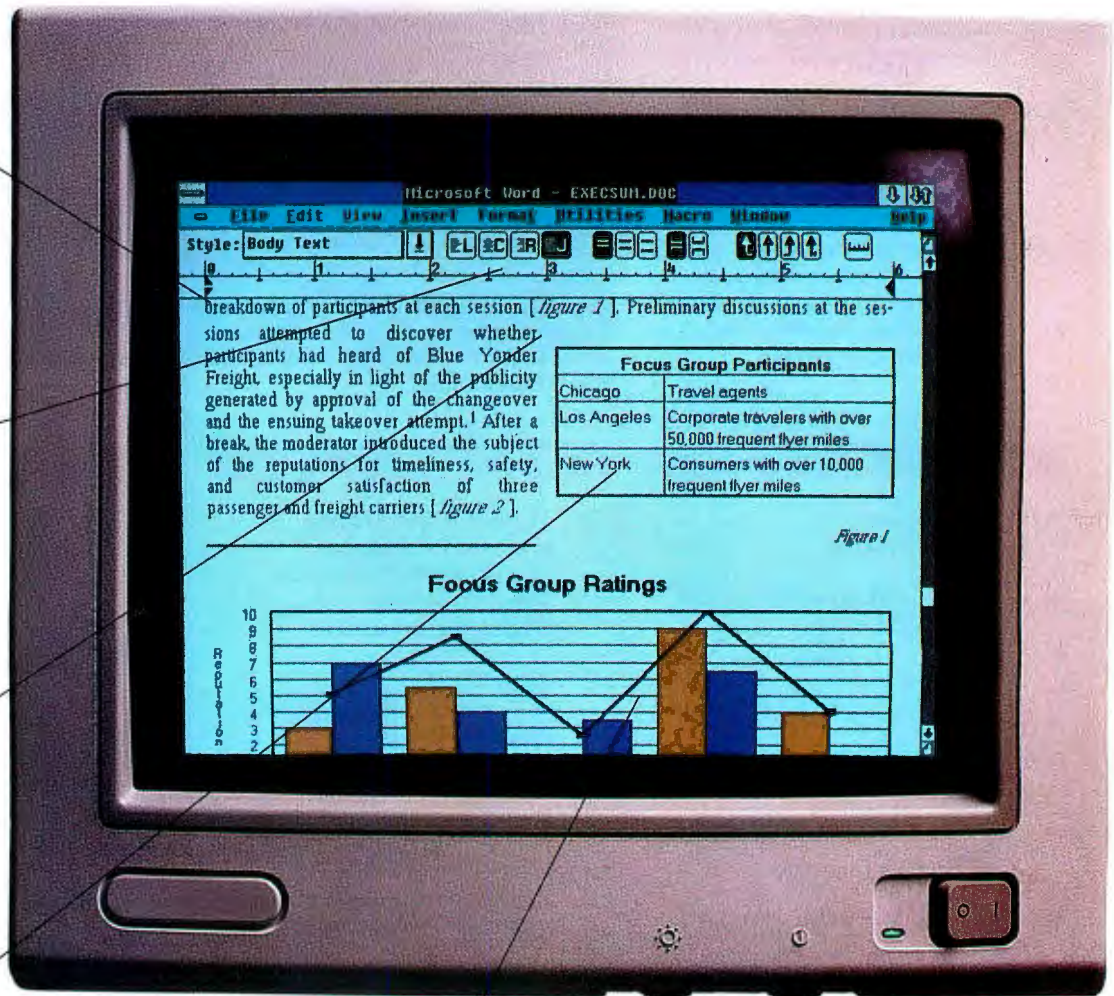
You stare. A conscious close of the mouth may even be necessary.

Don't worry. It's a standard reaction. Because when it comes to word processing on a PC, Word for Windows

isn't like anything you have ever seen before.

In creating it, we took the collective experience of producing the two leading word processing programs, powerful Word for the PC and the Macintosh®. Consequently, every level of word processing, from the quick memo to the complex document, becomes very easy and simple to do. Down-right elementary, actually.

Gone is the need to memorize a series of key-



Make sure your numbers add up.

Through dynamic data exchange (DDE), any changes made to the original spreadsheet will show up here automatically. It's convenience words can't describe.



evolve more on these s in the last ten years.

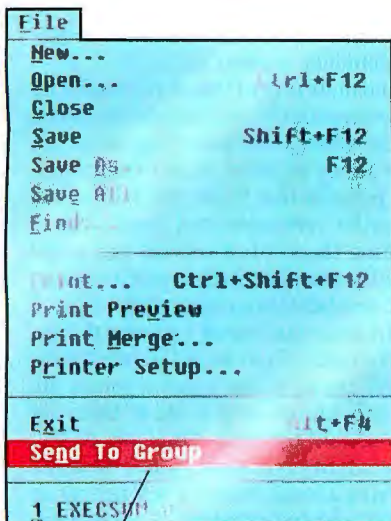


See, point, do.

A liberal collection of icons located on the Ribbon replaces an endless string of commands to let you format characters by eye instead of by memory.

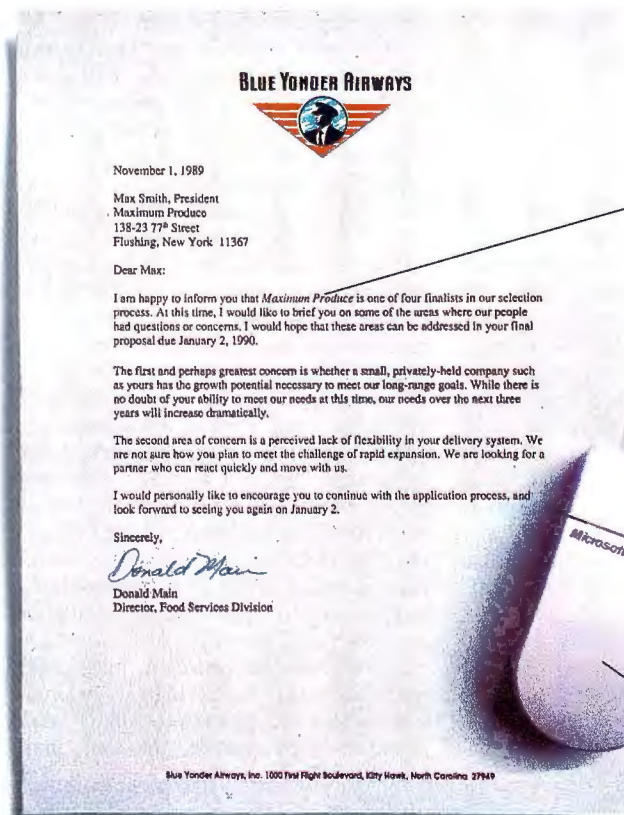
Help wanted.

Word for Windows context-sensitive, on-line help gets you up and running quickly. And keeps you there.



Customize your menu to serve you.

You can create your own time-saving menu commands to speed up your daily routine. And we've combined sophisticated features like macros, Styles and glossaries into Document Templates, bringing task automation to a new level.



Express yourself.

Change everything from the size of your type to the look on your face.

Choose your weapon.

Word for Windows was designed with the mouse in mind, but it can be used equally well with keyboard commands.

strokes. Now you can rely on icons that are instantly understandable. No more prompt this for that to happen. Prompt that for this to happen.

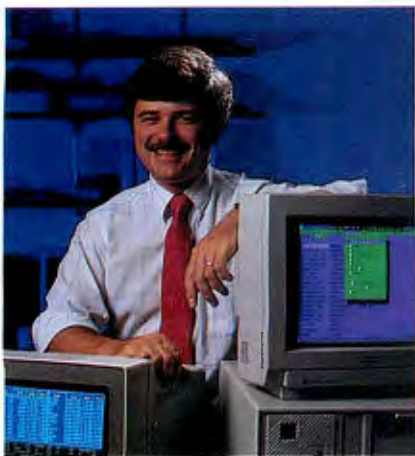
We've even devised a way for Word for Windows to utilize your existing work, by giving it the ability to directly read and write a number of file formats, including DCA, WordPerfect®, WordStar®, Word for the PC and MultiMate®.

To see exactly what we're talking about, call

(800) 541-1261, Dept. K51. We'll send you a free brochure or a fully-functional Working Model for \$9.95*.

We truly believe that Word for Windows, and the graphical user interface, are the way of the future. And the future is now.

Microsoft
Making it all make sense®

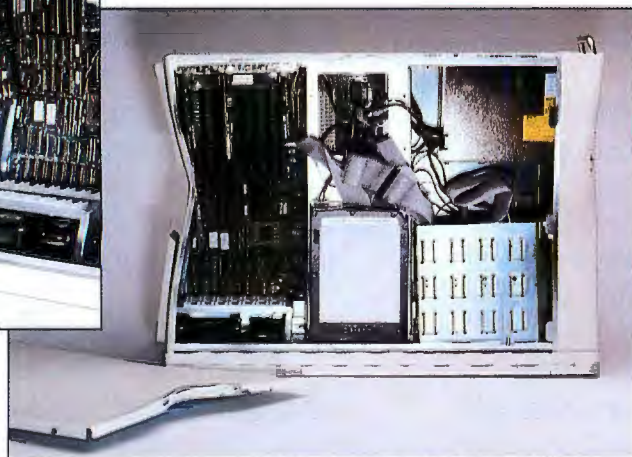
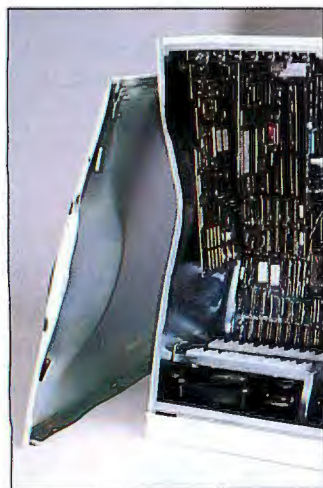


How Do You CRUSH AN 80486?

You drop it from a plane. Here's an update on the ups and downs of mail order.

I admit it: I'm a mail-order junkie. My two main home-office computers are mail-order clones. Almost all the rest of my personal-use equipment—printers, monitors, cables, modems, add-in cards, supplies, software—also came by mail. Name something computer-related, and I've probably bought it by mail.

The reason why I'm such a devoted mail-order fan is simple: The clone computers I've ordered by mail typically cost about half to two-thirds of what similar store-bought systems would have cost.



Brand name hardware and software also generally costs less by mail. But there's no free lunch; there have been snags, ranging from bad motherboards to bogus power supplies to flaky chips.

Then there are the times when things *really* go wrong. Look at the mail-order nightmare shown in the photos below; that's what's left of a brand-new 80486 machine that was shipped to BYTE for evaluation. Along the way, it had the extraordinarily bad luck to end up on the bottom of a pile of cargo that (literally) fell out of a plane at a New Jersey airport. But since that system was covered by the shipper's insurance, we received a replacement within days (see our First Impression of the Hawk II on page 96D).

Similarly, the other problems that I mentioned were covered by warranties, and the end results were reliable, fully functional, low-cost systems. The only real drawbacks were the moderate bother of troubleshooting and the hassle of sending the machines back for repairs or replacement. In effect, I was subsidizing mail-order's low cost with my own labor and inconvenience.

If that were the end of it, mail order might be worth considering only in situations where you are free to supply labor or suffer inconvenience. However, mail

order is changing.

For one thing, mail-order shops are better at testing the equipment they ship, and, when problems do crop up, the larger, reputable firms offer really good telephone support with toll-free numbers, reasonable hours, and knowledgeable technical-support staffs.

Some mail-order firms have beefed up their warranties to include on-site repair service. Other companies guarantee fast repair times or offer loaner computers. With policies like these, the best of the mail-order companies can come close to matching the kind of service you might normally associate with a retail or value-added reseller (VAR) operation.

Mail order isn't good for some things. For example, if you want the latest technology, brand name manufacturers are your only choice, and some of these are not available by mail. Or if out-of-the-box reliability is critical, you'll do better by having a local dealer or reseller set up and test your system before it's delivered.

In the event of a problem, a service-minded local firm probably can respond much faster than most mail-order companies. And, if your computing needs are complex (e.g., if you're trying to interconnect a large quantity of dissimilar equipment), a hands-on, personally involved local dealer or reseller is much more able to help you make the right choices, and to get everything up and running, than is a mail-order firm.

That's why BYTE buys its office equipment from a number of sources, including VARs, retail, and mail order. If you choose carefully, you can find the right combination of price and service you need. With commonsense guidelines (like those printed in the Microcomputer Marketing Council's "Buy with confidence" ad that often appears in BYTE), mail order can be a great addition to your purchase options. Check it out.

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

Integrated Software for Schematics & PCB Artwork



Introducing HiWIRE®-Plus

Wintek's smARTWORK® pioneered low-cost printed-circuit-board CAD. Then HiWIRE set the standard for productivity and ease-of-use in schematic capture. Now Wintek introduces HiWIRE-Plus, integrating HiWIRE's schematic features with a powerful printed-circuit-design facility.

Creating Schematics

With HiWIRE-Plus, simply connect library symbols with wires and buses. Creating and changing symbols is fast and painless. Produce your drawing using a dot-matrix printer, laser printer, or pen plotter.

Circuit-Board Design

HiWIRE-Plus gives you all the design freedom you want: you choose the grid size, trace widths, and pad shapes. The board size and number of layers are virtually unlimited. HiWIRE-Plus is perfect for surface-mount, micro-strip, and ECL applications.

Current Versions

HiWIRE-Plus V 1.3r0
smARTWORK V 1.4r6

HiWIRE-Plus Advantages

- ☐ One tool for schematics and printed-circuit artwork
- ☐ Easy-to-learn menu-driven operation; complete documentation and tutorial
- ☐ Schematic libraries with TTL, CMOS, ECL, ladder, micro-processor, and discrete components
- ☐ Netlist and bill-of-materials utilities included
- ☐ Circuit boards up to 60x60 inches and 256 layers
- ☐ Variable grid size, trace width, and pad size (.001" resolution)
- ☐ PCB library with DIPs, SIPs, SMDs, PGAs, TOs, and edge and D connectors
- ☐ Schematic-to-layout cross-checking
- ☐ Design-rule checker
- ☐ 800 number for free support



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System Requirements

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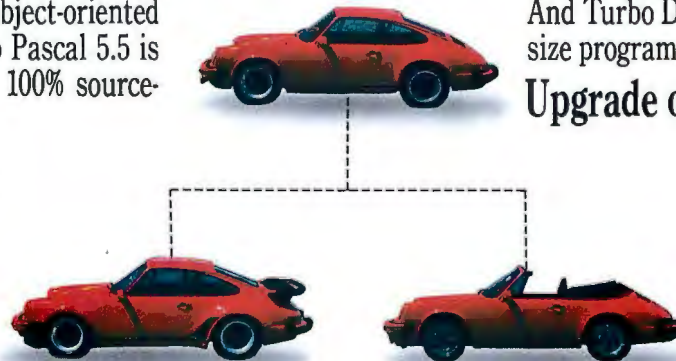
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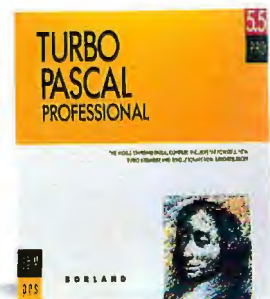
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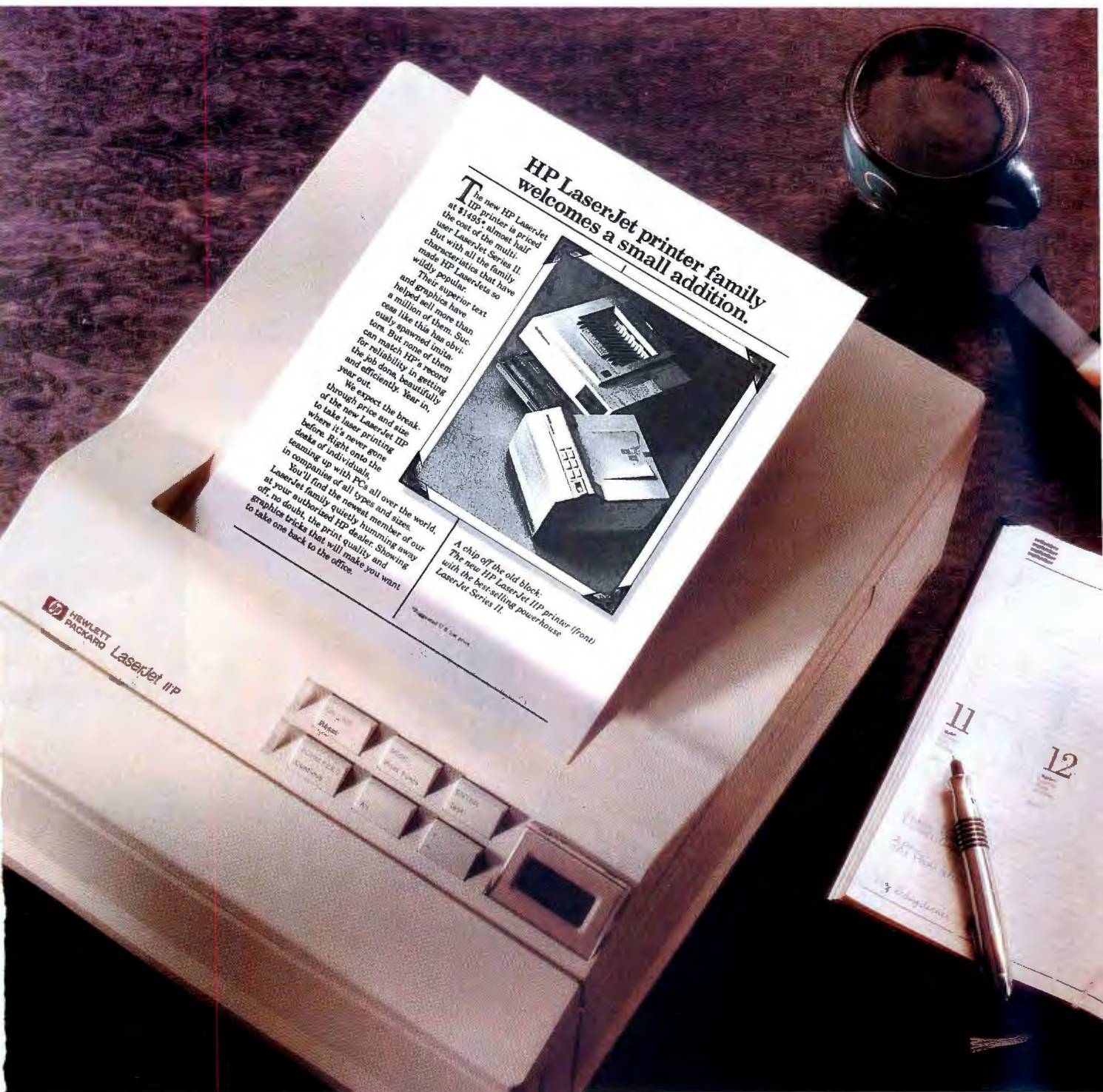
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MICROBYTES

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

New Connector Could Speed Memory Access

A new technology on the way should help shrink the gap between memory-access speeds and the rapidly increasing clock speeds of microprocessors, a gap that's hampering major advances in system performance. One thing that slows down computer performance is the connection between a system board and an add-in board. Augat, Inc. (Attleboro, MA) has designed a new connector that reduces signal propagation delay to one-third of the delay time inherent in conventional fiberglass "four-row box" connectors, which are typically used to hook expansion boards to the backplane bus or system board.

Augat says that its new Electronically Invisible Interconnect (EII), which is made from a flexible polyimide material, not only can handle three times the propagation speeds of conventional connectors, but also exhibits much lower signal distortion and interference (or "crosstalk," as it's called in the circuit business). One key feature of the new interconnect is the absence of ground pins, which are replaced by a single continuous ground plane, allowing as many as 80 signal lines per linear inch, versus 20 to 40 lines per inch on conventional connectors. The im-

pedance of the flexible connector is also matched to both the daughter-board and the system board, which is another factor in producing high signal integrity. (The connector comes standard with an impedance of 50 ohms, but it can be customized.)

The EII costs three to four times the price per line of a standard connector but requires fewer lines because the ground pins are eliminated. According to product manager Mike Prisco, initial customers will be mostly mainframe and superminicomputer vendors. However, workstation makers will eventually begin using these types of connectors. Augat engineer Muti Siddiqi commented that a major application for this type of connector will be in cache memory designs, speeding up propagation between the memory cache, the processor, and main system memory.

"The connector industry is going through a crossroads," said Prisco. "Signal integrity is a major issue. People are talking about it and doing something about it." Prisco said other companies will be offering advanced connector products in the near future. Augat has prototypes of the EII available now and plans to be in full production this year.

Mighty Processors Will Help "Humanize the Interface" with Speech and Vision

With Intel promising a 250-MHz chip cranking out 2000 MIPS and Motorola no doubt quietly planning the same, many personal computer users in the next 10 years will have more processing power than they know what to do with. But developers will be able to tap into that power to go beyond the 1980s-style keyboard and mouse to create computer interfaces that are truly revolutionary.

"I believe that within two to three years we'll see single-chip 250-MIPS processors available as improvements in CMOS and package technologies continue," says Andrew Heller of

Kleiner Perkins Caufield and Byers, a computer consulting firm. "At that kind of power you start to think about humanization of the interface, not just being user-friendly," he says. "We'll see things along the line of improved speech and handwriting recognition, and visualization."

David House, vice president of Intel's Microcomputer Components Group, agrees. Extremely integrated devices, expected later this decade, will provide enough raw processing power to bring full-motion video and speech recognition to tiny, single-chip computers, House says.

continued

NANOBYTES

Sharp Electronics (Mahwah, NJ) says that it has developed film-compensated supertwist LCDs, which are thinner and lighter than double supertwist and transmit 30 percent more light. New "edge-lit" backlighting that uses only two cold cathode fluorescent tubes (instead of the usual four) will also reduce weight, thickness, and power consumption of these displays, the company says. Sample units incorporating these technologies should be available early this year. In the area of active matrix color LCDs, Sharp said that it will soon deliver 4- and 6-inch thin-film transistor LCDs for the OEM marketplace. Sharp currently sells a portable computer with a 14-inch color LCD.

Software companies are committing to Microsoft **Windows** in "the tens of thousands," says Rick Barron, president of **Affinity Microsystems** (Boulder, CO). Affinity's Tempo program can record and replay Windows keystrokes and mouse movements. "We had our product ready in 1988," says Barron, "but there was no market. Microsoft even admitted that there were only about 100,000 users [of Windows]." Now, Barron claims, his company has been deluged with inquiries from other software vendors, who want to bundle the Tempo macro facility with their own products to automate their use under Windows. "These companies are talking about selling thousands of units," he says.

Dolphin Server Technology (Oslo, Norway) plans an emitter-coupled-logic version of Motorola's **88000 RISC** architecture that the company says will have a clock speed of 125 MHz and be able to execute 1000 MIPS; with unoptimized code, performance will average 300 MIPS. The processor will also be able to execute eight instructions in parallel.

NANOBYTES

One of the highlights of the recent IEEE Wescon show was **automated design software**, aimed at speeding up the process of developing, testing, and manufacturing electronic components. No longer limited to programs for printed circuit board design, these packages now have more sophisticated capabilities, such as auto-routing, logic synthesis, and simulation. A big exhibit section, called the Automated Design Center, featured some 75 vendors showing products that can help eliminate some of the dirty work. Many of these packages were running on personal computers rather than workstations. Exhibitors included CAD Software, OrCAD Systems, Racal-Redac, and Applied MicroSystems.

In spite of an economic slowdown this year, the **outlook for the electronics industry** looks promising, economist Mario Belotti told an audience at Wescon. Belotti, a professor at the University of Santa Clara, said businesses will spend less this year on equipment, but what they will spend will be for modernization, which means more money for electronics and telecommunications. Global competition will fire up in the 1990s, he said, with the emergence of high-tech facilities in Indonesia and other Far East countries.

Will U.S. Memories become only a memory? In recent months, Sun Microsystems, Apple Computer, Unisys, and NCR declined to join the cooperative chip-production venture aimed at ensuring a domestic supply of memory chips. Sun said that its decision was based on its assessment of "long-term DRAM trends, the company's memory requirements, and the risks and benefits of such an investment." Sun has "long-term contracts in place today" with American, European, and Japanese memory chip suppliers, a Sun spokesperson said. So far, seven companies have committed to help fund the chip cooperative: IBM, Hewlett-Packard, Digital Equipment, Intel, LSI Logic, National Semiconductor, and Advanced Micro Devices.

Michael Homer, Apple Computer's director of product marketing, says that whether central processors operate at 25, 100, or 1000 MIPS, the challenge comes in designing new interfaces, including continuous speech-recognition and speech-synthesis capabilities. "The biggest issue won't be how fast a computer can go, but how we can use that power to improve communication with the system," Homer says.

"To me, the most interesting thing will be communicating with the user: the user interface," says Andrew Hertzfeld, self-styled "software wizard" and member of the original Macintosh engineering team.

"Another interesting way to use all those MIPS is to interpret what the user is going to do next," Hertzfeld says, "to try to present the user with solutions instead of running through some menu hierarchy."

Single Chips Feature Double Graphics Modes

Two chip designers have taken two IBM graphics modes and squeezed them onto one slab of silicon, integration that should yield less-expensive graphics boards.

The new IGA (Integrated Graphics Array) controller from Integrated Information Technology (Santa Clara, CA) combines a VGA controller and an 8514/A controller on a single piece of silicon. The VGA section can handle CGA, MDA, Hercules, EGA, and standard VGA modes—up to 640 by 480 pixels with 16 colors, or 320 by 200 pixels with 256 colors from a palette of 256,000—as well as "Super VGA," which can handle 800 by 600 pixels with 16 colors. The 8514/A controller can display up to 1024 by 768 pixels with 256 colors from a palette of 256,000; it matches the IBM 8514/A graphics commands for drawing lines and rectangles and moving graphics blocks around on the screen.

PC graphics cards exist that offer both VGA and 8514/A compatibility, as IIT's Gene Parrott points out, but they really just combine two complete video subsystems on a single card, each with its own memory and support chips. And while the VGA section of one of these two-in-one cards typically uses the same DRAMs that IIT's IGA chip requires, the 8514/A side usually requires specially designed video RAMs that cost two or three times what standard DRAMs cost. VRAMs simplify video controller design, but because they take care of all CPU/video conflicts internally, they're more expensive to produce, and, accordingly, that pushes up the prices of cards that use them.

But the IGA chip uses just one video subsystem—with standard DRAMs. The key to making it work, according to Dr. Y. W. Sing, IIT's

vice president for engineering, was eliminating the standard hard-wired graphics controllers. To replace them, IIT designed a 25-MIPS RISC processor for handling graphics commands and then built the VGA and 8514/A functions around it. Sing admits that an IGA video controller board might not be quite as fast as some systems that are based on VRAMs.

The chip is currently being tested by several potential customers, and it should appear in half-size PC graphics cards next year, Parrott says. A low-end IGA-based card might have 8514/A command compatibility, 640- by 480-pixel resolution, and a list price as low as \$399. That would change 8514/A from a luxury to a commodity, since right now 8514/A cards are more expensive than their high-performance competition, such as Texas Instruments Graphics Architecture cards using Texas Instruments' 32010 and 32020 graphics controllers.

Trident Microsystems (Sunnyvale, CA) has also paired 8514/A and VGA on the same slab. The Trident Advanced Video Array 9000, a 1.2-micron CMOS chip, is register-compatible with the 8514/A specification as well as with VGA, EGA, CGA, MDA, and Hercules graphics. It supports resolutions of 1024 by 768, 800 by 600, and 640 by 480 pixels, and up to 256 colors. As with IIT's chip, the TAVA will work with DRAMs instead of VRAMs. Trident says that it will provide software drivers for several applications, including Windows, GEM, PageMaker, Lotus 1-2-3, Ventura Publisher, WordPerfect, and AutoCAD, as well as the X Window System, Windows/386, and Presentation Manager. The company expects to

continued

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NANOBYTES

Here's how to get that digitized photo of Elvira painted on the front of your house: The new Michelangelo Paint Jet System produces images as large as 5 by 5 feet on just about any type of surface, including concrete, brick, wood, tile, cloth, and glass. The printer connects to a PS/2 computer; its controller directs a paint sprayer to put down three primary colors (yellow, magenta, and cyan) line by line. The jet sprays acrylic resin paint that the vendor says dries quickly and is water resistant. Painting a 5-foot-square image takes up to 4 hours. And the price, like the images, is big. A representative of distributor Fleming-Dobler B.V. (Westervoort, Holland) said the Paint Jet System costs around \$100,000.

Users have three main needs that the computer industry still hasn't fulfilled, said David Liddle, chairman of Metaphor Computer Systems, at a recent conference: the ability to access data no matter where it is, tools that can be operated by all users, and tools that let even computer novices develop applications. While concepts such as Structured Query Language and client-server computing have helped improve access to data, users still have to become experts in their applications and ping-pong between the abstractions of their jobs and the abstractions of computing, Liddle said.

Hewlett-Packard (Palo Alto, CA) has developed a new microprocessor design technology that the company says will enable it to put its entire RISC-based Precision Architecture on a single chip and to at least double the performance of systems that use the CPU. The new CMOS chip, which is about 2 inches on each side and contains about 1 million transistors, will offer clock speeds of greater than 48 MHz and require less than 10 watts of power, HP says. Integer performance will reach 50 to 60 MIPS, according to an HP official. Although the chip will first appear in minicomputers and workstations, HP plans to use it across its entire line of computers.

ship a TAVA-based board early this year; it will probably sell for about \$795, said Trident president Frank Lin. Although 8514/A provides "stunning displays," Lin said he

doesn't think the IBM specification will be the ruling graphics mode and that even IBM is looking at other styles. "I still believe VGA and Super VGA will be dominant," he said.

RISC Changing Shape of Dedicated Controllers

One of the most interesting things about Integrated Information Technology's new Integrated Graphics Array chip is that, at heart, it's not really a graphics chip at all. Instead of building the usual hard-wired graphics controller, IIT designed the IGA around a 25-MIPS RISC processor. It's actually a very small computer, running a program stored in its own ROM to perform 8514/A graphics commands.

Programmable microcontrollers have been part of PCs from the beginning, and CPUs are currently designed into plug-in boards that aren't billed as coprocessor cards. But RISC should push the notion much further in the coming year.

Probably the most popular CPU currently being used on circuit cards is the Intel 80186. Originally an improved 8086, the 80186 also has many of the features of an embedded controller, such as timers, DMA channels, and a wait-state generator. The 80186 never found much of a home as a CPU for PCs; IBM passed over it, jumping directly from the 8088 to the 80286 used in the AT.

But the 80186 has recently begun to show up in PS/2s—on add-in peripheral cards. The PS/2's Micro Channel Architecture has made it possible to pump large amounts of data to and from add-in plug-in cards—and the 80186 has proven to be very good at handling all that data. Because it has all those embedded-controller features, hardware designers can build the 80186 onto a card relatively easily. More important, the software can be created with the same development tools used to crank out regular PC-compatible programs.

The 80186 is also showing up on the first crop of Extended Industry Standard Architecture bus master cards. A bus master can take control of the computer's address and data bus away from the main CPU (usually an 80386 or 80486) to move data within the computer at top speed. The 80186's address and data buses are already highly compatible with the 80386 and 80486 CPUs, so the 80186 has become a hot item.

RISC is beginning to make inroads into this area, too. A company called Microchip (formerly the microprocessor division of General Instruments) offers what it calls "the world's best-selling RISC processor," a relatively low-powered 8-bit chip designed to be used as a controller. Microchip says that it expects to see its RISC chip used in mice and other PC components in the next year.

RISC can be used to its full advantage in these controllers. The software that runs on a CPU acting as a controller has to run as fast as possible—no wasted cycles or inefficient instructions allowed. Because RISC instructions are very fast, it's possible, and practical, to fine-tune the software by hand, pushing it to maximum speed.

IIT's IGA graphics chip takes these two ideas—the 80186's CPU with embedded controller features, and Microchip's RISC controller—and merges them. Instead of replacing a dedicated controller with a RISC chip, IGA puts a RISC chip inside the dedicated controller. If other companies take this approach, it should mean more power and flexibility in disk and network controllers and less time required to design those controllers.

Low-End Macs Can Now Run Mac II Programs

Macintosh users who are operating a 68000-based machine will be able to run math-intensive programs for high-end Macs, thanks to new software from a West German

company. XMath, from d'ART Computer (Kiel, West Germany), emulates Motorola 68020 and 68881 instructions on a Mac SE, Plus, or

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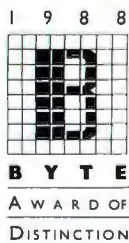
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NANOBYTES

Intergraph (Palo Alto, CA) has signed up **Samsung Electronics** as a second-source producer of Intergraph's Clipper RISC processor. Samsung will also help in the development of future versions, which could make Intergraph an even more significant producer of RISC chips. The company says that it has sold about 30,000 Clipper-based systems, as compared to Sun's 35,000 SPARC-based systems.

As for a **shakeout in the RISC business**, Intergraph's chief of its Advanced Processor Division said that it's not likely. Howard Sachs, who helped design the Clipper chip when it originated at Fairchild Electronics, said that there will "always be four or five players in the RISC market." He named seven: IBM, Sun, Hewlett-Packard, Motorola, MIPS, Advanced Micro Devices, and Intergraph. Increased migration to Unix and development of greater software compatibility will allow customers to choose more than one RISC architecture, he said.

XyQuest (Billerica, MA) has published a guide to the XyWrite programming language, which combines word processing functions with programming tools. The 124-page book (\$29.95 plus \$2 shipping) comes with a disk of sample programs and utilities. Phone (508) 671-0888.

Great expectations: Joe Tucci, president of **Unisys** (Blue Bell, PA) said he's counting on his company's immense contract with the Air Force to propel the firm into the forefront of desktop computing. Unisys, known for its large systems, recently won a bid to deliver \$700 million worth of computers to the Air Force; that's 250,000 80386-based AT compatibles. (Zenith, which expected to land the Desktop III contract, subsequently protested the award, and the situation was unresolved as we went to press.) In an interview with Microbytes, Tucci also said that "the potential is there" to sell even more computers to the Air Force.

Portable. With XMath, programs designed to run only on the Mac II can also run without modification on low-end Macs, which are based on the Motorola 68000 processor and do not have the 68881 math coprocessor.

XMath's major benefit, according to d'ART president Wilfried Beeck, is that it lets software developers compile a single version of their products that will run on all Macs. Without XMath, according to Beeck, programs that make direct calls to the 68881 coprocessor will not run on the lower-end Macs. To run on the 68000-based Macs, separate versions of the program must be compiled that use the Standard Apple Numeric Environment (SANE), which emulates the 68881 chip but does not let you use direct 68881 calls.

Beeck claims that XMath performs floating-point operations on low-end Macs up to 10 times faster than if you use equivalent SANE operations. It also allows developers to optimize their software for the Mac II without having to worry about compatibility with the lower end of the Mac product line, the company says.

Many CAD and spreadsheet companies offer separate versions of their software for low- and high-end Macs (e.g., WingZ, Mathematica, and VersaCAD), Beeck points out. With XMath, a single version optimized for the 68881 will work on all machines. Beeck says that the software works just as well on the 68882 and 68030 processors used for the Mac IIx and IIcx, since the instruction sets are compatible. However, XMath does not emulate the built-in paged memory management unit of the 68030.

Several "major software vendors" have licensed XMath and will integrate it into future versions of their software, according to Beeck. He claims that more than 50 percent of the number-intensive applications shown at the next MacWorld Expo will be using XMath. The only competition comes from Radius's SANE and Bravo's SPAMM, which try to optimize SANE operations but do not support direct 68881 calls, Beeck says.

XMath is available only to developers and only on a licensed or royalty basis.

MIT Gets X Window Running on NeXT Cube

While most of the Unix world has moved toward the X Window System as the windowing system for workstations and applications, the NeXT Computer uses a proprietary windowing system. But now MIT (Cambridge, MA), which developed and distributes X Window, has come up with a version that runs on the NeXT cube. After buying a number of NeXT machines, MIT wanted to integrate them into its Athena computing environment, which makes use of X Window.

The X Window port to the NeXT lets the user create a NextStep window on the screen, which is equivalent to an X Window device, according to

NeXT, Inc.'s Barry Silverman, who worked with MIT on the X Window port. This means that any application that adheres to X11 calls can run within this window on the NeXT.

Initially, the port supports X11 release 3, and eventually it will support release 4. MIT will make the X Window port for the NeXT publicly available on tape later this year. MIT will monitor bug reports and make changes to the code as necessary.

NeXT has no plans to support MIT's port of X Window to its machine, according to Silverman. The project was primarily for MIT's internal use, but, as is customary, MIT releases its programs for public use.

TI's Chip Could Cut Cost of Graphics Boards

So-called beyond-VGA graphics boards, which offer VGA compatibility and resolutions of up to 1024 by 768 pixels, are hard to come by for less than \$1000. But this situation could change as manufacturers start using Texas Instruments' new

Business Graphics Array logic controller for TI's 34010 graphics coprocessor. The new 34092 logic chip replaces much of the custom glue logic currently required on 34010-based high-resolution graphics boards.

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NANOBYTES

Modest expectations: Lotus CEO **Jim Manzi** can't be accused of overhyping Notes. He warned that his company's new "group communications software" won't bring instant results. "Notes is not a product that you can just buy and put up on a screen and expect immediate miracles," Manzi said.

Although Lotus officials say that Notes provides for "many-to-many interaction" among geographically and personally diverse people—Manzi said it can "reach across space and time"—the Notes vision of collaboration does not yet include people who use computers not based on Intel processors. Lotus is considering plans to bring groupware to non-DOS or non-OS/2 systems, "but we're making no announcements," said Larry Moore, general manager of the Lotus division that brought Notes to market. It's "technically feasible" to adapt the software to Macs or Unix systems, said Ray Ozzie, president of Iris Associates (Westwood, MA), which conceived the product back in 1984.

Facing a crowded Fall Comdex conference room, Gordon Eubanks, president of Symantec, said, "The last time I spoke before an audience this big was at a show called CP/M '83. Things in the industry were changing then, too." Eubanks, who in 1983 was marketing Digital Research's version of CP/M, said that things would have been much better if "all those people had just bought CP/M-86."

Along with Valentine's Day this is the month to celebrate **National Engineers Week** (February 18–24). This year the sponsors are conducting programs aimed at encouraging high school students to consider "the exciting world of engineering." Illustrious engineers such as **Burt Rutan** will be spending the week teaching students. And the National Academy of Engineering will present the first annual Charles Stark Draper Prize to two men to whom this entire industry is eternally indebted: **Jack Kilby** and **Robert Noyce**, who independently invented the IC.

The chip provides a memory controller and a "display pipeline controller," which handles the resolution and color palette on the screen. Otherwise, board manufacturers have to implement these memory and display control functions themselves.

The new chip will cut in half the required size of 34010 graphics boards and will significantly reduce the development and production costs of such boards, according to Leslie Price of the TI Graphics Group (Dallas). "The least expensive TIGA [TI Graphics Architecture] boards are in the \$800 to \$900 range," she said. "Because of this chip, prices should drop to about \$500 or \$600" by late

this year, she added.

TI's 34010 graphics coprocessor is used in high-resolution graphics boards for both Intel- and Motorola-based systems. Hewlett-Packard, Number Nine, Truevision, and several others offer graphics boards based on the 34010. With the new logic chip, these companies should be able to offer more competitively priced high-resolution graphics boards.

Prototypes and specifications of the 34092 are slated to be available soon, the company said, with volume production scheduled for the middle of this year. TI is working on a similar chip for its more powerful 34020 graphics processor.

After the Revolution: A Sampling of Forecasts

The end of a decade has a way of stimulating prognostication. As this issue went to press, 1989 was gasping its last breath, and some of the people who helped shape computing in the 1980s were talking about what they expect computing to be like in the 1990s. Here are some forecasts.

Steve Jobs, chairman of NeXT: "The era of personal computing has ended." The 1990s will be the decade of "interpersonal computing," putting users in an environment that transcends connectivity, E-mail, and shared data.

Jim Manzi, chairman of Lotus: "The PC revolution is now over." Service—servicing all those computers and helping users deal with complex programs—and not raw technology, will drive the next cycle in the personal computer industry. Revenues from systems integration services will jump from \$5 billion this year to about \$15 billion in 1993.

David House, vice president of Intel's Microcomputer Components Group: By 1993, look for the 80586 chip, containing 5 million transistors; by 1999, Intel will deliver the 80786, a chip that will run at 250 MHz and zip through 2000 MIPS. With this much power behind them, user interfaces

will change dramatically.

Steve Ballmer, vice president for systems software at Microsoft: Along with graphical user interfaces, two elements will be critical in the next half-decade: the ability to work easily with multiple applications from different software developers, and "information at your fingertips," the ability to use all data you need with any application.

Gordon Eubanks, president of Symantec: "In the 1980s, the PC changed the world, if not the computer world, forever." In the 1990s, the role of personal computers will expand from serving individual needs to serving the collective needs of groups.

Bill Joy, vice president of research and development for Sun Microsystems: The majority of desktop machines in the year 2000 will run DOS or Unix. "In five years, most desktop machines will be replaced by laptops anyway."

Mike Swaveley, president of Compaq North America: This decade will see a significant improvement in price-to-performance ratios for personal computers, which will be "functionally built into the basic wiring of the home. PC technology will be part of the book, part of the appliance."

NEWS STAFF SEEKS NEWS. DIAL (603) 924-9281.

The BYTE news staff is always interested in hearing about new developments that might affect microcomputers, the way they work, or the way people work with them. If you know of a project that could shape the state of the art, please give us a call at (603) 924-9281 or write to us at One Phoenix Mill Lane, Peterborough, NH 03458. An electronic version of Microbytes, offering a wider variety of computer-related news on a daily basis, is available on BIX.

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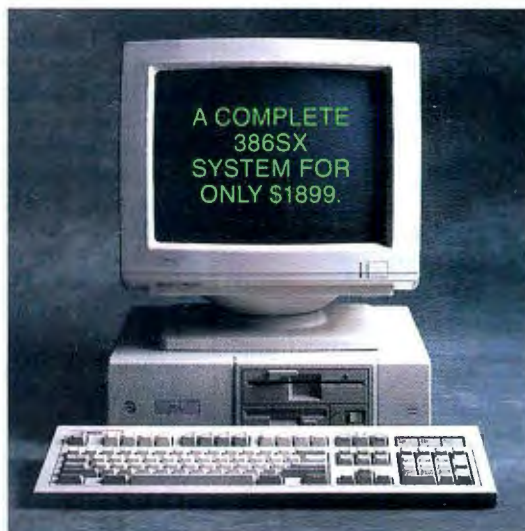
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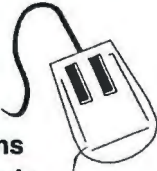


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LETTERS

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BASIC Inventor Praises Gates

In his article, "The 25th Birthday of BASIC" (October 1989), Bill Gates hit two bull's-eyes. BASIC is a language whose purpose was, and is, to make it easy for beginners and others to write programs. And BASIC is here to stay.

As a teacher, I have been required to teach or know about such languages as Pascal, PL/I, FORTRAN, and C. Programming in BASIC for any problem is at least twice as simple. Like Bill Gates, I switch to BASIC (actually, True BASIC) when I have a tricky programming problem to solve.

The ANSI Standard for BASIC extends the areas in which BASIC is considered legitimate. The International Standard for BASIC (technically equivalent to the ANSI Standard) is in the final stages of its approval. It will soon be possible, for example, to distribute subroutine libraries written in Standard BASIC and expect that the recipients can use them anywhere in the world.

We at True BASIC join Bill Gates in wishing a long and productive life for BASIC.

Thomas E. Kurtz
True BASIC, Inc.
West Lebanon, NH

Genealogy of GUIs

In "A Guide to GUIs" (July 1989), Frank Hayes and Nick Baran say that the genealogy of early GUIs (graphical user interfaces) was "straightforward: Researchers at Xerox's Palo Alto Research Center begat the Xerox Star; Steve Jobs visited PARC, saw the Star, went back to

Apple, and begat the Mac."

Not so. It is wrong as to both chronology and personnel, as readers of BYTE will be aware ("Macintosh's Other Designers," August 1984). It should have said, "Researchers at Xerox's PARC begat the Xerox Alto; Jef Raskin visited PARC, saw the Alto, went back to Apple, and begat the Mac."

The Xerox Star came later. Jobs first visited PARC after the Mac project had already been conceived, and he didn't join the project until the Mac had been under development for about two years.

Jef Raskin
Pacifica, CA

Software Plays Catch-Up

What a shock it was to open my mailbox and see the September cover of BYTE—a 25-MHz 80486! Programmers are just now scratching the surface of the 80286.

Everyone is concerned with speed, but no one has written code that effectively uses the 80286 and 80386 chips. Hardware developers are at least four to six years ahead of the software developers. Want to see a computer fly? Stop putting 8088-based software in an 80386 machine.

Wayne F. Brissette
Austin, TX

Enough Is Enough

Fred Langa's editorial, "Hip Deep and Rising" (October 1989), said something I've been waiting to hear for some time. Almost all the other computer magazines are trying to whip us into a feeding frenzy to buy all sorts of stuff. They got me. I just bought 2 megabytes of RAM when all I needed was 128K bytes.

Once the 80386SX was hailed as the greatest development in computer hardware since electricity, then it was the 33-MHz 80386, and now it's the 80486. These great revelations were made within months of each other.

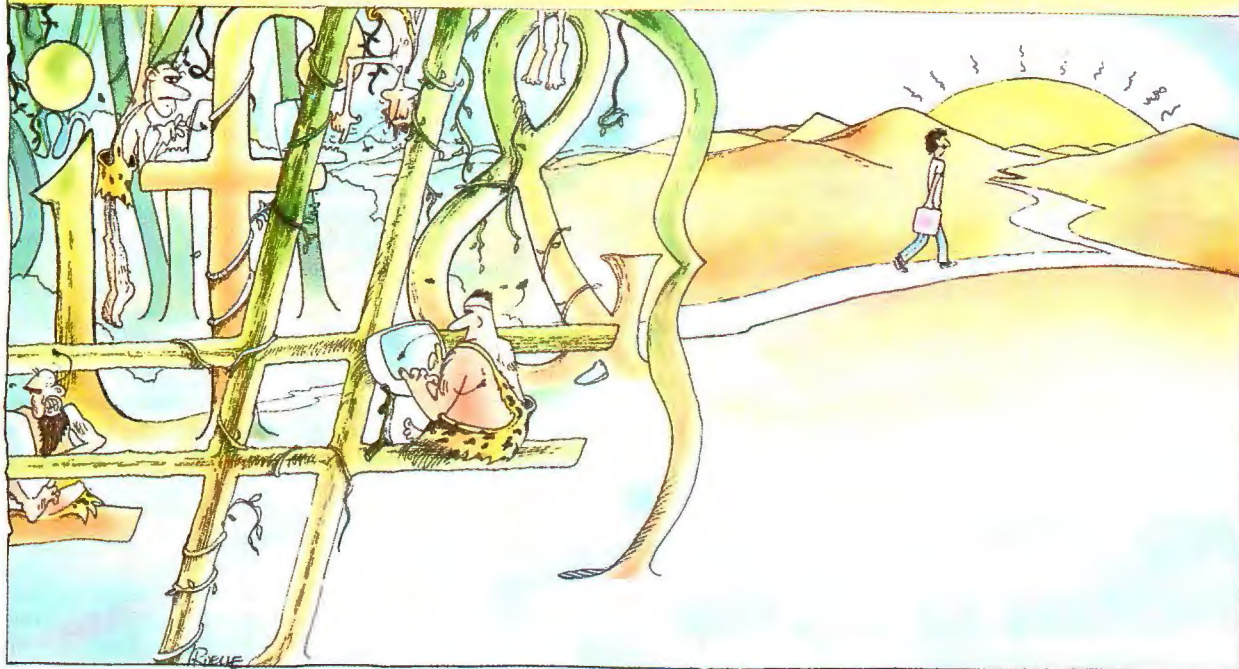
The fact is that an "obsolete" PC AT in full battle dress has more than enough firepower to bludgeon its way through most office applications. The 80286 is

continued

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

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.

Great Moments in C-Programmer Evolution



Code-dweller emerges from the jungle

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—Randy Jones, Beta Tester

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far from being dead.

Computer magazines need to focus on how to use the machines and software. I don't think they understand what the average user does for a living. Many of BYTE's articles are over my head, but trying to figure them out gives me a feel for the technology. I can now stand toe-to-toe with most technocrats on what counts—how to use the blasted things.

Michael Q. Gautier
Woodbridge, VA

Don't Forget the Amiga

I find BYTE the most universally informative magazine of all the general microcomputer publications. However, it is straying into a straightjacket mentality of being not much more than "IBM World/Mac World." BYTE seems to lack the generality it used to have.

A third computer is maturing into a solid and powerful alternative. It offers strengths in video and animation, as well as a genuinely multitasking operating

system. This is, of course, the Amiga. BYTE has mentioned it in articles concerning multitasking, graphics, GUIs, and so on.

Perhaps you could publish an Amiga supplement. Thanks for your quality publication.

Jeff Johnson
Cincinnati, OH

Optical Opinions

Being in the optical drive business, I was particularly interested in your October 1989 Product Focus, "The Optical Option." Although the article seemed fair, I thought that it was incomplete and that it stressed access time, data rate, and price too heavily.

Optical drives are at about the same stage of development as hard disk drives were 10 years ago. The technology is difficult, and the chip sets have not yet been developed.

Prices are high because sales are low, due to a developing marketplace. Access time and data rates are hindered by heavy optics and limited laser power. The good news is that all these factors are rapidly improving.

At Laserdrive, we concentrated on ease of use and reliability issues at the time of design, surpassing the competition in capacity and performance. The market is not static, and we are no longer tops in capacity, performance, or price. But I believe we are still the best in terms of reliability. We have recently made improvements in performance, cost, and packaging.

To judge design reliability, you might have listed some of the format variables, such as mark sizes, track pitch, and sector format. All optical drives have the potential for grown defects, and the method for handling these occurrences should be listed. You might have tested for data recoverability in the presence of added dust.

The servos for tracking, focus, spindle, and laser control are also important. Laserdrive uses servos that are adaptable to changing conditions. A few tests could reveal the ruggedness of the servos: operation during shock, vibration, temperature and humidity extremes, and high altitude. Of course, some of these tests are difficult to perform.

For WORM (write once, read many times) drives in particular, the method of interfacing the host system is important. Laserdrive uses the method of making the drive emulate a hard disk drive. With the appropriate software driver and SCSI card, our WORM drive can work with

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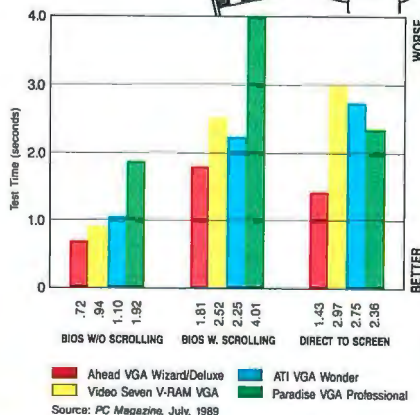
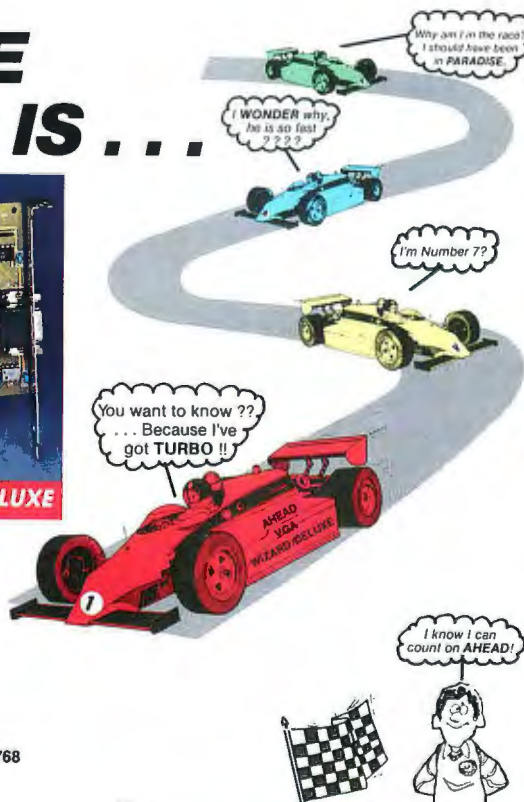
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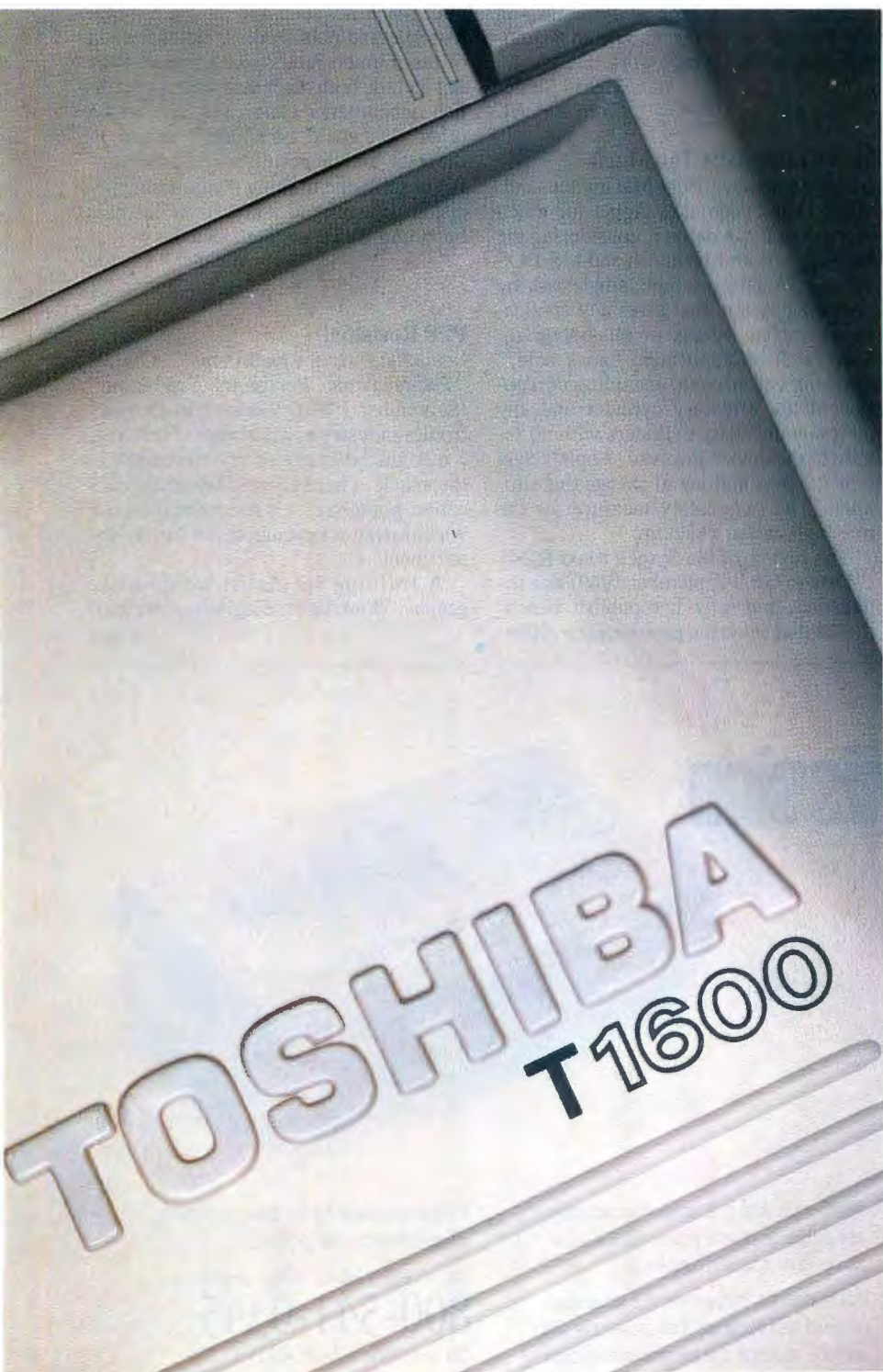
VGA Wizard/3270: for terminal emulation users.



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Your readers should also consider the issues mentioned above.

Ted Rees
Chief Scientist
Laserdrive Ltd.
Santa Clara, CA

I enjoyed the articles on optical disks in your October issue. At my company, we are in the process of selecting optical disk units for our systems, so the articles were well timed.

Regarding the table on page 166, however, I think that the *longer* segments show better performance rather than the shorter ones, as the caption indicates.

Ray Liere
Oregon City, OR

The caption is wrong, and you are right. We're glad you liked the issue.—Eds.

Kudos for Unix /bin

I enjoyed David Fiedler's Unix /bin (August 1989). My knowledge of Unix is minimal, but my interest is high, and I look forward to future installments. I ap-

preciate David's relaxed style and informative, anticipatory dialogue with the reader, and his sense of humor is not grounded in arrogance or cynicism—an increasingly rare phenomenon in technoproses these days. Good work.

Henry Sluder
Charlotte, NC

Don Crabb Asks Too Much

In his September 1989 Macinations column, Don Crabb asks Apple for much more than it can deliver, considering the hardware. Both Macintosh and MS-DOS computers have a simple single-tasking operating system that gives any application complete access to all system resources. If an application "goes wild," anything can happen, including corruption of the directory cylinder and any alternate directory cylinders with no regard to the device involved. Apple's System 7.0 does nothing to change this situation. The *only* safety measure for the masses is called a backup.

The review of the Sysgen Maxi RD45 ("Data to Go," September 1989) was interesting, but why not publish benchmarks that show the performance differ-

ences between the Mac and MS-DOS machines without the need to resort to a scientific calculator? It's possible to have both machines load and save a 5-megabyte file and publish those times instead of the mumbo jumbo you printed. Why not include both machines when you publish benchmarks concerning one or the other? You could use similar software in the tests, and the results would prove useful to someone making a purchasing decision. It's time to add a bit of fairness here, and BYTE ought to lead the way.

Michael J. Barton
Barre, VT

PPP Revisited

I chuckled when I read Peter C. Olsen's "Pachydermic Personnel Prediction" (September 1989). Working in the electronics industry as a manager of training, I recognized many of my coworkers in the article. I have one additional classification guideline. It's the standard I use when hiring a new employee for my department.

A training specialist would make graphs, flowcharts, diagrams, trans-
continued

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Joanne Stein
Culver City, CA

Palomar's Not the One

Thank you for mentioning Palomar Software's contribution to Hewlett-Packard's new DeskWriter printer (Short Takes, October 1989). However, Palomar did not write the driver shipped with the DeskWriter. Instead, we consulted with two Hewlett-Packard engineers, who wrote the driver based on a licensed copy of the Palomar Imaging Kernel.

Joel West
President
Palomar Software, Inc.
Oceanside, CA

CEBus Doing Just Fine

I'd like to comment on your Nanobytes report on CEBus (October 1989).

Rather than simply a specification for communication over the AC power lines in a home, CEBus defines a multimedia LAN for residential use. The network may comprise any combination of power line, twisted-pair, coaxial, and fiber-optic media, and it includes use of infrared and radio frequency devices for wireless applications. Your reporter visited the EIA Home Automation Booth at a recent Summer Consumer Electronics Show (CES) that demonstrated a network using five of these media.

While the booth was essentially unchanged from its first showing at the earlier Winter CES, it is unfair to suggest that little progress on the standard has occurred this year. In fact, the pace has been brisk in preparation for the interim release, which was scheduled for November 1989.

The purpose of the booth is to publicize the standard. The fact that the demonstration products have not been modified recently as the standard has been refined does not imply that little has been accomplished.

Bob Garry
Design Engineer
Diablo Research Corp.
Sunnyvale, CA

Multuser Support

I was disappointed that "The Multuser Solution" (September 1989) did not include our product, Quick Connect/386. We believe Quick Connect/386 to be the premiere multuser operating system on the market and worthy of inclusion in your article.

One significant aspect of multuser software that you did not discuss is the ability to support multiple Hercules, EGA, and VGA workstations. Using hardware developed by companies such as AMR, Viewport Technology, and SunRiver, you can run DOS graphics applications (e.g., AutoCAD, Ventura Publisher, or Corel Draw) on workstations.

Ralph W. Swearingen
President, Virtual Systems
Walnut Creek, CA

ASK BYTE



Musical Prayers Answered

In the October 1989 Ask BYTE column, reader Ivo Busko of Baltimore expressed a desire to build a music synthesizer card using the Commodore sound interface device for the PC bus. That exact product, called the ISS-2001, is available from Innovation Computer, whose phone number is (414) 693-3416. The list price is \$129.96. The ISS-2001 requires an external audio amplifier and speaker to operate.

Richard Zblocki
Innovation Computer Corp.
Cleveland, WI

Innovation sent us a version of its card, and we tried it out in the BYTE Lab on one of our PC clones. It's easy to install, worked right out of the box, and can be controlled by GWBASIC.

—BYTE Lab staff

Compact Unix

Last summer, I had the opportunity to work at AT&T in its college internship program. While there, I was given an AT&T Unix PC Model 7300 to use as a dumb terminal hooked into the larger mainframes. At the end of the program, the company was going to dispose of the computer, so I asked the people in charge if I could have it to use at the college. They agreed.

Although it's not manufactured by AT&T anymore, the Unix PC is still a very good computer. I wonder, however, how the AT&T engineers got the full Unix operating system on just a 10- or 20-megabyte hard disk. When I read about microcomputers using Unix today, I see that they require something like 100 megabytes worth of hard disk space to run Unix effectively.

Also, could you give me a contact at an AT&T service organization? I would like

to call and find out if the company still supports the Unix PC.

Finally, I have a question related to the Intel family of microprocessors. I know what the difference is between the 8088 and the 8086, but what are the differences among the 8086, 80186, and 80286? All three have 16-bit processing and 16-bit data buses.

Kelcey L. Clarke
Fort Collins, CO

On the subject of the AT&T Unix PC, your confusion stems from your use of the phrase "full Unix system." The actual operating-system kernel for Unix is quite small and in most cases can fit easily within 5 megabytes. Systems that you see today require lots of disk space for added utilities and files such as font definitions (which take up a lot of space) and all the support files for the X Window System. If you have the manual on-line, that can consume another 2 megabytes or so. Finally, a great deal of disk space can disappear at the hands of news or mail coming in through uucp.

You can still get a service contract for hardware support on the 7300. Contact AT&T Customer Systems Support, P.O. Box 8355, Iselin, NJ 08830. You can purchase hardware upgrades (e.g., memory and disk drives) from Discovery Electronics, 775 Franklin Rd., Suite 100, Marietta, GA 30067, (404) 425-5700.

Finally, on the differences among the Intel processors, we'll take them in sequence. The 80186 is basically an 8086 with much of the external circuitry ordinarily found in 8086 systems brought on-chip. For example, the 80186 includes two DMA channels, a programmable interrupt controller, and three timers integrated with the CPU. The 80186 also boasts instructions not found in the 8086 instruction set (these new instructions are also supported by the 80286). Some of these new instructions are PUSHA and POPA—which transfer the entire register bank to and from the stack—and multibit shift instructions that accept an immediate value for the number of bits.

You are correct that the 80286 uses 16-bit registers and a 16-bit data bus; however, the 80286's address bus is 4 bits wider than the bus on the 8086/80186. Hence, the 80286 can directly address up to 16 megabytes of physical memory. The 80286's memory management is beefed up, too—it can access up to 1 gigabyte of virtual memory and provides memory protection through its protected virtual address mode.

—B. S. and R. G.

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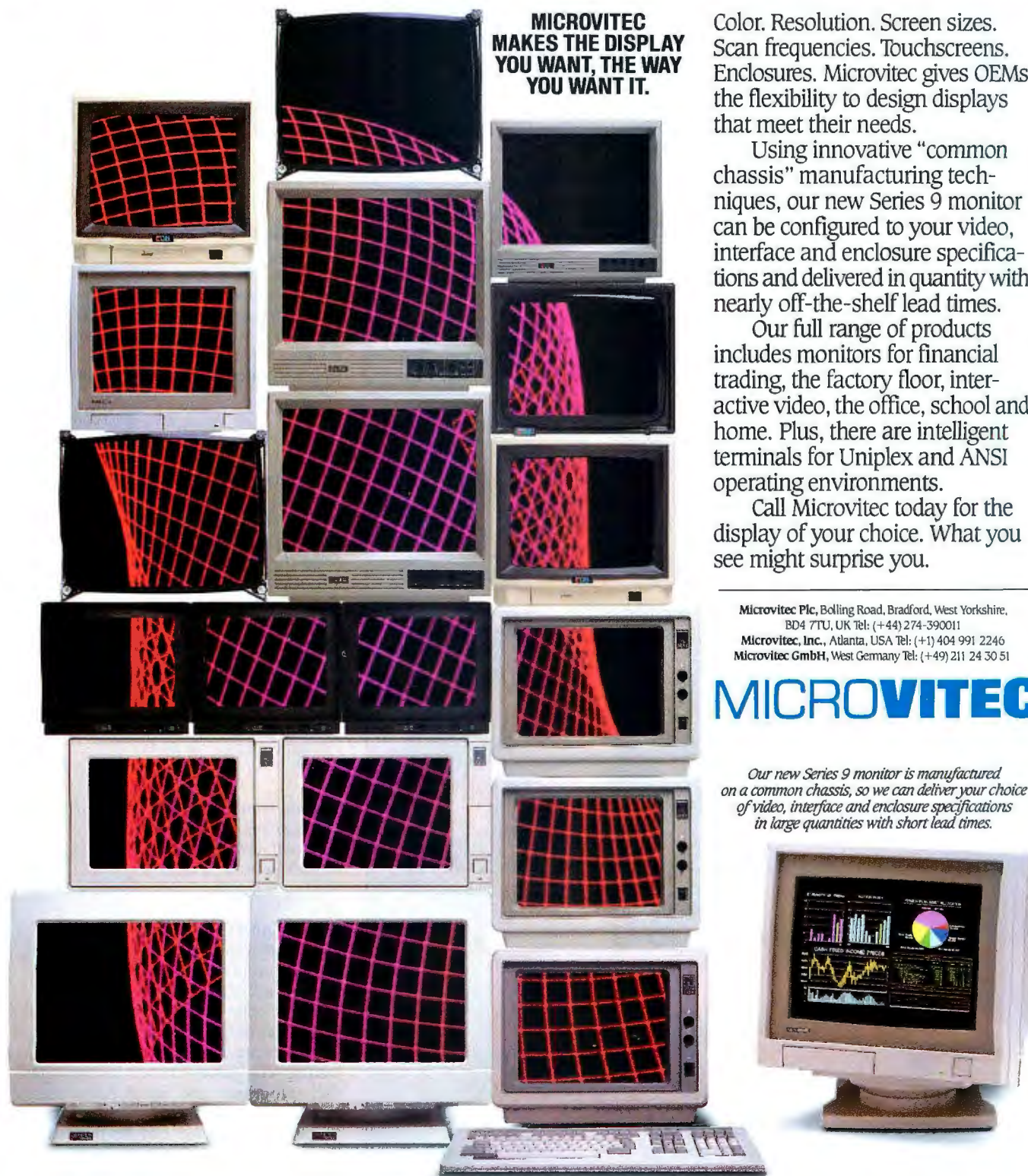
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ASK BYTE

More Write Protection

I am writing in response to the letter from Louis Robichaud in the September 1989 Ask BYTE. Robichaud asked about write-protecting a hard disk. There is at least one software alternative to the hardware solution you provided. NO-WRITE is available from Decision-Science Applications (1110 North Glebe Rd., Suite 400, Arlington, VA 22201, (703) 243-2500). It is available from Decision-Science for \$50.

Joseph C. Krupp
Decision-Science Applications
Arlington, VA

Thanks for the information.

—BYTE Lab staff

Can't Read Columns

I'm interested in accessing some numbers that are in four columns in a disk file, statistically manipulating them, and then writing them back to the disk. I can "crunch the numbers" with a hand calculator, but I am having difficulty getting a C program to access these columns.

L. Warren Rogers
Marina, CA

Assuming that I've read your letter properly, the C code to do what you need is easily constructed using the `fscanf()` function. Let's say you've opened the file using the `fopen()` function, and the associated file pointer is in variable `fpoint`. I'll also assume that you've defined a character array `strng[80]` and that the lines in your input file are no longer than 80 characters. The source code to read one line would look like this:

```
fgets(strng,80,fpoint);  
sscanf(strng,"%d %d %d  
%d",&val1,&val2,&val3,&val4);
```

and the numbers will be returned in the `val` variables. If your numbers are floating-point rather than integers, change the `%d` entries in the second line to `%f`.

—R. G.

Patents and Copyrights

Can a software program be patented? If so, what would the patent cover? The entire concept of using a gray-scale scanner to make color scans? The sequence of keystrokes used to write the program?

If software can be patented, why have leading companies chosen to copyright their programs, and not to patent them instead? Is it because a patent is public property and hence can be published,

continued

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thus allowing anyone who has programming ability to create his or her own version?

If programs can be patented, what's the implication for the computer software market? For example, could someone patent one or more methods to make a posterized image or a word processing program and thus "own" computer posterization or word processing?

Norman Breslow
Los Angeles, CA

First, a word of warning: Patents are part of a complex area of law with its own jargon and a long history. Please don't rely on anything we say here as legal advice; if you're concerned that the program that you've written might have legal problems, you would be wise to consult a patent attorney.

Is it possible for a software program to be patented? No—the only thing that can be patented is an invention. However, if the invention is a computer algorithm, that invention could be made part of a piece of software. If the invention is a system that uses both computer software and hardware, the software could be part of

the patented invention.

What is an invention? In simple terms, it's a device or system that no one else has developed before. To be patented in the U.S., the invention must be both new and nonobvious—that is, it can't be a device or technique that anyone competent in a field would normally come up with.

Patents aren't as popular as copyrights (which are commonly used to protect programs) because patents are more expensive, require more effort to file for, take longer to get, and don't last as long as copyrights. Under U.S. law, you normally have copyright protection the moment you create any original piece of work. You gain some additional rights by registering your copyright with the Library of Congress's Copyright Office, but that's just a matter of filling out a form and sending it, with a small fee and a copy of the work (in some cases, just a portion of the work) to the Copyright Office. Under current copyright law, copyright protection lasts until 50 years after the author's death.

Getting a patent is a much more arduous process. First you must file an application with the U.S. Patent and Trade-

mark Office. The application describes your invention in detail, including what part of the invention is actually new (and thus patentable), and it lists any earlier inventions that might prevent your patent from being issued. At the patent office, a patent examiner begins looking for the elements of your invention that already exist or have been previously patented. Your application might be rejected completely, or the scope of the patent may be narrowed considerably by the time that it's actually issued. And issuing a patent typically takes years or, in some cases, even decades.

Once the patent is issued, the description becomes part of the public record—thus, anyone can see how your invention works. It's not retroactive; you have no patent protection until the patent is actually issued. And patent protection lasts a relatively short time—less than 20 years. But for the life of the patent, no one can use your invention without your permission. If someone comes up with the same idea, even independently, you have the right to collect royalties or forbid the person to use the invention.

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Circle 291 on Reader Service Card

That's a strong right, and in spite of the time and trouble it takes, more than a few companies have been awarded software patents. IBM has a large portfolio of them, which it licenses to many other companies—including its competitors. Apple has long used its patents on features of the Macintosh system software to discourage Mac clones. Recently, smaller companies such as Quarterdeck and QuickView Systems have been awarded patents on elements of their software.

Could you patent something as broad as word processing and thus own the market? It's possible—one company recently sued Lotus, Microsoft, and other spreadsheet makers, claiming that it owns a patent that applies to all spreadsheet programs (that case will probably be in court for years to come). But, in general, patents tend to be pretty narrow in scope. And most patent owners are more interested in licensing their patents than in owning the market; after all, new

inventions regularly make older patents obsolete. Look for a book called *Legal Care for Your Software* (\$34.95) by Daniel Remer and Stephen Elias, due out in June from Nolo Press (950 Parker St., Berkeley, CA).—F. H.

He Lost His Memory

I have a Quadram ProSync EGA board, and one of the chips has burned out. It is labeled TMS 27C128JL LAP8705. Can you tell me where I can purchase a replacement chip?

Trang D. Nguyen
Clinton, MD

The 27128 is an EPROM chip. If you've burned out an EPROM chip on a graphics board, the odds are very good that you're dead in the water. You'll probably have to contact whomever you purchased the board from to see what sort of repair deal is available.—H. E.

Hard Disk, Please

Where can I purchase a hard disk drive controller card for a Tandy 1000EX? All the vendors that I've contacted will sell the card only as part of a complete hard disk setup.

Phil Cox
Cedar Rapids, IA

The Tandy 1000EX uses Plus cards, not XT or AT adapter cards. Also, Tandy does not officially support hard disk drives for the 1000EX. Consequently, unless you can find a third-party vendor that has a Plus card disk interface (or perhaps a Plus-card-to-PC-bus interface), it appears that you're out of luck.

—H. E. and R. G.

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FIXES

• In "The BYTE Awards" (January), we inadvertently omitted Quicksoft's PC Write 3.0, which received a BYTE Award of Distinction. As our nominating editor noted, the latest version of PC Write "does what you want it to do without costing two arms and a leg." For \$89, PC Write provides a full word processing program, complete with spelling checker. Our congratulations (and apologies for the omission) to Quicksoft.

• The price for OptionFinder (Regional What's New, November 1989) was incorrectly listed. The correct price is \$8995. Contact Option Technologies, 200 Carlestone Ave., East Islip, NY 11730, (800) 645-2287 or (516) 277-7000. ■

CHAOS MANOR MAIL

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

Surge Suppression

Dear Jerry,

I'm writing in response to "The Great Power Spike" (August 1989).

Even if better surge suppression were added to the power supplies of my miscellaneous computer equipment, it would not reduce my reliance on external surge suppressors. Consider the fact that you had good reason to replace every surge suppressor that was on duty when the Great Surge hit. Now imagine replacing the power supplies in 50 diverse computers and peripherals.

Sure, each device could have a power supply designed with a replaceable surge-suppressor module. You would then have to track down replacement modules for all your devices, each from its own manufacturer. What if the maker has gone out of business? Or discontinued that seven-year-old printer's parts?

Yes, I would welcome the extra protection. I simply wouldn't rely on it.

Guy R. Winters
Andover, MN

Yeah, I figured out why they don't put surge suppressors in the equipment just after the column went to press. Oh, well. —Jerry

Supercomputing

Dear Jerry,

Computing at Chaos Manor gives readers an excellent feel for the problems and solutions that are part of using computers. From my experience with computers, I know that whatever software you're using always works with every graphics card known to man except the one in your computer, or that the hardware you want to use requires a cable you don't have.

I spent a couple of years working with a computational fluid dynamics program, which was the base for a model of an industrial furnace. The CFD software, called Fluent, was lent to us by Creare, of Hanover, New Hampshire. Outside of military applications, I believe that our furnace model was one of the most comprehensive ever solved. The

most powerful computer available to us was a VAXstation II running at about 1 million instructions per second and equipped with 16 megabytes of core memory. On our VAXstation, the model used several months of processor time to reach a solution, but then why should a workstation sit idle all night?

We ran the model on a commercial Cray II system for a while, but the costs were prohibitive. As you mentioned in a recent column, students are able to get 2 hours on a Cray through the National Center for Supercomputing Applications. For me, it was too little, too late, but the people at NCSA were very accommodating, and I would encourage any interested students to take advantage of the opportunity.

Most of the jobs that I use a computer for are more mundane, such as word processing and making graphs. What do you think about the influence that Microsoft has had on the software industry in the last couple of years? I think that Windows has changed the way that people use their IBM-type computers. I was almost ready to switch to a Macintosh system to be able to produce camera-ready copy for my thesis. However, some excellent products, like Micrografx's Windows Draw, came along that made it easy for a non-artist like me to produce high-quality figures. Windows allowed me to switch back and forth between WordPerfect and Windows Draw, so I could print text and graphics without too much mental stress. Also, having Windows forced me to go out and buy a mouse, which I wouldn't be without now.

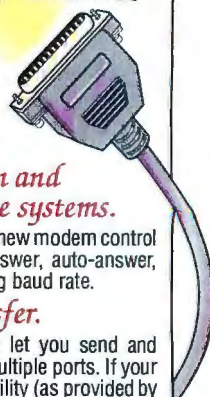
Since I often have Windows running, I prefer to use applications that are well behaved under Windows, which means that when I bought a spreadsheet, Excel

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 "jerryip."

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was the natural choice. I will also switch from WordPerfect to Word soon, partially to take advantage of Microsoft Works. Even though I think Turbo Pascal provides the best programming environment, I have been using Microsoft QuickBASIC in my work because the others in the group feel more comfortable with it. My point is that people like to have applications that look and feel the same, with identical graphical user interfaces. It is much easier to use applications that respond the same way to a mouse and don't require their own video and printer drivers. Consequently, I can see Microsoft dominating the future software industry even more than it has in the past.

While I'm on industry standards, when are we going to see a standard graphics format? I kind of like the Hewlett-Packard Graphics Language myself. Perhaps it isn't the most elegant way to store graphics images, but from my experience it is one of the most widely used. I have created HPGL metafiles on a VAX system, edited them with a standard text editor on my PC, and then pasted the image into WordPerfect 5.0 for printing.

Allan Walsh
Mackenzie, BC, Canada

Playing with a Cray can be an awesome experience; the Super Computer program has been an amazing success. Indeed, it's easy to show that the whole National Science Foundation budget gets us at least as much return as any other dollar spent by the federal government.

My suspicion is that in a decade or less it will be hard to tell whether you're using a PC or a Mac, and you won't know or care what the operating system underneath it all is called.—Jerry

Unix Debates

Dear Jerry,

Over the years, I've read several of your philippics against Unix. Today I have time to write a letter, so I'm going to put my two bits in.

Most Unix debates, when parsed, are recognizable as religious disputes between cult insiders and cult outsiders. The position of the insiders is, "If you would only believe in Unix, you would be saved from the twin demons of low productivity and ugliness." The position of the outsiders is, "I can manage my productivity a damned sight better than you can, and I spit on your aesthetic pretensions—get lost." Such conversations get really boring fast.

Unix has some outstanding prototyping tools—a bit too C-oriented for some

tastes (including mine), but very useful nonetheless. It handles multitasking and many other jobs correctly (i.e., unobtrusively). It trains developers to think in terms of total system architecture instead of isolated chunks of code. Unix is beginning to show its age, but it is still a superb general-purpose development environment—I've yet to find a better one. By comparison, DOS is a flimsy toy that has never worked properly—and never will, unless somebody like Borland can be talked into doing the job right.

Of course, there is another side to Unix. It is unspeakably bad as a production system. Training Unix users is expensive, and Unix processes have more overhead than New York has roaches. This is OK when the "users" are software engineers or students with a close connection to revenue, and when resource consumption is not controllable. But it's unacceptable when most of the users are data-entry clerks with a high rate of personnel turnover and when the same programs have been run in the same sequence every month for the last 20 years.

To accuse Unix of being a "system that requires... access to a wizard" is ignorant and unfair. I am not a wizard by any stretch of the imagination (my domain is financial software, and I usually run programs under DOS). I am only a software developer, but I love Unix—for development. You sometimes like to pose as a developer (hence the nice words for things like Modula-2), but you are only a software consumer, and you loathe Unix—for production. We're both right.

Why is it that the same crowd that sneers at mv and grep gets misty-eyed about the Norton Utilities' DS and NCD? The Norton Utilities (and FastBack, and DOS-16/M, and so on) are certainly superb, but the only reason they were written is that DOS was brain-dead at birth. The most depressing thing about DOS isn't that it needs prostheses, it's that the prostheses are better engineered than DOS itself, without exception.

John Kahila
Boston, MA

What's an appropriate answer here? I know if I were a doctor setting up a clinic for myself and four colleagues, I'd worry a lot about setting it up with Unix unless I had a wizard as a close relative; but maybe I just don't understand?—Jerry

International Standards

Dear Jerry,

William Matheson had great fun recalculating the speed of light in furlongs

per fortnight (furl/fort) using the latest international standards (July 1989). Unfortunately, he too got tangled up in one of the subtle intricacies of the international standards picture.

He makes a big point of the difference between the international standard of 2.54 centimeters = 1 inch and the "U.S.-approved factor" of 39.37 inches = 1 meter. What he overlooks is that the U.S. has two standard conversions between metric and English linear measurements. For all purposes except land surveys, the standard conversion is the international value of 2.54 cm = 1 inch, but for land surveys it is the old 39.37 inches = 1 meter. And this dual standard is not as ridiculous as Matheson makes it sound.

Prior to the advent of international standardization, there were three conversion standards between metric and English units in different countries around the world, differing by a few parts per million. When the middle of the three (2.54 cm = 1 inch) was chosen for international standardization, the U.S. promptly considered converting from the old 39.37 inches = 1 meter standard. However, the Coast and Geodetic Survey just as promptly pointed out that the land survey system of the U.S. is based on triangulation from a carefully measured baseline near the East Coast and that benchmarks on the West Coast would be wrong by some 30 feet. Can you imagine the chaos if every benchmark in the U.S. had to be resurveyed and every land description and deed had to be changed to reflect the new survey? This conflict of needs held up the formal adoption of the international standard for a decade or more until finally the "two-standard" compromise was adopted. The compromise lets the U.S. be consistent with the rest of the world where consistency is needed (including the nautical miles mentioned by Matheson) without introducing a new gold mine for the legal profession in untangling our real estate descriptions.

Since the furlong is a land survey unit (one-eighth mile), the furl (U.S.)/fort speed unit must be different from the furl (international)/fort calculated by Matheson by the same 2 parts per million as the difference between the two conversion standards. Thus, using the 10-digit rounding of my calculator, the speed of light becomes 1,802,613,895,000 U.S. furl/fort, as compared to the similarly rounded international furl/fort value of 1,802,617,500,000.

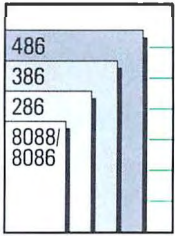
John Laidig
Holmdel, NJ ■

Just three years ago,
Compaq fired
the shot heard
around the world.



Compaq intro

As PC technology has evolved, Compaq has been consistently among the first to tap its power. Now with the COMPAQ



DESKPRO 486/25 and the COMPAQ SYSTEMPRO, Compaq brings new levels of performance to single and multiple users.

THE COMPAQ DESKPRO 486/25: THUNDEROUS PERFORMANCE.

For individual power users, nothing compares to the new COMPAQ DESKPRO 486/25 Personal Computer. It will let you work faster than ever before.

Every component has been designed to unleash the power of the new Intel 25-MHz 486 microprocessor. Power that drives numeric-intensive applications up to three times faster than 25-MHz 386-based PCs, outpacing many technical workstations.

It's power you can put to work on the most demanding applications. To handle CAD/CAM/CAE, statistical analysis, portfolio modeling, project management and multitasking.

The Intel 25-MHz 486 microprocessor is the heart of the system. Its breakthrough design integrates the processor with a numeric

coprocessor (to speed number crunching) and an 8-Kbyte cache (to reduce wait states).

To boost performance further, Compaq added a second-level cache memory controller with 128 Kbytes of high-speed static RAM. Combined with interleaved memory architecture, it lets your data fly between the microprocessor and memory.

The 486 works in concert with COMPAQ Flex Architecture, which integrates a processor/memory bus with the new EISA I/O bus. This enables information to be processed at the highest possible speed

while maintaining compatibility with 8-, 16- and powerful new 32-bit expansion boards.

The COMPAQ DESKPRO 486/25 is open for customization.

Four megabytes of memory are standard, so you can run applications under MS OS/2 Version 1.2, MS-DOS or UNIX operating systems. If you need more, you can

expand memory up to 100 megabytes using a separate high-speed 32-bit memory slot. That leaves up to seven EISA slots free for your choice of expansion boards.

You can work with up to seven internal storage devices, choosing from a range of high-performance, high-capacity fixed disk



The COMPAQ DESKPRO 486/25 was designed from the ground up to unleash the power of the 25-MHz 486 microprocessor.

duces performance For one.



drives (the 650- and 320-MB models have fast 1:1 interleave and ESDI controllers).

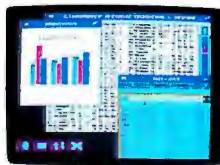
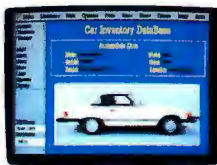
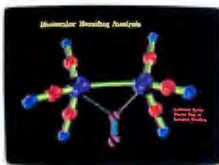
All told, you can store up to 1.3 gigabytes of data internally, or up to 2.6 gigabytes using the optional COMPAQ Fixed Disk Expansion Unit.

Compaq didn't stop there. Accelerated

VGA graphics are built in, giving you a crisp, colorful display and freeing an expansion slot.

The system even has a socket for an optional Weitek 4167 coprocessor to blaze through calculations.

The COMPAQ DESKPRO 486/25. It's sure to bring a little thunder to your office.



You can run the most complex CAD/CAM/CAE, scientific and business applications faster than ever before.

Now for the

In September 1986, Compaq introduced a personal computer that changed people's ideas about what a PC could do.

The COMPAQ DESKPRO 386 Personal Computer was the first PC based on the powerful 386 microprocessor. It gave people the speed and power to do more than ever before. It pushed out the envelope of technology. But did it in a way that let users continue to work with industry-standard software and hardware. With it, Compaq set a new standard in PC performance.

Compaq has done it again.

Introducing the COMPAQ DESKPRO 486/25 Personal Computer and COMPAQ SYSTEMPRO Personal Computer System.

Once again, Compaq has expanded the role of the PC—to meet the most demanding needs of both single and multiple users. And once again, Compaq has pushed out the envelope of technology to deliver new levels of performance and expandability, without sacrificing compatibility.



sonic boom.

These new computers were designed from a simple observation: People use computers differently. One user using a PC has different needs than a group working together on a network or multiuser system.

The COMPAQ DESKPRO 486/25 is for the individual whose job depends on a PC. It was designed from the ground up to unleash the power of the evolutionary new Intel 25-MHz 486 microprocessor.

The COMPAQ SYSTEMPRO delivers an unprecedented combination of system performance and expandability to networks and multiuser systems. Its breakthrough design gives users the flexibility to work with both 33-MHz 386 and future 33-MHz 486 technology. It also provides the unmatched capability to work with multiple processors.

Inside both you'll find advances like cache memory designs that boost processor performance. Extended Industry Standard Architecture (*Extended ISA or EISA*) that accelerates input/output performance while maintaining compatibility. New drive and controller technology that increases fixed disk performance and reliability. And that's just the beginning of this story.



that will have busi- And all.



THE COMPAQ SYSTEMPRO: HOW TO MAKE A CROWD ROAR.

Now people who work together
can work faster
than ever before.

*The new COMPAQ
SYSTEMPRO: an unprec-
edented combination of
performance and expand-
ability for multiple users.*



Every aspect of the new COMPAQ
SYSTEMPRO has been engineered to bring
unprecedented total system performance
and expandability to demanding con-
nected environments.

EIS

It's an ideal server to handle advanced local
area networking. To take advantage of new client-
server applications like shared databases. *And* to
manage multiuser transaction processing.

Business booming.

Inside, you'll find a series of technological breakthroughs.

The first is a flexible system processor design that lets you work with both 33-MHz 386 and future 33-MHz 486 technology.

Initial models offer a 386/33 system processor that employs a 386 microprocessor optimized with a 64-Kbyte cache memory design and a socket for optional coprocessors. This drives software more than twice as fast as the IBM PS/2 Model 80, and surpasses most minicomputers.

Computing potential can be increased up to four times by adding a second system processor. You can use two 386 processors now. Or work with a 386 and a 486, or two 486 processors in the future. So your investment is protected.

The multiple system processors are integrated into COMPAQ Flex/MP Architecture, which combines a separate processor/memory bus with the EISA I/O bus.

EISA delivers the fastest I/O performance, which is critical for data sharing.

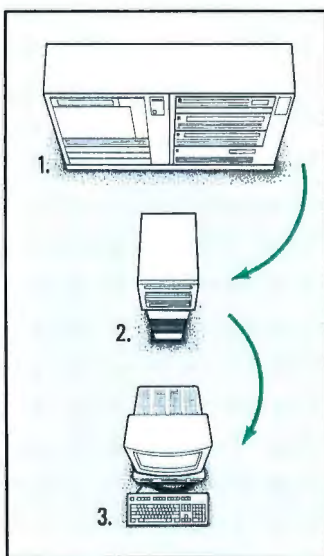
You can add up to six 32-bit network interface controllers for maximum server throughput. And you're ensured compatibility with 8-, 16- and 32-bit boards.

Users gain nearly instant access to fixed

disk data with innovative drive array technology that transfers data up to four times faster than nonarrayed drives. It also supports the most comprehensive range of data protection features.



The COMPAQ LAN MANAGER 386/486 optimizes the COMPAQ SYSTEMPRO for use in OS/2-based networks.



The COMPAQ SYSTEMPRO is a powerful network server and mainframe gateway, giving users the fastest access to departmental and mainframe data.

As you add more users and more complex applications, the COMPAQ SYSTEMPRO grows right along with you. It's the first PC to actually increase in performance when you add options like system processors or drive arrays.

It grows in other ways that are simply amazing. You can expand the 4 megabytes of standard RAM to 256 megabytes, use up to 11 expansion boards, work with 11 storage options

and store up to 4.28 gigabytes of data.

You're also free to work in your choice of network and multiuser operating system. This includes Novell NetWare 386, SCO UNIX System V/386, new COMPAQ LAN MANAGER 386/486 and others.

The COMPAQ SYSTEMPRO. Get your group together, and watch them roar.

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It simply works better.

When it comes to performance, we believe actions speak louder than words.



Since we introduced our first personal computer in 1983, no other computer company has delivered PCs with the technical excellence of COMPAQ PCs.

Today Compaq offers a full line of high-performance personal computers. Desktops based on 286, 386 and now 486 processor technology. Portables and laptops. And our new PC system, customized for multiple users.

In every COMPAQ personal computer you'll find innovative technology. Along with plenty of common sense. Like the ability to run the world's largest library of industry-standard software. And the room to add the peripherals your job demands.

This combination of technical leadership and practical thinking is why COMPAQ PCs consistently earn the highest marks for quality from computer experts. And unsurpassed marks for satisfaction from users.

Standing behind every COMPAQ PC is a worldwide network of Authorized COMPAQ Computer Dealers. Your dealer is trained to help you build powerful computing solutions. For the location of your nearest dealer and free information, call 1-800-231-0900, Operator 107. In Canada, 1-800-263-5868, Operator 107.

COMPAQ

It simply works better.

WHAT'S NEW

HARDWARE • SYSTEMS

Laptops Get Lighter

Copam's 286LT and 386SXLT are inexpensive laptops with 12-MHz 80286 and 16-MHz 80386SX microprocessors, respectively. Each weighs 12 pounds with the battery, and a battery quick-charger for 2-hour charge times weighs another 3 pounds.

Both systems feature backlit VGA screens and nickel-hydride batteries with 40 percent more efficiency for their weight than nickel-cadmium batteries, Copam claims. Each system includes a Phoenix BIOS, 1 megabyte of RAM (expandable to 4 megabytes), a 91-key keyboard, a 3½-inch 1.44-megabyte floppy disk drive, a 2½-inch 20-megabyte 28-ms hard disk drive, sockets for 80287 and 80387SX math coprocessors, DOS, and GWBASIC. Options include 40- or 100-megabyte hard disk drives.

Price: 286LT, under \$2000; 386SXLT, under \$3000.

Contact: Copam USA, Inc., 45875 Northport Loop E, Fremont, CA 94538, (415) 623-8911.

Inquiry 1120.

Portable EISA 80486 with Color Monitor

Micronics Computers has introduced the MP400 Series of portables, which includes an Extended Industry Standard Architecture (EISA) 80486 with an optional VGA color LCD monitor.

The 25-MHz 80486 system comes with 2 megabytes of RAM (expandable to 16 megabytes), a 40-megabyte hard disk drive, a 91-key



Copam's 12-pound AT laptops include VGA graphics, nickel-hydride batteries, and a 20-megabyte hard disk drive.

keyboard, two full-length EISA slots, a Phoenix BIOS, and a driver for VGA color graphics. One option is a 100-megabyte hard disk drive.

The 20-MHz 80386 comes with a monochrome VGA display, 2 to 8 megabytes of RAM, and a Phoenix BIOS.

The 80386SX, with the standard 16-MHz clock speed, includes 1 to 8 megabytes of RAM. All three systems measure 4½ by 15 by 16 inches.

Price: 80386SX, \$3800; 80386, \$4500; 80486 monochrome, \$7500; 80486, color, \$10,000.

Contact: Micronics Computers, Inc., 935 Benecia Ave., Sunnyvale, CA 94086, (408) 732-0940.

Inquiry 1121.

Dell Packs More into Small-Footprint SX Systems

The Dell System 316SX, a 16-MHz 80386SX system for under \$2000, comes with 512K bytes of RAM, one floppy disk drive (5½-inch 1.2-megabyte or 3½-inch 1.44-megabyte), a 20-megabyte 40-ms hard disk drive, and a 12-inch VGA monochrome monitor with driver.

The chassis (15½ by 4 by 15½ inches) can house three 16-bit add-in cards, two half-height 5¼-inch floppy disk drives, and one half-height 5¼-inch hard disk drive. The BIOS is from Phoenix.

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Price: \$1899.

Contact: Dell Computer Corp., 9505 Arboretum Blvd., Austin, TX 78759, (512) 338-4400.

Inquiry 1123.

Commodore's Multimedia Amiga

The Amiga 2500/30 features custom sound, animation, and graphics chips in a 68030 system for multimedia presentations. There are also options for DOS and Unix hardware and software compatibility.

The 2500/30 comes with a 25-MHz 68030 processor and 2 megabytes of 32-bit RAM, expandable to 4 megabytes. It also has a 25-MHz 68882 math coprocessor, a 68851 memory management unit, a 3½-inch 880K-byte floppy disk drive, a 40-megabyte hard disk drive, and an auto-booting SCSI hard disk drive controller. Ports include one parallel, one RS-232C serial, and two RCA-type audio output jacks for stereo sound. Expansion slots include two XT, two AT, five Amiga, and one video slot.

Two optional XT and AT bridgeboards let you add DOS and Unix hardware and software through Amiga's multitasking operating system. The 4.77-MHz 8088 bridgeboard has 512K bytes of RAM; the 8-MHz 80286 bridgeboard has 1 megabyte of RAM.

Price: \$4699; 8088 bridgeboard, \$699; 80286 bridgeboard, \$1599.

Contact: Commodore Business Machines, Inc., 1200 Wilson Dr., West Chester, PA 19380, (215) 431-9100.

Inquiry 1122.

continued

Mac-Compatible Dictionary-Size Printer from Kodak

The Diconix M150 Plus is a thermal ink-jet printer for Macintosh portables that weighs 3½ pounds, including its five C-size rechargeable batteries. About the size of a desk dictionary, the printer connects to a serial port and transmits at 9600 bps.

An Adobe type manager has 13 outline fonts, and you can use all the Adobe standard type-1 fonts, according to Kodak. Also included is MacPrint, a QuickDraw printer driver. The easily replaceable print head with its self-contained ink supply delivers a resolution of 192 dpi in quality mode and 96 dpi in draft mode and can print up to 500 pages in draft mode before you need to change it.

Price: \$699.

Contact: Eastman Kodak Co., 901 Elmgrove Rd., Rochester, NY 14653, (800) 255-3434 or (716) 253-0053.

Inquiry 1126.

MicroLaser Offers Low Price, Speed, and PostScript

The MicroLaser from Texas Instruments is a 6-ppm laser printer that comes standard with LaserJet emulation. Its 512K bytes of RAM is expandable to 4.5 megabytes.

A PostScript upgrade for the MicroLaser requires installation on the removable motherboard. Two versions are available: one with 13 fonts, and one with 35 fonts.

Price: \$1999; 13 PostScript fonts, \$3000; 35 fonts, \$3500.

Contact: Texas Instruments, Data Systems Group, P.O. Box 202230, DSG-290, Austin, TX 78720, (800) 527-3500.

Inquiry 1128.



Macintosh portables have met their portable-printing match in Kodak's Diconix M150 Plus.

High-Capacity Laptop and Notebook Drives

If you're on the road with data-intensive applications, you may need Areal Technology's 200-megabyte laptop hard disk drive, the BP-200, or the 100-megabyte notebook-size hard disk drive, the MD-2100.

The BP-200 is a 3½-inch drive that features a single glass disk for storing up to 200 megabytes of formatted data in what the company says is the highest data density ever achieved—142.5 megabits per square inch. Average access time is rated at 29 ms. The use of glass rather than aluminum produces a flatter disk surface, allowing the read/write heads to fly as close as 4 microinches to the spinning disk surface, Areal reports.

Other BP-200 specifications include a 2500-track-per-inch storage format, a weight of 8½ ounces, and a rotation rate of 1600 rpm.

The MD-2100 is a 2½-inch drive that's barely three-fifths of an inch thick, has an average access time of less than 29 ms, and can sustain a transfer rate of 7.5 megabits

per second, Areal claims. It requires only 5 V of input power and weighs 4½ ounces. The actual dimensions are ¾ by 2½ by 4 inches.

Price: BP-200, \$995; MD-2100, \$995.

Contact: Areal Technology, Inc., 2890 North First St., San Jose, CA 95134, (408) 954-0360.

Inquiry 1127.

Mac Portable Power for the Road

Two products from Lind Electronic Design help power your Mac Portable. A 12-V DC Power Adapter charges your Mac's internal battery using a 12-V source. The adapter weighs three-quarters of a pound and measures 2 by 2 by 3 inches.

The External Battery Charger recharges your Mac's spare battery using any 115-V AC or 12-V DC power source. The 1½-pound unit, which measures 3 by 6 by 7 inches, will charge your spare battery to 80 percent of capacity in 3 hours.

Price: DC Power Adapter, \$69.95; External Charger, \$99.95.

Contact: Lind Electronic Design Co., Inc., 6416 Cambridge St., St. Louis Park, MN 55426, (612) 927-6303.

Inquiry 1130.

Monitors for 8514/A-Compatible Applications

The Ultra II is a 14-inch color monitor with a resolution of 1024 by 768 pixels. It's compatible with the IBM XT, AT, and PS/2s, and Mac SEs and IIs. It's also compatible with all the latest graphics standards, from 8514/A down to MDA.

Autosynchronous scan frequency ranges from 15 to 55 kHz horizontal and 45 to 120 Hz vertical scan. The dot pitch is 0.26 mm. Video bandwidth is 70 MHz.

The CRT is a 14-inch diagonal Trinitron tube. Inputs can be analog video, synchronous analog, or TTL synchronous.

The Ultra X, which is available in 14-, 16-, and 19-inch color and monochrome versions, features multiple resolution support and memory support from 512K bytes to 8 megabytes.

It also features a Virtual Screen, which lets you access a screen that's much larger than the display resolution of the monitor. The Ultra X resolutions range from noninterlaced 512 by 512 pixels to VGA to an interlaced 1280 by 1024 pixels.

All five Ultra X models include a low-resolution controller, a monitor, a keyboard, and a mouse. The base model is a monochrome edition; the luxury models include color analog with 16 simultaneous colors. Bandwidth is 80 MHz.

Price: Ultra II, \$1295; Ultra X, \$1995 to \$5295.

Contact: Princeton Graphic Systems, 1100 Northmeadow Pkwy., Suite 150, P.O. Box 100040, Roswell, GA 30076, (800) 221-1490 or (404) 664-1010.

Inquiry 1129.

continued

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

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

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

The interactive database utilities and outstanding documentation make db_VISTA III easy to learn. All applications are portable to VMS, UNIX, OS/2, MS-DOS, even Macintosh. No royalties.

db_VISTA III is **Fast**. Using benchmarks originated at PC Tech Journal Laboratories, db_VISTA III measured 3 to 12 times faster than the average relational database! Call us and we'll send you the results.

db_VISTA III Database Management System		
Features	Yes	No
db_VISTA 3.1 High Performance DBMS:		
Single and Multi-User available	✓	
Relational B-tree Indexing	✓	
Network Database Model	✓	
Multiple database access	✓	
Referential integrity	✓	
Automatic recovery	✓	
Record & File locking	✓	
RAM resident		✓
db_QUERY 2.1 SQL-based Query:		
Relational Query & Report Writer	✓	
db_REWISE 1.0 DBMS Restructure Program:		
Total database redesign/restructuring	✓	
C Compilers*: Most supported	✓	
C++ compatible. Supports PRO-C	✓	
Operating Systems*: VMS, ULTRIX,	✓	
UNIX, BSD, SunOS, XENIX, QNX,	✓	
MS-DOS, MS Windows, and Macintosh,	✓	
OS/2 compatible,	✓	
LANs*: 3COM, Novell, Banyan,	✓	
AppleShare and more ...	✓	
WKS Library:		
Read & Write WKS, WK1 & DBF files	✓	
SOURCE CODE AVAILABLE:	✓	
ROYALTIES: (Absolutely not!)		✓
*Other environments are supported; call for complete list.		

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

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BEST *From Quality to Service*

386/25 WORKSTATION

\$4,395.00

80386 25 MHz system board with 32 KB static cache
80387 25 MHz Math Coprocessor INCLUDED
4 MB SIMM RAM
ATI VGA Wonder Card/512 K 1024 × 768 res.
ATI Bus Mouse
NEC Multisyn 3D Color Monitor 1024 × 768 res.
150 MB ESDI Hard disk
1.2 MB 5.25" floppy drive
1.44 MB 3.5" floppy drive
ESDI hard disk/floppy drive controller
2 serial, 1 parallel and 1 game ports
Vertical case
101 Enhanced keyboard
MS DOS 4.01
AMI BIOS with full MS DOS, OS/2, SCO Xenix, Novell, 3COM and PCNET compatibility



286 LCD PORTABLE

\$1,395.00

80286 12 MHz 0 wait states system board
AMI BIOS
640 KB RAM expandable to 4 MB
1.2 MB Floppy drive
40 MB Hard disk (28ms)
Color graphic card with
External CGA/Mono adaptor
640 × 200 LCD screen
2 serial, 1 parallel and 1 game ports
86 keys keyboard
200 Watts 120/220V power supply
Padded soft carrying bag
Weight: 22 lbs.
Size: 16" × 9" × 7"
LCD400 with 640 × 400 High Resolution screen available
LCDEGA with 640 × 400 EGA LCD screen available



386/20 WORKSTATION

\$2,695.00

80386 20 MHz system board
1 MB SIMM RAM
ATI VGA Wonder Card/256 K
NEC Multisyn 2A Color Monitor 800 × 600 res.
80 MB Seagate Hard disk
1.2 MB 5.25" floppy drive
1.44 MB 3.5" floppy drive
1:1 interleave hard disk/floppy drive controller
2 serial, 1 parallel and 1 game ports
Vertical case
101 Enhanced keyboard
MS DOS 4.01
AMI BIOS with full MS DOS, OS/2, SCO Xenix, Novell, 3COM and PCNET compatibility



286 CRT PORTABLE

\$1,195.00

80286 12 MHz 0 wait states system board
AMI BIOS
640 KB RAM expandable to 4 MB
1.2 MB Floppy drive
40 MB Hard disk (28ms)
Mono graphics card
2 serial, 2 parallel and 1 game ports
86 keys keyboard
200 Watts 120/220v power supply
3 slots available
Weight: 26 lbs.
Size: 17.25" × 19" × 7"

286 CRT EGA Mono

\$1,295.00

286 gas plasma mini portable

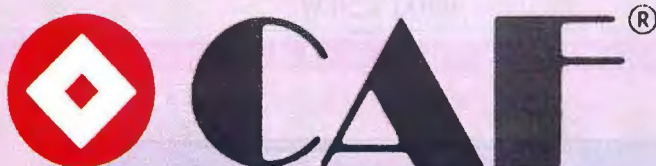
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EGA gas plasma screen 720 × 400
286-12 MHz 0 wait 640K Ram
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40 MB Hard disk (28 ms)
2 serial 1 parallel
86 key keyboard
180 watt power supply
Carrying bag
Weight: 16 lbs.
Size: 16" × 9" × 5½"

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CAF has been selling computers and laptop systems in Europe for years and now CAF has finally arrived. Simple and Efficient design combined with superb Engineering give CAF computers the reliability and power no other computer can beat.

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All CAF computer system boards are manufactured using Surface Mount Technology - one of the most advanced technology in circuit board manufacturing industry, thereby providing the dependability you can count on. After all, if you don't like the cover, why bother to open it?

More to Come . . .

The wave of 486's are coming, and CAF Are ready for it. CAF are introducing five new products shortly. These include a 486 workstation, a 486 accelerator board for existing 386 computers, a 80C86 battery computers in a size of a book, and finally, a SCSI Host adaptor for AT's in both the MCA and EISA architecture.



CAF ProLITE 286/16

\$2,495.00

80286 16 MHz 0 wait states system board
AMI BIOS
10.25" Gas Plasma screen
720 x 400 resolution, 4 level gray scale
EGA graphics card with external adaptor
1 MB RAM expandable to 8 MB
1.44 MB Floppy drive
40 MB Hard disk (Connor, 28ms)
1 serial, 1 parallel ports
External Floppy drive and keyboard connectors
Padded soft carrying bag
Weight: 16 lbs.
Size: 15" x 14.25" x 3.5"
Software: MS-DOS 4.0 GW basic, silk



CAF MASTER 286/20S

\$1,375.00

80286 20 MHz 0 wait states mono system

CAF MASTER 386SX/16S

\$1,845.00

80386SX 16 MHz 0 wait states system board
AMI BIOS
1 MB SIMM RAM expandable to 8 MB
1.44 MB Floppy drive
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2 serial, 1 parallel ports
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EISA Performance Bettors Sampling Rates

The National Instruments EISA-A2000 is a data acquisition board that uses DMA and associated software to functionally double the data acquisition performance of Industry Standard Architecture based systems, the company claims.

The EISA-A2000 samples analog signals at rates of up to 1 million samples per second, digitizes the samples with 12-bit resolutions, and then sends the data directly to memory.

The EISA-A2000 also features four analog input channels for simultaneous sampling. Each channel has its own sample and hold circuitry, and each can operate at 1 million samples per second; two channels can operate simultaneously at 500,000 samples per second, or four channels can operate simultaneously at 250,000 samples per second, according to National Instruments.

Other hardware features include: pre-, post-, and delay triggering; a real-time system integration bus for routing timing and triggering signals between multiple data acquisition boards; bus bandwidth optimization (but not bus mas-



National Instruments doubles data acquisition performance with the EISA-A2000.

tering), EISA burst-mode support, software-controlled configuration and calibration; and oscilloscope emulation.

VisionScope and DOS LabDriver software give you, respectively, oscilloscope emulation for easy capture and storage of waveforms, and programming functions that enable you to call functions from Microsoft C or QuickBASIC to control the board. Another software feature, LabWindows, gives you intuitive interfaces (called function panels) for interactively configuring and controlling programmable instruments and data acquisition boards.

Price: EISA-A2000, \$2995; VisionScope, \$295; DOS LabDriver, \$295; coaxial adapter for BNC connector, \$225; 1-meter coaxial adapter with two connectors, \$175.

Contact: National Instru-

ments Corp., 12109 Technology Blvd., Austin, TX 78727, (800) 433-3488 or (512) 794-0100.
Inquiry 1133.

Bus-Mastering EISA Board Controls Disk Drives

Qume's Data Technology division has introduced a bus master drive controller that offers interfaces for four ESDI drives. Optional interfaces on the DTC6280SE-15C board support four floppy disk drives and up to seven SCSI drives (through one SCSI connection).

The board includes 1 megabyte of RAM and offers full 32-bit bus support with burst mode at 33 MHz. It also includes up to 4 megabytes of on-board cache memory.

Price: \$1150.

Contact: Data Technology, 500 Yosemite Dr., Milpitas, CA 95035, (408) 942-4000.
Inquiry 1135.

Disk Caching for Multiple Operating Systems

The hyperStore•1600 dual-mode caching disk drive controller features state-of-the-art performance and compatibility with DOS, Xenix/ Unix, NetWare, OS/2, Pick, QNX, and other operating systems. It works off an XT or AT slot with a 16-bit Z280 microprocessor and includes two I/O ports per card and a dual-drive floppy disk drive controller for 5¼- and 3½-inch drives.

Hard disk performance enhancement is possible with 512K bytes of cache memory, expandable to 4 megabytes on the board and up to 20 megabytes of cache with Perceptive Solutions' 16-megabyte expansion card.

Data transfer is rated at more than 2.5 megabytes per second with 4-megabyte-per-second bursts. Average data access is rated at 0.28 ms.

Each hyperStore controller works with Perceptive Solutions' Mediadapter for compatibility with drives that need modified frequency modulation, run-length limited, ESDI, or SCSI. The hyperStore can support up to four Mediadapters per controller.

Price: \$1195.

Contact: Perceptive Solutions, Inc., 1509 Falcon, Suite 104, DeSoto, TX 75115, (214) 224-6774.
Inquiry 1134.

continued

Western Digital Makes MCA-Compatible 8514/A

Western Digital has expanded its Paradise graphics controller line to include three 8514/A graphics cards.

The new Paradise 8514/A Plus Card works in AT-bus machines. With 512K bytes of on-board RAM, it can generate 16 colors at a resolution of 1024 by 768 pixels on interlaced or noninterlaced monitors. With an ad-

ditional 512K bytes on a daughtercard, the Paradise card can generate 256 colors at 1024 by 768 pixels.

The company has also announced a version of the Paradise 8514/A for the Micro Channel. And the Paradise 8514/A Plus Combo Card, which incorporates both 8514/A and VGA support in an AT card, will let you access either VGA or 8514/A

graphics through software and even change from one to the other as if there were two cards, the company says.

Price: AT version, \$999; Micro Channel version, \$1099; 8514/A Plus Combo, \$1299.

Contact: Western Digital Corp., 2445 McCabe Way, Irvine, CA 92714, (714) 863-0102.
Inquiry 1136.



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Doing More For The Data Process

Chart Viewer Navigates the High Seas

Chart Viewer is an 8-MHz 8088-based computer that displays National Oceanic and Atmospheric Administration (NOAA) navigational charts on an LCD screen.

It receives Long Range Radio Navigation (LORAN) information through cables and a connector to your on-board LORAN device, and Global Positioning System and Satellite Navigation information through a direct radio link.

You use Chart Viewer by selecting your destination and pressing the Enter key. This creates a waypoint. When you select the second waypoint, Chart Viewer automatically draws a line between them. You can save up to 3000 waypoints on a single chart disk. Other features include pull-down menus, a zoom feature with 10 levels of enlargement, and a LORAN feature for dead reckoning.

The charts are available on 3½-inch 1.44-megabyte floppy disks from In Focus Systems.



Chart Viewer's LORAN accessory charts your nautical course and is PC compatible.

Chart Viewer uses a backlit, 10½-inch, 640- by 400-pixel monochrome flat-panel screen.

In Focus has digitized all NOAA charts for major U.S. navigational waters, and international charts are under development.

Price: \$2995; chart disks, \$139 each.

Contact: In Focus Systems, Inc., 7649 Southwest Mohawk St., Tualatin, OR 97062, (800) 327-7231 or (503) 692-4968.

Inquiry 1141.

JetWriter Lets Macs Print on HP's LaserJet

If you've been put off by the price of an Apple LaserWriter, you can now connect your Mac to the Hewlett-Packard LaserJet IIP. JetWriter includes a board for the printer and software drivers. The software drivers convert Macintosh QuickDraw files to HP's Printer

Control Language.

The product includes a high-speed interface board that replaces the serial interface in the LaserJet IIP.

The JetWriter interface operates at 230,400 bps as opposed to the standard 19,200 bps speed of the serial interface.

But the interface is not AppleTalk-compatible, and a LaserJet IIP with JetWriter cannot be used in an AppleTalk network, although the companies claim that's in the works.

JetWriter supports Adobe Type Manager but not PostScript.

Price: \$345.

Contact: Insight Development Corp., 2200 Powell St., Suite 500, Emeryville, CA 94608, (800) 825-4115 or (415) 652-4115.

Inquiry 1142.

Chameleon Simplifies Macros for PCs and Macs

The Chameleon Keyboard Customizer plugs into your XT- or AT-compatible keyboard port and stores about 3000 keystrokes in macro commands.

You can represent multiple keystrokes with one keystroke in any combination of keys, including Alts, Shifts, and Controls.

The XT and AT versions automatically intercept keyboard messages, giving you EPROM storage. The serial and DEC-compatible versions, Sirius says, will need about 25K bytes of system memory.

Price: \$59.

Contact: Sirius Industries, Inc., 21608 North 20th Ave., Phoenix, AZ 85027, (602) 780-0034.

Inquiry 1143.

continued

CalComp Moves with New Hybrid Input Device

CalComp is marketing a new gadget that's a hybrid of a mouse and a digitizing tablet and works with a PC or a Mac.

Called the Wiz, it looks like a mouse except for the transparent cross-hair pointer at its front, which you use to align the Wiz with locations on a special digitizing pad that you can customize with templates for various PC or Mac applications.

It has three buttons that toggle forward and backward, allowing six possible settings, four of which you

can define. The Wiz can also be configured for left- or right-handed users. Using an electromagnetic rather than an electrostatic surface for the digitizing pad, Wiz has a resolution of 1000 dpi.

Some 35 application templates are available that allow you to bypass the pull-down and pop-up menus that are typical of most graphical interface applications. Instead, all the menu options are displayed right on the digitizing pad, and you simply move the cross-hair pointer to the option that you

want and click on it. The Wiz package comes with a Windows template in the PC version and a Mac Finder/HyperCard template in the Mac version.

Some of the applications that CalComp reports work with the Wiz are AutoCAD, Generic CADD, Claris Mac programs, PageMaker, WordPerfect, and Excel.

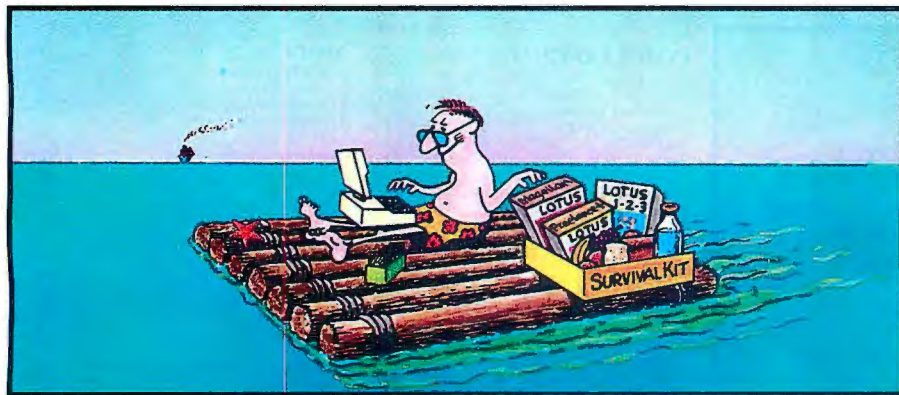
Price: \$249.

Contact: CalComp, 2411 West La Palma Ave., Anaheim, CA 92801, (800) 225-2667 or (714) 821-2000.

Inquiry 1140.

Programmer's Paradise

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445-7899

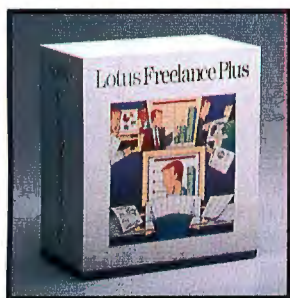


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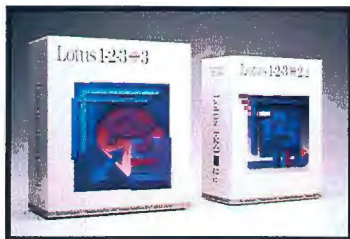


Lotus Freelance Plus 3.01

It's easy to see why Software Digest, InfoWorld, PC Week and PC World recently proclaimed the new Freelance Plus the number one business graphics package. Freelance Plus gives you the complete charting and drawing tools you need to make quick work of creating great presentations. It offers unparalleled links to 1-2-3, making the sharing of information across applications easy, and it's the only business graphics package that provides a "live link" to the 3-D worksheets in 1-2-3 Release 3.0. There's no easier way to create business diagrams, like flow charts, that communicate concepts and ideas. Or to enhance your graphics with symbols and maps. Create your own illustrations and logos, and incorporate scanned images into your graphics. To find out what a graphic difference it can make in your work, call today for your **FREE** Freelance Plus Demo Disk.

Lotus 1-2-3 Release 3.0

If you want a spreadsheet that can make your computer work to its fullest, we have one thing to say: More power to you. And that's exactly what Lotus delivers with this breakthrough in spreadsheet technology. Its new true 3-dimensional design lets you organize, analyze and navigate your way through large and complex spreadsheet applications with incredible speed, power, and ease. Equally impressive is Release 3.0's presentation quality output, its selection of advanced analytical graphics and its new relational database capabilities. And Release 3.0's fully customizable.

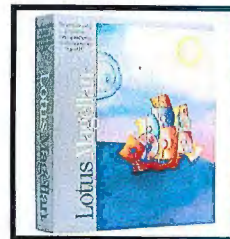


Lotus 1-2-3 Release 2.2

Now, without changing what's made it the best, we've made it even better. Release 2.2 brings you the most wanted features that seasoned 1-2-3 users have been asking for. Its 2-D spreadsheet includes file linking, minimal recalc, and UNDO error correction. Plus many other power options—like new macro commands, Learn automatic keystroke recording, and the Macro Library Manager. And you'll find improved graphics and precision-quality output thanks to Allways, the spreadsheet publishing add-in that's now part of Release 2.2.

Lotus Magellan

If you're tired of looking for specific information somewhere on your PC, and you don't feel like searching every directory or loading and unloading every file to find it, we have exactly what you need. **Lotus Magellan**. Lotus Magellan is the first PC utility to help you find your files by letting you instantly see their contents as they appear in your favorite applications. Unlike other programs, the Magellan Explore function can perform a search on a phrase, topic, idea or even an entire file. Not just key words. When you've found out what you need, you can Launch directly into the application that created the file. You also have the option of Gathering information from several files—even from different applications—and compiling it into a single file that you can use right away. See the special offer below to receive a trial copy today.



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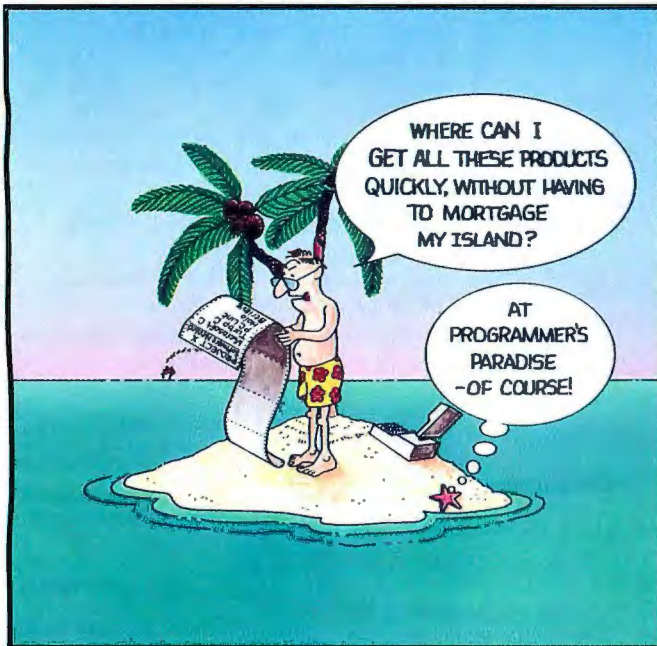
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.RTLink/Plus is an MS-DOS linker which has CodeView support for advanced overlays. Comes with Profiler utility for a highly-detailed performance analysis—details at user-adjusted times to the thousandths/second. No source code changes required. Source code provided for Profilers' read/analysis utility.

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CASE:W *Save Weeks in Windows Development Time*



CASE:W is a development tool that utilizes a high level prototyper to design the Windows portion of an application, and an Expert System to generate the Windows program source code in the "C" language.

Programmers add their program functionality directly to the source code framework that was created with CASE:W.

CASE:W also has a "Code Management Facility" that allows the developer's added code to be preserved even after changes have been made to the interface.

List: \$795 Ours: \$759

CASEWORKS™

The FairCom Toolbox

Don't struggle choosing between a 4GL or C. The FairCom Toolbox, with its development environment by d-tree™, file management by c-tree® and report generation by r-tree® integrates performance, productivity, and profitability into one industrial strength package.

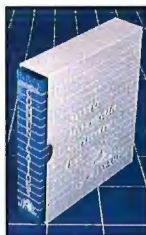


Features include prototype generation, data dictionary, resource swapping, screen management, overlapped windows, file restructuring, code portability, menu management, variable length records, key compression, client/server architecture, dynamic space reclamation, and complex multi-line reports with total runtime layout control.

Try the FairCom Toolbox risk free for 30 days.

Special Edition List: \$695 Ours: \$549
Professional Edition List: 1,095 Ours: \$869

Essential Communications Library



Essential Communications is a powerful asynchronous communications library stressing reliability and ease of use. The library supports interrupt driven communications for up to 34 ports at speeds up to 115,200 baud. The library supports XON/XOFF, XMODEM (CRC and Checksum), XMODEM-1K, XMODEM Batch, YMODEM-g and Kermit. True background communications and multiple concurrent sessions are allowed. Support for Hayes compatible modems is provided.

All source is included. Clear and concise documentation. No royalties. Borland Turbo C & Microsoft C/ Quick C compatible.

List: \$249 Ours: \$199



PANEL Plus II

Now available with full source, the latest release of this reliable, time-tested screen design product includes an interactive screen design editor, C and FORTRAN code generators, and an extensive library of user-interface functions. The library functions include virtual screens, scrolling windows with mouse-controlled scroll bars, pop-up and pull-down menus, and support for popular graphics libraries. All versions of PANEL Plus II include full library source, allowing your applications to be ported royalty-free between DOS, OS/2, Unix, VMS and other operating systems. The new Utility Source License option also allows you to develop software using PANEL Plus II on any suitable system with a C compiler.

List: \$495 Ours: \$395
With Utility Source: \$1,195 Ours: \$955



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DynaComm Optimizes Software for Windows

Future Soft Engineering's DynaComm Asynchronous Edition 2.1 is a communications software package for Microsoft Windows.

The company says that it supports CompuServe B+, XMODEM, YMODEM, YTerm, and Kermit. It also supports many terminal emulations, including HP 700/94, DEC VT52, VT100, VT220, IBM 3101, TeleVideo 925/950, Vidtex, and ADDS VP-60. Recent additions include support for NetBIOS, UBNNetCI, ComBios, and Device network interfaces.

A communications manager, Director, integrates the functions of a phone dialer and also lets you execute scripts created with DynaComm's script language. With 275 tools, you can create scripts to handle most communications tasks, such as dialing and logging onto BBSes, which you can subsequently execute by clicking on icons with a mouse.

Other additions include support for Digital Equipment's LAT protocol and multichannel capabilities that let DynaComm act as multiple servers and multiple clients at the same time.

A built-in text editor has several functions, including wrapping text, cut and paste, align, center, and reformat. **Price:** \$295; upgrade for 2.0 users, \$50.

Contact: Future Soft Engineering, Inc., 1001 South Dairy Ashford, Suite 203, Houston, TX 77077, (713) 496-9400.

Inquiry 1145.



Future Soft Engineering betters its Microsoft Windows communications software.

Madge Introduces Bus-Mastering EISA for Token Ring

Madge Networks has entered the Extended Industry Standard Architecture arena with the Smart 16/4 EISA Ringnode. As the name implies, the card is designed for 802.5 token-ring networks.

The Smart 16/4 EISA Ringnode uses bus mastering capabilities to achieve internal electrical transfers at the maximum speed of the EISA bus—33 megabytes per second, the company claims.

Smart Server software also helps you download NetBIOS and IPX/SPX onto each adapter's 128K bytes of RAM, which can free as much as 50K bytes of DOS memory, according to the company.

Microcom Introduces MNP Class 10 on V.22bis Modem

Microcom says that its new QX/2400t modem with MNP 10 is the highest-performing V.22bis unit on the market. It uses the data compression of MNP 7 to achieve transmission speeds of up to 12,000 bps under optimal conditions, Microcom says, and with the added features of MNP 10, it can accommodate dirty telephone lines, signal fading, and other interruptions.

The latest in a series of Microcom Networking Protocols, MNP 10 works with the compression features of the widely used MNP 5 and 7 standards, which provide double and triple the data rate through software.

Class 10 adds what Micro-

com calls ACE, or Adverse Channel Enhancements, which automatically change the transmission speed and packet size depending on the line quality. These improvements are especially useful, Microcom says, when signal clarity fades in and out, as in cellular links or for international transmission using outdated analog switching equipment. A feature of ACE called Robust Auto Reliable also provides backward compatibility with non-MNP modems.

Price: \$699.

Contact: Microcom, Inc., 500 River Ridge Dr., Norwood, MA 02062, (800) 822-8224 or (617) 551-1000.

Inquiry 1146.

Price: \$1495.

Contact: Madge Networks, Inc., 1580 Oakland Rd., Suite C-206, San Jose, CA 95131, (800) 876-2343 or (408) 441-1300.

Inquiry 1147.

Diagnostic ARCnet Hub Includes Net Management

The Ultra Hub serves up to eight ARCnet users with built-in diagnostic capabilities. It's available with transceivers for thick coaxial, twisted-pair, and optical fiber cabling.

For network management, the hub keeps a historical list of the 64 most recent reconfiguration events complete with time-stamp information, and it also maintains a connectivity map and has provisions for automatic disconnection/reconnection sequences. For example, Ultra Hub will automatically disconnect a problem-causing node, and when the problem has been resolved, it will automatically reconnect the node to the network.

The hub also protects the network from duplicate node IDs, one of the biggest problems with ARCnet LANs, Network Interface says. Rather than disconnect both nodes, the hub will automatically disconnect the duplicate ID that has created the problem.

Each hub supports redundant cable pairs for network security and, of course, for redundancy. Hub software is included.

Price: Coaxial, \$725; twisted-pair, \$895.

Contact: Network Interface Corp., 15019 West 95th St., Lenexa, KS 66215, (800) 343-2853 or (913) 894-2277.

Inquiry 1148.

continued



INSTANT WORKSTATION. JUST ADD OPEN DESKTOP.

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

An integrated UNIX® System environment.

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SCO, the SCO logo, Open Desktop, and the Open Desktop logo are trademarks of The Santa Cruz Operation, Inc. UNIX is a registered trademark of AT&T in the USA and other countries. POSIX is a trademark of The Institute of Electrical and Electronics Engineers (IEEE). X/Open is a registered trademark of X/Open Company Ltd. OSF/Motif is a trademark of The Open Software Foundation, Inc. XENIX is a registered trademark of Microsoft Corporation. NFS is a trademark of Sun Microsystems, Inc. © 1989 The Santa Cruz Operation, Inc. All Rights Reserved. The Santa Cruz Operation, Inc., 400 Encinal Street, P.O. Box 1900, Santa Cruz, California 95061 USA The Santa Cruz Operation, Ltd., Crawley Centre, Hatters Lane, Watford WD1 8YN, Great Britain, +44 (0)923 846544, FAX: +44 (0)923 817781, TELEX: 917572 SCOLON G

An All-in-One Communications Center

The Navigator is a telephone, an answering machine, a fax machine, and an XT-compatible computer. The system has separate circuits for the 8086 and the fax CPU, which let you use the phone and fax while running applications.

The computer has 640K bytes of RAM, dual 3½-inch 1.44-megabyte floppy disk drives, one parallel and one serial port, and a 10-inch monochrome EGA monitor that doubles as a pressure-sensitive control panel. This touchscreen lets you start applications by pressing the icon or symbol on the menu screen.

The unit's built-in answering machine holds up to 12 incoming messages, which you can play back or delete from a remote phone.

The Group 3 fax machine lets you send a stored document from the disk by touching the screen. You can also send a document to as many as 100 different locations by using the sequential broadcasting capabilities of the system.

Price: \$2995.



Voice, data, and video integration in the Navigator from Canon.

Contact: Canon U.S.A., Inc., Information Systems Division, One Canon Plaza, Lake Success, NY 11042, (516) 488-6700.

Inquiry 1151.

Make Your NuBus Mac a Multiuser Unix System

The DigiChannel Nu/Xi is an intelligent, multi-channel NuBus communication board that lets a Macintosh II running Apple's A/UX Unix operating system act as a host computer for a multiuser

environment. With eight boards, your Mac could support up to 64 channels.

Each DigiChannel Nu/Xi is equipped with a 12-MHz 68000 processor and 256K bytes of RAM. It offers either four or eight channels of synchronous or asynchronous communication, as well as four DMA channels. It also includes two to four serial controllers.

Price: Four-channel, \$995; eight-channel, \$1295.

Contact: DigiBoard, Inc., 6751 Oxford St., St. Louis Park, MN 55426, (800) 344-4273 or (612) 922-8055.

Inquiry 1150.

Hayes Upgrades the V-series with V.42bis

The V-series Ultra Smartmodem 9600 is a new 9600-bps V.32 modem from Hayes. It provides CCITT V.42bis for data throughput to 38,400 bps.

The Ultra 96 is backward compatible with V.22bis, V.22, V.21, and the Bell 103 and 212A standards. Features include V.42 Link Access Procedure for Modems (LAPM) for point-to-point error control, and V.42 Annex A for backward compatibility for modems with MNP 2-4. Support for Link Access Procedure Balanced (LAPB) provides error control for point-to-point or point-to-multipoint X.25 networks.

Also included is equipment for synchronous transmission and for leased-line communications, making the Ultra Smartmodem 9600 compatible with X.32, which is X.25 in dial-up.

Price: \$1199; in Canada, \$1699.

Contact: Hayes Microcomputer Products, Inc., P.O. Box 105203, Atlanta, GA 30348, (404) 441-1617.

Inquiry 1152.

continued

Everex Joins Storage Dimensions for NetWare Server

Everex and Storage Dimensions have together developed a network server that eliminates the bus bottleneck.

The Everex Stepserver and Storage Dimensions LANstor FileMaster include a 33-MHz 80386 CPU with a modified (16.5-, 11-, or 8-MHz) AT bus, three-tiered caching, 32-bit networking adapters, and SCSI disk caching.

The resulting file servers

have two to three times the data throughput of "PC-as-server" systems, the companies claim.

The base systems include a 150-megabyte SCSI hard disk drive, a 5¼-inch 1.2-megabyte floppy disk drive, 4 megabytes of RAM, a 128K-byte RAM cache, a 101-key keyboard, a Hercules driver, and a 12-inch monochrome monitor. The BIOS is a modified AMI design.

At maximum configuration, the systems sport 16 megabytes of RAM, an internal storage capacity of 1.3 gigabytes, and an external storage capacity of more than 18 gigabytes, thanks to the SCSI daisy chain and 1.2-gigabyte drives from Storage Dimensions.

In terms of caching, the 128K bytes of RAM cache is optimized for Novell's disk-caching algorithm. In addition, there's a scalable CPU

cache of 256K bytes and a read-ahead caching scheme on the SCSI peripherals of at least one track (e.g., 64K bytes on a 38-megabyte hard disk drive).

Price: \$11,599.

Contact: Everex Computer Systems Division, 48504 Kato Rd., Fremont, CA 94538, (800) 356-4283; Storage Dimensions, 2145 Hamilton Ave., San Jose, CA 95125, (408) 879-0300.

Inquiry 1149.

Now There Are Two Choices For OS/2 Databases:

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ORACLE Server

Runs on every vendor's operating system:
OS/2,[®] VINES,[®] UNIX,[™] VAX[®] VMS, IBM[®] MVS, etc.

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Transparent access to data in other vendor's databases:
IBM's DB2[™] and SQL/DS, and Digital's RMS.

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Your Lotus 1-2-3[®] spreadsheets and dBASE[®] applications
work with ORACLE Server today.

Developers have a complete and integrated family of portable
tools for CASE, applications generation, report writing, etc.

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ORACLE Server is certified by Codd and Date to run at
11.0 TP1 transactions per second.

Call 1-800-ORACLE1, ext. 4965 today and order ORACLE Server for OS/2 for only \$2499 and get six months of phone support and upgrades for free (a \$500 value). Or try our Developer's Version (limited to 3 Users) for only \$699.

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Closed Server



Ashton-Tate[®] SQL Server[™]

Runs only on OS/2.

Supports only Named Pipes.

Does not provide access to any other database.

Can't even transparently share data between
two PCs running Ashton-Tate SQL Server.

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

Supports only Focus.

Supports only C.

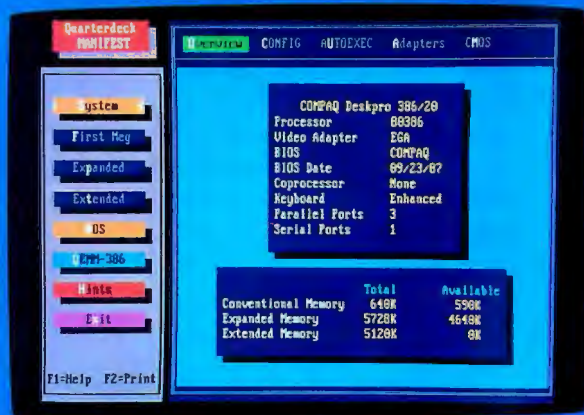
Ashton-Tate SQL Server's published benchmarks
show it to be slower.

Everything you always wanted to know
about memory but didn't know
how to ask.

DESQ
view
Quarterdeck

There's Gold in Your PC!

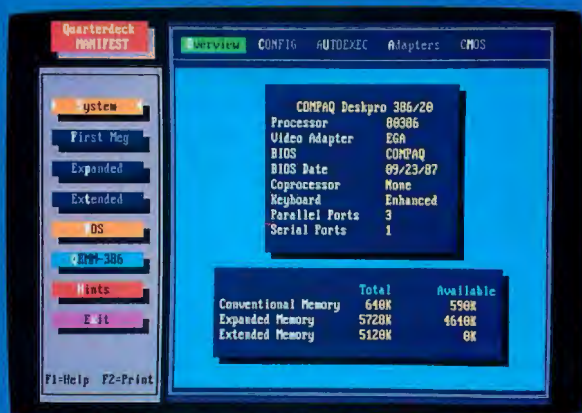
And Here're
the Map & Tools
to Find It.





There's Gold in Your PC!

And Here're
the Map & Tools
to Find It.



Memory's

When your PC programs were few and small in size, you didn't have to think about memory as a precious resource to be rationed and used smartly. Today memory is just that! Pure Gold!

Today, each new program update brings a larger, more featured program. PC networks require software, resident in your PC, that communicates to the network. Easy-to-use, point and click, program interfaces require memory-resident mouse software. Terminate and stay resident (TSR) software, such as Sidekick, work best when they are on hand instantly.

What this means to PC users is that the 640K of memory used to run DOS programs is crammed full. So there's much to be gained when you can use this memory more efficiently.

But, memory is important for another reason. It's memory (*and the right kind of memory*) that enables DOS to be transformed into a next generation operating system. With the right kind of memory, you can run large (32MB or larger) programs. You can run several programs simultaneously (multi-task). And you can give your programs the space they need to communicate and work together (sharing data and starting new tasks).

Precious.

Those who understand how to get the most power out of a PC's memory have a significant advantage over those who don't. We know this—for Quarterdeck has been a leader in using memory to give DOS the power of OS/2.

1986—Quarterdeck's DESQview broke through the DOS 640 barrier—using expanded memory to multitask programs on 8088 and 80286 PCs.

1986—DESQview became an 80386 control program, providing multitasking for DOS using the 80386's extended memory.

1987—the Quarterdeck Expanded Memory Manager-386 (QEMM-386) transformed the 80386's extended memory into expanded memory.

1987—the Quarterdeck Expanded Memory Manager-50/60 (QEMM-50/60) transformed IBM's 80286 PS/2 Memory Expansion Option & Expanded Memory Adapter/A into expanded memory.

1987—in conjunction with Phar Lap Software specified the Virtual Control Program Interface (VCPI), which ensured compatibility among DOS extended programs (such as Paradox 386, 1-2-3 Release 3), expanded memory managers, and control programs.

Introducing Your Treasure

Manifest is the map that can lead you to whatever gold is in your PC. It gives you an instant snapshot of your PC. And it tells you everything about your PC's memory.

This includes an inventory listing of the hardware in your PC, details about your version of DOS, as well as a picture of the contents of your CONFIG.SYS and AUTOEXEC.BAT files. Manifest includes details on whatever memory you have (first megabyte, expanded, or extended) and *even gives you hints on how you can better use it.*

There's lots you can do with Manifest. But for sure, keep Manifest on hand when you're calling for support on a program or on your PC.

For the user new to a PC, Manifest is an introductory course, not only in memory, but in all the key components of a computer system—with the advantage that the information provided is about your own PC.

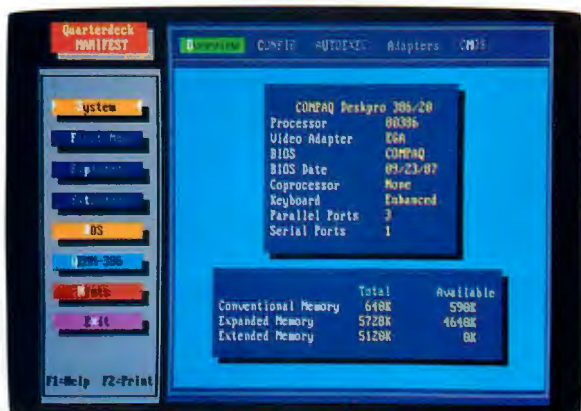
When you run Manifest, you'll instantly learn whether your PC has the math coprocessor needed by AutoCAD, or the expanded memory recommended by 1-2-3 Release 2.

If you're a power user, Manifest shows you the memory your PC hardware is addressing, and how interrupts are being used by both

Manifest Map to the Gold.

hardware and software. And because Manifest can be run as a TSR, it becomes a debugging tool.

For the person responsible for supporting PCs in a company, Manifest gives an instant inventory of a PC—especially about memory and each device or program using this memory. Manifest gives you detailed information about the processor type (8088, 8086, 80286, 80386), DOS version, BIOS manufacturer and date, video adapters, serial and parallel ports, microchannel adapters, and much more—*all without opening the case*. This information can be printed or saved to a file on disk instantly. A real time savings!



You can use Manifest to display your CONFIG.SYS and AUTOEXEC.BAT files—very convenient when describing your PC.



Take Manifest along with you to the store. Manifest tells you what's under the hood of a PC. It even times your PC's memory and runs benchmark tests on expanded memory.



Manifest shows you whether you can use the memory from 640K to 1MB to run TSRs, network drivers, and DOS resources. It gives you maps of the first megabyte and information about the size and memory location of your TSRs. And it even makes recommendations on how to optimize the memory used on your system!



Strike it Rich on

It's often not easy to assess how much gold is in any claim, but we've a product called QRAM (pronounced cram) to help. QRAM is a set of memory tools for 8088, 8086 and 80286 PCs that assist you in getting the maximum use of your PC's memory. QRAM can't work magic—but if you have memory capable of running programs but not currently being used, QRAM makes it available. To that end, QRAM manages your PC's high memory, EGA/VGA video memory, and extended memory.

High memory (the memory addresses between 640K & 1024K) has been traditionally reserved by IBM for use by PC hardware. As DOS programs have become larger, and as TSRs and networks have become more popular, high memory has increased in importance. The reason—there are often more memory addresses reserved for system hardware than are actually being used. So there are precious available memory addresses, waiting to be used!

If you have expanded memory hardware (compatible with either EMS 4 or EEMS expanded memory specifications), QRAM uses the expanded memory's mapping capabilities to fill unused memory addresses in your PC's high memory. Using QRAM, you can then load TSR's, device drivers (such as networks), and DOS resources (i.e. FILES or BUFFERS) in this memory.

an 8088 or 80286.

Depending on your PC, QRAM makes anywhere from 30-130K of high memory usable.

Note that QRAM can also load TSR's, drivers and DOS resources high if your PC has shadow RAM.

You don't have to be a PC guru to use high memory. QRAM, in conjunction with your expanded memory manager, automatically maps expanded memory into available addresses. Then QRAM's optimize feature examines your CONFIG.SYS & AUTOEXEC.BAT files to determine what can be loaded high, and makes any changes necessary.

For those of you who need memory *more than* EGA or VGA graphics, QRAM makes the 96K reserved for your EGA or VGA adapter available to DOS programs. The caveat is that while you are using this memory, you can't be doing graphics. But, QRAM makes it easy for you to turn on and off this feature.

That's not all! QRAM is also an extended memory manager, compatible with the XMS extended memory specification, specified by Microsoft and used in Windows 286 v2.

The end result is that however you need to use memory, QRAM will do its best to make your memory into what you need.

A Gold Vein in

If you have an IBM PS/2 Model 50 or 60 with either an IBM 80286 Memory Expansion Option, an IBM Memory Expanded Memory Adapter/A, or compatible, there's a gold vein in those boards, ready to be mined.

Although you might not know it, built into these boards is the hardware necessary for expanded memory. You need only a special software driver to access that hardware! And that's what the Quarterdeck Expanded Memory Manager (QEMM-50/60) does. We have a new version, Version 5, which, in addition, takes advantage of high memory, EGA/VGA video memory, and extended memory.

QEMM-50/60 transforms any of the above boards into expanded memory, compatible with all three expanded memory specifications (EMS 3.2, EMS 4.0, EEMS). So there's no need to buy a special expanded memory board for a PS/2 Model 50 or 60. No worry. Just run your programs designed to take advantage of expanded memory (like 1-2-3 Release 2, Framework, Paradox 3).

QEMM-50/60, like QRAM, enables you to load TSR's, device drivers (such as networks), and DOS resources (i.e. FILES or BUFFERS) in high memory. And to assist you in determining what can be loaded high and where, QEMM-50/60 comes with its own microchannel adapter library.

PS/2 50's and 60's.

Even the novice PC user can set up QEMM-50/60 to get the best use of memory. For QEMM installs itself (and if you wish) has an optimize feature which can load your TSRs, network drivers and DOS resources in high memory—automatically.

For those of you who need memory more than EGA or VGA graphics, QEMM-50/60 makes the 96K reserved for your EGA or VGA adapter available to your DOS program. The caveat is that while you are using this memory, you can't be doing graphics. But, QEMM-50/60 makes it easy for you to turn this feature on and off.

QEMM-50/60 is also an extended memory manager, compatible with the XMS extended memory specification, specified by Microsoft and used by Windows 286 v2.

If you use QEMM-50/60 with DESQview, DESQview can run (multitask) programs in expanded memory. However, in order to effectively use any DOS multitasking environment on a PS/2 Model 50 or 60 (DESQview, Microsoft Windows 2.0, or IBM 3270 Workstation Program), the PS/2's motherboard memory must be disabled. You do need, then, at least 1.5 megabytes of memory on your IBM 80286 Memory Expansion Option before multitasking is effective.

QEMM-386: A Bon

You reap a memory bonanza with the Quarterdeck Expanded Memory Manager-386 (QEMM-386) Version 5. It's an expanded memory manager for 386 PCs and PS/2s.

And more. For QEMM-386 gives you maximum flexibility in memory usage.. Like QRAM and QEMM-50/60, QEMM-386 lets you load TSR's, device drivers and DOS resources in high memory, manages EGA/VGA memory and acts as an extended memory manager.

In addition, QEMM-386 is also an 80386 control program. This enables QEMM-386 not only to take advantage of the 80386 processor to help you find more available high memory, but also to make 80386 power available to Quarterdeck's DESQview for multitasking, screen virtualization, and program protection.

QEMM-386 is compatible with all the current industry memory specification standards. EMS 3.2, EMS 4, and EEMS expanded memory specifications. The XMS specification for extended memory. And the Quarterdeck/Phar Lap virtual control program (VCPD) interface, (incorporated in 1-2-3 Release 3, IBM Interleaf, Paradox 386, and other powerful programs), for running protected mode programs in DOS.

It is QEMM-386's expanded memory capabilities that enables it to load TSR's,

anza (Unto Itself).

drivers, and DOS resources in high memory. In order to give you as much high memory as it can, QEMM-386 finds and maps memory addresses as small as 4K (rather than the 16K mapped by EMS managers).

Additionally, if your PC is either a Compaq configured with top memory or if it has Chips & Technologies shadow RAM, QEMM-386 detects this memory and makes the best use it can out of it. For PS/2s and others using microchannel architecture, QEMM-386 includes an "Adapter Description Library" (ADL). QEMM-386 uses this information to insure a maximum amount of safely accessible high memory with PS/2 s.

For users new to 386 PCs, QEMM-386 sets up your memory as optimally as it can—*automatically*. And it has an optimize feature which can load your programs high—so there's no need to be a memory guru.

But, for memory addicts, QEMM-386 has two other features. The first, called Accessed, watches high memory and notes what has been accessed by your programs. The second, called Analyze, uses the information from Accessed to tell you what memory addresses you may additionally use to load TSRs, drivers, etc. The goal, of course, always, is to give you the maximum utilization of your most precious PC resource, memory.

DESQview & DESQview 386 Not to Be Ignored.

The future of personal computing is clear. Easier to use PCs. More powerful PCs with graphics and text programs working side by side. Talking to each other. Multitasking. Windowing. Transferring data. Menuing. Mousing.

With DESQview you get the next generation computing capabilities now on your 8088, 8086, 80286, or 80386 PC or PS/2. And you get these powerful capabilities without obsoleting your investment in DOS, your programs, or your time spent in learning and using these programs.

For DESQview today multitasks within 640K and beyond. It does windows. It transfers data. It dials your phone. It gives you menus for DOS. It remembers your keystrokes (macros). And more.

When DESQview is combined with QEMM-386, it becomes an 80386 control program, taking advantage of its virtual 8086 machine architecture and its 32-bit protected mode. We call this combination, DESQview 386.

By controlling these 80386 features, DESQview 386 gives you program protection plus the ability to run large memory intensive 80386-specific programs side by side with your standard DOS programs. Moreover, DESQview 386 lets you run text or graphics (CGA, EGA, VGA, or Hercules) programs in small windows and in background.

NOTE: The 80386 processor's most powerful mode is its 32-bit protected mode. So that 32-bit 386 programs can run on DOS, a special program, called a DOS extender, must be part of the program. Realizing the importance of the DOS Extender, Quarterdeck has worked to ensure compatibility between DOS extenders (286 & 386) and DESQview. The result is the Quarterdeck Phar Lap Virtual Control Program Interface Specification (VCPI), specifying the interfaces between DOS extenders and 386 control programs.

Yes! I'm interested in finding gold in my PC!

No.	Diskette 5¼ 3½		Product	Price Each	Total
			QEMM-386 (V5.0) (includes free Manifest!)	\$99.95	
			QEMM-50/60 (V5.0) (includes free Manifest!)	\$99.95	
			QRAM (V1.0) (includes free Manifest!)	\$ 79.95	
			Manifest (V1.0)	\$ 59.95	
			DESQview 2.26	\$ 129.95	
			DESQview 386 (V1.1) (DESQview, QEMM-386 and free Manifest!)	\$ 219.90	
			Shipping & Handling USA	\$ 5.00	
			Outside USA	\$ 10.00	
			Sales Tax (CA residents)	6.5%	
			Amount Enclosed	\$	

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Quarterdeck Office Systems

150 Pico Boulevard, Santa Monica, CA 90405

(213) 392-9851

Fax (213) 399-3802

Trademarks

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Quarterdeck Office Systems
150 Pico Boulevard Santa Monica, CA 90405



Quarterdeck Office Systems
150 Pico Boulevard Santa Monica, CA 90405

There's gold Now, Quarterdeck's new

Memory is gold.

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

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

Introducing Manifest—the Quarterdeck memory analyzer

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

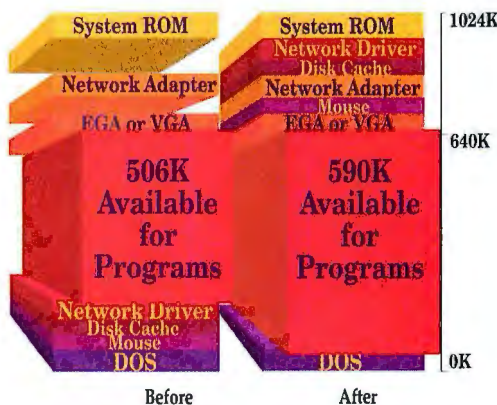
That's why Quarterdeck Office Systems, publisher of DESQview, developed a new utility that helps you find and use this memory. It's called Manifest. And it does for memory what PC Tools does for disks. For under \$60.

Quarterdeck's seven years of memory expertise made Manifest

Manifest guides you deep inside your PC.

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

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



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

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

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

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

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

Introducing QRAM—the Quarterdeck memory optimizer

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

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

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

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



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

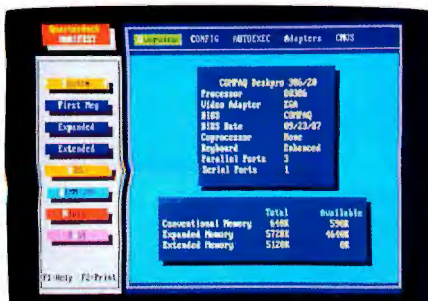
parts and puts them under your control.

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

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

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

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



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

in your PC. tools can mine it for you.

Introducing QEMM 50/60 Version 5.0

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

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

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

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

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

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



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

Introducing QEMM 386 Version 5.0

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

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

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

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

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

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

A few words about DESQview

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

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



DESQview's recent awards.

System Requirements

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

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

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

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

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



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Yes! I need increased productivity on my current PC!

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Qty	Product	5-1/4	3-1/2	Each	Totals
	Manifest 1.0			\$59.95	
	QRAM and Manifest 1.0			\$79.95	
	QEMM 50/60 5.0 (with Manifest*)			\$99.95	
	QEMM 386 5.0 (with Manifest*)			\$99.95	
Shipping & Handling \$5 in USA/ \$10 outside USA					
California Residents add 6.5%					
Grand Total					

* introductory offer expires 3/31/90

DOS and OS/2 Compiler for C++ 2.0

Zortech's C++ 2.0 Developer's Edition includes a compiler that complies with AT&T's C++ 2.0 specification, supporting object-oriented programming features such as multiple inheritance and type safe linkage. The compiler also supports the use of EMS in developed applications and includes a seamless edit/compile/debug environment that uses a Systems Application Architecture/Common User Access user interface.

In addition to the compiler, C++ 2.0 has full standard library source code, programming compatibility with Microsoft Windows, graphics classes, and a TSR library that lets most applications become resident with a single function call. The company has also released an OS/2 compiler upgrade.

Price: \$450; OS/2 compiler upgrade, \$149.95.
Contact: Zortech, Inc., 1165 Massachusetts Ave., Arlington, MA 02174, (617) 646-6703.
Inquiry 1154.

Dialogue Programming Tool for Windows

DialogCoder reduces the coding normally associated with dialog box programming, its developer reports. DialogCoder generates native C source code from a template you've created with a Microsoft or Whitewater Group dialogue editor.

With DialogCoder, you can establish relationships among controls and specify the initialization state of each control. If your specifications are incomplete, DialogCoder will prompt you to fix the ambiguity or omission.

You use DialogCoder's icons to establish control and

action relationships. It supports listbox initialization from ASCII files, resources bound to an application, and directory lists. It also provides validation code for edit fields.

DialogCoder runs on the IBM AT with Windows 2.0 or higher.

Price: \$499.
Contact: The Software Organization, Inc., P.O. Box 1926, Brookline, MA 02146, (800) 443-2864 or (617) 354-2012.

Inquiry 1157.

Normalize Databases for Unix Applications

With the Canonizer for Unix operating systems, you can reduce the amount of time it takes to normalize your database system, helping you to create a system with increased data integrity, improved query integrity, and simplified data organization. The design tool normalizes to

the third normal form, its developer reports.

The Canonizer creates an ANSI-standard Structured Query Language script for use with Unix DBMSes such as Informix, Oracle, Ingres, Sybase, and others. It also provides a data dictionary for holding definitions of every item in the database.

One-to-one, one-to-many, and many-to-many relationships are supported. The Canonizer maintains multiple directories of database models and multiple databases within a directory. A view can maintain any number of data items and relations.

The Canonizer is compatible with SCO Xenix, System V Unix, SunOS, and BSD Unix.

Price: \$1295; SQL converter, \$295.

Contact: Six Sigma CASE, Inc., 14405 Southeast 36th St., Suite 210, Bellevue, WA 98006, (800) 827-4462 or (206) 643-6911.

Inquiry 1163.

continued

Two Ways to Develop CUA Interfaces

EasySAA is an application generator for developing cooperative processing interfaces in DOS that are upwardly compatible with OS/2 while complying with IBM's Systems Application Architecture/Common User Access. You can use EasySAA to develop front-end interfaces to 3270 mainframe applications, allowing the intelligence of the PC to share responsibility with a mainframe in a communications task.

With EasySAA, you can develop peer-to-peer applications and mixed 3270 and peer-to-peer applications. The generator combines editing, compiling, debugging, and testing in one environment. It can automati-

cally produce prototype applications with color, menu placement, help, and keyboard handling. Language templates assure consistency at large sites.

EasySAA has a code library and is object-based. Objects supported include procedures, windows, dialog boxes, list boxes, help files, and libraries. EasySAA requires Infront or Infront/HPO, Multi Soft's development system, and an IBM PC with 640K bytes of RAM.

Price: EasySAA, \$500; Infront, \$1500.

Contact: Multi Soft, Inc., 123 Franklin Corner Rd., Suite 207, Lawrenceville, NJ 08648, (609) 896-4100.

Inquiry 1155.

The cooperative processing package Mozart now includes a Librarian that lets you distribute PC files to remote workstations, Aspen Research reports. Changes made at the workstation are stored in a host library. In addition to interface updates, the Librarian can distribute data files and other applications directly through screens using a proprietary data compression and conversion technique.

Mozart lets you modernize host applications at the front end, allowing you to make them SAA/CUA-compliant without moving to OS/2 or rewriting application code. It supports IBM S/370, AS/400, System

36/38, Hewlett-Packard, Digital Equipment, and Prime computers. An application can have up to 64,000 panels, Aspen says. Mozart includes a dBASE III Plus database management facility for validating files at the PC level.

Mozart runs on an IBM PC and consumes about 300K bytes of memory. It is upwardly compatible with OS/2, and an OS/2 version is scheduled to ship late in the first quarter.

Price: \$1295; run-time modules, \$195 to \$495; Librarian, \$7995.

Contact: Aspen Research, Inc., 1350 Bayshore Hwy., Suite 630, Burlingame, CA 94010, (415) 340-1588.

Inquiry 1156.

BAYTECH MULTIPLExER- CONTROLLERS

*14 Years of Quality
Multiplexing*

CONTROL & DATA ACQUISITION

Enter the picture...the BayTech H-Series Multiport Controllers—stand-alone multiplexers that connect one host computer to as many as 23 peripheral devices. By cascading, the number of devices you can connect is practically unlimited. Full duplex transmission of asynchronous data is provided at speeds up to 38,400 bps. These intelligent multiports will operate with any RS-232C serial computer or peripheral device. (Optional RS-422A).

The H-Series models have been used extensively in each of these areas:

- security and environmental sensing, to improve monitoring capabilities for large and small businesses

Security



Courtesy Honeywell Protection Services.

- medical data monitoring environments, where speedy responses are vital and critical information must reach the host computer immediately

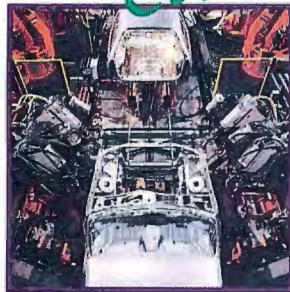
*Medical
Data Systems*



Courtesy Siemens Life Support Systems.

- industrial robotics-control environments, where multiple numerical or assembly-line machines can be centrally controlled

*Process
Control*



Courtesy Ford Motor Company.

- data exchange among point-of-sale devices, through which a myriad of business equipment can be operated from one computer

Point of Sale

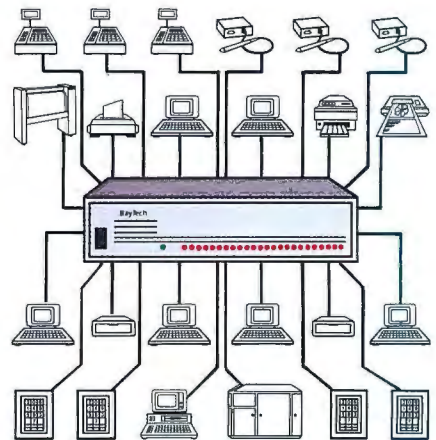


Courtesy Hugin Sweda.

SIX MODES OF MULTIPLExING

To meet individual needs, these flexible, multifunctional devices are easily tailored by selecting one of six modes of multiplexing: time-division, port expansion/sharing, and four modes of buffered message multiplexing. In a typical application, the host port may be connected to a

computer and the peripheral ports may be connected to such devices as: bar code readers, cash registers, fire alarms, numerical machines, modems, plotters, printers, security systems, and terminals (see illus.).



PRODUCT SUPPORT

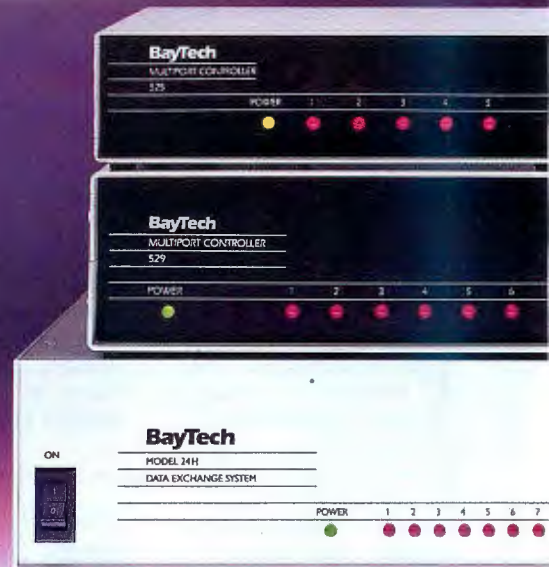
BayTech offers unlimited hotline technical support before and after you purchase a unit. Designed and manufactured in the USA, the reliable H-Series is UL- and CSA-listed and fully covered by a one-year warranty.

So put yourself into the picture...call us today to learn about the many ways the H-Series Multiplexer-Controllers can benefit your business.

BayTech

Bay Technical Associates, Inc.
Data Communications Products Division
200 N. Second Street, P.O. Box 387
Bay St. Louis, MS 39520 USA
FAX: 601-467-4551
Phone: 601-467-8231 or toll-free

800-523-2702



VP-Planner in 3-D

Paperback Software says that the new version of its VP-Planner spreadsheet offers most of the advantages of Lotus 1-2-3 release 3.0, including three-dimensional worksheets, while running in as little as 384K bytes of RAM.

The three-dimensional feature lets you work with a stack of worksheets where the worksheets form a cube of information that you can view or rotate. Formulas on any page can include cell references to different pages.

Other improvements include hot links among graphs, worksheet data, and worksheet files on disk and in memory. In hot linking, a change made to a graph is automatically reflected in a dependent worksheet, and vice versa. Paperback Software also promises LAN compatibility, with file locking, and support for up to 32 megabytes of expanded or virtual memory.

VP-Planner is keystroke-, file-, and macro-compatible with 1-2-3 release 2.2 and

lower, the company reports. **Price:** \$295.

Contact: Paperback Software, 2830 Ninth St., Berkeley, CA 94710, (415) 644-2116.

Inquiry 1168.

Two for Uncle Sam

It's time to start thinking about that April 15 deadline, when we'll offer a portion of our earnings to Uncle Sam. The following are two programs to help you prepare your taxes on a PC or Mac.

TurboTax can help you prepare your Personal/1040 tax return and plan for the rest of the year.

You start by answering a series of questions that help determine the tax forms you'll need to use. IRS instructions that are keyed to each line of the tax form are available online, and the program is shipped with the *Price Waterhouse Personal Tax Adviser*.

TurboTax includes pop-up notes that you can use to post reminders. The program can link to 41 state versions of the

program, so that when you prepare your federal return, you're also working on your state return.

Available schedules include D1, a second copy of F, Schedule 2 (Form 1040A), and Forms 4952, 8283, 8808, and 8814. The program can handle up to four what-if scenarios.

TurboTax works on the IBM PC with DOS 2.0 or higher and 384K bytes of RAM. With DOS 3.2 or higher, you will need 512K bytes of RAM.

Price: \$75; state versions, \$40 each.

Contact: ChipSoft, 5045 Shoreham Place, San Diego, CA 92122, (619) 453-8722.

Inquiry 1169.

By using the 1989 edition of MacInTax or MacInTax for Windows, you can file your taxes electronically and receive a refund in as little as three days, Softview reports. The company has joined forces with a nationwide electronic filing service to provide for electronic filing. To receive a refund within three days, you pay a \$39.95 filing fee. To receive a refund in the normal amount of

time, you pay \$29.95 to file electronically.

MacInTax for Windows and MacInTax can display Form 1040 and more than 75 other federal tax forms, schedules, worksheets, and statements, plus eight state tax supplements, on-screen. You can then print an exact replica of the form, complete with data, the company reports.

MacInTax requires a Mac 512KE or higher. For the Windows version, you'll need an IBM AT with 640K bytes of RAM. A version for professionals, called Taxview, is also available in Windows and Mac versions. It consists of a series of individual modules—1040, 1065 (partnerships), 1120 (corporations), and 1120-S (S-corporations)—plus state supplements, electronic filing, and a multiyear tax modeling program.

Price: \$99. Taxview: Electronic Filing, \$149; Planner, \$295; 1040, \$495; 1065, 1120, and 1120-S, \$395 each; state supplements, \$79 each.

Contact: Softview, Inc., 1721 Pacific Ave., Suite 100, Oxnard, CA 93033, (805) 385-5000.

Inquiry 1170.

continued

Interface Makes DOS a Breeze

A new version of SoftBreeze, the user interface that offers you task switching, an applications menu, and file, disk, and memory management for plain old DOS, provides a Systems Application Architecture-compatible menu structure while letting you view and launch applications from data files.

According to SoftShell, SoftBreeze makes DOS easier to use and more powerful, but not in the restrictive and limited ways of DOS shells.

SoftBreeze 3.0's menu

lets you choose among applications, task switching, the file manager, disk utilities, memory management, and customizing. As with Brightbill-Roberts' HyperPAD, system administrators can customize an individual's user interface.

SoftBreeze is a character-based application with a tree-style file manager. The document manager lets you link each file to its application program. Each filename can be up to 60 characters long in the new version. You can search for filenames by name, by part of name, or

by who created it. The program's proprietary programming language, called Nautilus, lets you use disk swapping to create virtual memory, and you can toggle among the four management modules and up to 10 applications.

You can also use the program to copy data from one application to another. If you're not sure of an application's DOS name, you can press the Enter key and jump into a tree diagram, where you just point and click at what you want to copy. More than 100 common programs

are automatically incorporated into the menus if SoftBreeze finds them on the disk when it's installed.

SoftBreeze runs on the IBM PC with 512K bytes of RAM and DOS 3.0 or higher. For task switching, the program needs 640K bytes of RAM. When running the program's Switch module, it requires an additional 19K bytes of RAM.

Price: \$99.

Contact: SoftShell Systems, 1163 Triton Dr., Foster City, CA 94404, (415) 571-9000.

Inquiry 1167.



Introducing AccuCard.TM The only UPS that fits in your hand. And into your computer.

Remember when UPS systems were bulky, expensive outsiders?

No longer.

AccuCardTM is the first UPS that fits right in your XT or AT expansion slot. It takes up only half a slot next to the power supply. No space at all on your desk. And very little budget.

Yet AccuCard provides enough DC battery power to automatically



save whatever you're working on to hard disk when the power goes out.

When the power comes back, built-in AccuSaverTM software will even automatically re-load your PC back

to precisely where it was. All system status, registers, buffers, memory, and data intact. Just as if nothing had happened.

The remarkable new AccuCard lists for only \$249. Yet it can save

your MS-DOS based PC data even when it's unattended. This may be the best insurance value you've ever seen.

AccuCard comes from the world's leading UPS supplier and is available through distributors and dealers near you. Just call 1-800-Back-UPS.

EMERSON UPS
We protect the ones you love.

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Smalltalk/V[®] PM.
Think of it as a bold, "seat-of-the-pants" solution that cuts to the heart of the OS/2 Presentation Manager complexity challenge. Thus unlocking the potential of this powerful operating system.

With the introduction of Smalltalk/V PM, object-oriented programming



Introducing Smalltalk/V PM. The to fulfill the promise of OS/2.

moves out of the realm of mystery and into a new era of breakthrough applications that promises to be of legendary proportions.

OS/2 PM is designed to push

"user friendly" to a whole new level of sophistication. If you compare it to an orchestra, OS/2 has capabilities no ordinary assemblage of instruments has ever dreamed of

possessing. Yet to tap its potential, OS/2 PM demands a conductor capable of true genius. That conductor is Smalltalk/V PM.

You'll find Smalltalk/V PM a perfect language for representing and manipulating high-level information. Because

you go from designing to prototyping to delivering a completed application in one seamless step, you cleanly avoid the old costly "crash and burn" delays so common with languages born in the age of mainframes.

UNLEASHING THE AWESOME POWER OF OS/2 PM

Smalltalk/V PM. It helps stop the natural drift toward vaporware so common in software development today. It lets you dive right in and get to the creative parts without the usual grunt work. For example, if you want to ignore the complexities of understanding OS/2 PM details you can immedi-

Is The Most Important Part Of Your Developer's Kit Missing?

OS/2 PM offers you a powerful, rich environment loaded with advantages like a Graphics Programming Interface (GPI), a LAN manager, multitasking, SQL, just for starters. And all of these components are accessible in a standard way using Smalltalk/V PM through Dynamic Link Libraries (DLLs). Combined with DDE (Dynamic Data Exchange), you can call and exchange data with other PM services or applications. Seamlessly. Now developers can write truly reusable components, which greatly increases their value. And you'll find Smalltalk/V PM the perfect "glue" between applications written in other languages.



The Gordian Knot. A legendary case of complexity. It had baffled and stymied the best minds of the ancient world until Alexander the Great cut through the convoluted challenge with one bold, swift stroke of his sword. This "seat-of-the-pants" solution set in motion the prophecy that whoever unraveled the knot would one day rule Asia.

"THIS IS THE RIGHT WAY TO DEVELOP APPLICATIONS FOR OS/2 PM.

OS/2 PM is a tremendously rich environment, which makes it inherently complex. Smalltalk/V PM removes that complexity, and lets you concentrate on writing great programs. Smalltalk/V PM is the kind of powerful tool that will make OS/2 the successor to MS/DOS."

*Bill Gates, Chairman
Microsoft Corp.*

grammer struggling with the complexities of Presentation Manager should take a close look at this product."

*Charles Petzold, Contributing Editor,
PC Magazine*

"Digitalk's Smalltalk/V PM is dazzling! This product makes Presentation Manager pay off."

*Jeff Duntemann, Contributing Editor,
Dr. Dobbs Journal*

"Smalltalk/V PM is an excellent tool for rapid delivery of prototypes which have all the functionality and user interface of a complete PM application."

*Richard A. Landsman,
System Architect, Lotus Development*

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Editor-in-Chief, Computer Language*

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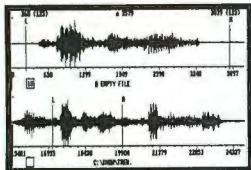
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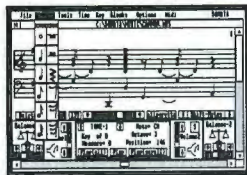
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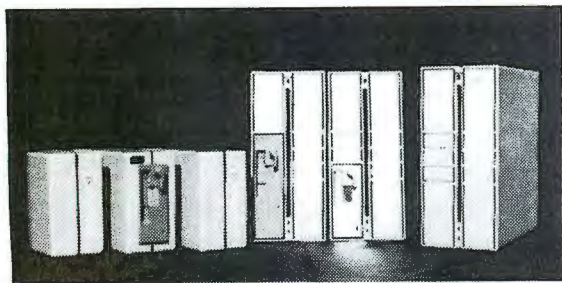
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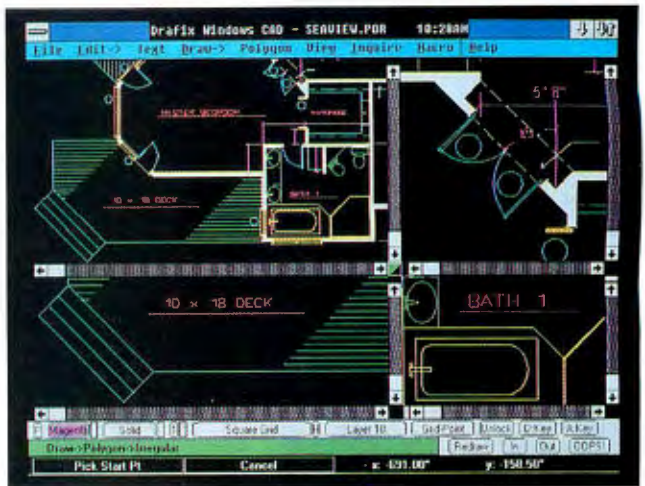
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WHAT'S NEW**CAD AND GRAPHICS**

Drafix Windows CAD can enlarge a portion of a deck plan, eliminating the need to repeatedly zoom in and out of a view.

CAD for Microsoft Windows

Drafix Windows CAD, a Microsoft Windows application, lets you divide your screen into four independent views, each of which can show a portion of a drawing at a different ratio. Windows can be actively linked, so that when you make a change in one, it is reflected in the others. The program has a programming language, called Drafix Graphic Language, that offers extensions for interfacing with the program's database, function definitions, and menu modification.

Drafix Windows CAD's attribute system lets you annotate images with text or numeric values. You can tag up to

60 attributes to a symbol, line, or arc, allowing for the easy creation of job estimates or invoices. The program's icon display lets you view a picture of a symbol instead of requiring you to remember an obscure filename.

Drafix Windows CAD supports associative dimensioning facilities, which means that if you change an entity, all dimensions linked to the entity are automatically redrawn. It also includes a library of more than 400 symbols. Optional symbol libraries are available.

Price: \$695; symbol libraries, \$150 each.

Contact: Foresight Resources Corp., 10725 Ambassador Dr., Kansas City, MO 64153, (816) 891-1040.

Inquiry 1173.

continued

Photorealism with CADKey

CADKey Render employs Pixar's RenderMan technology to let you produce photorealistic color images of three-dimensional geometric models by using CADKey 3. Once you've drawn a project using CADKey 3, you use CADKey Solids to prepare the drawing. With CADKey Render, you can place light sources

and assign attributes (such as reflectivity or the appearance of wood) to a surface, and the program will produce the image.

Price: Unix version, \$5995; DOS version, \$5595.

Contact: CADKey, Inc., 440 Oakland St., Manchester, CT 06040, (203) 647-0220.

Inquiry 1175.

WHETHER REPORT.

Whether you're a software developer writing new applications for the IBM or Mac, or a PC user securing proprietary data files, software and data protection has never had a brighter silver lining. For a number of very good reasons.

Beginning with the 'whether-expert' Rainbow Technologies. And ending with its Software Sentinel family of hardware keys. Starring five models that fit virtually any software program or data file you need to protect.

There's the best-selling SentinelPro for the IBM PC/XT/AT, PS/2 and compatibles, and even the Atari ST. Known worldwide for its virtually unbreakable security. And its ASIC technology. And its invisible operation. A close relation, the Sentinel-C stands at-the-ready for custom configurations and multiple software packages.

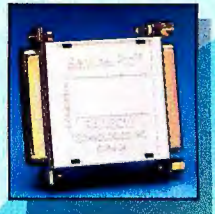
In the Apple market, security-minded Mac software developers turn to Eve. For completely transparent operation and world-class security of the protected software. Just by plugging Eve into the Mac ADB connector.

PC users wanting a low cost, user-friendly solution to the problem of securing sensitive data can call on the DataSentry. Using a proprietary Rainbow algorithm or DES, the DataSentry encrypts data files on individual PCs, protects modem transmissions and secures data on local area networks.

Rainbow's latest protection strategy is the SentinelShell—that lets users place a 'shell' around existing, off-the-shelf programs. Because access can be limited to those issued a key, libraries, universities and corporations can very simply guard their software investments.

Whatever your whether, Rainbow Technologies has the software and data protection products that make the difference. For more information, call 714-261-0228 in the U.S., or contact Rainbow Technologies Ltd. in the United Kingdom for the distributor nearest you. Whethercasters are standing by.

SentinelPro™



- Runs under DOS, OS/2 and Xenix • Algorithm technique (Never a fixed response) • External parallel port installation • Minimal implementation effort • Higher level language interfaces included • 100 times faster than fixed-response devices (1 ms) • ASIC design for reliability

Sentinel-C™



- Protects multiple packages with one device • 126 bytes of non-volatile memory programmed before shipment of the software • Rainbow supplies a unique adapter for programming the unit • Higher level language interfaces included • Runs under DOS, OS/2 and Xenix • External parallel port installation

Eve™



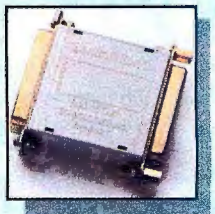
- For the Macintosh SE and II • Complies with Apple Desktop Bus Interface requirements • Rainbow-assigned developer passwords to prevent tampering by other developers or sophisticated "hackers" • 7 locks per key, usable individually or in combination, on one or up to seven applications

DataSentry™



- Completely user-installable • Pocket-sized external device • Menu-driven, user-friendly interface • Single- or multi-user security system • Audit trail, log-on identifiers and automatic encryption/decryption of entire directories • Secures data transmitted by modems • Prevents recovery of data by utility programs

SentinelShell™



- Runs under DOS on IBM PCs and compatibles • Protects without requiring access to the source code • Completely transparent to the end user • User-friendly software • Pocket-size key attaches quickly to any standard PC parallel port • ASIC design for reliability



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As a software producer, you can't market your software without protecting it. Aladdin Knowledge Systems is a leading company in the field of software protection: during the last four years we have enabled hundreds of software producers in more than 30 countries to protect their software.

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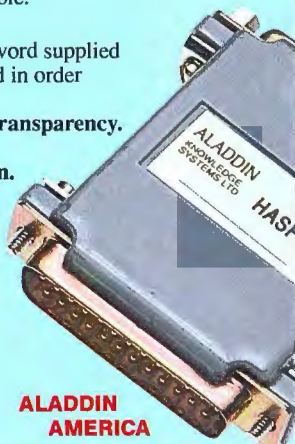
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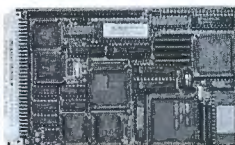
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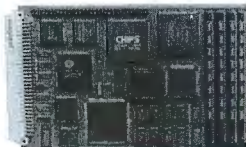
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WHAT'S NEW

CAD AND GRAPHICS



Mac-Civil, an engineering and site-design program.

Civil Engineering and Architecture on the Mac

DCA Engineering has released two add-ins for AutoCAD for the Macintosh. Auto-Architect includes tools for design, three-dimensional planning, elevation, and input and editing in plan. Three options are available for plumbing, HVAC (heating, ventilation, and air conditioning), and electric.

Mac-Civil provides coordinate geometry, topographic, and civil engineering design applications.

Price: Auto-Architect, \$995; each module, \$395; Mac-Civil, \$1995.

Contact: DCA Engineering Software, Inc., P.O. Box 955, Henniker, NH 03242, (603) 428-3199.

Inquiry 1180.

Convert PostScript into Editable Mac Fonts

Metamorphosis can convert printer-resident PostScript fonts into editable outline formats that you can use in a drawing program on the Mac. The utility grabs the font outline from the printer and brings it into the Mac.

During the process, you

can create an editable font for use in Aldus FreeHand, Adobe Illustrator, or Altsys's Fontographer, a PostScript font design program that creates Type 3 PostScript fonts that you can use in your Mac application.

Metamorphosis runs on the Mac Plus or higher.

Price: \$295.

Contact: Altsys Corp., 720 Avenue F, Suite 109, Plano, TX 75074, (214) 424-4888.

Inquiry 1178.

Four Types of Drawing in One Package

UltraPaint lets you do black-and-white and color painting, gray-scale image processing, and object drawing. It supports 256 colors, blended fills, a multicolor air-brush, masking, and other special effects. UltraPaint also supports Bézier curves, scaling, 600-dpi precision, eight layers, and auto-tracing of bit-map images.

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Price: \$199.

Contact: Deneba Software, 3305 Northwest 74th Ave., Miami, FL 33122, (305) 594-6965.

Inquiry 1176.

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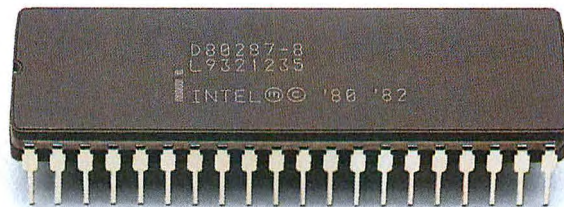
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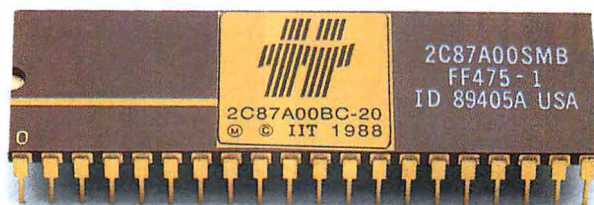
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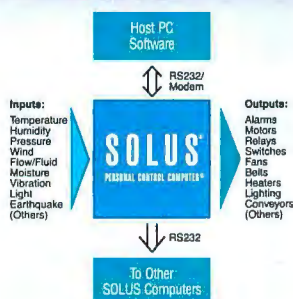
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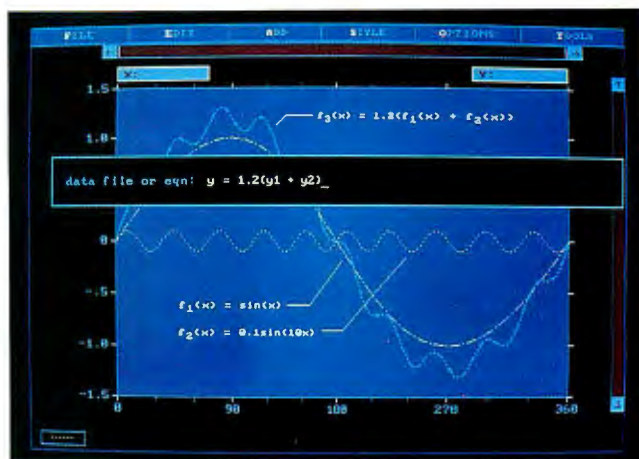
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WHAT'S NEW

SCIENCE AND ENGINEERING



EasyPlot's interactive math feature lets you plot an equation, transform data with a complex function, and compare the two.

Plotting Software for the Daily Grind

EasyPlot combines a graphical interface with technical plotting capabilities in a package that's intended for everyday use in the lab. According to Spiral Software, EasyPlot's intuitive interface makes computing a complex fast Fourier transform as simple as a basic adjustment of the range of an axis.

With EasyPlot, you present the data, and it plots it for you. It can accept ASCII, .WK1, and .WR1 data files and automatically plot them with easy-to-understand tick marks and axis ranges. You can select from linear, log-log, contour, and other popular graph types. The program lets you interact with the data by zooming in and out of a graph, scrolling, and placing the cross-hair view on a data point to view its coordinate.

EasyPlot also lets you transform data with any mathematical equation that you specify. It will plot the new graph in a different format for comparison.

The program runs on the IBM PC with 400K bytes of RAM.
Price: \$269.

Contact: Spiral Software, 6 Perry St., Suite 2, Brookline, MA 02146, (800) 833-1511 or (617) 739-1511.
Inquiry 1027.

PCB Design Package for OS/2

Microtel Pacific Research has released what it says is the first set of printed circuit board design tools that run under OS/2.

Called Ledax Plus, the program includes XScheme (schematic capture), XBoard (two-dimensional documentation/drafting), XPlace (automatic/interactive file routing), and XPost (artwork/plotting postprocessors). Each is linked to the others through a single database, with changes in one tool immediately reflected in the others. The company says that active linking reduces data entry, errors, time, and cost.

Microtel says that the program fully supports OS/2's multitasking capabilities and the Presentation Manager graphical interface.
Price: \$8795.

Contact: Microtel Pacific Research Limited, 8999 Nelson Way, Burnaby, BC, Canada V5A 4B5, (800) 663-6226 or (604) 294-1471.
Inquiry 1028.

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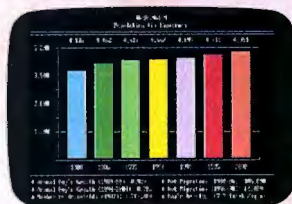
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WHAT'S NEW

SCIENCE AND ENGINEERING

Mechanical Engineering by Dimension

A mechanical engineering program for Microsoft Windows, called Analytix, uses a geometry system that lets you perform kinematic, static, dynamic, and tolerance analysis without entering formulas or using a spreadsheet. Saltire Software says that the system, called constructive variational geometry (CVG), offers the advantages of speed, accuracy, stability, and simplicity over the conventional approach of using numerical analysis techniques.

Saltire's program, Analytix, uses constructive geometry to reduce a geometric figure to a sequence of constructions. Once you've dimensioned a sketch, you can solve kinematics and statics problems analytically instead of converting the geometry problem to an algebraic problem.

The algebraic approach can be flawed in that the algebraic problem may not coincide exactly with the geometry problem. In some cases, the problem can yield multiple solutions, or none at all, when solved algebraically. Analytix chooses the solution that is closest geometrically to the sketch. Saltire says that when doing tolerance analysis, one advantage of using CVG over the Monte Carlo technique is that you get true maximum/minimum tolerances.

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

Price: \$895.

Contact: Saltire Software,

P.O. Box 1565, Beaverton, OR
97075, (503) 642-1874.
Inquiry 1029.

Make Waves on the Mac

SuperScope is a waveform acquisition, analysis, presentation, and data management program that works in conjunction with GW Instruments' MacAdios family of add-in boards for the Mac SE and II. The software provides a real-time oscilloscope, an XY recorder, a strip chart recorder, and spectrum analyzer capabilities. It can analyze eight waveforms simultaneously and display up to 50. SuperScope includes an internal spreadsheet-like environment and a text editor.

The program lets you control all instruments and sensors from the Mac. Using the program's analysis and graphing capabilities, you can create your own instruments. Analysis features let you manipulate your data with both arithmetic and transcendental functions. Included are trigonometric and logarithmic operations and statistical analysis like averaging, minimum/maximum locations, and standard deviations. In addition, digital signal processing functions are included. You can store and display the results of all analyses in graphical or tabular form.

Postprocessing modules support such tasks as pulse analysis, IEEE-488 data manipulation, data transfer, delay processing, drivers, digitizers, timing, function generators, and time stamping.

Price: \$990.

Contact: GW Instruments, Inc., 35 Medford St., Somerville, MA 02143, (617) 625-4096.

Inquiry 1030.

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WHAT'S NEW

M I D W E S T

Controversy in Reorganization of APCUG

The fourth annual Users Group Summit held in Las Vegas began amid reports of growth and the formation of an incorporated nonprofit organization. The summit ended with mild controversy over the selection of officers and concern over the future of the organization.

Jerry Schneider, executive director of the Association of PC Users Groups (APCUG) until the group reorganized, began the meeting by noting that the association included 117 member groups, from the U.S., Canada, Japan, Australia, and the Soviet Union.

Schneider then introduced

the new officers and board of directors of the volunteer organization, which is designed to bring vendors and manufacturers together with the hundreds of users groups around the world. Schneider also announced a new structure of APCUG, which also includes a 15-member users group advisory board. Three of the new directors, Don Kaufer of Salt Lake City, Cathy Konas of Chicago, and Scott Young of Minneapolis, hail from the Midwest.

The officers and board members will not represent any specific users group, instead holding their allegiance to APCUG, according to Schneider. The users group advisory board will be made up of people elected by designated delegates from member users groups. The advisory group

will help the directors set policy and provide direction.

Some delegates to the Users Group Summit expressed concern about their inability to vote for the directors and the direction in which APCUG seemed to be heading.

Despite some lively discussion, the general consensus of the group was to give the new officers a year to show what they can accomplish. Named as the first official officers were: President: Roland J. Cole, a former officer of the Pacific Northwest IBM Users Group; Secretary: Jerry Schneider, executive director until incorporation; Treasurer: Larry Shaw, from Seattle and a founding member of the Pacific Northwest group.

Schneider also announced that the new board has set an-

nual dues for member users groups at \$25, starting with the 1990 calendar year. Previous dues collected from noncharter member groups will be re-funded as part of the reorganization.

—Reported by David Reed of the Central Kentucky Users Group.

Contact: Association of PC Users Groups, 1101 Connecticut Ave. NW, Suite 901, Washington, DC 20036.

Yellow Pages Now on Disk for Major Cities

Electric Bookshelf reports it now has versions of the PC Yellow Pages for several major metropolitan

continued

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markets, including Chicago. PC Yellow Pages includes name, address, ZIP +4 code, and carrier route code for each listed business, making it helpful for direct marketing.

When you prepare a mass mailing, the program tells you whether a mailing list or portion of it qualifies for a carrier route. You can search the database for a certain business type and add, change, or delete entries. You can make up to one page of comments per entry. Each city version includes sales lead management software for tracking sales leads and quotations.

Monthly updates are provided, or you can download them with AT&T's 900 telephone service. The program requires 512K bytes of RAM on an IBM PC. A hard disk

drive is recommended.

Price: Atlanta, \$165; Boston, \$195; Chicago, \$175; Dallas/Fort Worth, \$175; Los Angeles, \$275; Miami, \$195; New York City, \$395. Other areas are available for \$129 per 5000 names and addresses.

Contact: Electric Bookshelf, Inc., 3066 Mercer University Dr., Atlanta, GA 30341, (404) 455-8763 or (404) 448-6881.

Inquiry 1002.

Computer Show in Ohio

The Mansfield Midwinter Hamfest/Computer Show will be held on Sunday, February 11, at the Richland County Fairgrounds in

Mansfield, Ohio.

Contact: Dean Wrasse, 1094 Beal Rd., Mansfield, OH 44905, (419) 589-2415 after 4:00 p.m. EST.

SoftwareFest Sponsored by St. Louis Group

The St. Louis Users Group for the IBM PC reports that it will be holding its third annual SoftwareFest on March 24.

The 600-member users group meets the first Thursday of every month at Simon Hall on the Washington University campus.

Contact: St. Louis Users Group for the IBM PC, P.O. Box 69099, St. Louis, MO 63169, (314) 968-0992.

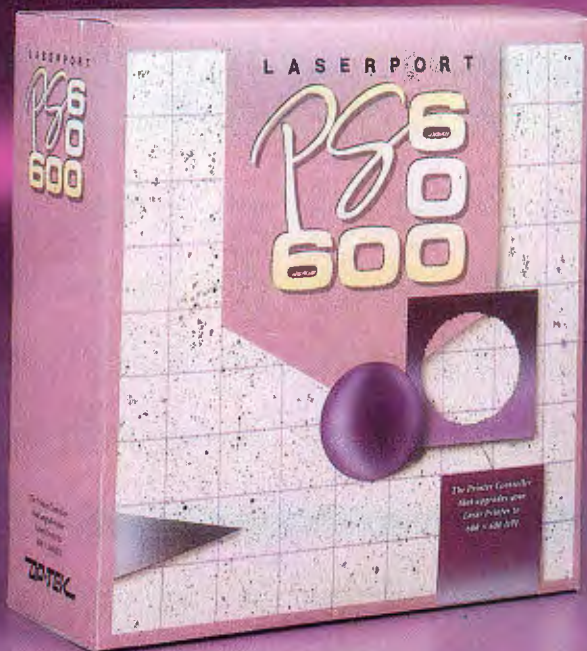
Colorado Group Merges with LAN Group

The Front Range PC Users Group recently merged with a local chapter of the Rocky Mountain Local Area Network Users Group. The LAN group will be structured as another Front Range special-interest group. Almost all the members of the SIG are corporate or governmental, but anyone can join the group, FRPCUG reports.

Front Range general meetings are usually held the first Tuesday of every month.

Contact: Front Range LAN/SIG, 305 Magnolia, Suite 152, Fort Collins, CO 80521, (303) 482-3413 or (303) 484-1352.

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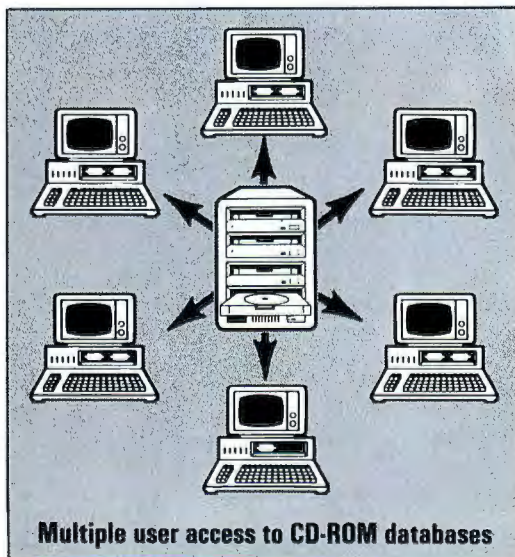
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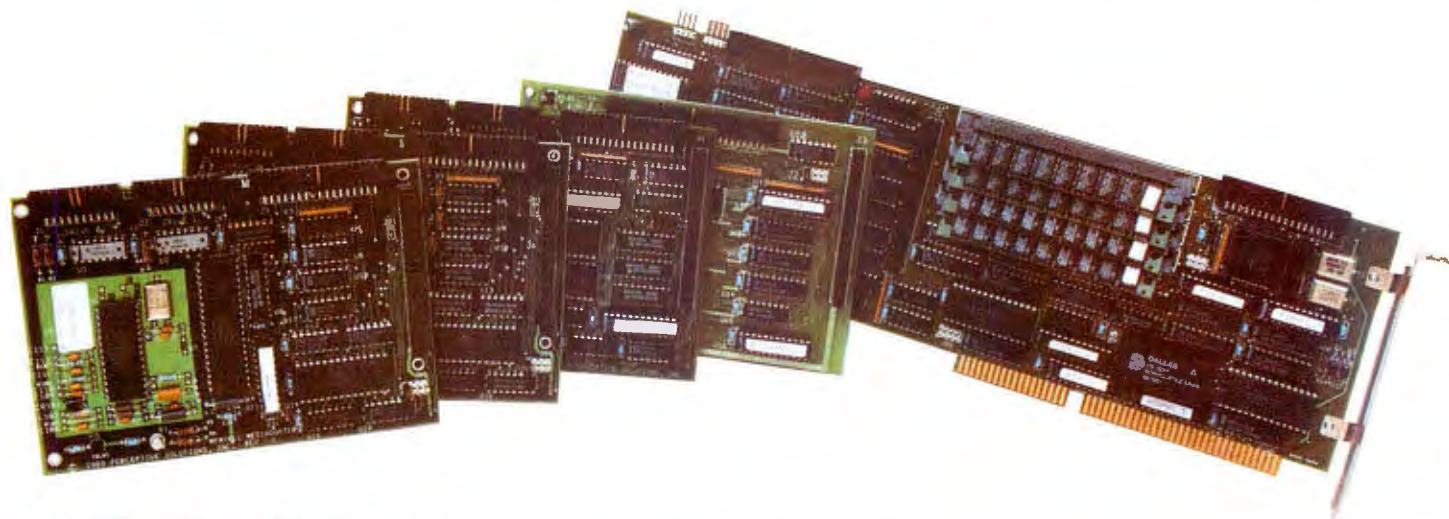
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Skyworld Upgrades Fax Software

SkyFAX 2.0 software works with the SkyFAX Intelligent PC-Fax Board. The software includes a print-to-fax feature that sends the output file of any IBM PC application to a remote fax station, according to Skyworld Technology. Database broadcast is a feature that lets you merge data from dBASE III Plus records into a fax and broadcast the documents according to fax numbers contained in the database.

The SkyFAX board conforms to CCITT Group 3 standards and communicates at 9600 bps and lower.

Price: Software and board, \$399.

Contact: Skyworld Technology, 1772 Lark Lane, Sunnyvale, CA 94087, (408) 446-9392.

Inquiry 1003.

DOS Extender Loads FCBs, IFSeS into High Memory

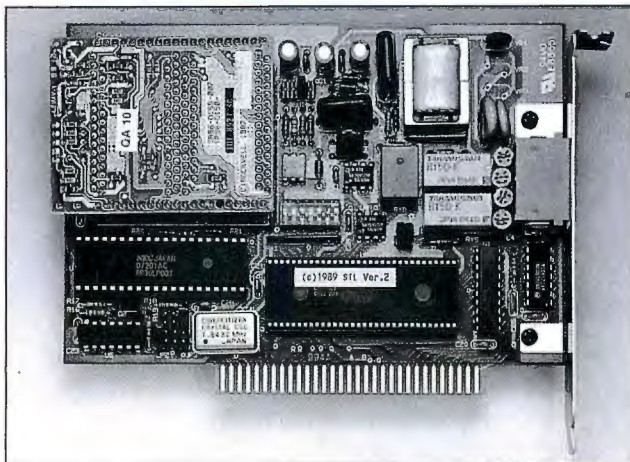
The newest version of Advanced Memory Specification (AMS), RYBS Electronics' DOS extender, lets you load buffers, stacks, device drivers, the network shell, and TSR programs into high memory. It also lets you load DOS 4.01 file-control blocks, stacks, and installation file systems into high memory above 640K bytes, the company reports.

RYBS says that AMS supports almost any device. The program also supports extended and expanded memory.

Price: Software-only version, \$99.95.

Contact: RYBS Electronics, Inc., 2590 Central Ave., Boulder, CO 80301, (303) 444-6073.

Inquiry 1005.



The half-size SkyFAX Intelligent PC-Fax Board fits into any IBM PC or compatible.

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The CodeRunner library lets you write TSR programs in C that have the compactness and performance of programs written in assembly language, Microsystems Software reports. When the TSR program becomes resident, its initialization code and data are eliminated, allowing for elegant sign-on screens, comprehensive command-line parsing, and other initialization tasks without burdening resident-memory overhead, the company reports.

With CodeRunner, you can write multitasking TSR programs where a timer, communications port, keyboard, or any other hardware or software interrupt can trigger multiple threads. CodeRunner automatically handles all stack and entry protection.

CodeRunner includes a binary-coded-decimal floating-point package with variable precision from 8 to 248 significant digits. You can specify up to 256 hot keys for any application. The run-time library is function-level

granular and auto-initializing, which helps save program memory overhead.

Because CodeRunner allows transparent DOS access for your program, you can call up the application regardless of DOS's state, according to the company.

CodeRunner is written in assembly language and works with Borland's Turbo C and Microsoft C.

Price: \$149.

Contact: Microsystems Software, Inc., 600 Worcester Rd., Framingham, MA 01701, (508) 626-8511.

Inquiry 1004.

Draw Chemical Structures in Four Environments

With Molecular Presentation Graphics for OS/2, Hawk Scientific Systems now supports four platforms on which you can draw chemical structures. In addition to Presentation Manager, the company supports versions of MPG for DOS, Microsoft Windows, and the Macintosh.

MPG supports rings, alkyl chains, bonds, Greek text, and display text. You can annotate reactions with arrows and add titles and captions. The Windows and DOS versions can export images in Word-Perfect, PIC, Encapsulated

PostScript, CGM, and Hewlett-Packard Graphics Language format. On the Mac, you can export images through the Clipboard. You can also import HPGL and Tektronix 4010 images.

MPG for OS/2 requires about 300K bytes of system memory. The DOS version runs on the IBM PC with 512K bytes of RAM. The Windows version runs on the IBM PC AT with 640K bytes of RAM. On the Mac, you'll need a Plus or higher.

Price: OS/2 version, \$350; other versions, \$275.

Contact: Hawk Scientific Systems, Inc., 170 Kinnelon Rd., Suite 8, Kinnelon, NJ 07405, (201) 838-6292.

Inquiry 1006.

ChemWindow lets you draw chemical structures under Microsoft Windows. Using Windows' ability to switch among applications in several windows, you can draw the structure without leaving the word processor and then pull it into the document with the Windows clipboard.

Tools in ChemWindow let you place symbol strings and 10 types of bonds. Five arrow types include reaction, equilibrium, resonance, dashed, and retrosynthetic. You can draw solid or dashed circles, ovals, and arcs. ChemWindow has an undo facility, and you can use the program to scale objects.

To run ChemWindow, you need an IBM PC with 512K bytes of RAM, a mouse, a graphics adapter, and a hard disk drive. A run-time version of Windows is included with the program.

Price: \$295.

Contact: SoftShell International Ltd., 2754 Compass Dr., Suite 375, Grand Junction, CO 81506, (303) 242-7502.

Inquiry 1007.

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Nanao Monitors for the Mac or IBM PC

The FlexScan 6300 displays two pages side by side in resolutions of up to 1664 by 1200 pixels on the IBM PC and up to 1024 by 768 pixels on the Mac II. The 6300 adjusts for horizontal scanning frequencies of between 31.5 and 78 kHz and vertical scanning frequencies of between 60 and 80 Hz. It substitutes a palette of more than 64,000 shades of gray for the colors supported by VGA and Extended VGA.

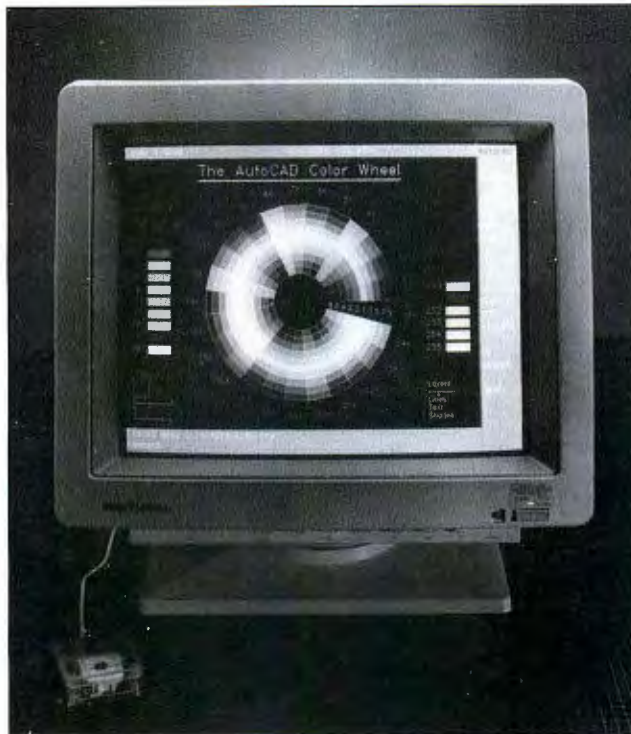
The FlexScan 9400 is a 20-inch multiscanning color monitor that displays resolutions of up to 1280 by 1024 pixels. It offers a palette of 16.7 million colors and resolutions of up to 1024 by 768 pixels on the Mac II, when used with graphics boards like the SuperMac Spectrum/24 or Spectrum/32 or the RasterOps ColorBoard 108. The 9400 features a standard nine-pin connector for standard TTL and analog signal input and BNC connectors for high-frequency analog input.

The FlexScan 9060S is a 14-inch high-resolution multiscanning monitor. It has a horizontal scanning range of 15.5 to 38.5 kHz and a vertical range from 50 to 90 Hz. It displays in resolutions of up to 800 by 600 pixels noninterlaced on the IBM PC and compatibles and in resolutions of up to 640 by 480 pixels on the Mac II.

Price: 6300, \$1989; 9400, \$3799; 9060S, \$1059.

Contact: Nanao USA Corp., 23510 Telo Ave., Suite 5, Torrance, CA 90505, (213) 325-5202.

Inquiry 1009.



The FlexScan 9400 adjusts to horizontal scanning frequencies of from 30 to 65 kHz and 55 to 90 Hz vertically.

Multuser, Multitasking Operating System

PC-MOS 4.0 is an operating system that supplants DOS and lets you run most DOS applications in a multiuser, multitasking environment. With version 4.0, you can reboot a task without interrupting other users, The Software Link reports. Other additions include new driver software that lets PC-MOS support full-color, bit-mapped graphics with resolutions up to VGA, allowing up to 16 workstations with graphics to tag onto a single CPU, the company reports.

A new print spooler lets a single print processor control the output to multiple printers simultaneously. With the included monitor program utility, a system administrator controls various aspects of a task, including priority and time allocation.

PC-MOS 4.0 can relocate into extended memory and re-

quires about 128K bytes of RAM. It supplants DOS 2.0 or higher.

Price: Single-user, \$195; five-user, \$595; 25-user, \$995.

Contact: The Software Link, Inc., 3577 Parkway Lane, Norcross, GA 30092, (404) 448-5465.

Inquiry 1010.

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Layouts consists of 215 page-layout templates for business cards, letterheads, envelopes, brochures, newsletters, and flyers. This program for page designers using Aldus PageMaker includes seven borders for use with brochures, newsletters, and flyers. The templates include crop marks, fold marks, and registration marks.

With Layouts, you can import custom logos and other graphics.

Versions for the Macintosh and IBM PC versions of PageMaker are available.

Price: \$179.95.

Contact: Starburst Designs, Inc., 1973 North Nellis Blvd., Suite 315, Las Vegas, NV 89115, (702) 453-3371 or (702) 382-5913.

Inquiry 1013.

HyperCard with Sound, Music, and Multitasking

Intuitive Technologies' UltraCard lets you collect and link information with HyperCard-like stacks in a multitasking environment while supporting color, sound, animation, and the Amiga's video genlocking abilities. Because it supports Arexx, you can use UltraCard as a front-end control panel for vertical applications, letting you navigate through data stored in a spreadsheet, database, or stack.

UltraCard's built-in scripting language, UltraTalk, is patterned after English, and it includes statements that run programs, play sounds, perform calculations and string manipulations, and manipulate properties in the UltraCard stack, the company reports. The program supports the command-line interface and the Workbench interfaces.

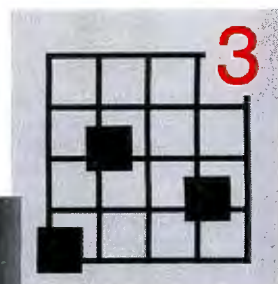
UltraCard runs on the Amiga 500, 1000, 2000, and 2500. It automatically supports NTSC and PAL (European) video standards. The program also supports external laser videodisk players.

Price: \$49.95.

Contact: Intuitive Technologies, 2700 Garden Rd., Suite 6, Monterey, CA 93940, (408) 646-9147.

Inquiry 1011.

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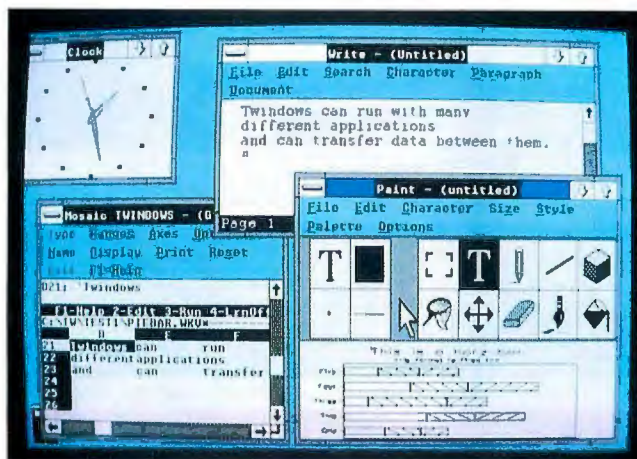
Twindows

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A Lotus-Compatible Spreadsheet for Windows

Imagine Lotus 1-2-3 with pull-down menus, dialog boxes, and overlapping windows; what you're seeing is **Twindows**, a Lotus-compatible spreadsheet for Microsoft Windows from Mosaic Marketing.

After working with a beta version, I found that Twindows is as true a Lotus 1-2-3 clone as Mosaic's DOS spreadsheet, *Twin*. It successfully mimics all the functionality of Lotus 1-2-3 release 2.01. What makes Twindows special is not so much its Lotus 1-2-3 compatibility, but rather its innovative cross between the familiar Lotus 1-2-3 feel and the Windows graphical interface.

The goal, according to a Twindows developer, was to make Lotus 1-2-3 users feel right at home. The screen resembles Lotus 1-2-3 so closely that it's hard to tell Twindows isn't just a text application running in a window. Once I started working with it, however, all the advantages afforded by the Windows interface became apparent.

The interface is clean: The menu bar, scroll bars, and Windows border icons are the only active graphical interface elements on the open-

ing display. Nearly all the functions use dialog boxes to verify an operation or prompt for more data. Inveterate Lotus 1-2-3 users might be a bit rattled by the extra keystrokes (or mouse-button presses) and time spent waiting for a redraw after some pop-up or pull-down. Those who prefer graphical interfaces, however, will find that the benefits far outweigh these minor inconveniences.

While building in support for graphics, Mosaic didn't neglect keyboard users. A dedicated line on the display shows the current function-key mappings, and the menu bar is mapped to the "F" key, the same character used to activate the function menu in Lotus 1-2-3. The F1 key brings up a window of context-sensitive help, and you can select topics by clicking

on menu items with the mouse.

Twindows imports and exports DIF, ASCII, and WKS files. However, Mosaic warns that various versions of Lotus 1-2-3 can't read Twindows files and have to be translated using a dialog box utility that comes with the program. Twindows also includes an import/export option, "Twindows Print Format," which lets you use the same print format with several worksheets.

An added feature in Twindows is the page-preview mode, which lets you expand the default 80-column by 25-row view to 132 columns by 43 rows (with an EGA or higher). The font is tiny, and the entire page takes several seconds to repaint, but it's still useful. The transport of data to and from other applications

is covered through both the clipboard and an @DDE function call. The program also lets you assign colors to cells, based on their content.

At 600K bytes, which doesn't include Windows, Twindows is not a small program. Without expanded memory, the largest spreadsheet I could load was about 170K bytes.

Mosaic promises that the final release will include support for up to 8 megabytes of expanded memory but warns that it will work only with hardware-level expanded memory.

It seems logical that a Windows spreadsheet be capable of producing knockout graphs. Unfortunately, this is the one area where Twindows really misses the mark. You can create up to eight graph types with selectable type styles and fonts. The interface for creating the graphs is simple and versatile, but the graphs themselves are unimpressive. Users requiring presentation-quality graphs will have to resort to other means.

Those not familiar with Lotus 1-2-3 will be able to dive quickly into Twindows by following the tutorial lessons provided and by reading the well-written manual.

Twindows is what Mosaic promises it to be: a Lotus 1-2-3 clone for Windows. New users will find the point-and-click interface and thorough manual will help them come up to speed quickly, while Lotus 1-2-3 users will have to choose between a fast interface and an attractive one. Twindows isn't Excel, but those who need tight Lotus 1-2-3 compatibility will trade some of the bells and whistles.

—Tom Yager
continued

THE FACTS

Twindows
\$349

Requirements:

Any IBM PC XT or higher with 640K bytes of RAM; the company recommends an 80286 or 80386 system

running Microsoft Windows/286 or Windows/386 2.11.

Mosaic Marketing, Inc.
1972 Massachusetts Ave.
Cambridge, MA 02140
(617) 491-2434
Inquiry 997.

QMS Brings Presentation Manager to Paper

One of the biggest problems with OS/2's Presentation Manager (PM) is that it's been a graphical user interface that was all dressed up with no place to go. Just try to translate all those spiffy colors and multitudinous fonts that you see on the screen to paper. WYSIWYG it's not.

But QMS has taken a giant leap in bringing the possibilities of PM to paper with the **QMSWriter PM10**, a full-color thermal printer that interfaces directly with OS/2's GPI (graphical programming interface) layer. The GPI, which is responsible for the "look and feel" of PM and its applications, is a complex and powerful part of OS/2. Other printers can't communicate directly with the GPI, and they require an intermediary printer driver. But many developers have found to their chagrin that writing full-featured printer drivers for OS/2 is what's politely termed a nontrivial undertaking.

Of course, connecting a printer directly to the GPI requires an abundance of processing power. The PM10 comes with its own custom add-in card (either AT bus or Micro Channel) that uses Texas Instruments' powerful TMS34010 graphics processor running at 60 MHz. There's also a hefty 7 mega-



THE FACTS

QMSWriter PM10
\$9995

Requirements:
IBM PC AT, PS/2,
or compatible running
OS/2 1.1 or higher.

QMS, Inc.
One Magnum Pass
P.O. Box 81250
Mobile, AL 36689
(205) 633-4300
Inquiry 998.

bytes of RAM on the board for preparing images for the print engine.

Setting up the PM10 is easy. However, for those of us used to traditional toner cartridges or printer ribbons, loading the huge rolls of wax-based ink film is an unfamiliar but far from difficult process. And there's no ink mess either because the ink can melt only from the extreme heat that is used by the thermal printing head.

Installing the software was also easy, although I had to "fool" OS/2 by associating the PM10 with an unused printer port. Once in a PM application, it takes about a

minute for the PM10 to print a page. And although that sounds like a long time, the printer starts to work almost immediately. With all that on-board processing power (and no intermediate driver), you experience none of the preprint pauses that I've come to expect when working with graphics images using laser printers.

If you think that thermal printers mean low-quality images, the PM10 is a big surprise. With its 300-dot-per-inch resolution and color capabilities, images produced by the PM10 almost literally jump off the paper. Admittedly, the specially coated

heavy glossy paper that you need for the PM10 adds a touch of class, but the high-resolution color is the kicker.

The prerelease software that came with the unit I tested was a bit limited in its capabilities. By the time you read this, however, QMS says it will be shipping the final version, which will include 35 built-in fonts. More and more developers will be including direct GPI printer capabilities in their applications. And for more mundane printing jobs, the PM10 will also include standard Hewlett-Packard LaserJet and PostScript emulators.

With a budget-busting price tag of \$9995, the PM10 certainly isn't for everyone. The expendables (i.e., special paper and ink film) aren't inexpensive either. It's obviously a natural for serious graphics arts and presentation applications. The printer can also use special transparency film for overhead projection slides that are sure to impress. And using black-ink film and the transparency sheets, the PM10 (along with special software) can even produce four-color separations for color printing.

The PM10 is another step in making OS/2 and its still-increasing repertoire of applications useful tools with real advantages over the old world of DOS. And if 10 grand is out of your ballpark, QMS says it will ship a black-and-white-only version this spring, which should sell for about half the price of the color version.

—Stan Miastkowski

New and Improved Turbo Basic

Borland assigned the future publishing rights of Turbo Basic to original developer Robert Zale, who, along with Spectra Publishing, will be releasing a new version of it. I was able to take a look at a beta version of the new product, **Power-**

Basic 2.0, although the library, help files, and sample programs I'd come to associate with Borland products were not yet available.

The look of PowerBasic's main menu and window bears an obvious family resemblance to the latest versions

of Borland's Turbo C and Turbo Pascal. When you run the compiler, all you see is PowerBasic's main window and main menu; the clutter of multiple windows in Turbo Basic is gone. Otherwise, PowerBasic functions much the same as its predecessor.

As a superset of Turbo Basic, PowerBasic 2.0 has many new features, commands, and functions that give it substantially more power and convenience. For example, it has binary coded decimal fixed- and floating-point data

continued



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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.

4. Optimized Code: CrossCode C uses minimum required precision when evaluating expressions. It also "folds" constants at compilation time, converts multiplications to shifts when possible, and eliminates superfluous branches.

5. Custom Optimization: You can optimize compiler output for your application because you control the sizes of C types, including pointers, floats, and all integral types.

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 70 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.

There's More

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.

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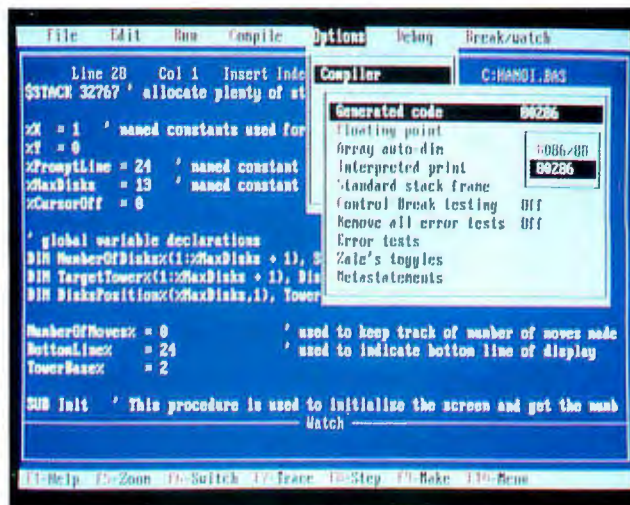
types for 18-digit accuracy. The compiler also has extended-precision (80-bit) floating-point and Quad-word (64-bit) integer data types.

You can compile and link separate source code modules for modular programming. Also, you can link assembly code or object code from other languages into your programs using object modules.

PowerBasic can generate either 8086/8088 or 80286 processor code, and it supports 80287/80387 math coprocessor code in your programs. It also has an optional procedure-based math package, and Spectra Publishing claims it performs IEEE-standard floating-point operations faster than a coprocessor emulator.

The integrated debugger lets you single-step through your code, set breakpoints, examine variables, modify expressions, and monitor the call stack during program execution.

Library stripping is one interesting feature of PowerBasic that lets you reduce the size of your executable file



when compiling to disk. You can select which options to disable and remove code containing language features that are not being used in your source code.

This library stripping covers serial communications support, printer support, and all graphics support (i.e., CGA, EGA, VGA, and Hercules monochrome). You can select these options from the PowerBasic command line, from the Options section of the main menu, or by insert-

ing a metastatement in your source code.

I tested library-stripping with HANOI.BAS, a 7034-byte sample program from the Turbo Basic 1.1 package. HANOI.BAS, which is a simulation of the Towers of Hanoi game, is an example of recursive programming. When compiled with Turbo Basic, my HANOI.EXE file was 39,642 bytes long. With all the options turned on in PowerBasic, I recompiled the program and got a file that

THE FACTS

PowerBasic 2.0
\$109.95 (registered users of Turbo Basic 1.1 can upgrade for \$50)

Spectra Publishing
1030D East Duane Ave.
Sunnyvale, CA 94086
(415) 730-9291
Inquiry 999.

was 39,570 bytes long. With all the options turned off, the same file compiled to a much smaller 36,130 bytes long—a savings of 3440 bytes. This feature can be especially handy if you're trying to save RAM space or squeeze a lot of code onto one 360K-byte floppy disk.

PowerBasic is not just a rehash of the existing Turbo Basic package. It's a new and much improved BASIC compiler.

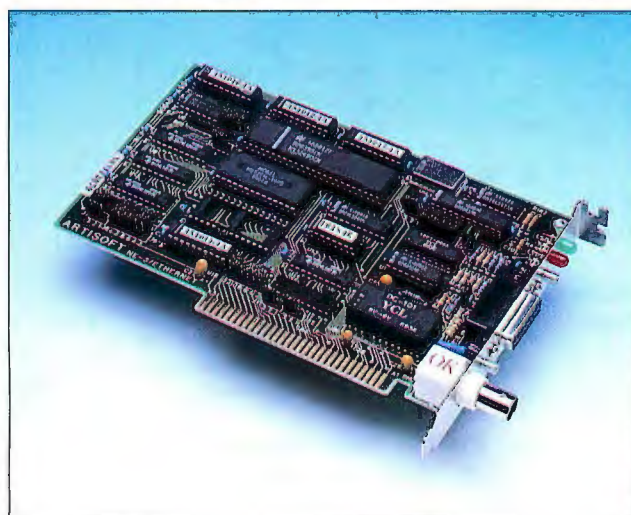
My best compliments to Borland for letting a third party support Turbo Basic users. It's good to see that Turbo Basic is resurrected and vastly improved.

—Stanley Wszola

Artisoft Speeds Up LANtastic

The Artisoft LANtastic network is well known for being a simple to use local-area network that is also inexpensive and amazingly efficient in its memory consumption. It has become an ideal system for small networks of IBM PCs that have a need to share printers, hard disk drives, NetBIOS-compatible network software, and even CD-ROM drives without tying up a system as a server. Last year, these qualities earned Artisoft's LANtastic a BYTE Award of Distinction.

The only problem with LANtastic was that it was a bit slow, with an advertised speed of 2 megabits per sec-



ond. People who wanted a higher-speed network would purchase Ethernet hardware from another vendor, but they would still make use of Artisoft's incredibly compact

NetBIOS code.

Now Artisoft has decided to issue its own Ethernet hardware, and it has done so at a price that makes it hard to pass up. The LANtastic

THE FACTS

LANtastic Ethernet Starter Kit
\$725 (two nodes); each additional node, \$349

Requirements:
Two or more IBM PCs or compatibles.

Artisoft, Inc.
Artisoft Plaza
575 East River Rd.
Tucson, AZ 85704
(602) 293-6363
Inquiry 1000.

Ethernet Starter Kit sells for \$725, and it includes two half-length Ethernet adapters, a 25-foot piece of thin Ethernet cable, and the LANtas-

continued

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PC WEEK

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```
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#define NUMMARK 4
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{
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    int mark[NUMMARK];
};
```

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SHORT TAKES

tic network operating system (licensed for up to 120 computers). Amazingly, that's all that you need to get a small but pretty powerful and sophisticated network up and running.

Of course, that will suit only the most basic needs. Each additional Ethernet card costs \$349. Optional cables come in lengths of 25, 50, and 100 feet. For \$99 more, you can get a ROM chip that attaches to the adapter and lets a workstation boot itself from the server (which will enable you to set up a diskless workstation).

Despite the new higher Ethernet speed, the LANtastic software is positively frugal in its memory requirements. The NetBIOS driver takes up less than 15K bytes. To set up a regular LANtastic node, you only need to have 11K bytes more. To function as a full LANtastic server, you need a total of only 55K bytes, including

NetBIOS.

I found the Ethernet version of LANtastic to be a snap to set up and a pleasure to use. And now, thanks to the Ethernet Starter Kit, the system is also quite fast. On a low-end IBM PC connected to a high-speed server, the network is significantly faster than the PC's local hard disk drive. My only suggestion, and it is a minor one, is that the manual be a little better organized. And by the time you read this, a better manual should be available.

Networks are not the easiest things to install. There are dozens of things that can be easily set wrong. In the case of LANtastic, they somehow all seem to automatically be set right. With more and more products such as this becoming available, it is going to be impossible in the near future to find any group of computers that are not connected in some way.

—Rich Malloy

Esc: Help off, cancel. F1: Help off, to last menu. Arrows: Select Help topic:

Basic editing	Deleting text	Formatting	Page layout	Shortcuts
Auto-numbering	DOS commands	Headers/footers	Paragraph style S	
Box operations	Dot lines	I	Printer setup	Spell checker
Change margins	Enhancing text	Margins/tabs	Printing	Status line
Characters	Entering text	Marking text	Problem solving	Switching files
T	File conversion M		Recording keys T	
Control files	File management M		Repeating	Windows
Copy/move text	Find/replace	Misc. operations	Ruler lines	Support service
Cursor mover	Footnotes	P	Shell to DOS	Shareware

S. Edit the Ruler, either as text or in Ruler mode. More: FgJj

Mini-Rulers are just an Alt-G followed by a right margin letter. They only change the right margin or reformat mode in use.

Example:

1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100-101-102-103-104-105-106-107-108-109-110-111-112-113-114-115-116-117-118-119-120-121-122-123-124-125-126-127-128-129-130-131-132-133-134-135-136-137-138-139-140-141-142-143-144-145-146-147-148-149-150-151-152-153-154-155-156-157-158-159-160-161-162-163-164-165-166-167-168-169-170-171-172-173-174-175-176-177-178-179-180-181-182-183-184-185-186-187-188-189-190-191-192-193-194-195-196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000-1001-1002-1003-1004-1005-1006-1007-1008-1009-1010-1011-1012-1013-1014-1015-1016-1017-1018-1019-1020-1021-1022-1023-1024-1025-1026-1027-1028-1029-1030-1031-1032-1033-1034-1035-1036-1037-1038-1039-1040-1041-1042-1043-1044-1045-1046-1047-1048-1049-1050-1051-1052-1053-1054-1055-1056-1057-1058-1059-1060-1061-1062-1063-1064-1065-1066-1067-1068-1069-1070-1071-1072-1073-1074-1075-1076-1077-1078-1079-1080-1081-1082-1083-1084-1085-1086-1087-1088-1089-1090-1091-1092-1093-1094-1095-1096-1097-1098-1099-1100-1101-1102-1103-1104-1105-1106-1107-1108-1109-1110-1111-1112-1113-1114-1115-1116-1117-1118-1119-1120-1121-1122-1123-1124-1125-1126-1127-1128-1129-1130-1131-1132-1133-1134-1135-1136-1137-1138-1139-1140-1141-1142-1143-1144-1145-1146-1147-1148-1149-1150-1151-1152-1153-1154-1155-1156-1157-1158-1159-1160-1161-1162-1163-1164-1165-1166-1167-1168-1169-1170-1171-1172-1173-1174-1175-1176-1177-1178-1179-1180-1181-1182-1183-1184-1185-1186-1187-1188-1189-1190-1191-1192-1193-1194-1195-1196-1197-1198-1199-1200-1201-1202-1203-1204-1205-1206-1207-1208-1209-1210-1211-1212-1213-1214-1215-1216-1217-1218-1219-1220-1221-12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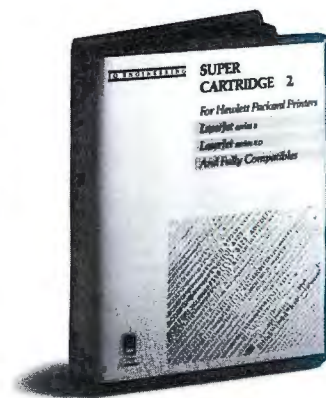
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RAM	384K	512K	640K	640K
OPERATING SYSTEM	PC/MS DOS 2.1/HIGHER	PC/MS DOS 2.1/HIGHER	PC/MS DOS 2.1 or HIGHER MOS, VAX/VMS	PC/MS DOS 2.1 or HIGHER MOS, VAX/VMS
CPU	8086, 8088 80286, 80386	8086, 8088 80286, 80386	8086, 8088 80286, 80386	8086, 8088 80286, 80386
DISK STORAGE	360/720KB	360/720KB	360/720KB	360/720KB
NETWORKING	NO	NO	YES	YES
FIELDS PER RECORD	99	199	299	499
NUMBER OF RECORDS	UNLIMITED	UNLIMITED	UNLIMITED	UNLIMITED
NUMBER OF FILES	UNLIMITED	UNLIMITED	UNLIMITED	UNLIMITED
NUMBER OF DIR SORTS	99	199	299	499
RECORD SIZE	4096 BYTES	8192 BYTES	16384 BYTES	32768 BYTES
LINKAGE	YES	YES	YES	YES

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SHORT TAKES

expect to find in a word processor (e.g., mail merge, proportional fonts, and support for columns), but this is a calculated omission by the company. The program is aimed at the student or professional who wants a fast cursor to crank out memos, reports, and other prose.

I tested the beta version of PC-Write Lite against XyWrite 3.51, a full-featured word processor with a reputation for having a fast cursor. First, I did a search-and-replace operation in a 131,732-byte file. It took XyWrite 41.72 seconds for 533 occurrences; PC-Write Lite breezed in at 13.72 seconds. Then I did a word count (an especially important feature in the collegiate atmosphere) on the same file, a BYTE listings index. XyWrite took 24.50 seconds; PC-Write Lite took 4.34 seconds.

While PC-Write Lite won't stack up to XyWrite or WordPerfect in a features slugfest, it's obvious that this word processor is built for speed. But all the cursor speed in the world isn't much help unless the program is obvious to use. When you first start the program, you see a simple screen that displays information regarding the function keys. All you need to do is press F3, and you're ready to begin. Press F1, and you get a complete help menu with information on 45 different subjects, including formatting, page layout, footnotes, shortcuts, and basic editing.

Some of the help screens were empty, but that's to be expected in a beta version. Without looking at the manual, I was able to perform basic operations such as moving paragraphs and stripping out non-ASCII characters correctly the first time. Once I got used to the menu, which took only a few minutes, I was quickly moving in and out of files.

Two features, page preview and sending footnotes

THE FACTS

PC-Write Lite \$49

Requirements:
IBM PC with 384K bytes of RAM (256K bytes without the spelling checker)

Quicksoft, Inc.
219 First Ave. N, Suite 224
Seattle, WA 98109
(206) 282-0452
Inquiry 1001.

to the end of a file, were not implemented in my beta version, but the company says they'll be in the shipping version. Two other features, jump to line number and parentheses matching, are specifically designed for programmers.

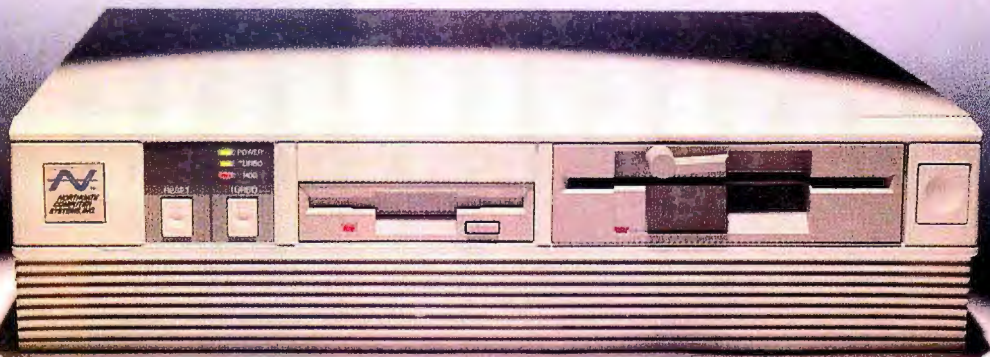
With all the trimming Quicksoft did on PC-Write, the company still managed to save the important features for Lite. Block and box copy, move, and delete operations are supported. You can still split a screen to view two files at once and edit files as large as available memory. The spelling checker lets you check a given word, check each word as you type, or scan a file for misspellings. You can also add words to the word list.

The program supports basic font effects such as superscripts and subscripts, italics, boldface, and underline. For margin control, paragraphs can be ragged right, justified, centered, or flush right. PC-Write Lite doesn't support left and right page layout or parallel independent columns. When printing, you can print a range of pages in a file or a series of related files.

If you have simple word processing needs, I would recommend looking at PC-Write Lite. It's got speed, and the price won't burn a hole in your pocket. ■

—David Andrews

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Recently, Dr. Pournelle looked at Northgate's 80386 Pipeline Page Mode system and reported in **BYTE** July, 1989 (excerpted):

*Jerry Pournelle holds a doctorate in psychology and is a writer who also earns a comfortable living writing about computers present and future.



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Circle 188 on Reader Service Card

Photo 1: The Zenith Z-386/33E. Except for its EISA slots and disk drive controller, it's virtually identical to the company's non-EISA 33-MHz 80386 system.



FIRST IMPRESSIONS ■ Stan Miastkowski

Zenith's EISA Does It

With nine companies involved in its difficult labor and birth, the Extended Industry Standard Architecture has been lots of talk and little action until recently. Although EISA machines are starting to appear, few products actually plug into those nifty 32-bit slots.

But Zenith has pushed EISA further along with the Z-386/33E, an EISA machine built on the solid foundation of Zenith's proven 33-MHz 80386-based platform. And the company has gilded the system with a true EISA board. The 33E's disk drive controller is more than an upgraded AT-bus board; it's a new, unique design that gives a tantalizing glimpse of the type of performance improvements that EISA can provide.

Opening the Box

As I expected, the outside of the Z-386/33E gives little clue to the goodies

The Z-386/33E delivers
on EISA's promise
with its cutting-edge disk
drive controller
technology

COMPANY INFORMATION

Zenith Data Systems
1000 Milwaukee Ave.
Glenview, IL 60025
(312) 391-8860
Inquiry 1082.

packed inside. In fact, it's the same box as the Z-386/33 (see photo 1). Zenith has a well-deserved reputation for top-quality products, and the 33E's weight (45 pounds) goes a long way toward enhancing its built-like-a-tank stature.

That overall feeling of quality was validated after I removed the cover (see photo 2). This isn't some cobbled-together clone. From the heavily shielded power supply to the extra-large cooling fan to the motherboard, the 33E is a system that's designed for heavy-duty use in hard-driving corporate environments.

Sitting next to the CPU are two empty sockets for either an Intel 80387 or a Weitek math coprocessor. And the design uses 16K bytes of fast (15-nanosecond) static RAM cache memory with Zenith's singular 16-layer write queue.

Zenith included 4 megabytes of 80-ns 32-bit RAM in the 33E. That's about a minimum for the type of applications this

system will be put to, and it's an absolute necessity for running OS/2 or Unix. There's plenty of RAM expansion space. If you're up to paying the hefty premium for 4-megabyte single in-line memory modules, which typically cost \$1500, you can pack your 33E with up to 20 megabytes of RAM.

The only real difference between the 33E and its predecessor is the 33E's seven EISA slots. Out of the box, four are free for future expansion. A standard 16-bit VGA card uses one. Another slot is taken up by the disk drive controller, and a third, Zenith's proprietary SuperSet slot, is taken up by a 32-bit I/O controller.

The 33E comes with the usual complement of standard features. In addition to the VGA card, there's a 1.44-megabyte 3½-inch floppy disk drive (a 1.2-megabyte 5¼-inch drive is optional), a parallel port, and dual serial ports.

Making Disks Fly

On the all-important mass storage front, the 33E comes with either a 150- or a 320-megabyte MiniScribe hard disk drive. But it's the controller attached to the drive that accelerates the 33E beyond its competition. It supports up to 13 devices, including two floppy disk drives, four ESDI hard disk drives, and seven SCSI disk drives (daisy-chained from the single SCSI port). And because it's an EISA controller (and configured from disk), there are no pesky DIP switches to deal with. (The prototype that I tested had one set, but Zenith says that it will disappear in the shipping version.) Nice as it is, however, it's just the beginning.

To underscore the distinctive position of the system's EISA disk drive controller, Zenith has applied for no less than five patents on its technology. The controller is built by Data Technology Corp. (DTC) and is certainly imposing in its presence. In addition to the main controller board, there's a large daughterboard attached, along with a "stepdaughter" board. Zenith says that initial shipments of the controller will have the three-board configuration. But within several months, through the use of gate arrays, all the circuitry will get packed into two boards.

It's not hard to see why Zenith went after the disk drive controller as the first add-in board to take advantage of EISA's capabilities. Despite the emphasis on 33-MHz processors, disk I/O is one of the most critical components of overall system performance. EISA's increased bandwidth offers lots of potential to deliver data to the processor much faster

than the AT's wimpy 8-MHz bus speed, but fast-access hard disk drives and 1-to-1 interleave disk drive controllers alone are not good enough.

Seek time, the time it takes a disk head to reach requested information, is the most performance-robbing aspect of disk operations. Due to the physical limitations of hard drives, about 16 milliseconds is the lower limit of seek time. So any remaining improvements have to come from the disk drive controller.

Caching In

Although it's far from a new concept, Zenith's first line of defense against slow-disk malady is hardware caching. The controller comes with a megabyte of on-board cache. (It's expandable to 4 megabytes.) Zenith uses a variety of sophisticated (and proprietary) algorithms hard-coded into the controller to let it figure out where the next needed data will come from. The process is helped along by two processors on the controller: A venerable 8-bit V20 administers the cache, and a proprietary processor developed by DTC handles the interface between the controller and the drives.

But the most interesting aspect of Zenith's EISA controller is its *position sensing*, which allows the controller to know how close the drive's read/write heads are located to the data, by head position as well as where the hard disk platters are located in their rotation.

Position-sensing (one of the technologies for which Zenith has applied for a patent) doesn't make much difference in a single hard disk drive system. But once you connect multiple drives to the 33E, the whole picture changes dramatically. When "looking" at more than one drive, the Zenith controller uses its position sensing to get data first from the drive that's closest to starting its transfer.

Position sensing leads to an apparent

paradox: The more drives you attach to the 33E, the faster and more efficient the system becomes. But even with a single disk drive attached, the 33E is no slouch. Overall, Zenith claims that the 33E can transfer data at 15 megabytes per second.

DTC says that it will soon offer a stand-alone version of the Zenith controller, but it won't include Zenith's position sensing. Position sensing will be available only in Zenith systems.

Plainly, the 33E is designed with the future in mind. In addition to its patent-pending features, the controller can, with the right software, act as bus master. This makes it a natural for multitasking applications and environments such as networks, OS/2, or Unix.

The Bottom Line

Of course, all this power doesn't come cheap. The Z-386/33E lists for \$11,999 (\$13,799 with a 320-megabyte hard disk drive). But a system of this type isn't designed for individual users, "power" or no. It will quickly find a happy home as a file server or even as a replacement for the corporate minicomputer.

Zenith has taken a giant step toward securing the future success of EISA. What makes the Z-386/33E so tempting is that its heart is built on proven technology. Its EISA disk drive controller is added muscle. Even if you think that you really need an 80486-based system, it's hard to see how it would give you more than marginally better performance over that of the 33E. For some time to come, the 33E is likely to be the standard by which other systems are measured. ■

Stan Miastkowski is a BYTE consulting editor, managing director of K+S Concepts (a documentation and consulting firm), and editor of the OS Report newsletter. He can be reached on BIX as "stanm."

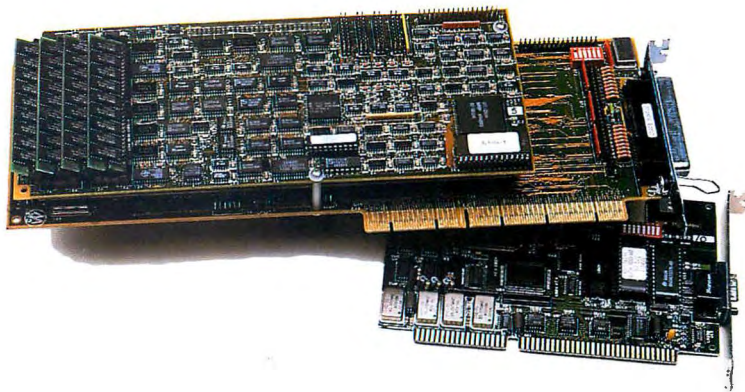


Photo 2: The 33E's EISA disk drive controller is on the top. A third board is tucked between the two that are visible. The standard 16-bit VGA card is on the bottom.

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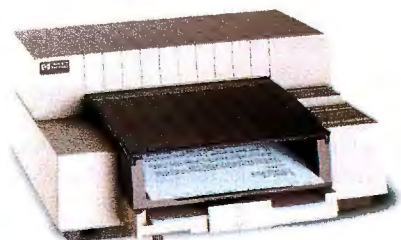
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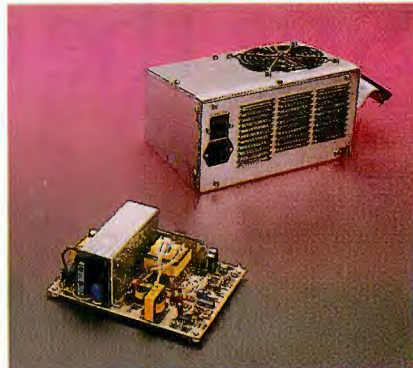
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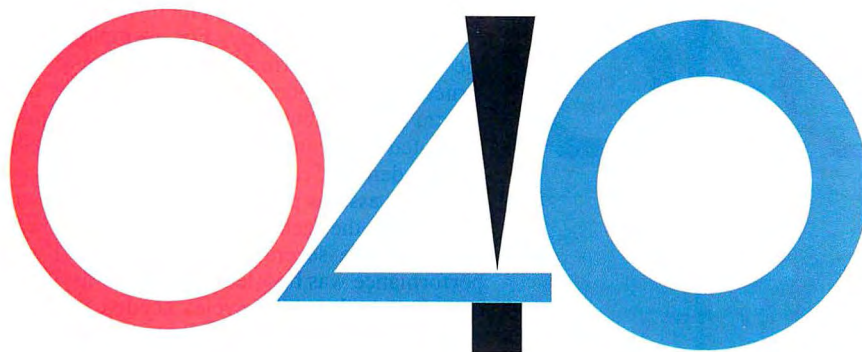
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Motorola's 68040 Microprocessor

Last month Motorola announced the availability of its newest 32-bit microprocessor, the 68040. Manufactured with 0.8-micron high-speed CMOS technology, the 68040 packs 1.2 million transistors on a single silicon die. With 900,000 extra transistors to work with over the 300,000 transistors in a 68030 processor, the 68040's designers added new features and boosted performance. These new features include the following:

- **Optimized 68030 integer unit.** While retaining object-code compatibility with previous 68000-family processors, the IU has been optimized to execute instructions in fewer clock cycles (i.e., run faster). The claimed boost in performance is three times that of a 68030.
- **Integral FPU.** The 68020 and 68030 require external FPU coprocessor chips to handle floating-point math. The 68040, however, has an FPU built into it, giving it the power to do serious number crunching. The FPU's data types are compatible with the ANSI/IEEE 754 standard for binary floating-point math, and its instruction set is object code-compatible with Motorola's 68881/68882 FPUs. Like the IU, the 68040's on-chip FPU has been optimized to execute frequently used instructions using fewer clock cycles. The claimed performance boost is 10 times that of a 68882.
- **Large caches.** Processor accesses to the system bus are minimized by storing

the most recently used set of instructions or data in on-chip, 4K-byte caches. Both caches operate independently but can be accessed at the same time. Bus snoop logic is used to maintain cache coherency (i.e., it ensures that the cache's contents match those parts of memory corresponding to the cache). The bus snooper's design is fined-tuned to support multiprocessor systems where one or more bus masters or 68040s might share the same section of memory.

- **Separate memory units for instructions and data.** Each memory unit consists of a memory management unit, a cache controller, and bus snoop logic. The MMUs use a subset of the 68030's MMU instruction set. Both memory units function independently of each other to improve processor throughput.

The 68040 ships with an initial clock speed of 25 MHz; higher speeds are to be available in the future. The 68040 comes in a 179-pin grid-array package. With the elimination of coprocessor function lines (now that the MMU and FPU are consolidated onto the processor) and the addition of snoop control lines, the 68040 is *not* pin-compatible with the 68030.

Because of the 68040's software compatibility with its predecessors, it can tap into the existing software base of 680x0 applications. It does this not only while eliminating a component (the FPU) from a computer's design, but also while improving performance. In fact, the 68040 executes instructions on the average of nearly once per clock cycle—the same as a RISC processor.

continued

This new CISC
microprocessor offers
RISC performance



Fine-Tuned for Performance

The 68040 was built on the firm foundation of its predecessors. The design team used the experience garnered from developing earlier processors to aid in optimizing the throughput of the 68040.

The 68040 was redesigned from the ground up. It incorporates a high degree of parallelism using a number of internal buses. An internal Harvard architecture gives the processor full access to both instructions and data (see figure). Both the

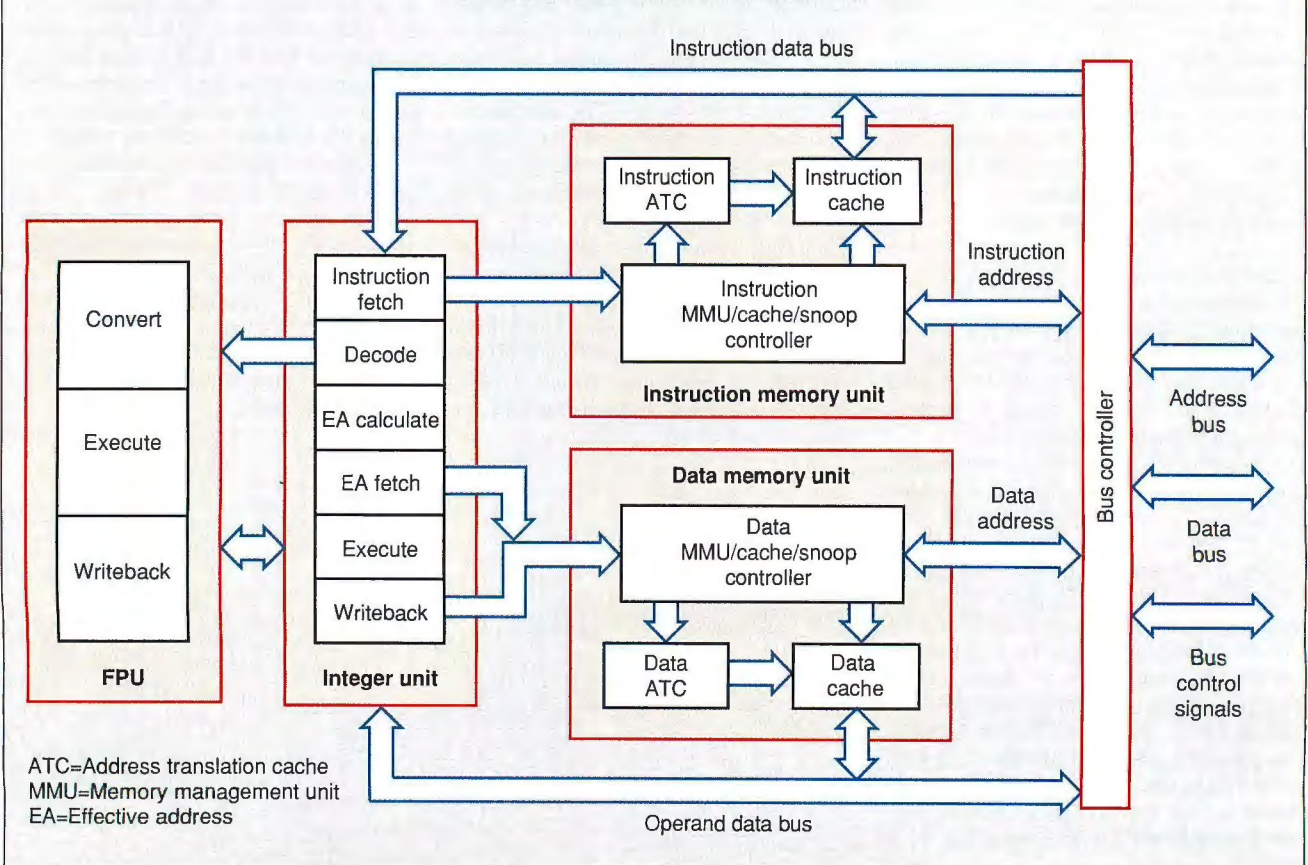
IU and FPU have separate pipelines and can operate concurrently. For example, the FPU can perform floating-point instructions independently of the IU. Each stream (instructions or data) has its own dedicated cache and MMU that function independently of each other. A smart bus controller assigns priorities to bus traffic to and from the caches.

There were several key areas where performance was boosted. The first was in reducing the clock cycles needed to execute certain instructions. The next was to ensure that the processor funnels instructions and data into itself quickly and constantly, lest it stall while waiting on information. The processor then gets its results back into the system without interfering with incoming information. Finally, as if this wasn't enough, the processor stays off the system bus to a greater extent than is the case with other processor designs. This lets DMA transfers and other bus masters have use of it.

The IU was optimized so that high-usage instructions execute in fewer clock cycles, particularly branch instructions.

Motorola performed thousands of code traces using real-world applications to determine which instructions were used most often. The IU consists of six stages: instruction prefetch, decode, effective address calculation, operand fetch, execution, and writeback (i.e., the result is written to either a register or memory). Each stage works concurrently on the instruction pipeline. Dual prefetch and decode units deal with the branch instructions: One set processes the instruction taken on the branch, and another processes the instruction not taken. In this way, no matter what the outcome, the IU has the next instruction decoded and ready to go without seriously disrupting the pipeline. This complex design has a big payoff: Motorola has determined that the average instruction takes 1.3 clock cycles to execute. The ability to execute an instruction once per clock cycle is the performance edge of RISC processors—yet the 68040's IU accomplishes the same goal while executing complex-instruction-set computer (CISC) instructions.

THE 68040 BLOCK DIAGRAM



A Harvard architecture provides separate paths for instructions and data.

The FPU adds 11 registers to the 68040 register set: Eight of them are 80-bit floating-point registers, and three are status, control, and instruction address registers. The FPU has a three-stage execution unit, and, like the IU, each stage operates concurrently. Load and store instructions (FMOVE) can be performed during other arithmetic operations, and a 64- by 8-bit hardware multiplication unit speeds many calculations. However, the FPU only implements a subset of the 68882 instructions on-chip. The transcendental (trigonometric and exponential) functions are emulated in software via a software trap. But Motorola claims that even these instructions should execute 25 percent to 100 percent faster on a 25-MHz 68040 than on a 33-MHz 68882 FPU.

Boosting Throughput

In the area of throughput, each stream is managed by a separate memory unit that uses an MMU for logical-to-physical address translations during bus accesses. These MMUs support demand-paged virtual memory. Both MMUs have a four-way set-associative address translation cache with 64 entries (versus 22 entries for the 68030). The ATCs reduce processor overhead by storing the most recent address translations. When an address translation is required, the ATC is searched, and if it contains the address, it is used immediately. Otherwise, a combination of high-speed hardware logic and microcode searches the translation tables located in main memory.

Like the FPU, these MMUs implement a subset of the 68030's MMU instruction set. Gone are the PLOAD and PMOVE instructions, because enhanced existing instructions made them superfluous. Also, only two memory page sizes are supported, 4K and 8K bytes, whereas the 68030 MMU supported eight page sizes ranging from 256 bytes to 32K bytes. A design trade-off was made here: A performance gain was possible by supporting only the two most common page sizes. In any case, this change impacts only operating-system code, since MMU instructions aren't normally used by applications.

The two on-chip 4K-byte caches improve processor throughput in two ways: They keep the pipelines filled and minimize system bus accesses. To see how this is done, you must examine the structure of the cache. Each is a four-way set-associative cache composed of 64 sets of four lines. A line consists of four longwords, or 16 bytes. Cache lines are read or written rapidly using burst-mode ac-

cess (a type of bus transfer that moves 16 bytes in a minimum of clock cycles). For read operations, this fills the cache efficiently and, at the same time, loads adjacent instructions or data into the cache that could be used in the near future.

Zen and the Art of Cache Maintenance

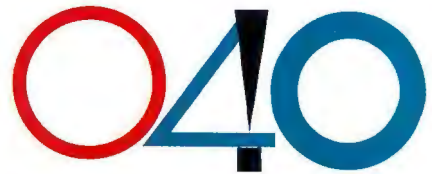
As the cache is accessed and data modified, cache-mode bits in the ATC determine, on a page-by-page basis, the method by which the information is handled. That is, the ATC entry that corresponds to the address in main memory whose contents were copied into the cache decides how the data will be updated. The modes are cacheable write-through, cacheable copyback, noncacheable, and noncacheable I/O.

In the cacheable write-through mode, an update to the data cache forces a write to main memory. While this generates additional bus activity, this mode is required when working with a portion of memory that other processors share. The copyback mode updates the cache line but without updating main memory. The modified (or "dirty") cache line is copied back into main memory only when absolutely necessary. "Noncacheable" indicates that the data shouldn't be cached, which is typically the situation for shared data structures or for locked accesses (e.g., an operand access or a translation table entry update). Noncacheable I/O indicates that the data can't be cached and must be read or written in the exact order of instruction execution. This mode is for memory-mapped I/O devices (typically a serial device) where the information's order is crucial.

The bus snoopers are used in multiple bus master situations where a noncaching bus master, such as a DMA controller, might modify the memory that is mapped into the 68040's cache. The bus snoopers monitor the external bus and updates the cache as required.

Cache validity is handled on a line-by-line basis (i.e., a cache miss triggers a burst-mode access that updates 16 bytes either in the cache or main memory). The copyback mode minimizes writes to main memory, and the bus controller prioritizes each cache's external memory requests. Read requests take priority over writes to ensure that the pipelines remain filled.

The caches are critical to the 68040's overall throughput. They keep instructions and data moving into the processor while satisfying the apparently contradictory role of minimizing system bus accesses. Motorola estimates that the cache



hit rate is about 93 percent for instruction and data reads and about 94 percent for data writes.

A Processor for the 1990s

It is perhaps appropriate that Motorola has introduced the 68040 in the first month of the new decade. The 68040 has the power to tackle the jobs with large amounts of information that we will be dealing with regularly in the 1990s.

Preliminary results have a 68040 weighing in at 20 million instructions per second versus the SPARC's 18 MIPS and the 80486's 15 MIPS, all clocked at 25 MHz. On floating-point operations, the 68040 antes up 3.5 million floating-point operations per second versus the SPARC's 2.6 MFLOPS and the 80486's 1 MFLOPS. If these numbers are accurate, then the 68040 already outperforms one RISC processor.

But the computer industry doesn't stand still. As we move into the new decade, we can expect new RISC processors to once again take the lead in performance. Still, the 68040 shows that owners of CISC systems can have their cake and eat it, too. They don't have to forsake their software base or settle for mediocre performance. And Motorola is already working on the 68050. ■

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Tom Thompson is a BYTE senior technical editor at large. He can be reached on BIX as "tom_thompson."

COMPANY INFORMATION

Motorola, Inc.
6501 William Cannon Dr. W
Austin, TX 78735
(512) 891-2000
Inquiry 892.

Hawk II Soars

Built for individual use, the Hawk II introduces more for less to the 80486 market.

I'll admit that I'm not a speed freak, but I do enjoy working on a fast machine. When the first 80486 machines came into BYTE, I was quite impressed by the performance, and even more so by the price. At 100 pounds and \$20,000 or more per machine, these critters seemed like toys of the idle rich, destined to become file servers or multiuser systems.

Club AT's Hawk II (see photo) is built for a single user. It comes in a standard tower case with room for one full-height and four half-height drives. Power comes

from a single 250-watt power supply, mounted high in the case. Along with the standard cooling fan, a second, filtered fan is mounted near the card slots to help out with the cooling.

While most of the 80486 machines have tons of extra security features, the Hawk has none. The case is held together with three screws, just like any standard tower machine. Also, there's no reboot or power protection. A small plastic door covers the power and reset switches, but it's only for aesthetics and accidental reboot protection.



Club AT's 25-MHz

80486 may be faster than most people need

There's no overkill in configuration, either. Other manufacturers have decided to have their 80486 machines sport exotic disk drive controllers and memory configurations. Club AT equips its Hawk II with 4 megabytes of paged memory, a 128K-byte CPU cache, an 85-megabyte Maxtor modified-frequency-modulation hard disk drive, an Everex Viewpoint VGA card, a monitor, a keyboard, and your choice of a 5¼-inch or a 3½-inch floppy disk drive. All this costs about the same as an equally powered 80386 machine—\$4995. The only options added to this base package on my test machine were a second (3½-inch) floppy disk drive and a serial/parallel I/O card.

Elbow Room

If you need more options, there's room for them. Sockets are provided for another 4 megabytes of single in-line memory modules, bringing the total RAM up to 8 megabytes. A 32-bit slot accommodates another 8-megabyte memory board at full clock speed. A coprocessor socket takes the Weitek 4167 math coprocessor. The seven 16-bit slots give you room to add any Industry Standard Architecture (AT bus) cards. You might even consider extending the 128K-byte instruction cache to 256K bytes for an added performance boost.

My evaluation unit was a prototype; the final case tooling wasn't available. My overall impression was that the Hawk II is built like a tank, certainly as well-built as any tower I've seen in some time. Club AT is still working on the front-panel bezel; the door covering the power switch was very stiff and hard to open. I wonder why the turbo LED was left on the bezel; there's no turbo switch, and no obvious way to control the processor speed. Perhaps the final version will address that. Also, the power light on the front of the unit wasn't working.

If I can nitpick about one last thing, it's the keyboard. The Hawk II came with a typical clone keyboard. It felt mushy and had a very short cord. Happily, it's a standard item, and you can re-

place it with any keyboard you like. I've never understood why people sell tower cases with short keyboard cords.

Fast? You Might Say That

On the BYTE low-level benchmarks, the 25-MHz 80486 was able to hold its own against all but the fastest 80386 machines. The table above shows the performance indexes of the Hawk II, the Apricot VX FT 486, Advanced Logic Research's FlexCache 33/386, and the Compaq Deskpro 386/33. A casual observation of speed suggests what I expect the formal applications benchmarks will show—the Hawk II is as good as the best of the 33-MHz 80386 machines. Windows/286, which is normally quite nice on the Compaq 386/33, paints the screens in a visible motion. On the Hawk II, you select a function that repaints the screen, and the image is there instantly. As Windows does a lot of memory moves to handle its graphics, I suspect that the 80486's superior string handling has a lot to do with the fast graphics. Other graphics applications showed similar improvement.

PERFORMANCE INDEXES

Relative performance of the Hawk II, another 80486 machine, and two popular 33-MHz 80386 machines.

System	CPU	FPU	Disk	Video
Club AT Hawk II	7.09	28.15	1.91	3.64
Apricot VX FT 486	6.69	21.77	2.29	5.17
ALR FlexCache 33/386	6.74	15.66	2.60	2.83
Compaq Deskpro 386/33	6.09	15.50	2.90	4.53

For indexes, an 8-MHz IBM AT = 1. For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

I would like to see more machines like the Hawk II. When the 80486 was announced, Intel said that the 80486 architecture would allow machines that outperform the 80386 and cost less. The Hawk II is the first machine (of many, no doubt) that fulfills this prophecy. If I were in the market for a high-end 80386 machine, I'd give this personal 80486 system a look. Perhaps when my 16-MHz 80386 dies, I'll buy one myself. The Hawk II is a good piece of equipment, and compared to the other 80486s I've seen, you can have it for a song. ■

Howard Eglowstein is a testing editor for the BYTE Lab. He can be reached on BIX as "heglowstein."

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OPTICAL DISK DAZE

From dusty WORMs to cows-on-disk, there's been a whole lotta optical happenings at Chaos Manor

You can be sure of one thing about small computers: few things are ever as simple and easy as you expect them to be.

Case in point: we recently sent the Maximum Storage APX-3200 WORM (write once, read many times) drive back to be refurbished. I'd been using it for over a year with no problems; then, suddenly, I got retry errors. No data was lost, but it was worrisome, so I took it apart.

It didn't take long to find the problem. The external drive case had real filth at the air intake, and the fan drew air past the laser mechanism. I was actually getting dust balls! The laser could usually see through them, but sometimes not. Once I figured out what was happening and vacuumed the innards of the drive, the problem went away. Then I called Maximum Storage.

It seems they had also only just discovered the difficulty. They had two remedies. First, they have changed the fan placement so that the problem isn't likely anymore; and second, they started an annual cleaning and maintenance service for WORM drive owners. "Send yours in," they said. "We'll clean it up, and while we're at it, we'll upgrade it to an APX-5200." The storage capacity of the APX-5200 is much greater than (500 megabytes per side versus 122 megabytes per side) that of the APX-3200, but the APX-5200 can still read and write to the older disks. Upgrading was clearly a good idea, the only drawback being that I'd be without the WORM drive for a few weeks, but I had a trip scheduled in that

time period anyway.

The trip, incidentally, is more proof that things associated with computers seldom go as planned. It was to the fifth annual Hackers' Conference, followed by a meeting in Palo Alto with BYTE's senior editorial staff. This put me in the Bay Area precisely in time for the earthquake, which upset me less than it did the BYTE people. After the quake, I got into the Bronco II and drove home without incident. The BYTE staff fought their way to the San Francisco airport and flew out just in time to be trapped by a blizzard in Chicago.

The B: Blues

The APX-5200 looks identical to the APX-3200, except that the controller board is a tad larger. It comes preset so that installation is simplicity itself: put the board in your machine, put the installation disk in your floppy disk drive, type Install, and answer the questions. At least once it was that simple for me, but not this time.

My Big Cheetah 386 has, in addition to the WORM drive, an Amdek Laserdek CD-ROM drive. That comes addressed to the same I/O channel as the default address for the WORM drive. Because Maximum Storage's documents and software are really well thought out (some of the best I've seen), it is considerably easier to readdress the WORM drive than the CD-ROM drive. All you have to do is flip a DIP switch on the board. Then, when you run the Install program, the software finds where the controller is addressed and adjusts itself accordingly. Once again, I'd used it before, and it was painless—but not this time.

In the past, the software came on a 5¼-inch disk. This time it was on two 5¼-inch disks, but a 3½-inch disk was also included. Since Big Cheetah has both drives, I figured I'd use the 3½-inch floppy disk, so I put that in drive B, logged onto B, and typed Install. For a few moments all was well—then the pro-

gram tried to make copies from drive A, and nothing I could do would induce it to believe that it should look to B. Eventually there was nothing to do but reset the machine.

Alas, one of the things the Install program does is to make changes in your CONFIG.SYS file—and it hadn't finished doing that. I'd reset with the file not closed. The result was utter garbage in the CONFIG.SYS file, which meant it was now time to find the emergency backup boot floppy disk for Big Cheetah. If you haven't made an emergency backup boot floppy disk for your system, stop reading this article, go to the machine, and make one *now*. If you don't know how to do it, find someone who does. Then keep it somewhere near the machine.

Maximum Storage was feeling sheepish about the Install program, as well they might. They've fixed it, of course; and perhaps it can be a lesson for any software designer reading this. There aren't many reasons why an Install program shouldn't run off any disk drive, floppy or fixed.

When we got the machine booted up properly and the CONFIG.SYS file taken care of, we found that DESQview wouldn't come up.

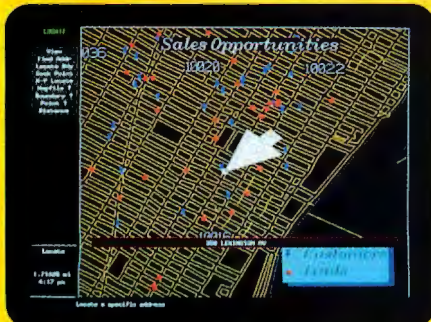
Tweaking DESQview

DESQview, for those few who don't know, is a multiwindowing program that lets you switch from one job to another without saving them off to files and reloading. When used with its companion memory manager QEMM-386 and run on an 80386 machine—or an 80386SX, or an 80286 that has been upgraded with the All Chargecard—DESQview can make full use of your *extended* memory as well as *expanded* memory.

Moreover, DESQview can stuff a lot of things, including itself, into unused memory areas between 640K bytes and 1 megabyte. That extended memory below

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CHAOS MANOR

1 megabyte—to coin a less confusing name for it, I'll refer to it as 640+ memory—is special, in that it's easy for DOS to address it. It's therefore precious, and you need to conserve it.

What I want from DESQview is access to the CD-ROM in at least one window, access to the WORM drive from *all* windows, and at least five *large*, say 520K-byte, windows running at once. As it happens I can just do that, so it was dismaying to find that I couldn't with the new Maximum Storage software.

Fortunately, my son Alex was able to fix that by tweaking the CONFIG.SYS file. As a result, I can once again run the following:

```
DEVICE=C:\LOADHI.SYS
C:\BIN\AMDEK.SYS
/N:1/D:AMDEKCD
DEVICE=LOADHI.SYS
C:\MAXSYS\MAXBIOS.SYS
/1/200
DEVICE=LOADHI.SYS
\MAXSYS\MAXSYS.SYS
```

which loads those three drivers into the 640+ memory. I can then run the following:

```
C:\BIN\MSCDEX.EXE
/D:AMDEKCD/M:8
```

inside a big DESQview window. I then have N as the WORM drive, which is available in all windows; and O is the CD-ROM drive in that window (but no other). Since DESQview has a mark-and-transfer program, I can cut and paste text from CD-ROMs into any other window, including communications windows, and for that matter, this one.

What Alex did was set up the basic CONFIG.SYS statement:

```
DEVICE=C:\QEMM.SYS RAM
ROM INCLUDE=F000-F7FF
FRAME=E800
```

and reset, and then run QEMM.COM to look at the memory map it generates. From that, he deduced that certain memory areas have to be excluded, so he excluded them all. The result was to add X=A000-C9FF to the DEVICE=QEMM.SYS line and reset. When that worked, he began to whittle off the excluded areas until trying to load DESQview sent the system off into the land of lost bits. He kept this up until we discovered that all we need is X=C700-C7FF to make things work.

That particular exclusion may not work for you—in fact, if you have a Ze-

nith Z-386, I guarantee you'll have to exclude a larger area—but you can still use the general method to build the largest possible DESQview window.

The CD-ROM Scene

One neat thing about CD-ROM drives is that you can daisy chain them; at least you can if they're all Hitachi drives (which the Amdek Laserdek is). I have seen a stack of four, with the Oxford English Dictionary in one of them. When you try to access the OED, you can see each drive light come on in turn, until it hits the OED. Alas, that was only a test. I don't have four Hitachi drives, and given the cost of CD-ROM drives, it's unlikely that I will for a while. I am getting a second one, though, so I'll probably keep a Microsoft CD-ROM (Bookshelf alternating with Programmer's Library) in one of them.

CD-ROM drives cost too much. The good news is that prices are falling at about 10 percent a year. I wish I had better news.

There are a lot of new CD-ROMs, so many that it's nearly impossible to keep up with them; I must get half a dozen a month. Many are quite interesting. Some are downright odd.

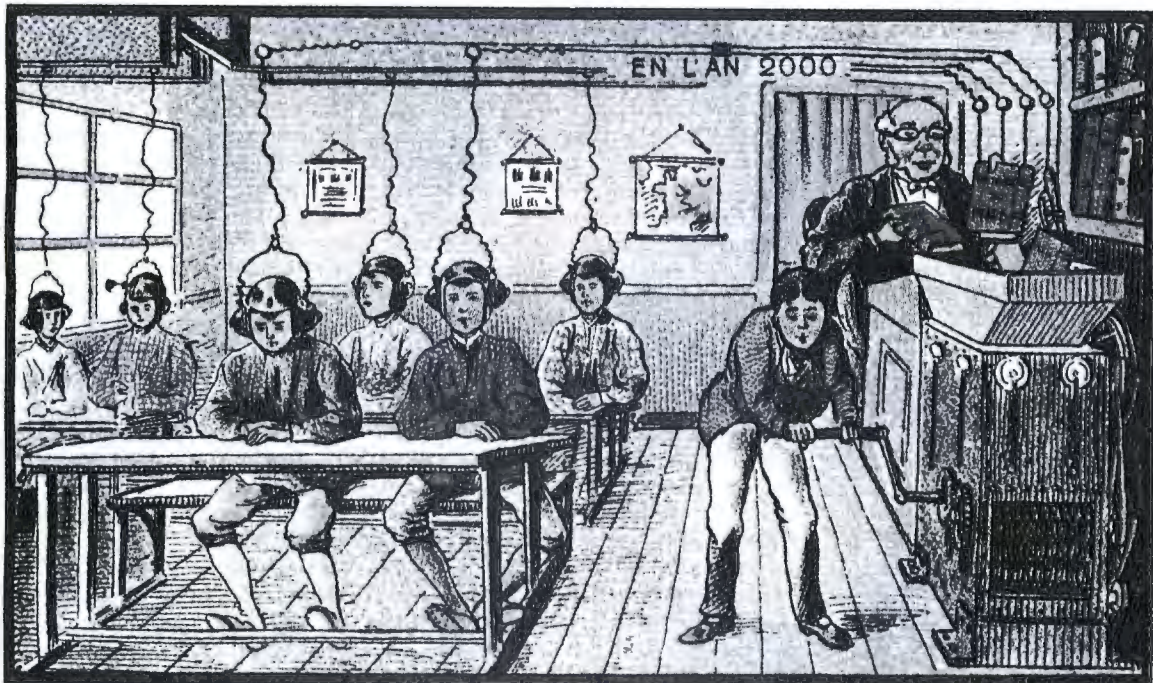
Example: BYTE is located in one of the largest buildings in Peterborough, New Hampshire, a five-story brick affair. In its early years, BYTE shared the building with the American Guernsey Cattle Club. After the guernsey group moved to Columbus, Ohio, the building wasn't redecorated for some time. As a result, anywhere you looked you'd find pictures of cows, and literature about cows, and posters featuring cows. And it was the custom never to explain that to visitors...

Most of the cow clutter is gone from Peterborough, but here at Chaos Manor I still have my picture of The Ideal Type Guernsey Cow on the wall above the Mac II. (Don't ask.) Now Quanta Press has sent me a CD-ROM called About Cows, along with a framable certificate proclaiming me a member of the Cow Moo Nist Party of the U.S.

This CD-ROM will tell you just about anything you ever wanted to know about cows, from serious articles about artificial insemination (how to do it, and when not to) through poems ("Then there are cows, who love to boast, of affairs they've had by parcel post") to a still picture of the scene from the 1983 PBS production of "Swan Lake Minnesota" showing a line of classic ballerinas in tutus standing in dairy stalls waiting to be

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milked, and I think I don't want to say anything more about that. Half of About Cows is spoof; the other half is quite serious, and it would be useful to dairy farmers.

Another CD-ROM from Quanta Press is Dick's Some of the Earth's Planes. You may find that name similar to a better-known series of publications about military hardware. As is traditional with CD-ROMs, the installation program is confusing, there are no instructions for installation, and the retrieval software is hard to use. However, with enough patience, you will eventually be able to get it to show you a series of pictures of military aircraft.

The most interesting CD-ROM I've got in the last couple of months is called Between Heaven and Hell. Created as a showpiece to advertise a company that has, alas, foundered, this CD-ROM contains 145 megabytes in 10,429 files. These include the title files: the King James Bible with concordance (Heaven) and some scanned images of nudes in various naughty to raunchy poses (Hell).

There's also just about everything else you can imagine, most either shareware or public domain. There is a shareware game of Risk. There is a whole slew of desktop publishing software. There are word processors. There is a bewildering variety of retrieval software. There are math and chemistry tutorial programs, a family-history tracking program, communications software, and a hypertext development system. You name it, it may be on there.

I say "may be": there are over 300 catalog files on this crazy disk, and I haven't had a chance to look at them all. Just trying to can eat time. I have looked at enough to know there's a bewildering variety of programs and images.

The Bureau of Electronic Publishing (a private company despite the name) sells this thing for \$99, and my recommendation is that you get your club or users group to buy a copy. There's something on there for every member. With 10,429 files, how could it fail?

XTreePro Gold

Although there's a variety of retrieval software on Between Heaven and Hell, none of it is very good. Actually, that's probably not true; let's just say that I don't have time to figure out how to make it work right. In hopes that they could help with the retrieval software, I called the Bureau of Electronic Publishing. They told me what they did was to use XTreePro Gold to examine the disk and peel off parts as wanted.

By coincidence, I'd recently had correspondence with XTree's representative, so there was a copy on my desk. No time like the present, I thought, and installed it. That went all right. Then I logged onto the O drive.

XTreePro Gold does statistics on every file—not on every file in the current directory, but every file on the entire disk. That's why I know the exact number of files and bytes on Between Heaven and Hell. That does take time: 7 minutes, to be exact.

Once done, though, it was pretty impressive. There was a full diagrammatic display of the CD-ROM directory structure, and it was easy and quick to move about among those directories. Then I wanted to find the number of catalog files on the CD-ROM. XTree lets you change the file specifications, so I set that to "*.CAT" and let it go. It trundled for 3 minutes and told me it was out of memory. I was eventually able to get the answer by exiting DESQview, stripping my system down to bare bones, rebooting, and then running XTree, but it was hardly convenient. Still, I could do it.

A CD-ROM with 10,000 files on it isn't the average problem a directory utility is designed to work on, so I tried the program on different logical directories of my 300-megabyte Priam hard disk drive. I keep that drive partitioned into 33-megabyte logical drives because I'm still using DOS 3.3, and while SpeedStor and other programs let you have larger logical drives, I run so much new and different and even oddball software that I like to keep things as standard as possible. XTree works fine on normal disk drives. It takes a few seconds to get all the disk statistics; it then shows you a full diagram of the directory structure and tells you how many total bytes make up how many files for the entire drive.

Unfortunately, what it tells you is not exactly wrong, but—well, it's best you listen to the story.

The obvious thing to compare XTree with is Norton Commander, the DOS utility I normally use. I put that in one DESQview window and XTree in another and logged both onto the XTree subdirectory. Actually, you can't really log XTree onto a subdirectory; more on that in a moment.

Anyway, both programs told me there were 8.03 megabytes of free space on drive C—and that was the only thing they agreed on. Norton Commander knows that there are 33.2 megabytes on the C logical drive, of which 8.03 are free and 25.2 are used. Norton Commander does

continued

not tell you how many total files there are on the drive. XTree doesn't tell you the total drive size, but it does report that I have 1664 files using 23.3 megabytes. CHKDSK reports something different from both XTree and Commander because it breaks the files down into 5328 bytes in three hidden files, 139,264 bytes in 59 directories, and 25.06 megabytes in 1662 user files. None of these add up properly.

XTree and Commander don't agree on

how large the XTree subdirectory is: XTree claims there are 772,287 bytes in 40 files, but Commander reports 41 files using 817,152 bytes. On the number of files, they're both right; that is, Commander counts the "." file while XTree doesn't.

I didn't feel like adding up the numbers on the byte count, so I went to a smaller subdirectory with only a few files. XTree reports there are three files with 6128 bytes. Commander reports

four files with 10,240 bytes; but if you tell Commander to select all files, it says there are three with 6128 bytes. That prompted me to take Commander over to the XTree subdirectory and try again. Sure enough, selecting all the files there shows 40 files with 772,287 bytes.

The upshot is that both programs will give you the right answer on subdirectory sizes, but you have to tweak Commander to get it.

Meanwhile, Commander, because it doesn't examine the entire drive, will let you look at the CD-ROM directory by directory without using up a whole day. XTree, alas, won't let you merely log onto a directory; it wants to tell you about the entire drive or nothing. The company does list a complex batch file that uses the DOS SUBST command to fool XTree into believing that a directory is the X drive, but it's in the manual, not on their disk, and it's never explained.

A call to XTree revealed there's another undocumented feature: you can use Alt-Z after the program has logged onto a drive, and it will save those drive statistics into a disk file and reload them the next time you log onto that drive. If you have changed anything on that drive, it has to do the statistics search again, but for a WORM or CD-ROM, that would be no problem—provided that you don't change cartridges. If you do, XTree sees there's something odd and reexamines the drive again. In the process, it erases the previous statistics file for that drive. This isn't right.

What XTree probably should do is save the drive statistics by *volume name* and look at that, or, failing that, let you force it to look at a particular disk file of statistics; but, alas, it won't do that.

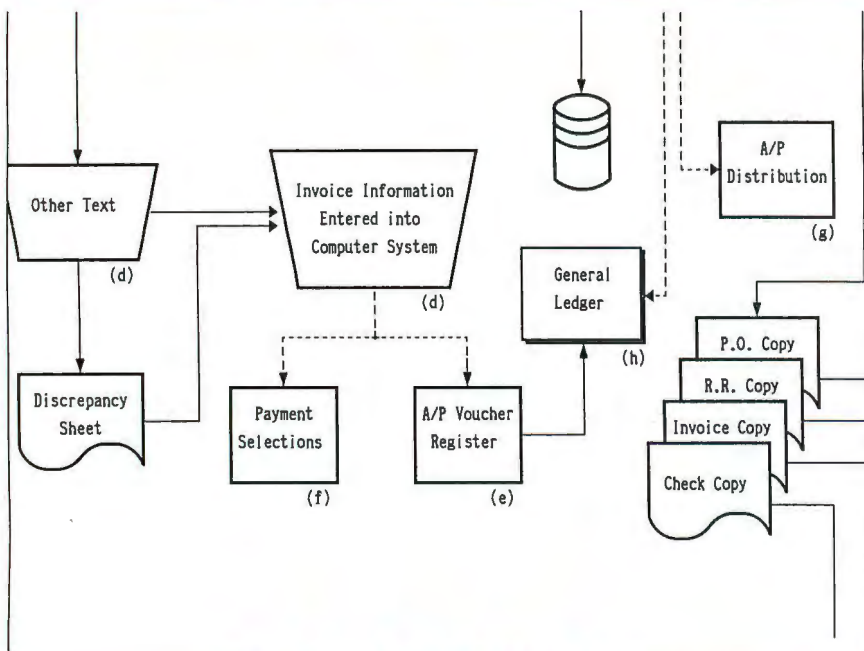
In fact, that's my general conclusion about XTreePro Gold: it's a great toolkit of really well-written stuff, but just about the time you're ready to use it, there's a problem. The user interface is fine for most of what it does, but suddenly you're faced with typing in complex batch files. It could save you time with CD-ROM disks, but you can't get it to keep each CD-ROM on file. In a word, it's infuriatingly good. I'll leave XTreePro Gold on my drive because sometimes it's more useful than Norton Commander, but I don't think I'll use it all that much. I sure want to see the next revision, though; if they fix the problems, this could be the hot disk drive manager utility of the year.

Mac CD-ROMs

Before I leave the subject of CD-ROMs, I should mention that there are a whole

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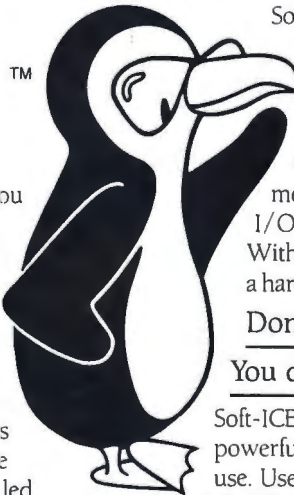
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bunch of them for the Macintosh.

I've previously discussed the Grolier Academic American Encyclopedia for PCCompatibles. Now there's a version that works for the Mac Plus, the SE, and the II family. The encyclopedia database is identical to the PC version, but the access software is more Mac-like. I didn't get to keep my copy long. My youngest boy uses a Mac. He's on the UCLA debating team, and it took him about 30 seconds to decide that this was something he really needed, and "Dad, you've already got it for your computer. . . ." The problem is that I've also lost the CD-ROM drive for the Mac, but I'm supposed to get it back Real Soon Now.

He also took the Mac version of the World Factbook. This is published by Wayzata Technology and distributed by Quanta Press. It comes without a manual, but with a Mac floppy disk of retrieval software; as with most Mac products, you won't need the manual if you find the Mac intuitive, and a manual probably wouldn't do you any good if you're a Mac hater.

There's still nowhere near as many CD-ROM products for the Mac as for the

IBM PC, which is surprising, because I'd have thought CD-ROM and HyperCard were made for each other. Still, there's more all the time.

Grammatik IV

It wasn't broke, but they fixed it anyway. They upgraded Grammatik, and Grammatik IV has the distinction of not working as well as Grammatik III did.

In fact, I can't use it. Version IV says that it fully supports Q&A Write—version III almost did, but it can't let you change the length of a line because of the odd file structure Q&A Write uses—but what happened when I aimed it at a Q&A Write file (this one, in fact) was that the program displayed a message, "Preparing Document," and trundled for 9 minutes, after which I gave up and tried to stop it. I couldn't.

The only way to turn the silly thing off was to close its DESQview window, which is equivalent to turning off the machine. I then found that Grammatik IV had created a file called BYTEFEB.\$G\$ with 0 bytes in it, and another file called GK009560.\$G\$ that had grown to 301,056 bytes when I stopped it.

When I saved my text as an ASCII file and aimed Grammatik IV at that, the program worked fine. The only difference I noticed between versions III and IV is that III has a somewhat better user interface. The new interface isn't all that bad, but the old one wasn't broke and didn't need fixing; it's now harder to get the program to find files on other logical drives.

Grammatik is still my favorite grammar and style program (but see last month's section on Scandinavian PC Systems' Readability, which is also necessary), and I suppose they'll fix whatever bug makes it unusable with Q&A Write; but for the moment I'll stick to version III unless I adopt a new word processor. I'm told that version IV works very well with WordPerfect and Microsoft Word, but I haven't tried it with those.

Simulations and Games

A week after the earthquake happened, we were up in the Bay Area again, this time attending the annual Computer Users in Education (CUE) conference

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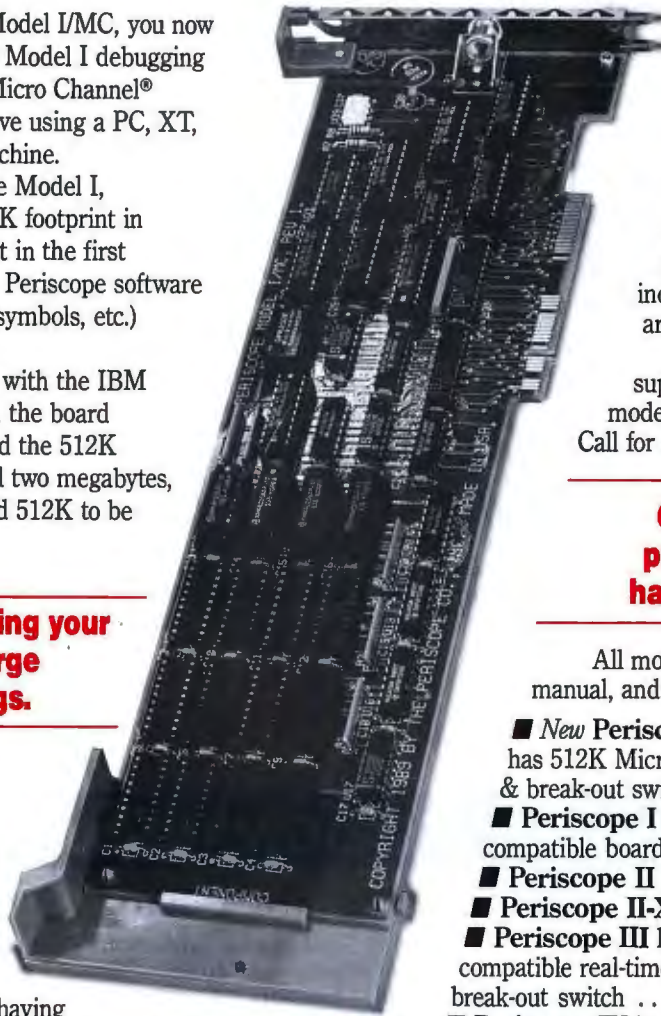
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(for information, contact Computer Users in Education, 1923 Menalto Ave., Menlo Park, CA 94025, (415) 325-8934). Naturally, this is one of Mrs. Pournelle's favorites; indeed, if you're in education, you ought to get to it. The conferences, demonstrations, and just plain networking are excellent.

There's getting to be a lot of educational software. Alas, it's a mixed bag. Much of it doesn't seem very useful.

Some programs, like Broderbund's *Physics for the Mac*, are excellent. *Physics* is just plain fun. It could, I guess, be used by an imaginative teacher for classroom demonstrations, but the main value would be in a lab situation in which the student could just play around with it. The animated simulations of concepts like harmonic motion are quite good. You can play with a pendulum to see what happens if you change the mass, or the length, or both. In another demonstration, you can see the molecules inside a sealed box and watch the pressure change as you add heat or change the box size. I'd have killed for this program when I was in high school.

Unfortunately, not all simulation pro-

grams work that way. A case in point is *The Budget Process* from Tom Snyder Productions, a program that is part of the *Decisions, Decisions* educational programs series. According to its literature, Tom Snyder Productions "specializes in group simulations that inspire cooperative learning across the K-12 curriculum." The company has an excellent reputation. Dr. Snyder gave the keynote speech at the CUE conference, and I thought what he said was well informed, sensible, and much to the point.

The Budget Process is a simulation program. The class plays the role of a member of Congress. In the words of the program book, "You were elected to the U.S. House of Representatives as an Independent.... A small majority of the registered voters in your district are Republican, but the Democrats in your district are very vocal and influential."

"You and a colleague of yours, Rep. Joe Bain, are the principle [sic] authors and sponsors of a federal budget bill, HR123."

The booklet is about 25 pages long, with about 300 words per page; not a very large book. The concepts dealt with

are quite complex. Some of them are well done. Some are in baby talk. Some read like propaganda. Some of the entries are supposed to be propaganda.

The problem is that the game is supposed to simulate the real political and economic world—and unlike the physics of harmonic motion, we don't know how the real political and economic world works. Since the Nobel Prize in economics was instituted, there have been about a dozen recipients. I don't believe that any two of them agree on very much. Certainly I could get a number of them to disagree with the economic concepts taught by this program.

The same is true of political science. While I know of several congressional districts that have returned Republican members even though registered Democrats outnumber Republicans, I don't know of any district where Republicans outnumber Democrats but an Independent was elected. More to the point, an Independent representative wouldn't be authoring a budget bill.

Moreover, the choices offered this Independent are (a) meet with important

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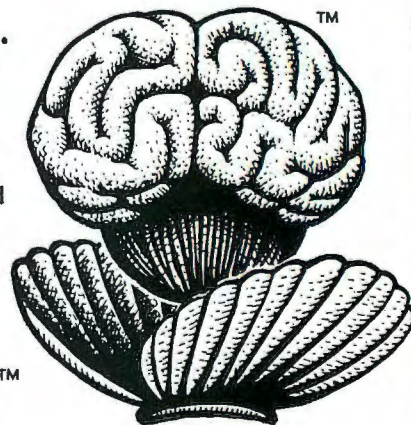
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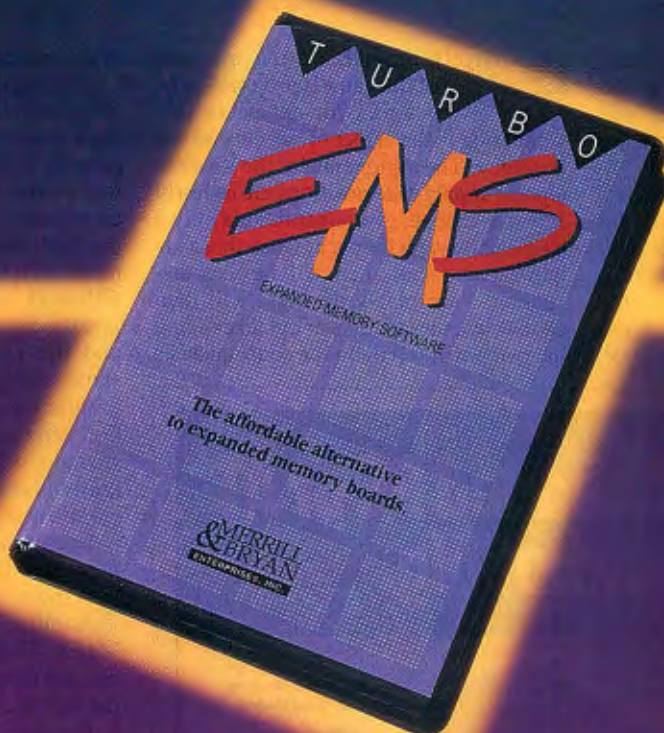
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Republicans, (b) meet with leading Democrats, and (c) wait and see. One of the Congressman's aides asks, "What will people think if they see you meet with the Republicans?"

The class is now supposed to discuss these choices and decide what to do. So far, so good: the discussion can't hurt them. Next, though, you must make a choice—and the game will tell you what happens next. I don't know what the game will decide. I do know that the out-

come largely depends on the opinions and theories of the game's programmer.

One of the topics for debate in this simulation is the effect of tax cuts on the economy. The arguments for the Keynesian and supply-side positions are as fairly stated as can be, given that there's only a single paragraph for each. Once those arguments are read, there will be class discussion. Presumably the class will then choose whether to raise or cut taxes—and the game will tell them the consequences

of that decision.

Once again, I don't know whether the program will decide that the economy went boom or bust after a tax cut (or increase). I do know this: if the program was written by a fanatic Keynesian, deficit spending will stimulate demand, people will buy, and the economy will boom. If it was written by one of Laffer's followers, a tax cut will cause renewed investment, everyone will work harder, and the economy will boom. Which should the game decide? Then again, the program might consult a random-number generator. Whatever happens, the students will be learning more than we really know about economics and political science.

I don't mean to pick on this particular program. It works harder at being fair than most.

Another case in point: *Sim City* by Maxis. This is a game that simulates city management. It's a fun game (barring the fact that the IBM PC version has an annoyingly obtrusive copy-protection scheme). I'll even concede that it has some instructive value.

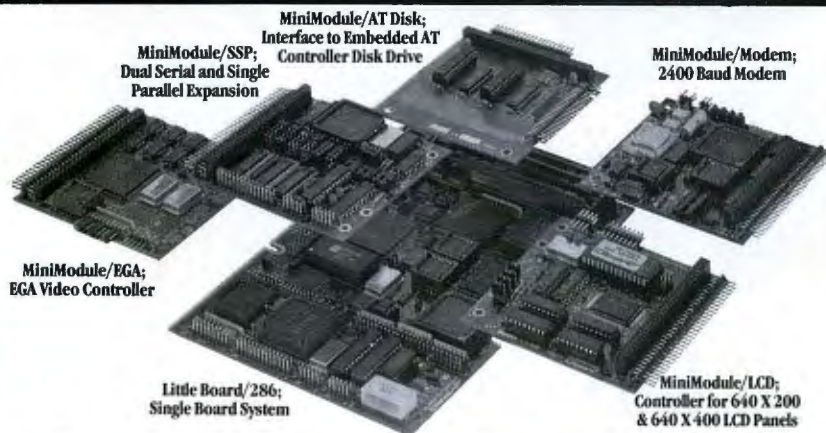
Of course, some things aren't very realistic: ships crash into bridges, airplanes fall into the business district, fires and floods happen with alarming frequency, tornadoes are common, and once in a while a big, green monster swims ashore. The rest, though, is supposed to be a simulation of reality—in particular, the interrelations among taxation rates, zoning, pollution, transportation, power plants, industrialization, and suchlike.

They've done a heck of a job with this. The animation is great, and the simulation is pretty convincing—and that's the problem, because once again it's a simulation of the designer's theories, *not* of reality. Case in point: the designer prefers rail transportation to automobiles. It's costly, but it doesn't pollute. In fact, you can design a whole city with nothing but rail transport, not a single road in the place. In the real world, such a city would soon strangle in garbage.

Again, my point is not to condemn these programs. Instead, I want to warn against their misuse. For all too many, computers retain an air of mystery, and there's a strong temptation to believe what the little machines tell us. "But that's what the computer says" is a pretty strong argument in some circles. The fact is, though, the computer doesn't say anything at all. It merely tells you what the programmers told it to tell you. The Physics program could be jiggered to

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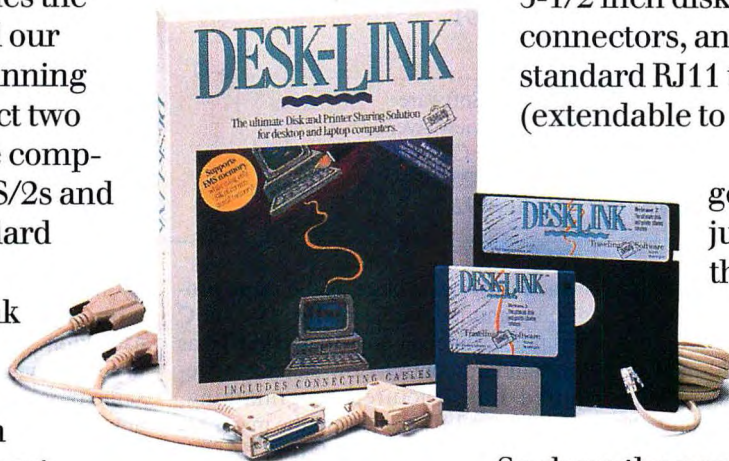
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A few years ago, a "world-model" program predicted global doom. That program inspired the book *The Limits to Growth*, and soon we had "national malaise" and "an era of limits." Today, we know things aren't that simple.

Simulation programs and games can be valuable tools to better understanding, but we'd better be aware of their limits. One of the best things such programs could do would be to let the students know what the inner relationships are. I don't know of any programs that let you fiddle with the equations inside the model, but I think that might be one heck of an educational tool.

P.D.Q.

One of the main complaints against BASIC is that even compiled BASIC programs tend to be large. Typically, the QuickBASIC version of a program will

be about twice as large as the same program compiled with a really efficient C compiler. Indeed, now that BASIC has the standard control-flow statements required for structured programming, code size and efficiency are the major rational arguments favoring C over BASIC.

Modern C compilers aren't as efficient as the old ones. The fact is that a lot of C code isn't much smaller than what you get with QuickBASIC 4.5. Leave that for another time. The conventional wisdom is that C gives you smaller and faster programs than anything but assembly language.

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Like many part-time programmers, I can't work on code for any long period of time, or even regularly. I have to make do with a few hours here and there, interrupted by long periods when I don't get to look at the code at all. Under those circumstances, I find that if I use C, I spend

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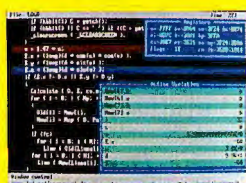
*Written by Neil Martin of the British Standards Institution (BSI) and printed in Personal Computer World June 1989, page 241.

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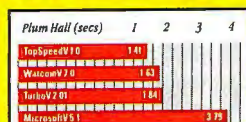
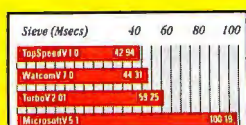
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Every QuickBASIC programmer ought to have P.D.Q.

more time trying to figure out what I've already written than adding more code to the program. With BASIC, though, I can often pick up where I left off.

P.D.Q. has a number of limitations. The major one is there's no floating-point: you can use only integers and long integers. That leaves out logs and trigonometry functions and the floating-point divide operator (/). On the other hand, you can treat fixed-point numbers as long integers and format them with a special built-in function called Dollar\$, so most financial arithmetic is possible. There are no graphics, and the current version doesn't have communications. However, by the time you read this, there will be a P.D.Q. supplement to handle communications.

I've also heard rumors that a floating-point package is in preparation. I can't confirm that, but it's a logical next step. But even without floating-point, every QuickBASIC programmer ought to have the P.D.Q. library. If you can program within P.D.Q.'s limits—and they're actually pretty broad—the speed and code size reduction will amaze you.

Recommended.

Looking Ahead

There's nothing in Mrs. Pournelle's Reading Program that can't be done with the P.D.Q. library. All our graphics are done with BLOAD and PUT, both of which are supported by P.D.Q., and although the QuickBASIC SOUND command calls floating-point routines and is thus not supported, there is a PDQSound function that is near enough to SOUND that we can use it by doing a global search and replace on the source code. P.D.Q. does not support DATA statements, so the stock phrases I've compiled into the code would have to be read into their array from a file, but that's hardly a major problem.

I'm much tempted to try it. The result would make the program leaner, which would in turn let me add a number of help messages that are now in the manual.

I have another alternative. Some pro-

grammers at Borland were kind enough to translate Mrs. Pournelle's Reading Program into Turbo Pascal. The resulting code is not all that much smaller than the QuickBASIC version, but it is much better structured.

I've promised myself some programming time as soon as I complete *Wrath of God*, which I ought to have done *Real Soon Now*. I'm very much looking forward to working with the latest and greatest versions of BASIC and Pascal. Once I have Mrs. Pournelle's program streamlined and improve the user interface, I've been thinking about doing a game. Maybe I'll make it a simulation of the way the world works.

Winding Down

Once again I'm out of space before running out of nifty stuff to talk about. The Shareware of the Month is PC-Browse from Quicksoft, the people who brought you PC-Write. PC-Browse is a little like Gopher, a little like ViewLink, a little like hypertext, and very much worth looking at. I've had it only a week, and I'm mildly addicted to it. Try it; you'll probably like it.

The book of the month is Poul Anderson's *The Boat of a Million Years* (Tor Books, 1989), some of the best science fiction Anderson has done in a long time.

The computer book of the month is a Pascal text for high school students, *Computer Science with Pascal for Advanced Placement Students* (West Publishing Co., 50 West Kellogg Blvd., P.O. Box 64526, St. Paul, MN 55164). It's available with a workbook and a teacher's manual. The book is thorough and well written and doesn't talk down to the students. Best of all, it recognizes that the advanced placement tests are based on standard Pascal, but no one is likely to have a machine that runs ISO Pascal, so the text has boxes illustrating the examples in Turbo and UCSD Pascal. Good stuff, and I wish it had been available when Alex was in high school. I'd have tried to persuade his school to adopt it. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerrypp."

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IS THE END NEAR? NOT A CHANCE

Computer software and hardware as evolution in action

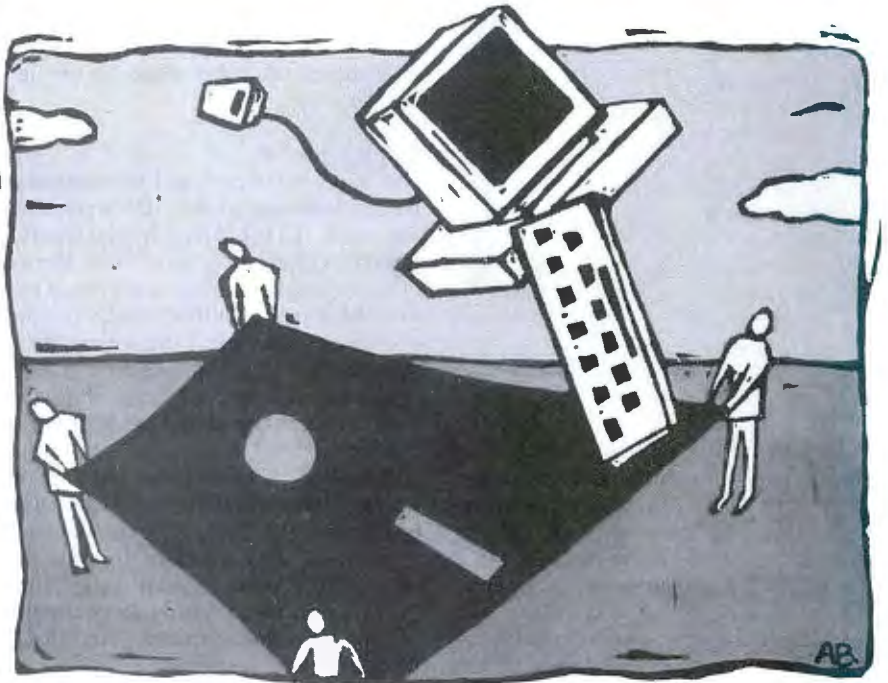
Last fall was a bad time for the U.S. computer business. On October 17, the almost but not quite "big one" (elsewhere they call them earthquakes) hit Northern California and creamed many Silicon Valley computer companies. Analysts across the country predict that if the Valley companies don't move to more stable seismic territory, the U.S. computer industry will literally be buried when the really "big one" hits.

If this weren't bad enough, a few days later IBM and Digital Equipment announced that their third-quarter sales and income were way down. Wang, Unisys, and Tandem announced they were again cutting their labor forces, which meant that more good people got fired. To top this glorious week off, *Time* magazine told us that the U.S. computer industry was down-and-out.

Now, this doom-and-gloom stuff makes for interesting reading, especially to a great many Americans who are puzzled or downright confused about the computer industry's own unique culture. Despite those earnest feelings, the U.S. computer industry is not failing. Stumbling? Most assuredly. Needing to refocus its development efforts? You bet. Scaling back to a more normal business-growth pattern? Certainly. But doomed? Not a chance.

The Fine Art of the Update

There's hardly anything in today's personal computer market more gratifying than the natural evolution of good software. It's one of the reasons that I'm so optimistic about the future, and why I consider the doom-and-gloom scenario to be based on a serious misreading of the



way technology development proceeds.

The Macintosh is one software platform where meaningful, real software updates seem to come out with some regularity. Software vendors seem to actually listen to their customers and add the features they want, fix the bugs they want fixed, and generally advance the state of the art—if only a little at a time.

I can think of three good Mac programs that I've grown attached to and use all the time: Nisus, Symantec Utilities for Macintosh (SUM), and AppleLink. I've reported on their strengths and weaknesses here. And I'm happy to report that all three have been updated and revised in the last few months.

Nisus 2.02

Nisus, the programmable word processor from Paragon Concepts, is my everyday editor. Without it, writing this column would take much more effort on all the time-wasting details of spelling checking, continuity checking, punctua-

tion, and the other technical details of writing. Version 1.0 was a laudable first effort, but it had weaknesses. The most notable were some intermittent updating problems (e.g., the screen would jerk along if you typed too fast), the inability to break a single document into multiple windows without opening several versions, and lack of footnotes. The latter was a real killer for academic users.

Version 2.02 fixes all those deficiencies, and it also runs faster. It scrolls faster, saves files faster (including auto-saving), and jumps between the main text and print-preview windows faster. In short, Paragon Concepts extended its already good program without junking it up with a lot of bells and whistles.

Still, there's room for improvement. A real outliner should be incorporated, and the already large set of prebuilt macros should be expanded to cover lots more punctuation and editing quirks that often need to be fixed in a document.

continued

ITEMS DISCUSSED

AppleLink 5.0

(Included free when you subscribe to AppleLink. Upgrade free to current AppleLink 4.0 customers. Printed manual costs \$15.)

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

Inquiry 981.

Nisus 2.02\$395

Paragon Concepts, Inc.
990 Highland Dr., Suite 312
Solana Beach, CA 92075
(619) 481-1477

Inquiry 982.

Symantec Utilities for**Macintosh II\$99.95**

Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600

Inquiry 983.

SUM II

I have an intense love/hate relationship with SUM. On one hand, I love it because I've used it to recover files from disks that have gone belly-up. On the other hand, I hate to have to use it, since the stupid disk shouldn't have crashed in the first place.

SUM I was a good program, but it suffered from a quirky interface that was hard to use even if you read the manual. SUM I also didn't do a solid job on disks whose directory structures had been flattened. Its writing of a second shadow directory on the file sometimes worked, but more times it did not, leaving you the single alternative of pulling off your files and directories with little structure left.

SUM II has changed my feeling about SUM entirely. While I still don't like to have to use it, at least now I don't hate the feeling, since I've seen the program pull a couple of disks back from the brink with nary a missing file or folder.

The new SUM incarnation refines the interface and how it operates, at the same time offering many new file protection and recovery features. It manages to do all this while still being much easier to master than the first version.

Its recovery prowess was pretty impressive. In fact, I put it to work on the Jasmine DirectDrive 140 that died on me a while back. I had used SUM I to pull the unstructured files (most of them, that is) off the disk, but I had never bothered

to reinitialize the disk.

Enter SUM II. I invoked its first level of disk recovery techniques on the disk, and 10 minutes later, the disk icon appeared on my Desktop after rebooting. I was pretty amazed by this, since even Jasmine's own disk utilities had failed to recognize the drive before. I quickly SCSI-chained another new disk drive onto the afflicted drive and copied everything over, with the full directory structure intact. Thanks, SUM II.

Like Nisus, though, SUM II is not really at the end of its development. There are still crashed disks that SUM II can't recover, and many ease-of-use improvements could be made to the interface.

AppleLink 5.0

One of my pet peeves, as I've mentioned before, is having to use DOS laptops on the road. Thankfully, Apple finally fixed that problem for some of us. Plenty of my colleagues have accused me of being a Mac snob, but that's really not the point. Just as they can't live without their favorite DOS, Unix, or OS/2 programs, not having access to a Macintosh on the road produces the same kind of frustration for me.

Although the Mac Finder and I are on intimate terms, I can make do with DOS on the road, especially if I spiff it up with a graphical user interface like Simple Win or DESQview. But all the spiffing in the world won't let my DOS laptops run my Macintosh software. And that's the rub.

As much as I like Nisus and SUM II, I could live without them on my DOS laptops. But the one piece of Mac software that I use every day and can't afford to be without isn't either of those programs. Nor is it Excel, or HyperCard, or Think Pascal, or even VersaTerm. Nope, the single piece of Mac software that I miss the most is AppleLink.

AppleLink is Apple's on-line system that's run by GE Online Computer Services (the same folks that run GENie). AppleLink is also the name of Apple's software that accesses this system. Without AppleLink, I'd be a dead duck in the Mac community. It's Apple's official on-line organ for the dissemination of System software updates and untold utility goodies. It contains important forums for higher education, and it's where the Apple University Consortium schools gather electronically.

Since AppleLink is a graphically oriented application that extensively uses Mac QuickDraw and other Toolbox routines, it runs only on a Mac (and I don't

see Apple doing a port to OS/2 Presentation Manager or Windows any time soon!). So, no matter how fancy or expensive a DOS laptop I've had at my disposal, I just couldn't use AppleLink on the road. I have been known to pester friends, colleagues, and even strangers in order to borrow their Macs for 15 minutes, just so I could check my AppleLink E-mail.

The AppleLink application began as pretty good stuff. But in keeping with my thesis on the refinement of the computer industry, it's been updated several times in the last few years. The most recent revision, dubbed AppleLink 5.0, fixes a lot of quirks.

First of all, Apple has made it Multi-Finder-compatible, so you can now do file uploads and downloads in the background (thank you!). The company also made it more customizable, by adding a personal menu that you can use to create special usage commands. Not forgetting the user interface, Apple improved the way that windows move about and scroll, which again improves its use with Multi-Finder. A built-in file compression/decompression utility has been added, as well as support for a larger number of modems. Finally, the way in which AppleLink interrogates the network and updates the display has been sped up.

None of these improvements is striking, but they all add to the program's value and extend its functionality. Like the changes made to SUM II and Nisus 2.02, these are refinements that the Mac software industry has become adept at over the past year.

Now It's Apple's Turn

By the time Nisus, SUM, and many other programs reach the peak of the technology development cycle, Apple should have been there for some time. It needs to set the pace and push the technology along with new operating systems and new machines to the next stage.

And when the time comes, Apple needs to help start the cycle over again, so that the reality of U.S. computer technology never becomes like the fiction that *Time* would have you believe is reality. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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

Why Experienced Computer Users Don't Think Very Much About Modems

Our research shows that knowledgeable MIS managers, PC coordinators, and end users simply don't want to think of modems at all.

Not exactly what modem makers relish hearing! But it's hardly surprising that you want to save your thinking for bigger and more important things.

Modems are a lot like plumbing. As long as the data is flowing, they're practically invisible. However, when something goes wrong, those little boxes are just lavished with attention.

By then, you've lost data, time, money, and perhaps an opportunity. Both senders and receivers are dismayed and disarrayed.

Fortunately, there are simple ways to limit this aggravation. Our research suggests a few points to keep in mind.

The cost of the modem is not the modem's cost.

The fixed price of the modem is relatively insignificant. Ongoing costs matter far more.

In the long run, for example, a high-speed modem can save you a small fortune on phone bills. More data sent in less time means less money to the phone company.

You can also save with more reliable and robust modems that communicate over a wide range of telephone line conditions.

Resending data costs both time and money. The less time you spend transmitting data, the more time you have to spend on your business.

Downtime and adaptation time can also cost you dearly.

Be sure to ask if the modems are compatible with their earlier generations. You don't want to start with suppliers who regularly obsolete their own products, or who don't offer you an upgrade path.

Modem support can be a real hassle with the wrong vendor.

Setting up and installing your modem can affect both your budget and your sanity. Many manufacturers forget to make their modems easy to use!

This becomes expensive when you want to start up fast or need to support a large number of users.

Dip switches, on-line help screens, and easy-to-use manuals should be demanded. It also helps to have a quick-reference guide printed on the bottom of the case.

In sticky situations, it's vital to have toll-free support and applications engineering.

Bottom line: The data must get through.

A bit of data traveling from your computer is converted by your modem and sent to your local telephone office.

From there, it is exposed to the vagaries of phone lines, various transmission media, and weather patterns.

They all conspire to corrupt your data and slow down your throughput.

All modems are not created equal; some are less sensitive to noise and have better error-correcting protocols.

Some are simply more robust and have better filters.

Modems are more than mere commodities — technology does count.

"When things go wrong, I want the supplier there."

That's when you need the *right* supplier on board. Look for one who gives fast turnaround time on repairs and adjustments, and who doesn't vanish *after the sale*.

Look for a company with history and promise — one that's here today and here tomorrow.

Not everyone needs the same modem.

The best way to keep modems from wasting your time and money is to buy them from a reliable supplier with a broad product line. Those with limited lines sometimes try to cram square pegs into round holes.

People with differing applications have differing requirements. Dealing with a broad-line supplier simplifies ordering, reduces training/support time and cost, and limits hassle and coordination.

In the end, if you give enough consideration to choosing the right supplier, you'll hardly have to give modems any thought at all.

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A LETTER FROM A DISSENTER

Is OS/2 really difficult
for developers to use?

I recently received an interesting letter from Steve Mastrianni of Windsor, Connecticut. He's unhappy with the comments in my September 1989 column about OS/2 as an easy development platform. I've got limited space, so I hope Steve will forgive me if I paraphrase his main points. He says:

- There's no support for multithreaded applications under CodeView for OS/2.
- Writing the simplest Presentation Manager (PM) program involves pages and pages of code.
- The documentation for the programming hooks (application programmer interfaces, or APIs) is awful.
- Device drivers are much harder to write under OS/2 than they were under DOS.

I'm surprised that Steve claims there's no debugging support in CodeView for multithreaded applications. That certainly was true with early versions of CodeView, but it has supported multithreading for almost a year. And if you want an extremely powerful OS/2 debugger, run, don't walk, to your nearest computer store for Logitech's MultiScope, which makes debugging a real snap.

A Page and a Half of HELLOs

Steve charges that the code to put a PM window on the screen is difficult. I'd first ask, "Who says you have to?" Remember that the PM relates to OS/2 the way Windows relates to DOS: You can choose to write programs that use the graphical interface, or you can choose not to. In the column he mentioned, I talked to three developers. Only one of



them had written a PM application. His point about window complexity is well taken, but it's the same thing if you write a Windows application under DOS. With the PM, you have the added benefit that the operating system is a protected-mode system. Thus, program crashes don't always have to mean system crashes, as they often do under DOS.

Also, since the subject was raised, I'd like to see people stop beating up on PM and Windows development. Yes, writing Windows or PM applications is not trivial. A common argument against such programming is something like, "It takes a page and a half of code to write HELLO under Windows." (HELLO, for the nontechies, is the simplest program conceivable: It just puts "hello, world" on the screen and exits.) Yes, writing HELLO under Windows takes a page and a half of code—but who wants HELLO? I want to talk about doing real work. In today's world, HELLO is not even a meaningful program *example*, because it just

spits output in a teletypewriter fashion to the screen.

For those who have trouble envisioning this, I'll give a simple example. A typical program listing for HELLO looks something like the following:

```
Begin Program HELLO
  Print "hello, world."
End
```

That's not in any real-world programming language, by the way. Think of big-selling real-world DOS or OS/2 applications like Lotus 1-2-3, WordPerfect, or PC Paintbrush. All three control every aspect of the screen for the entirety of their session: Not once in the code of any of these programs does the program just squirt a message out to the screen. Every message must be properly placed on the screen, and all information currently on the screen must be managed when it is affected by new information. A more

continued

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BYTE May 1989

OS/2 NOTEBOOK

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OS/2 NOTEBOOK

realistic HELLO would have to look like the following:

```
Begin Program HELLO
  retain the current information on
  the screen somewhere in memory
  clear a portion of the screen for a
  window
  set the default colors
  place the cursor
  print "hello, world."
  wait for the user's input
  close up the window and restore
  the screen information
End
```

Doesn't that look like it might take up a few pages of code all by itself? Windows/PM programs get that automatically, as well as letting you place or resize windows, reduce programs to icons, or move to another application without closing the current application.

So, of course, Windows/PM applications take a bit more to get started: The minimum ante is higher and more realistic. But start building big applications, and you see that Windows code can be *smaller* (and easier to write) than non-Windows code for the simple reason that Windows does more for you. The problem with Windows programming is that it has a very steep learning curve. But once you're there, you can crank out programs quickly.

How do I know? I used to complain about Windows programming, but then I sat down and took the time to learn how to do Windows/PM code. It is a pain until you get over the hump, however. And there is a major problem with running Windows in the first place.

No matter what you do in Windows, you constantly run up against memory constraints. Install all the expanded memory you like, but it doesn't matter: It's always conventional memory that you're out of. That's why the PM is such an improvement—there is no more "insufficient memory to display dialog box" and the like.

Furthermore, if you're a programmer, you could do a lot worse than learn to write Windows/PM code. It's the way the world is going: Once you've learned the basic paradigms of Windows/PM coding, it's much easier to move over to the Macintosh or to Unix's X Window System. Most of my full-time programmer friends are doing at least a little Windows programming, and they all seem to think that it's something they'll have to do sooner or later. "It's either that or maintain somebody else's old COBOL payroll programs," seems to be the consensus.

Programming Documentation

Yes, the original Microsoft/IBM OS/2 documentation stank. The documentation with the first pile of OS/2 1.0 code was fairly complete but badly organized. Worse yet, the then-new APIs for the PM were documented only in an on-line documentation system called QuickHelp. QuickHelp is a nice reminder about programming minutiae, but (because you couldn't print out the entirety of the QuickHelp library) using it as a primary reference document made PM programming kind of like playing Zork. I think most of us ended up starting our code from examples of PM programming published in magazines and modified from there, passing bits of trivia to each other via BIX or the like.

That's all changed now. The PM Softset has been around for months, and the stuff shipped with the Softset is a great improvement. Documentation on the APIs is written out now, and, while it would be nice to see examples of how to use these things, the books stand as a fairly compact reference.

Finally, you should remember that OS/2 is more fully documented than DOS: There are not many undocumented system features, unlike the TSR-related functions that exist under DOS and that Microsoft uses in its own code but won't explain to the rest of us.

Devices Driving Him Crazy

I can't argue with Steve's contention that device drivers are in a class all their own when it comes to difficulty. You do *not* have the protection that you ordinarily do, and debugging OS/2 device drivers is, as far as I can see, a nightmare, although I must confess that I've never written one.

I have written a couple of DOS device drivers, however, and if OS/2 device drivers are truly as difficult to write as people say (Steve is not the only one to voice this complaint), he's got my sympathy. What's the answer here? Hardware debuggers, I suppose, although I don't know of any for OS/2.

If the PM Is So Smart, Why Don't We Have Applications?

Finally, he asked, "If it's so easy to write OS/2 applications, why aren't more available?" Good question. I've written in past columns about the number of OS/2 applications, and I argued in the *IBM Special Edition* (Fall 1989) that the number of OS/2 applications isn't that out of line with DOS's experience in its early months. Furthermore, the OS/2

continued

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application lineup isn't bad at this point, featuring such heavy hitters as Lotus 1-2-3, WordPerfect, PageMaker, and every database you can shake a stick at. But some big negatives still exist, so I'll take up the question again.

As I see it, the forces still slowing OS/2 development are lukewarm support of OS/2 developers from Microsoft, cost, market uncertainty, and continuing lack of device support.

The first problem seems to be a rather half-hearted commitment to developers on Microsoft's part. The poor turkeys who shelled out \$3000 for the Software Development Kit have been left out in the cold as far as OS/2 1.2 goes. Microsoft isn't sending them a copy of version 1.2, much less documentation on the new API calls.

This is incredible in my view. These are the people who supported OS/2 from the beginning! Microsoft has said that when it offers the version 1.2 upgrade to owners of the version 1.1 toolkit, it will offer Software Development Kit owners the upgrade for the same low price. No date has been announced for the version 1.2 toolkit. This is a good halfway measure, but what good is having version 1.2 if no one can build products for it? (How many of the OS/2 2.0 Software Development Kits does Microsoft expect to sell?)

Despite the fact that OS/2 development costs about the same today as DOS development cost in 1982, 4 to 8 megabytes of RAM for a workstation looks like a lot of memory. Some companies are getting cold feet about OS/2 acceptance. I talk to many developers: Virtually all of them are surprised that OS/2 is taking as long as it is to be accepted, and that has dampened some enthusiasm. Now that many of the big applications are out for OS/2, however, I expect that will change. Except for a giant, gaping hole: Where are the printer drivers?

We're still waiting for a PostScript driver that doesn't leak. And it was just recently that Hewlett-Packard and Microsoft finally agreed about who's going to write the LaserJet drivers and buckled down to work. Nobody has even fuzzy shipment dates yet. So we still live in interesting times. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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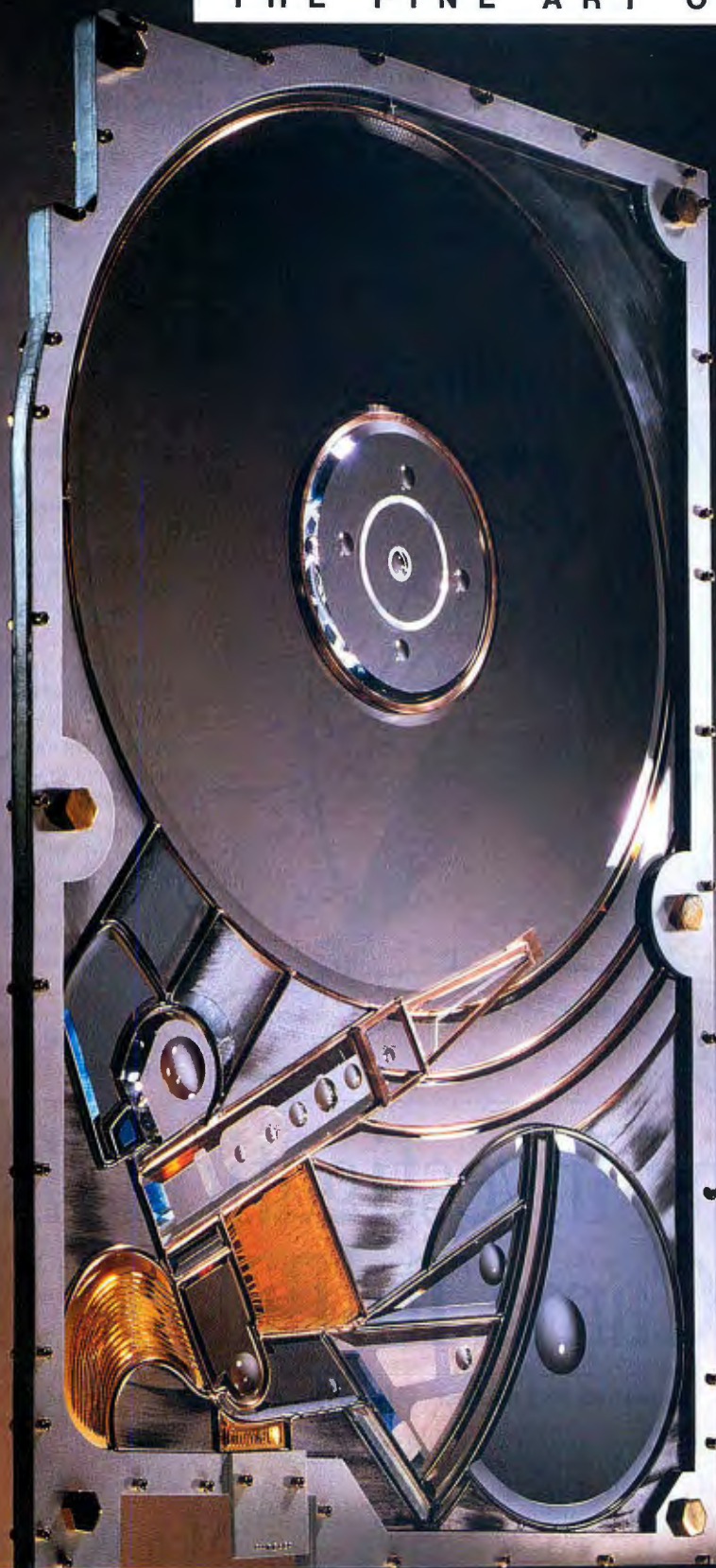
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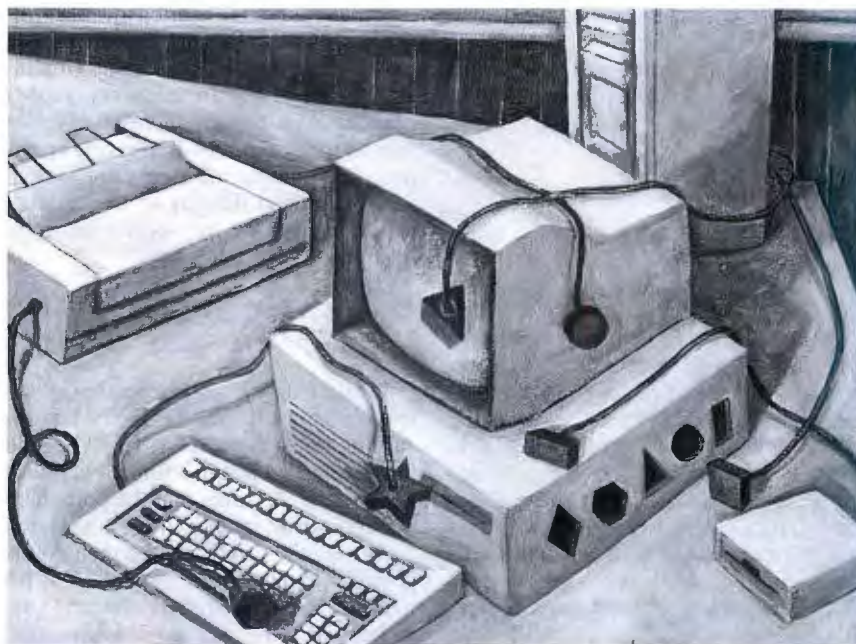
Some of our readers' more technical questions and problems

Dealing with the devices that are attached to a Unix computer is often more complex than working with the machine itself. Linking a device to a new name is one shortcut that may help. But printers are another matter. Some printers are connected directly to the computer and should use the Unix print spooler. Others, connected to terminals, can be handled differently. This month, I'll go into these two issues and that of upgrading 80286 Xenix software for an 80386 system.

Floppy Disk Drives

Pete Johnson of New London, New Hampshire, wants to know if there's any shorthand available for disk names. My guess is that Pete, like lots of other people, is getting tired of typing things like `/dev/dsk/fd096ds15` when all he's trying to do is talk to his floppy disk drive.

First of all, typing all that is often unnecessary. On many systems, there already is a shorthand filename linked to a floppy disk entry under the `/dev` directory. Look around your system with a command such as `ls -l /dev/*fd*`; if you're on a vanilla AT&T-based Unix system of recent vintage, you might need a command such as `ls -l /dev/dsk/f*`, because such a system has the disk-oriented devices moved to its own subdirectory. In either case, you are likely to find an entry such as `/dev/fd` or `/dev/fd0`. This entry will probably be linked to a longer name, such as `/dev/fd096ds15`, which means it can be used interchangeably with the longer name. Links let you call a file by more than one equivalent name, and this is a perfect application for links.



How do you know which name is linked? Look for a match in major and minor node numbers (see listing 1).

If you want an even easier way to refer to your drive, Pete suggests taking a page from the DOS manual: The name `/dev/A:` would be nice. If it's your system, give it a try.

First, you should understand the nomenclature that is generally used to identify floppy disk drives on most Unix-based personal computers. The name `/dev/fd096ds15` refers to the first floppy disk drive (numbered from 0) using high-density recording of 96 tracks per inch (96), double-sided (ds), with 15 sectors per track (15). This is a 1.2-megabyte floppy disk. Other systems may refer to it as `/dev/dsk/f0q15d`, for quad density, 15 sectors, double-sided. The naming scheme for 5-inch high-density would be `/dev/dsk/f05h`.

Similarly, `/dev/fd048ds9` is the first floppy disk drive, in 48-track-per-inch mode, double-sided, with nine sectors

per track. This corresponds to a regular 360K-byte disk. On some systems, you can also read and write to older single-sided and lower-density disks by accessing the appropriate entries in the `/dev` directory.

If your system doesn't have a simple `/dev/fd` entry, it can probably still accept at least the name `/dev/fd096` (or something similar) for drive A in high-density mode and `/dev/fd048` in low-density mode. But say you want to use the idea of naming it `/dev/A:`.

First, check to see if there are any files that you might wipe out while installing this new name:

```
$ ls /dev/*A:* /dev/*B:*
$
```

In this case, it is a good sign if no files are listed by the `ls` command: It means that you don't have any conflicts with your planned device name. (It is also

continued

Listing 1: *The partial output from `ls -l /dev/fd0*`. The second column shows the number of links to the file, which helps you quickly find files with more than one name. The two numbers separated by a comma are the major and minor device numbers. In this case, `fd0` is linked to `fd096ds15`.*

```
brw-rw-rw- 2 root sys 5, 7 /dev/fd0
brw-rw-rw- 1 root sys 5,14 /dev/fd048ds9
brw-rw-rw- 2 root sys 5, 7 /dev/fd096ds15
```

always good practice to use `ls` with whatever wild card you plan to use with `rm` before removing the files. This way, you will see which files will be removed; they might not be the ones you had in mind.)

To switch to superuser mode and make the links, type the following:

```
$ su
Password:
# cd /dev
# ln fd096ds15 A:
# ln fd048ds9 Alo:
# exit
$
```

(If you have a `/dev/dsk` directory, you should `cd` to that directory.) Your high-density drive can now be accessed using the simple name `/dev/A:`; the same drive in low-density format can be accessed as `/dev/Alo:`. If you have a second drive, you can use `/dev/B:` and `/dev/Blo:`, as well. If you don't like these names, pick any you want; leave off the trailing colon, or whatever you like. It's your system!

Printing at Home and Abroad

Rita Naudts of Antwerp, Belgium, has two questions that other readers may share. The first involves printers. Specifically, how do you configure centralized as well as distributed printing on Xenix?

I'm glad she specifies Xenix, because Xenix *does* have a way to perform what can be considered "distributed" printing from terminals.

On a typical PC running MS-DOS, you have one user, one computer, and, generally, one printer. When you are ready to print, the data is sent to the printer, and you can resume working when the printer is finished. Slightly more sophisticated systems have a spooler program or buffer box that accepts the data at high speed, allowing you to get back to work well before the printer has actually finished with its task.

On Unix, as well as on most "big computer" operating systems, the print spooler is much more complicated, since

it is assumed that multiple users and multiple printers may be involved. On Unix, print spooler administration can be so complex that even people with their own home systems are often afraid to tinker with it—preferring instead to run only default spooler operations (for instance, printing unnecessary report headers even though there's only one user on the system), or even giving up entirely by running all their print jobs in the background directly to the printing device, bypassing the spooler entirely, like this:

```
$ cat filename > /dev/lp &
$
```

While I do sympathize, running the spooler isn't all that hard; it's just installing it that is complex. I will be glad to cover the subject in a future column if reader mail warrants, but the point here is that the print spooler can be considered "centralized" printing, even though it is possible to configure "local" or "remote" printers through the spooler. Distributed printing, as I see it, is the situation where people have their own local printers at their remote terminals, and *they* control them, not some spooler system sitting in `/usr/spool/lp` or anywhere else!

Many Xenix releases have for some time had (although not always documented) a program called `lprint`, which works with a local printer that is connected to a terminal. What the `lprint` program does is something like this:

1. Lock the terminal keyboard so accidental user input won't interfere.
2. Put the terminal into "transparent print" mode, so that everything sent to the terminal is piped directly to the auxiliary terminal port without appearing on the screen.
3. Take the file(s) appearing on the command line, or standard input, and simply send them to the user's terminal. Since the terminal is now in transparent print mode, the files will be printed if there is a local

printer connected.

4. Take the terminal back out of transparent print mode.
5. Unlock the keyboard.

Step 3 is simply a fancy version of `cat file > /dev/tty`, but what about the other four steps? They're done by sending the correct escape sequences to the terminal to put it into the desired mode, such as "keyboard locked," "transparent print off," and so on. These sequences can be found in your terminal manual and are generated with a simple C or shell program. (Hint: Look at the options for the `echo` command to see how to get "unprintable" escape sequences to go to your terminal.)

Once you understand the concept, it's easy to write your own `lprint` command equivalent. And that's why I'm *not* going

How do you configure centralized as well as distributed printing on Xenix?

to provide one here—if you aren't sure what I'm talking about, you will learn a lot more by experimenting with using `echo` to generate escape sequences than you will by typing in some program I cooked up. If you do know what I'm talking about, you have only about 5 minutes' work ahead of you, anyway.

In any case, the Xenix version of `lprint` does a few extra things, such as reading the `/etc/termcap` database using the curses library to determine the proper escape sequences for your terminal. This can be done by a C programmer with access to curses or by a clever combination of shell scripts and an `awk` program.

Upgrading to an 80386

The second question from Rita Naudts involves upgrading 80286-based Xenix software to run on an 80386 system.

This is a judgment call that depends on the type of software involved: applications, development, or operating system. Let me add that the principles are the same whether you're talking about Xenix, Unix, or even DOS software.

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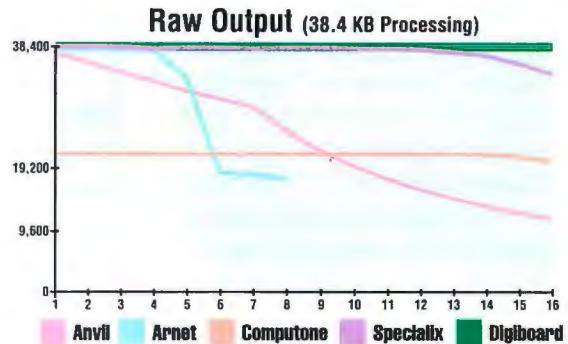
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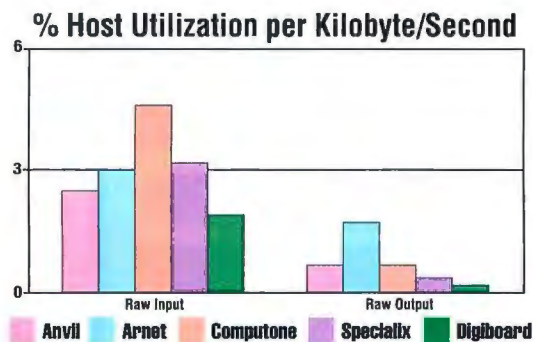
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THE UNIX /bin

Since the 80386 CPU is upwardly compatible with the 80286 CPU, an 80386 will run any software written for the 80286 (or 8086 or 8088, for that matter) without change, although the software will generally run faster. Some DOS software, such as games, and older peripherals designed for a slower chip might be adversely affected, but I haven't yet heard of any kind of Unix or Xenix software that has such problems.

Needless to say, software written especially to take advantage of the 80386 architecture should run more efficiently on an 80386 than the same software written for the 80286 and run on an 80386. However, for most applications, this efficiency gain will be so slight that most users will probably not find it cost-effective to upgrade their software to 80386-specific code.

There are a few exceptions, of course. If you're a software developer, you might want to work with the latest C compiler, so your code can be recompiled for the 80386, if necessary. On the other hand, compiling for the 80286 gives you a greater potential market because of the upward compatibility mentioned above. Like everything else, there's a trade-off involved.

Operating-system software gets slightly more complicated. Say you're running SCO Xenix 286 on an IBM AT, and you trade it in for a new 80386-based machine. Can you now run the 80286 Xenix and applications on your 80386? Assuming your software and license wasn't traded in with your hardware, the answer is yes. If you are satisfied with the 80286 software and its capabilities, you can certainly run it on your 80386, and you will enjoy the higher performance of the new machine as well.

If, however, you want to take full advantage of the 80386 architecture, or run DOS as a task under Unix, or run the latest software under Unix System V release 3.2 or even 4.0, you're going to have to upgrade to an 80386-based operating system. But you can *still* run your old 80286 applications, because Unix System V releases 3.2 and 4.0 are themselves backward-compatible with your 80286 Xenix applications. ■

David Fiedler is publisher of the Unix Video Quarterly and the journal Root, as well as coauthor of the book Unix System Administration. He can be reached on BIX as "fiedler."

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BACKING UP THE BIGGIES

With the increased storage capacity of today's hard disks, the old backup techniques no longer make sense

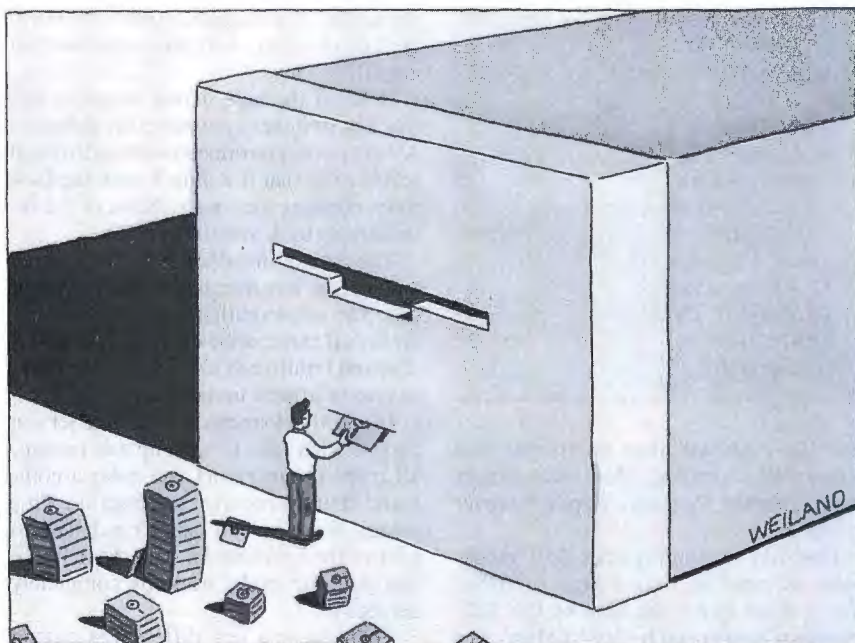
Maybe if I had seen the big orange Virginia Power truck pull up in front, I'd have been ready, but I wasn't. Instead, I had that old familiar sinking feeling as the power company started their line replacement program by turning my power off for 5 eternal minutes. The reason it seemed eternal was that the power went off while I was saving my December **BYTE** column to the hard disk. I hadn't backed anything up since I got a new Zenith Z-386 with a 150-mega-byte hard disk drive.

The Biggies

One problem with the current trend toward high-capacity hard disk drives is that previous backup strategies no longer make sense. Where a box of floppy disks was once sufficient to support your backup requirements, now it would take a case of them. More important, it would also take someone (meaning you) to sit there and insert and remove floppy disks at the prompting of the software.

People are avoiding backups more than ever because the task has become impossible to manage. For today's hard disk drives, floppy disk backups are clearly yesterday's technology. Something better is needed so that people will perform backups, and it must be good enough to be a safe repository for the company's data.

For that "something better" to be useful, it needs to be more than just safe. It needs to lend itself to working the same way that people actually use their computers. That is, the backup medium



should be able to hold *all* the data. You don't want to kill 25 minutes waiting to swap tapes.

The software should be easy to use, requiring nothing beyond the most minimal of training. Once started, operation should run unattended. You don't want to hang around to tell the software what to do, any more than you want to change tapes.

Backup should be fast enough that it can be performed while you're away at lunch or in a meeting, and the machinery should be quiet enough that it won't interfere with office routine. Automatic operation should be possible for those who don't want to get involved in the process beyond the point of inserting the medium and typing a command.

Of course, in companies that have LANs, an easy way is to back up all data to the LAN. Then the LAN management crew backs up your information while it's backing up the LAN. I'll look at LAN backup another time.

Another method that's growing in popularity is tape. That's right, the medium of the past is back in a new, compact, quiet, and easy-to-use form, and it may be the best all-around backup technique available. I've looked at three tape systems designed to support either a LAN or a workstation with a large hard disk drive: the Irwin Magnetics Model 2120, the Mountain Computer FileSafe TD-8000, and the Emerald Systems Rapid Recover Series 9000. Rather than worry about benchmarking the drives for speed or gross capacity, I looked for ease of use and setup and the flexibility to work in a variety of organizations.

A Look at the Drives

The Irwin Magnetics 2120 and Mountain Computer FileSafe are reasonably similar. They are designed to fit into a 3½- or 5¼-inch drive bay, and they can receive data from a dedicated controller card or from a floppy disk drive controller. They

continued

ITEMS DISCUSSED

FileSafe TD-8000 ... \$740 to \$1095
Mountain Computer, Inc.
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Campbell, CA 95008
(408) 379-4300
Inquiry 1102.

Model 2120
drive.....\$849
installation kit \$100
controller board\$299
Irwin Magnetic Systems, Inc.
2101 Commonwealth Blvd.
Ann Arbor, MI 48105
(313) 930-9000
Inquiry 1101.

Rapid Recover
Series 9000 \$2095
application kit
(includes software and
five cartridges)\$495
Emerald Systems, Inc.
4757 Morena Blvd.
San Diego, CA 92117
(619) 270-1994
Inquiry 1103.

use 120-megabyte tape cartridges that appear to be identical. Both were slower than Emerald Systems' Rapid Recover system.

Emerald Systems packs 150 megabytes of capacity into a tape cartridge that's about twice the size of the 120-megabyte units used by Irwin Magnetics and Mountain Computer. As a result, the Rapid Recover won't fit into a 3½-inch drive bay, although it will work in a 5¼-inch bay. The biggest difference between the Rapid Recover and the others is that it's SCSI. Emerald's drive was clearly faster than the others, and this interface is probably the reason.

The Rapid Recover also stood out for another reason. This was the only system that used Microsoft Windows as the operating environment. The result was a fast, easy-to-use tape drive.

Why These?

There are a lot of tape drives on the market that can be used to back up workstations with large hard disk drives. Some, such as the helical-scan drives based on 8-mm videotape technology, are simply too large to be practical. It's rare for a stand-alone workstation to have a hard disk drive larger than the 330-megabyte Priam. The 2.2 gigabytes in a helical-scan drive is overkill.

On the other end of the spectrum,

plenty of tape drives have cartridges in the 40- to 60-megabyte range. These work fine, but they require you to swap tapes during the backup—a task that's sure to discourage the process. These are large enough to back up the data that I currently have, although if I were to perform an image backup of the Priam, I'd need a larger tape.

Difficulty in installation can be another discouraging factor. Fortunately, the three drives I looked at excelled in this area. Installation was just a matter of putting the tape drive in the drive bay, inserting the controller card, and attaching the cables. The Rapid Recover was delivered in a cabinet, so it was even easier to install.

None of the tape drives required setting any switches away from the defaults. All supported parameter setting through software so that if it didn't work the first time, changes were easy. None of the installations took over 10 minutes.

The ease of installation for these three tape drives was matched by their ease of use. The software that controls the backup for all three drives was logical in design and intuitive to use. I found the manuals to be almost unnecessary.

In addition to menu screens that let you choose what files to back up and restore, all three programs let you enter a command string to control the backup. This means that you can use a batch file to control the operation of the tape drive so that you can make backups completely automatic.

There were a few differences among the three drives. The Irwin Magnetics 2120 was the noisiest and slowest, but that's not to say that it was objectionably noisy or slow. It was able to back up 50 megabytes of data on the Z-386 in about 19 minutes. The Mountain Computer FileSafe accomplished the same task more quietly in about 15 minutes, while the Rapid Recover was the quietest and did the backup in about 12 minutes. Each one was fast enough to accomplish its task in the average lunch hour.

Despite its size, I prefer the Rapid Recover, primarily because of its exceptionally good Windows-based software. I only needed to consult the manuals after using the drive to make sure that I wasn't missing anything. The Rapid Recover Series 9000 drive, because of its speed, its silence, and its excellent software, is a superb backup device.

Actually, all three of these tape drives are excellent choices for backing up a workstation with a large hard disk drive. They meet the basic criteria that most business users care about: They are easy

to use, they are fast enough that backups are likely to be accomplished, and they work well.

Both the FileSafe and Rapid Recover support complete backup of a Novell file server. This means that all the files will be copied, as will the system files, bindery information, and user rights data. The Irwin 2120 will back up the files on a server, but there's no indication of support for backing up Novell-specific files.

Other Ways

There are, of course, other ways to make sure that your data is backed up and protected. You can, for example, use an optical disk, either as a WORM (write once, read many times) drive or as a rewritable optical drive. Both types keep their disks in a cartridge that can be stored away from the computer. They are quick and easy ways to back up, although the optical drives are many times more expensive than the tape drives considered here.

In some cases, the idea of backing up to the file server may well work, especially if you have an employee who is assigned to this sort of task. Then you can make sure that the work is done. It's even better if the file server is a VAX or some similar machine that is routinely backed up on a daily basis.

Justification

The main reason that users don't back up their hard disk drives is that they don't have the time. The second reason (not counting procrastination) is that it costs too much to get a tape drive.

However, the software provided with the three drives I've discussed lets them perform their function during the night, during lunch, or otherwise without supervision. And cost really can't be an issue. All you have to do is figure out how much it would cost to reconstruct or replace all the data that's on your hard disk drive, plus the money you would lose by not having the information, and you'll see that a tape backup unit is cheap insurance. ■

Wayne Rash Jr. is a contributing editor for BYTE and a member of the professional staff of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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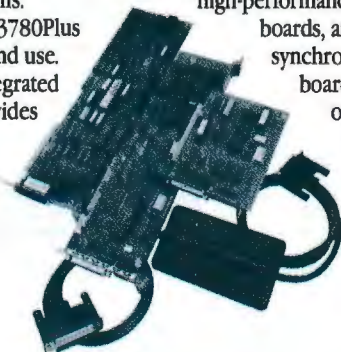
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NETWARE'S MISSING LINKS

Novell's NetWare products connect many disparate systems, but the pieces don't always fit together perfectly

People frequently think of Novell's NetWare as a single PC LAN product, but it's actually a family of products that have a common set of protocols. Naturally, they're supposed to work well together—which they do, as long as your LAN is all IBM PCs and compatibles. When you add Macs or VAXes, however, things aren't quite so simple.

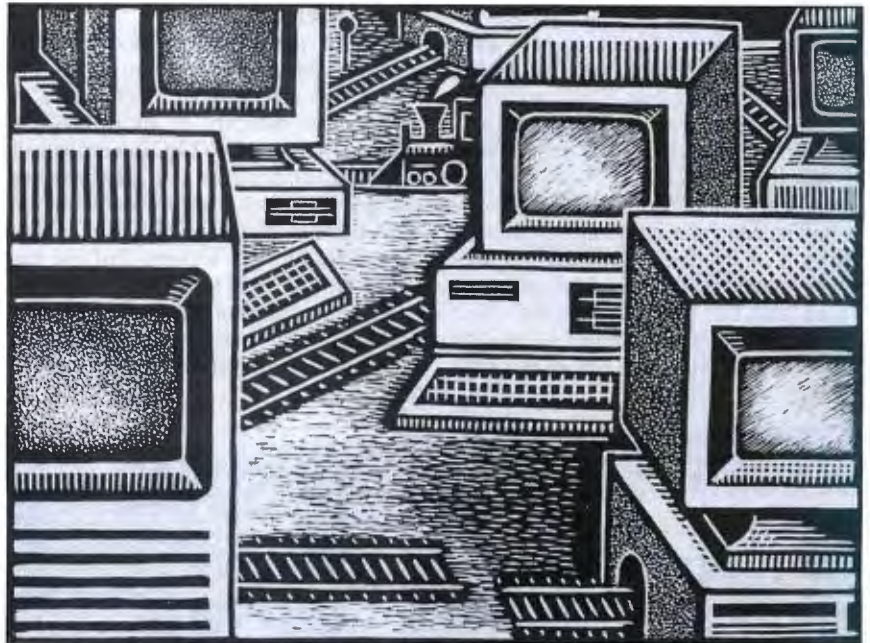
The major problem here is version skew. Newer products, such as NetWare for Macintosh and NetWare 386, aren't in sync with the older ones. Both lack some of the capabilities of their NetWare predecessors and add some new features. Novell can, should, and probably will fix these problems, but until it does, you might be surprised when you try to mix these products in a single LAN.

The only way to avoid unpleasant surprises is to be aware of the problems that await you. Before we can talk about the problems of linking the various pieces, however, we have to look at the pieces themselves.

The Servers

At the low end of Novell's PC LAN scheme is NetWare ELS (Entry Level System), which comes in four- and eight-user versions (\$695 and \$1895, respectively). ELS actually lets you run such small LANs without a server.

Novell's bread-and-butter product, however, is Advanced NetWare/286 (\$3295). You buy one copy of Advanced NetWare/286 per server, which can work with as many clients as the network will



bear. You can also have many Advanced NetWare servers on a single LAN.

While most Advanced NetWare LANs run with a dedicated server, you can actually use the product without one. You still have to designate a PC as the server, but that system is available for other tasks as well. Of course, Advanced NetWare consumes a large amount of memory and processing power, so that server machine is probably not useful for any other large tasks. Most LANs need a dedicated server.

The next step up is SFT (System Fault Tolerant) NetWare 286. SFT adds to Advanced NetWare some features designed to protect its data disks. SFT supports multiple disk drive controllers, disk mirroring, and uninterruptible power supplies. It also includes the Transaction Tracking System, which is designed to improve the reliability of database operations. While SFT obviously has many desirable features, at \$4995 it's expensive enough that you should be very sure that

you need those features.

The new cornerstone of the NetWare PC family is NetWare 386, which Novell has designed to take advantage of the 80386's built-in multitasking and memory management features. NetWare 386 offers all the fault-tolerant features of SFT, as well as more power and a much more modular design than its predecessors. In particular, NetWare 386 has cleaner and better-defined interfaces between its drivers, protocol stacks, and server applications than any previous NetWare product. These clean interfaces make NetWare 386 a better platform for running different protocol stacks and applications than the earlier 80286-based NetWare products.

If you want even more server power, you can turn to a Digital Equipment Corp. VAX, courtesy of NetWare VMS. NetWare VMS makes a VAX running DEC's VMS operating system look like any other NetWare server. Its price

continued

varies depending on the size of your VAX. NetWare VMS lacks some of the flexibility of the PC server products: Those servers can work with such different network technologies as Ethernet, Token Ring, ARCnet, and StarLAN, while NetWare VMS currently can run only over Ethernet.

The Clients

A single NetWare client program lets DOS-based PCs work with any of these servers. But such PCs are no longer the only NetWare clients.

OS/2-based PCs, for example, can now work with any NetWare server via NetWare Requester for OS/2 1.1. This product is a key part of Novell's if-you-can't-beat-'em-join-'em OS/2 strategy, because it lets current NetWare users add OS/2 PCs to their LANs without having to move to an OS/2 LAN.

Another new client is Apple's Macintosh. The Mac is a much more difficult platform for NetWare than OS/2 is, because there are existing Mac protocol stacks and file-system protocols. (See "Breaking Down the Barriers," October 1989 BYTE.) NetWare for Macintosh in-

cludes both Mac client software and software that lets a NetWare server work with the existing Mac networking protocols and file system.

Novell's troubles with supporting Macs were obvious in NetWare for Macintosh's first release, which had many bugs and anemic performance. Novell has since delivered a new version (1.1; \$200 per site) that fixes most of the early bugs and dramatically improves performance. Version 1.1 also includes some utilities that give Mac users access to most server maintenance functions.

Piece Offerings

It's clear how all these pieces should work together. Any client can access any server, or any number of servers, to which it is directly or indirectly attached. DOS and OS/2 PC clients can sit alongside Mac clients, all getting files and print services from any combination of Advanced NetWare/286, SFT, NetWare 386, or VAX servers. Just one big happy family, right?

Not quite. Most of the problems center on Mac clients. Novell implemented the server portion of NetWare for Macintosh

as NetWare Value Added Processes. VAPs run fine on Advanced and SFT NetWare, but not on NetWare 386, which uses a new format, NLM (NetWare Loadable Modules), for its add-on programs. This difference is potentially significant for PC clients as well, because most NetWare add-ons, not just NetWare for Macintosh, are implemented as VAPs and won't work with NetWare 386.

Fortunately, many Mac NetWare users have a way around this problem: NetWare for Macintosh doesn't need to be on all your LAN's NetWare servers, just on the one to which you've attached your Macs. The Macs can use that server as a "gateway" to a NetWare 386 server. We have both an 80386 running NetWare 386 and an SFT server with NetWare for Macintosh, and our Macs can get to both servers via the SFT server.

The one catch here is that this plan works only with servers running NetWare 2.15 or higher (NetWare 386 is technically version 3.0), because NetWare didn't support the Mac file system before version 2.15. This problem crops up when you try to link Mac clients to a

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VAX server. Novell based NetWare VMS on NetWare 2.0, so Macs can't access it—even when connected to a NetWare 2.15 server.

NetWare for Macintosh has also fallen behind Apple's own networking products: It doesn't support the newer Apple-Talk Phase 2 protocols.

The Problems Within

So far, we've acted as though the only problems with NetWare are in the con-

nections between the products and not in the products themselves. While we like NetWare, we certainly don't think that it's anywhere near perfect. Far from it.

At the low end, for example, we think that NetWare ELS just isn't as good as some of the other entry-level LAN operating systems, such as CBIS's Network-OS and ArtiSoft's LANtastic. ELS is both more difficult to install and harder to maintain than those products.

ELS is also a bad choice when you

need to add users. To go from the fourth user to the fifth, you have to shell out the money to upgrade to the eight-user version. Worse, if you need a ninth user, you have to abandon ELS entirely and move up to the more complicated Advanced NetWare.

NetWare has traditionally been a bear to install. The process can take many hours. NetWare 386 goes a long way toward simplifying this task; in many cases, you can set up a NetWare 386 server in less than an hour. But NetWare 386 doesn't yet work with Mac clients, and it costs a hefty \$7995.

NetWare VMS also has several rough edges. Perhaps the biggest drawback is that it works only with RMS fixed-length-record VMS files. There are many other popular RMS file types, including delimited and indexed sequential, that you just can't share via NetWare VMS. Also, the performance of NetWare VMS is currently nowhere near what it should be. Right now these limitations make this product interesting primarily to existing NetWare users who have VAXes that they must tie into their NetWare LANs.

In the Future

Novell is clearly having some problems bringing all its existing products in line. While we have no doubt that the firm is planning to do so as quickly as possible, the future may make that task even harder. In the next year, vendors such as Data General, Interactive Systems, NCR, and Prime plan to release NetWare server products for their Unix and minicomputer systems. These versions are all based on Novell's Portable NetWare, a reimplementation of NetWare designed to be easy to migrate to new systems. You can expect to see some of these products around the time this issue of BYTE hits the stands.

Of course, these new products will add still more pieces to the NetWare puzzle. We hope that Novell will take the time not only to fix the existing problems, but also to make sure that the new versions work seamlessly with the existing ones. ■

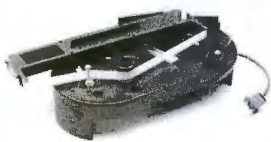
Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvannname" and "wbc3," respectively.

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- High Capacity System Power supply
- Real Time Clock/Calendar with 5 Year Battery
- 80287 Co-Processor Support
- AMI BIOS w/full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM and PCNET compatibility
- Built-in System Board LIM 4.0 EMS hardware
- User configurable I/O timing permitting compatible operation w/older peripherals or faster I/O for newer devices
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/5 Disk Drive bays

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- LCD or Plasma Portable
- Factory Installed RAM Upgrades
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1 Floppy	\$539	\$664	\$824	\$1054
2 Floppy	\$624	\$739	\$899	\$1129
40MB-45MS	\$844	\$944	\$1104	\$1334
66MB-25MS	\$994	\$1094	\$1254	\$1484

PC BRAND 286/12

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives	No Video	Mono	VGA/Mono	VGA/color
40MB-45MS	\$1107	\$1207	\$1402	\$1637
66MB-25MS	\$1332	\$1432	\$1627	\$1862
71MB-18MS	\$1472	\$1572	\$1767	\$2002
110MB-25MS	\$1572	\$1672	\$1867	\$2102

PC BRAND 286/20

w/512k, Hard Disk Drive, Monitor & Video Card

Hard Drives	No Video	Mono	VGA/Mono	VGA/color
40MB-45MS	\$1307	\$1407	\$1602	\$1837
66MB-25MS	\$1532	\$1632	\$1827	\$2062
71MB-18MS	\$1637	\$1737	\$1932	\$2167
110MB-25MS	\$1762	\$1862	\$2057	\$2292
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-Computer Buyer's Guide,
Cover Story, Dec, 1989

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512K RAM, 1.2MB or 1.44MB Drive, 101-Key Keyboard

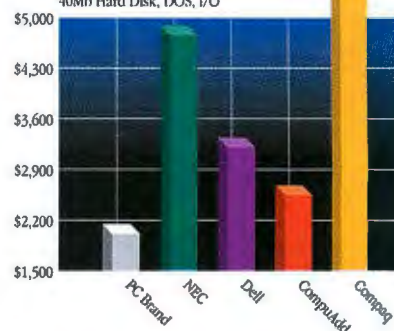
Standard System Features:

- 80386SX Processor Operating at 16MHz delivering 18MHz Effective Throughput
- 512K RAM expandable to 8MB on the System board using 256K and/or 1MB RAM
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- FCC Class "A", Intended for business use
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- 1:1 Interleaving Dual Hard Drive/Floppy Drive controller
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- Real Time Clock/Calendar with 5 Year Battery
- 80387SX Co-Processor Support
- AMI BIOS with full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatibility
- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/ 5 Disk Drive bays (Shown w/optional Mini Size Tower ® Case)

Options:

- Low profile Slim Line Case
- Mini Size desk top Tower ® Case
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PC BRAND 386/SX-16

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71MB-18MS	\$1737	\$1837	\$2032	\$2267
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-PC Magazine, 25MHz 386 PC's, Feb. 14, 1989

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-Computer Shopper, Cover Story
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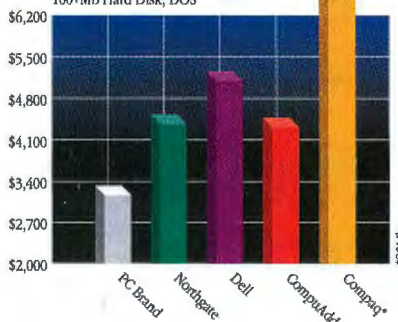
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- PC Magazine, 25MHz 386 PC's
Feb. 14, 1989

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Standard System Features:

- True 20MHz or 25MHzZ Intel 80386 CPU Operating with Zero Wait States
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- 8 Slot motherboard design (5 16Bit & 3 8Bit)
- Medium foot print case w/5 Disk Drive bays

Options:

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- Full or Mini Size Tower @ Case
- LCD or VGA Plasma Portable Case
- 32k or 64k Cache upgrade (25Mhz only)
- Custom configurations w/Name Brand peripherals of your choice

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Hard Drives	No Video	Mono	VGA/Mono	VGA/color
40MB-45MS	\$1895	\$1995	\$2170	\$2370
66MB-25MS	\$1995	\$2095	\$2270	\$2470
71MB-18MS	\$2120	\$2220	\$2395	\$2595
110MB-25MS	\$2230	\$2330	\$2505	\$2705
150MB-17MS	\$2760	\$2860	\$3035	\$3235 ESDI
320MB-16MS	\$3205	\$3305	\$3480	\$3680 ESDI

PC BRAND 386/25

with Hard Disk Drive, Monitor & Video Card

Hard Drives	No Video	Mono	VGA/Mono	VGA/color
40MB-45MS	\$2082	\$2182	\$2387	\$2577
66MB-25MS	\$2232	\$2332	\$2537	\$2727
71MB-18MS	\$2362	\$2462	\$2667	\$2857
110MB-25MS	\$2492	\$2592	\$2797	\$2987
150MB-17MS	\$3062	\$3162	\$3367	\$3557 ESDI
320MB-16MS	\$3312	\$3412	\$3617	\$3807 ESDI



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-PC Magazine, 33MHz 386 PC's,
October, 31, 1989

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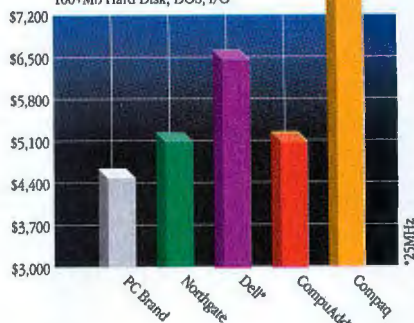
Standard System Features:

- True 33 MHz INTEL 80386-33 CPU operating w/Zero Wait States Delivering up to 58.7 MHz Effective Throughput
- Intel 82385-33 Cache Processor with 32K 25NS Static RAM Standard, Field Upgradable to 64K
- 1024K RAM Standard Expandable to 16MB
- FCC Class "A", Intended for business use
- High performance 16bit VGA Cards on all VGA systems w/1024 x 768 capability
- 1.2MB 5.25" or 1.44MB 3.5" Diskette Drive
- 1:1 Interleaving Dual Hard Drive/Floppy Drive Controller, 977.6 KB/SEC Caching Controller w/ESDI Configurations
- Enhanced 101-key AT Style Keyboard
- High Capacity 200 Watt System Power Supply
- Real Time Clock/Calendar with 5 Year Battery
- 80387 or Weitek Co-Processor support
- Phoenix BIOS with Full MS/DOS, OS/2, XENIX, UNIX, NOVELL, 3COM compatible
- 8 Slot motherboard design
- Full size case with 5 Disk Drive bays

Options:

- Full size Tower @ Case (shown above)
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- Factory Ram Upgrades

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66MB-25MS	\$3354	\$3454	\$3649	\$3884
71MB-18MS	\$3454	\$3554	\$3749	\$3984
110MB-25MS	\$3579	\$3679	\$3874	\$4109*
150MB-17MS	\$4024	\$4124	\$4319	\$4554 ESDI
320MB-16MS	\$4534	\$4634	\$4829	\$5064 ESDI

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-PC Magazine : Over 20 pounds,
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December 12, 1989

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Standard System Features:

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- 3 Accessible Drive Bays for 2 5.25" & 1 3.5" Units
- 2 Available Peripheral Card Slots
- 16 Grey Scale 640x480 VGA Plasma or 4 Grey Scale 640x400 CGA/Mono Graphics Backlit Supertwist LCD Display
- Simultaneous internal and external displays
- 200Watt Auto Voltage Switching Power Supply



Actual VGA PLASMA Screen Image

VGA Gas Plasma Portables

Drives	286/12	286/20	386/SX-16	386/20	386/25
1 Floppy	\$2595	\$2795	\$2895	\$3350	\$3550
40MB-28MS	\$2995	\$3195	\$3295	\$3750	\$3950
66MB-28MS	\$3095	\$3295	\$3395	\$3850	\$4050
110MB-28MS	\$3395	\$3595	\$3695	\$4150	\$4350
150MB-17MS	\$3960	\$4160	\$4260	\$4710	\$4910 ESDI

LCD Backlit Portables

Drives	286/12	286/20	386/SX-16	386/20	386/25
1 Floppy	\$1745	\$1945	\$2045	\$2495	\$2695
40MB-28MS	\$2145	\$2345	\$2445	\$2895	\$3095
66MB-28MS	\$2245	\$2445	\$2545	\$2995	\$3195
110MB-28MS	\$2545	\$2745	\$2845	\$3295	\$3495
150MB-17MS	\$3110	\$3310	\$3410	\$3855	\$4055 ESDI

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HL6905 20" VGA/EGA	2325
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MultiSync GS-2A 14" Multi Mono	\$249
MultiSync 2A 14" VGA	499
MultiSync 3D 14" VGA/EGA	649
MultiSync 4D 16" VGA/EGA	1150
MultiSync 5D 20" VGA/EGA	2350
Panasonic	
C1391 PanaSync 14" VGA/EGA	\$489
15"/19" Grey Scale Monitors	Call
Princeton Graphics	
Max 15 14" Multifreq. Mono	\$249
UltraSync 14 14" VGA/EGA	520
UltraSync 16 16" VGA/EGA	879
Princeton Publishing Labs	
Multiview 15" Full Page w/adaptor	\$890
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9503 14" VGA Mono	\$135
9513 14" VGA	369
1520 15" VGA/EGA Multifreq	Call
Seiko NEW!	
1440 14" VGA	\$599
1450 14" VGA	Call
Sony	
1304 14" VGA	\$689
Zenith	
ZCM-1490 14" Flatscreen VGA	\$619

Disk Drives

360K 5.25" HH Black	\$75
720K 3.5" HH Black w/5.25" Mounting	80
1.2MB 5.25" HH Grey	85
1.44MB 3.5" HH Grey w/5.25" Mounting	95

PS/2 Floppy Drives

CMS 5.25" 360K/PS-2 Ext.Floppy	\$199
--------------------------------------	-------

Imega

B1201 Single 5.25" 20MB Int. w/o Interface	\$765
B1441 Single 5.25" 44MB Int w/o Interface	995
B244X Dual 5.25" 44MB Ext w/o Interface	1995

Hard Disk Drives:

Micropolis	
330MB 18ms 1558-15 ESDI Full Hgt.	\$1550
640MB 18ms 15 Mbit ESDI Full Hgt.	2695
Miniscribe	
71MB 18ms M3085 MFM	\$595
150MB 17ms M3180E ESDI 1/2 Hgt.	1195
320MB 16ms M93080E ESDI Full Hgt.	1595
Seagate	
20MB 65ms ST225	\$209
20MB 35ms ST125	\$245
30MB 35ms ST138	310
40MB 24ms ST151	419
80MB 28ms ST4096 Full Hgt. MFM	590

Add \$50 for XT Kit for ST1xx, ST2xx

Toshiba	
66MB 25MS MK134 RLL	\$429
110MB 25MS MK72 RLL	669

Tape Backups

40/60MB Colorado Memory-Internal QIC-40	\$279
60MB Archive Int. or Ext. w/Cntrl.	590
60MB Maynard Mayntream Portable	889
150MB Archive Internal/External	925/1250
150MB Maynard Mayntream Portable	1395
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FX850 330/88 CPS	345
FX1050 264/54 CPS	445
LQ850 330/88 CPS	Call
LQ1050 330/88 CPS	Call
LQ950 264/88 CPS	Call
LQ2550 400/108 CPS	Call
Kodak Diconix	
150Plus 150/50 CPS	\$315
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Not Just for Numbers Anymore

Sophisticated graphics and file linking add new depth to spreadsheets

Steve Apiki, Stanford Diehl, and Howard Eglowstein

Remember VisiCalc? If not, you may not appreciate how far spreadsheets have come in the last few years. The newest crop can handle vast amounts of data and generate graphics that rival the best charting packages.

The BYTE Lab examined 15 of these data munchers, all of which can handle more than 640K bytes of RAM; under MS-DOS or OS/2 or on the Macintosh. All 15 products allow you to include multiple layers of standard spreadsheets, either by linking sheets together or by providing a "cube" of data. Data needs room, so we wanted products that handle more than 640K bytes of RAM; under MS-DOS, this means supporting either extended or expanded memory. Finally, we wanted to see an integrated charting capability. Table 1 lists the functions that each spreadsheet supports, and table 2 compares the spreadsheets' features.

Of the improvements, the most obvious is the ability to connect multiple layers. If you think of a spreadsheet as the electronic equivalent of a ledger sheet, think of these packages as big stacks of ledger sheets. Even better, you can have any sheet access data from any other sheet without messing up your desk. And while advanced spreadsheets are much the same, they have their differences. Spreadsheets are classified as linking, three-dimensional, or relational, depending on the consolidation

method that they use.

Linking spreadsheets are fundamentally the same as standard sheets. While a normal cell reference might be B11, a linking spreadsheet allows you to preface the cell with the name of another sheet in memory or on disk. PAYROLL:B11 might be the reference you enter in a budget sheet to use a value from the payroll sheet.

A 3-D product takes this one step further. B11 is essentially a reference to the second row, eleventh column of a flat sheet. 3:B11 might be a 3-D reference to that same cell, three layers deep. The advantage over linked sheets is that all the data can be in one structure, making it somewhat easier to manipulate.

A last category is the relational spreadsheet, which assigns data to fields, much as a database does. These are essentially hybrid products that are better suited to data management than straight number crunching. For that reason, we did not include any here. Examples of relational products include Javelin Plus from Javelin Software and TM/1 from Siaper Corp.

Performance Measures

High-end spreadsheets are used for heavyweight applications, so performance is often critical. We benchmarked DOS and OS/2 packages on a Compaq 386/20 with 6 megabytes of memory, and Macintosh software on a Mac IIcx with 4 megabytes of memory. The results are graphed in figures 1 through 3. All the test sheets forced DOS packages into expanded (CEMM emulated) or extended memory.

The Mathmix test recalculates a worksheet of 128 rows by 128 columns. The sheet is organized into 64 columns of small blocks alternated with 64 blank columns; each cell is the result of a basic math operation (addition, subtraction, multiplication, or division) applied to the first two cells in its column. The result reflects speed in basic operations. Since spreadsheets are sometimes called upon

to perform database functions, our second test is a one-key sort of a 7000-row by 5-column table.

Three tests based on the familiar Savage formula measure performance with floating-point operations and deeply nested formulas. The first, Load Savage, times the loading of a 320-row by 100-column Savage spreadsheet from disk. Recalc Savage measures the time to recalculate the sheet. Recalc Linked or 3-D times the recalculation of five 80-row by 80-column linked worksheets or a single 40-row by 40-column by 20-page 3-D sheet, whichever the tested package could complete faster.

A test of the efficiency of minimal recalculation rounds out our suite. That test worksheet is a 320-row by 100-column block of simple formulas. The entire sheet depends on a single key, but 800 of the cells, grouped in interleaved rows, also change with a second key. Modifying the second key, the Short Recalc test, should recalculate only these cells; the Long Recalc test times a full-sheet recalculation.

Welcome to the Real World

We also wanted to see how these products fared in a real environment. We made up a sample business, a pet store chain, and had each of the spreadsheet products compute the regional sales figures for four sales regions. Each region was on a separate sheet and used typical spreadsheet features.

A fifth sheet consolidated the data into a national summary. Either linking or the 3-D feature was used to extract results from the regional sheets. We found out that the spreadsheets differed not only in the way that they consolidated sheets, but in the ease with which the user negotiated such a task. True 3-D sheets make adding across sheets as simple as summing a column or row. Others link with a couple of clicks of the mouse. Some, however, require a truly awkward

continued



Table 1: Extensive function support is important if you have a very complex or very unusual application.

	NUMBER OF SUPPORTED FUNCTIONS BY TYPE							
	Date/ time	Financial	Logical	Matrix	Math	Statistics	String	Other
DOS and OS/2 products								
Excel for OS/2	12	13	7	4	22	25	0	0
Excel for Windows 2.10	12	13	6	4	22	25	0	0
Lotus 1-2-3 rel. 3.0	5	12	8	3	11	14	8	4
Lucid 3-D 2.2	9	12	7	4	17	8	5	12
PlanPerfect 5.0	14	10	14	14	33	10	17	10
ProQuibe 1.03	13	12	6	0	26	9	17	21
Quattro Pro 1.0	12	18	8	2	19	10	21	25
SmartWare Spreadsheet 1.0	26	16	12	2	12	9	0	0
SuperCalc 5	16	18	18	0	18	15	16	30
20/20 version 2.33.11	14	10	5	0	17	6	13	20
Twin Level III 3.03	12	13	11	3	20	14	20	10
Macintosh products								
Excel 2.20	12	13	7	4	22	25	0	0
Full Impact 1.1	31	10	11	0	19	11	7	32
WingZ 1.1	23	18	9	6	34	10	23	20

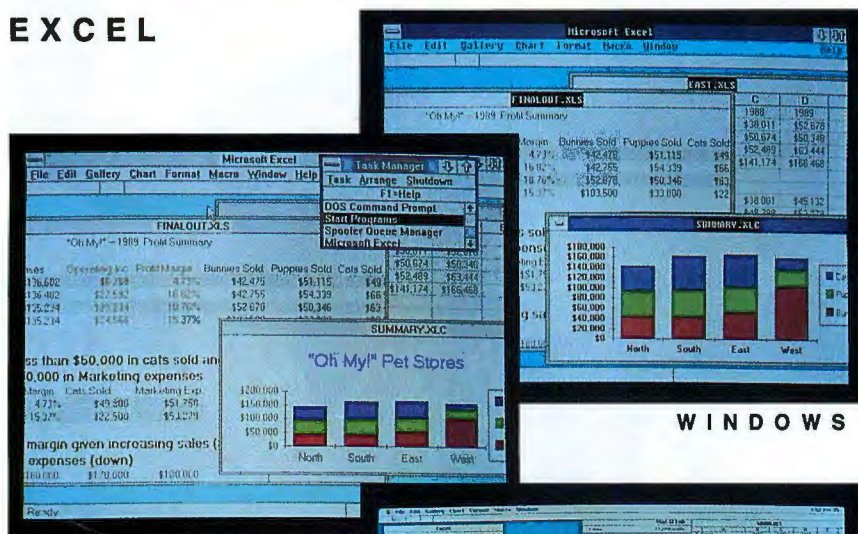
sequence of operations.

The spreadsheet's database functions brought out those departments that spent too much money on marketing and sold too few pets. We wanted to be able to see the effect of increased sales on profit margin, and the data table (what-if) functions handled that for us. Finally, we tried to integrate a stacked bar chart onto the spreadsheet.

Throughout our testing, we used different fonts and visual effects to add impact. Most of the products did a creditable job; some of them came up with terrific output. Borland's Quattro Pro was a standout among PC products, and WingZ for the Macintosh did a remarkable job as well.

Working this project through each of the packages gave us a good feel for their ease of use and overall performance. Remember that spreadsheets, like word processing packages, are a very subjective lot. Selecting the right spreadsheet for your needs is a delicate balance between functionality, speed, and usability. Our evaluations of each product follow, in alphabetical order.

EXCEL



WINDOWS

Excel for Windows allows chart and worksheet window types.

Microsoft's OS/2 version of Excel retains the familiar interface with new capabilities made possible by the Presentation Manager.

Excel functions as well on the Macintosh as it does under Windows.



MACINTOSH

Excel has the distinction of being the only product in our review to run under all three of our test environments; DOS, OS/2, and Macintosh. Windows and Presentation Manager (PM) give the PC products an interface almost identical to that of the Mac.

More important, the files are fully transportable among the three versions. Our output test was first assembled in the DOS/Windows version, read in by the OS/2/PM version, and then finally copied to the Macintosh via the Mac's SuperDrive. The only hitch was with the linked files—the Mac's operating system wasn't happy with the naming convention from the PC. A couple of clicks with the mouse, and it was fixed.

The mouse interface is a natural for spreadsheets—not so much for data entry, but for editing data, it's great. Mac users may already know this, but PC users may be in for a pleasant surprise. And if Excel is your first introduction to Windows or PM, the added ability to cut and paste spreadsheet data and graphs to other applications is certainly a big advantage.

One fly in the ointment is Excel's inability to combine charts and spreadsheets. Assembling a combined page with both graphics and text requires some other program. We used PageMaker 3.0. Word processors under the

different operating systems can probably do as well.

All three versions of Excel worked identically. Excel takes some getting used to, especially if you're new to PC

graphics environments.

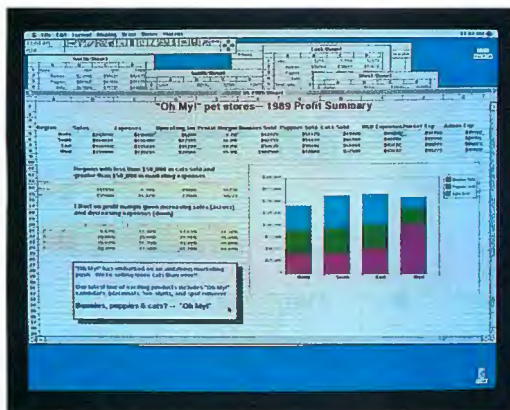
On our benchmarks, Excel placed in the low middle of the pack. The Mac and OS/2 versions undoubtedly benefit from their environments' better memory han-

dling. Overall, we found Excel to be an adequate performer. Anyone who needs to port data across different PC operating environments may want to check this spreadsheet out.

FULL IMPACT

Ash-ton-Tate's product record has been hit-or-miss lately. Full Impact (for the Macintosh) is one product that often gets overlooked for all the wrong reasons. That's too bad, because it's nifty. It did a terrific job with our pet store project and turned in excellent times on all our benchmarks—all, that is, except the sort test, where the 7000 rows of test data wouldn't load. Full Impact's limit is 2048 rows for any one sheet.

The biggest surprise may be the clean interface and ease with which you can manipulate charts once they're drawn. If data-based presentations are your specialty, Full Impact has a good selection



of charts and graphics primitives.

Full Impact is more limited than WingZ, but in a way that makes it more useful. Unlike WingZ, Full Impact's graphics primitives are easy to find and easy to control. After all, you buy a

Full Impact 1.1 has a gentle learning curve, but it sacrifices some sophistication.

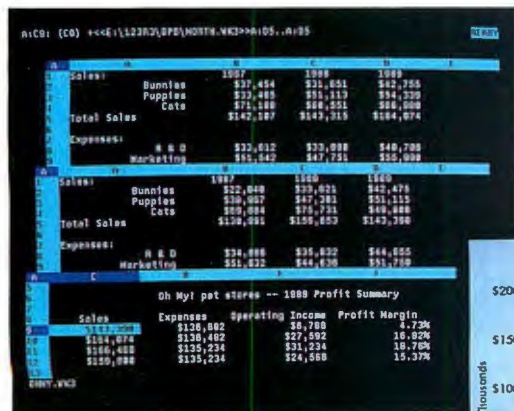
spreadsheet primarily to manipulate data, not graphics.

Linking spreadsheets together takes simply a click or two in the right place. The kicker here is Full Impact's requirement that you load all your sheets into memory—and you can't open more than eight at a time. Both Excel and WingZ are limited only by the amount of free RAM.

The array of icons on the screen was a little busier than we'd like—better than some applications, worse than others. We wouldn't mind if some of the functions were moved to pull-down menus.

Full Impact should please all but users with the largest worksheets. We think Full Impact is a hit.

LOTUS 1-2-3 3.0



Lotus 1-2-3 release 3.0 features a perspective window showing three worksheets and improved graphics.



Since Lotus released the latest version of 1-2-3 a few months ago, most of the criticism has been leveled at its performance. While release 3.0 is certainly a step down from the lightning reflexes of its predecessor, 2.01, our tests show that, on the proper hardware, 3.0 more than holds its own against other high-end packages.

That hardware remark is not made casually. Release 3.0 won't even run on a PC with less than an 80286, and it requires at least 1 megabyte of memory under DOS. However, 3.0's use of ex-

tended DOS memory certainly brightened its benchmarks in comparison to the expanded-memory packages.

Release 3.0's 3-D implementation is the best of those of the packages that we reviewed. It combines the convenience of a pure 3-D spreadsheet, where pages behave just like rows and columns, with the flexibility of multiple file linking. You

can load many files at once, and each file may or may not consist of multiple sheets.

Range commands and formulas work with 3-D selections just as you'd expect them to; when you move a block of data, you can move it up, across, and deeper into the spreadsheet, and all relative formulas remain intact. If you're familiar with earlier versions of 1-2-3, you'll find the transition to three dimensions easy. The only 3-D weak spot in 3.0 is the rigid window structure, which limits you to a fixed view of three partial windows.

Enhancements to 3-D also improve 3.0's database capabilities. Multiple sheets and multiply linked files allow you to create a true relational database inside 1-2-3, and extended database functions give you full access to them. Lotus's DataLens database interface offers potential access to a host of external databases, but as of this writing, users remain limited to the dBASE III driver provided with 3.0.

While graphs have been improved in 3.0, 1-2-3 still has disappointing report presentation. Fonts are limited to those of your printer, and there is no capability for adding special effects such as shading and outline boxes.

continued

PRODUCT FOCUS
THIRD-GENERATION SPREADSHEETS

Table 2: A spreadsheet comparison summary. Although many packages share advanced features, we found that good implementations of features set a few apart from the crowd.

FEATURE COMPARISON — HIGH-END SPREADSHEETS

	Price	Minimum system	Network aware	Expanded memory	Maximum sheet size (cells)	Recalc. features ¹	Consolidation type	Files in memory	Files on-screen	Link to disk file
DOS and OS/2 products										
Excel for OS/2	\$495	80286 or 80386, 2.5 Mb RAM, OS/2 1.1+	○	N/A	16,384×256	M,B	Linking	RAM	RAM	○
Excel for Windows 2.10	\$495	80286, 640K, DOS 3.0+, Windows 2.10	○	RAM	16,384×256	M,B	Linking	RAM	RAM	○
Lotus 1-2-3 release 3.0	\$595	AT, DOS 3.0+, OS/2 1.0+, hard disk drive, 1 Mb RAM (for DOS), 3 Mb RAM (for OS/2)	●	32 Mb 15 Mb ³	8192×256 ×256	M,B	3-D	256	3	●
Lucid 3-D 2.2	\$99.95	PC, 256K (384K for graphics)	○	8 Mb	254×9999	M,B	Linking	9	9	●
PlanPerfect 5.0	\$495	PC, 384K, two floppy drives	●	8 Mb	812×256	B	Linking	2	2	●
ProQube 1.03	\$99	PC, 512K, hard drive	○	8 Mb	512×512 ×512	○	3-D	1	1	●
Quattro Pro 1.0	\$495	PC, 512K, hard drive	●	8 Mb	8192×256	M,B	Linking	32	32	●
SmartWare Spreadsheet 1.0	\$349	PC, DOS 2.0+ (3.0+ for LANs), 640K, hard drive	●	16 Mb	9999×999	M,B	Linking	50	50	○
SuperCalc 5	\$495	PC, DOS 3.0+, 512K, hard drive	●	32 Mb	9999×255 ×256	M	3-D	255	3	●
20/20 version 2.33.11	\$500	XT, DOS 2.0+, 640K	○	8 Mb	8193×1000	○	Linking	1	1	●
Twin Level III 3.03	\$219	PC, DOS 3.0+, 384K, two floppy drives	●	8 Mb	256×8192	M,B	Linking	RAM	3	●
Macintosh products										
Excel 2.20	\$395	Mac Plus, System 6.0.2, two 800K floppy drives, 1 Mb RAM (2 Mb w/MultiFinder)	○	N/A	16,384×256	M,B	Linking	RAM	RAM	○
Full Impact 1.1	\$395	System 4.1, two 800K floppy drives (hard drive recommended), 1 Mb RAM	○	N/A	2048×256	○	Linking	8	8	○
WingZ 1.1	\$399	Mac Plus, System 6.0.2, two 800K drives, 1 Mb RAM	●	N/A	32,767×32,767	M	Linking	RAM	RAM	○

¹ B=background, M=minimal.

² S=standard (bar, line, pie); E=enhanced; 3=3-D.

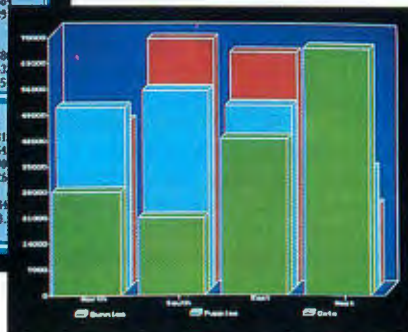
³ Extended memory.

N/A=not applicable.

●=yes ○=no



Lucid 3-D 2.2 offers a TSR interface, mouse support, and a convenient notepad feature.



LUCID 3-D

Lucid 3-D (for DOS machines) stacks up surprisingly well for a \$99.95 spreadsheet. It's fast, it supports a mouse, and it delivers some features you might not expect.

As a TSR program, it sits on top of your application, passing data through a clipboard file. From Lucid's menu bar, you can Grab data from an underlying application or Dump spreadsheet data into it. We listed a text file at the DOS prompt, called Lucid with a hot-key se-

PRODUCT FOCUS
THIRD-GENERATION SPREADSHEETS

FEATURE COMPARISON — HIGH-END SPREADSHEETS

Macro features			Graphics					Printer features					Sort keys	Data formats supported
Run 1-2-3	Procedural language	Debug mode	WYSIWYG preview	Graph types ²	Live updates	Draw features	Export graphics	Post-Script	Fonts	Embed graphs in spreadsheet	Print side-ways	Data query		
○	●	●	●	S,E	●	●	Clipboard	●	256	○	●	●	3	DBF, DIF, SYLK, WK1
○	●	●	●	S,E	●	●	Clipboard	●	256	○	●	●	3	DBF, DIF, SYLK, WK1
●	●	●	○	S,E	●	○	CGM,PIC	●	8	○	○	●	255	DBF, DIF, SYLK, WK1, WKS, WR1, WRK
○	○	●	○	S,E,3	○	○	○	○	N/A	○	○	○	2	DBF, WK1, WKS
●	●	●	●	S,E,3	○	○	CGM,WPG	●	32	○	○	●	10	DBF, DIF, WK1, WKS
○	●	●	○	S,E,3	○	○	HALO,PIC	○	16	○	○	○	9	DBF, DIF, WK1, WKS
●	●	●	●	S,E,3	●	●	EPS,PIC	●	8	●	●	●	5	DBF, WK1, WKS, WRK, WRQ
○	●	●	○	S,E,3	○	○	CGM	●	20	○	●	○	N/A	DIF, SYLK, WK1, WKS
●	●	●	○	S,E,3	○	●	CGM,PIC	●	16	○	●	●	3	DBF, DIF, SDI, VC, WK1, WKS
○	●	●	○	S,E	●	○	CGM	●	1	○	○	●	Unlim.	DIF, WK1, WKS
●	○	●	○	S,E,3	○	○	○	○	11	○	○	●	256	DIF, SYLK, WK1, WKS
○	●	●	●	S,E	●	●	PICT	●	256	○	●	●	3	DBF, DIF, SYLK, WK1
○	●	○	●	S,E	●	●	PICT	●	System	●	●	●	Unlim.	DBF, dBASE Mac, SYLK, WK1, WKS
○	●	○	●	S,E,3	●	●	PICT	●	System	●	●	●	255	DIF, SYLK, WK1, WKS

quence, selected the Grab option, and captured the listed data by a click and drag of the mouse. Better still, you can paste spreadsheet data to the clipboard and pass it to a word processor or database. It's as easy as a Mac, and it worked flawlessly with WordPerfect and the Norton Editor. Lucid manages all this with a character-based interface, so it can't run on top of Windows.

Lucid lets you open up to nine windows at once, and you can switch among them using the Alt key combined with a window number. You can link an entire

sheet to one cell to create a hierarchical approach with embedded files, or you can link in the traditional way by adding an external file reference to a cell. Lucid does not allow multiple file references in a single cell, though. Also, the interface seems intrusive once you get down to serious work, but a host of shortcut keys solves that problem.

Lucid's notepad feature makes spreadsheet annotations simple and effective. The notepad has its own menu and can also pass data through the clipboard to the spreadsheet or underlying applica-

tions. Lucid has an adequate set of functions, but if you need more, you can easily define them yourself.

We ran into an unusual problem that kept us from running the Recalc Linked Savage benchmark. On attempting to update the links, Lucid searched for non-existent files and aborted. (DacEasy says it is working on a fix that should be complete by the time you read this.) Lucid also lacked 3-D graphs and allowed us to save only one graph with each spreadsheet.

continued

MATHMIX AND SORT BENCHMARKS

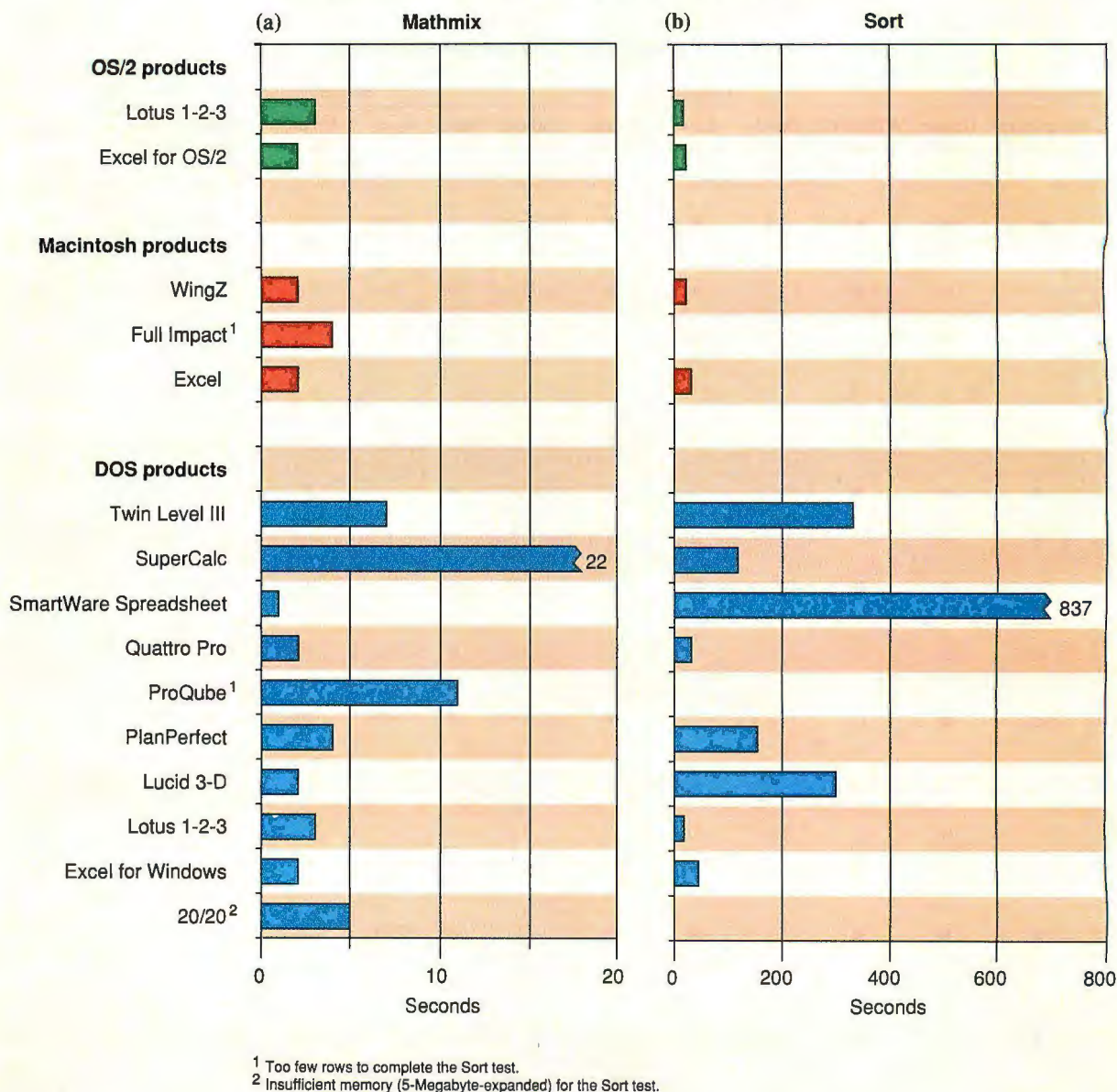


Figure 1: (a) Our Mathmix benchmark measures performance with common arithmetic operations. SmartWare Spreadsheet was outstanding; SuperCalc and ProQube were disappointing. (b) The effectiveness of sorting functions varied widely. Lotus 1-2-3 release 3.0 and Excel for OS/2 were the strongest performers.



PlanPerfect 5.0 gives you a choice of pull-down menus or a Lotus interface. A major shortcoming is that you can load only two files into memory.



PLANPERFECT

If you're a WordPerfect user, PlanPerfect (for PCs) should appeal to you. It offers the same function-key interface and an easy way to dump spreadsheets into a WordPerfect file. PlanPerfect also provides pull-down menus and the familiar Lotus command structure. One way or another, you should be able to find your way around.

Once you've settled on an interface, the program is fairly easy to use. It has a few nice perks, including page preview and table generation. PlanPerfect easily handled our what-if table from the menu

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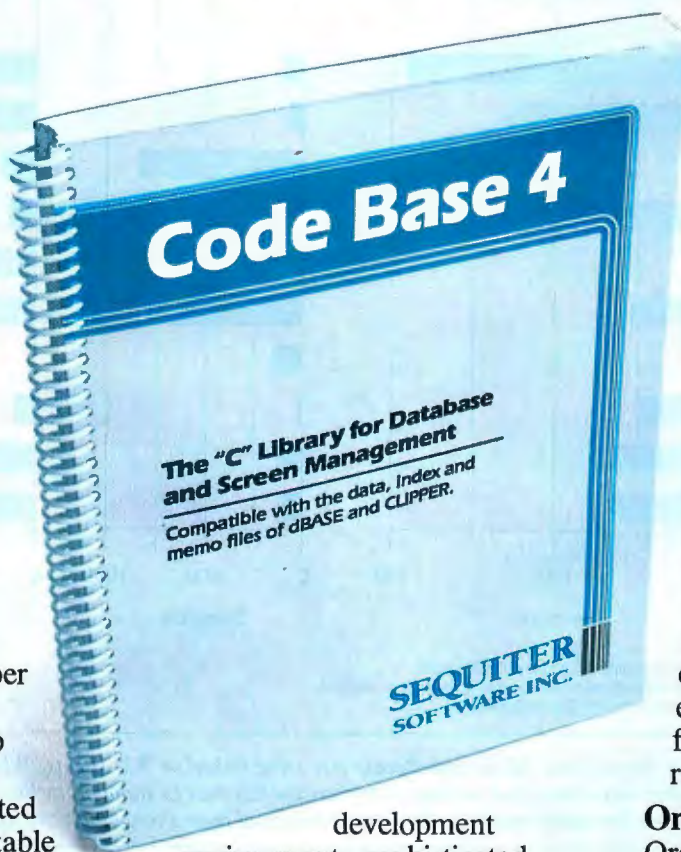
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SAVAGE TESTS

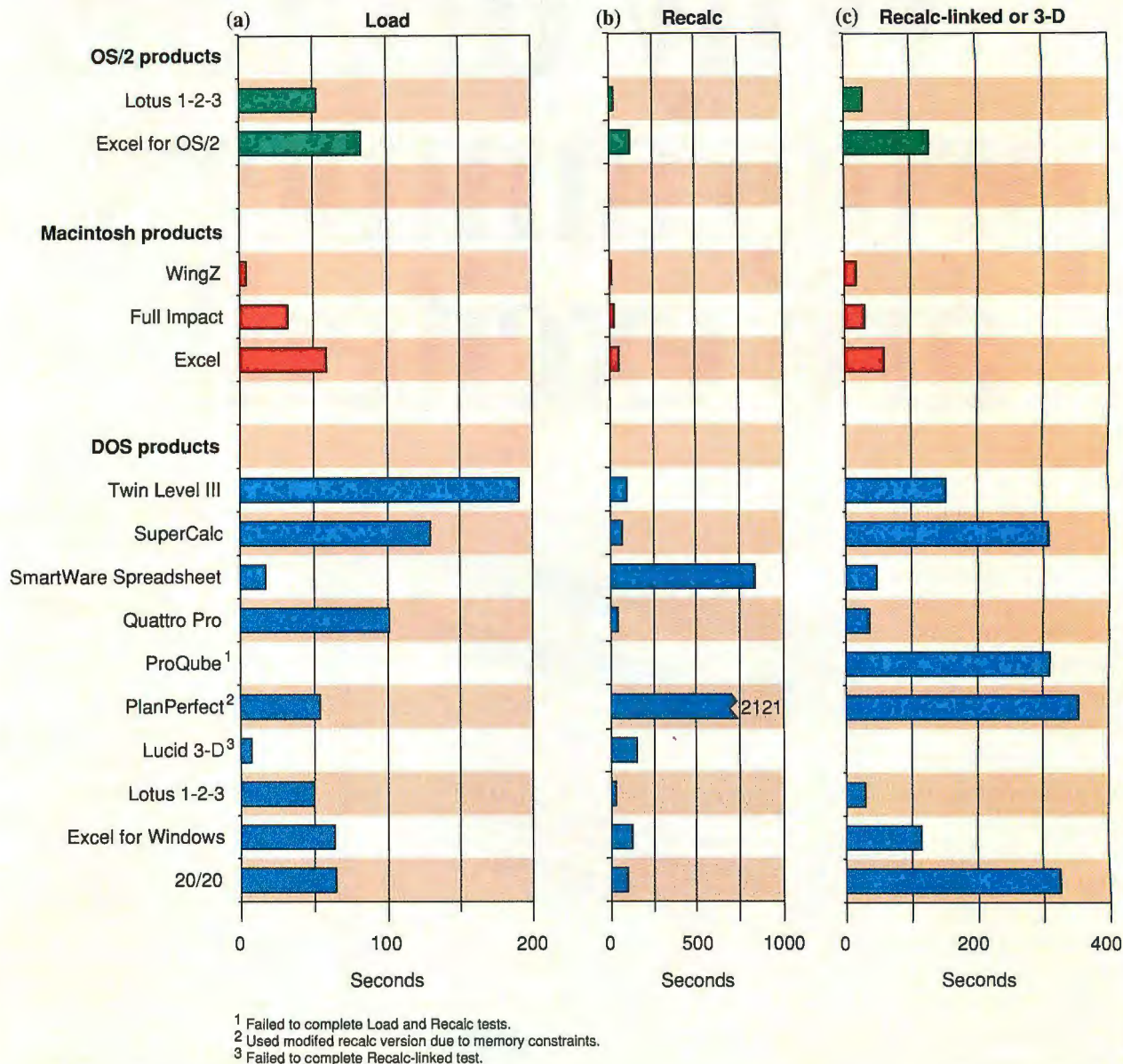


Figure 2: (a) Load test. (b) Savage Recalc test. (c) Savage Recalc test using linked or 3-D sheets. WingZ and 1-2-3 shared top honors on all these tests. PlanPerfect ran a modified version of the Savage test that fit in memory but downgraded performance; 20/20's requirement that linked sheets be saved and reloaded contributed to a poor showing on the Recalc Linked test.

bar. The graphics module insisted on re-displaying the graph each time that we changed an option—an irritating habit—and when we told it not to print a legend, it littered the label legends randomly about the screen. The graphs did look sharp, though, once they made it to our LaserJet.

PlanPerfect's memory structure led to some unusual benchmark results. The software reserves areas of memory for regions on the sheet—if memory for one region is exhausted, even if all the others are empty, you're out of luck. The only way we could get the large Recalc Savage benchmark to run at all was to create a

short, user-defined function and map it to the much longer Savage formula. We were able to conserve enough space to fit the test in memory, but the results of this modified benchmark are unavoidably skewed to PlanPerfect's disadvantage. The memory limitation is something that you're unlikely to encounter with everyday spreadsheets, but our other benchmarks make it clear that performance is not PlanPerfect's best feature.

PlanPerfect's major shortcoming is its linking capability. First, you can load only two sheets into memory. Although you can still link cells to files on disk, you lose speed and versatility. Normally,

you could display an overview worksheet and, when you need more detailed data, hot-key between the subsidiary sheets. You cannot have more than one file reference in a linked cell, and, worst of all, the link is not dynamically refreshed. You must first save your source file to disk; then you can either display a list of links and hit a function key, or you can save the destination file and reload it (all links are refreshed when a file is loaded).

WordPerfect users should consider the package just for the interface, but with Quattro Pro available for the same price, you'll be sacrificing some serious power.

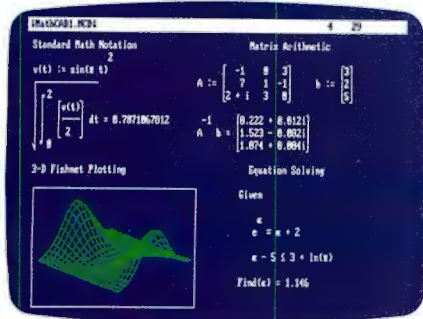
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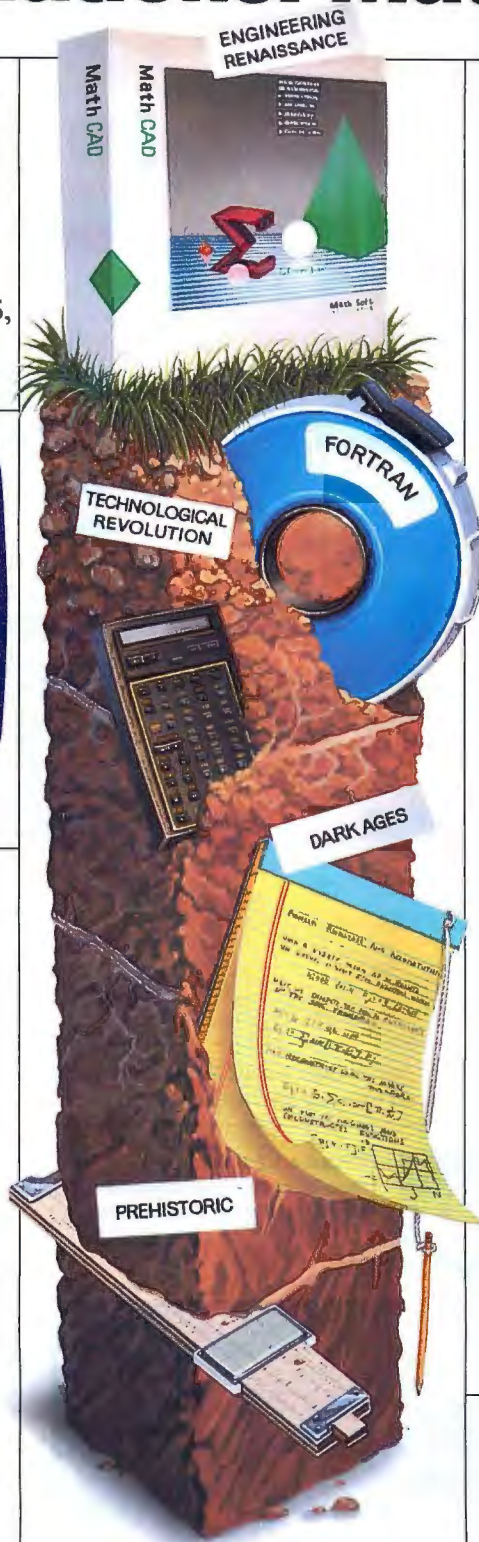


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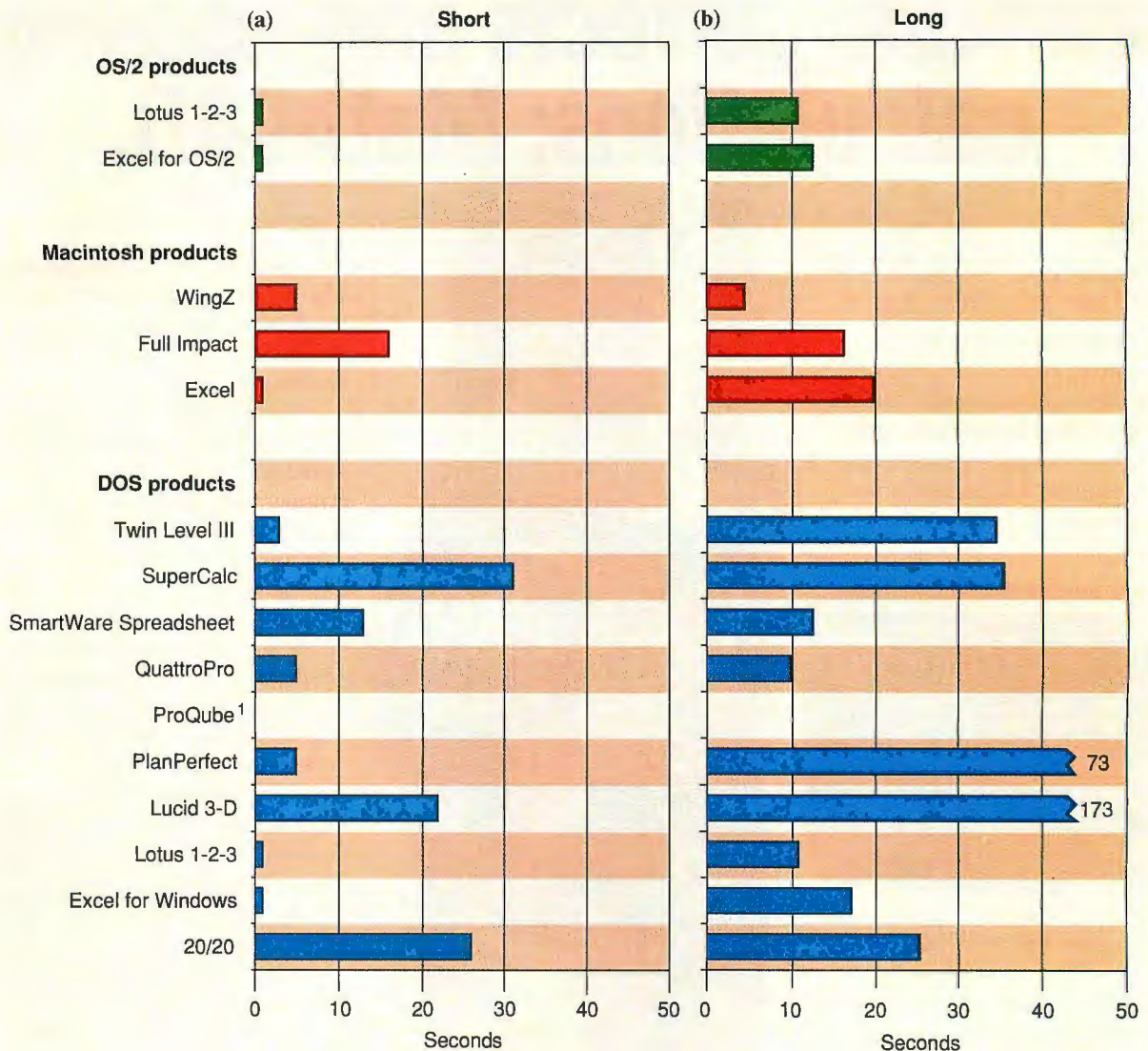


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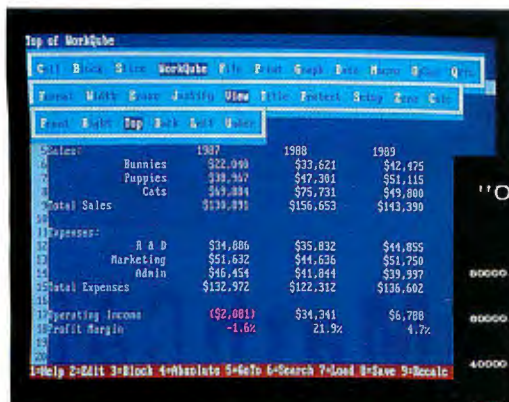
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OPTIMAL RECALC TEST



¹ Failed to complete both tests properly.

Figure 3: (a) Short Recalc test. (b) Long Recalc test. WingZ blazed through both of these Recalc tests, while 1-2-3 showed effective minimal recalculation with sharp contrast between the two tests.



ProQube 1.03 has true three-dimensional capability, including alternate data views.

PROQUBE

ProQube stands out with true 3-D operation at a price under \$100. When you open a "workcube," you have immediate access to as many as 512 spreadsheet pages. The PC's PageUp and PageDown keys step you through the pages. To draw data into a consolidation page, you simply add the cell references. You can also do a sum through the layers.

ProQube's 3-D interface also includes an interesting view function. Menu options let you look at your spreadsheet from many different angles. From the standard front view, our project included

column headings for three different years, with "numbers of pets sold" for row entries. Each page covers a different region. A right view shows sales for each region, with each page covering a different year. A top view lists the pets sold as column heads and each year as a row. Each page then covers a type of pet. The menu bar lists six different view angles.

The menu bar also grants access to a

slick file manager. The left side of the screen displays a menu tree of your default drive. You can select directories by arrow keys or the mouse. The right side of the screen lists the files within the selected directory. Function keys can then load a spreadsheet file or even trigger standard DOS file operations, such as copy and delete.

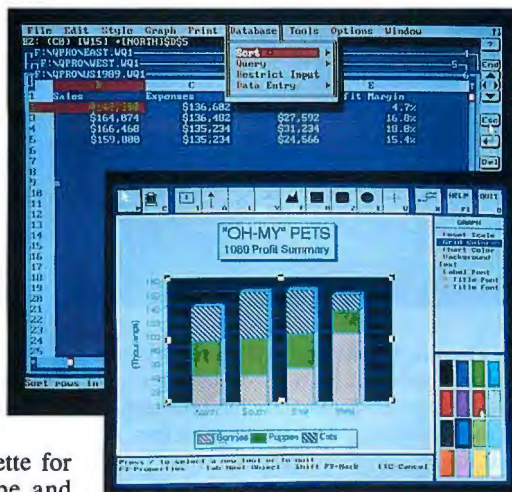
ProQube falls short in a couple of

areas. It handles a maximum of only 512 rows. It would not run our large Savage benchmark because the test included more than 7000 chained cell references, and what it could run, it ran slowly. The company says that a new version of ProQube will include new algorithms without these limitations. Perhaps a worse problem was that the graphs were not presentation quality.

QUATTRO PRO

While Lotus has divided its users into two different camps, Borland offers one spreadsheet for all DOS users. Borland employs a proprietary memory management scheme to swap unused code segments to disk, thus offering a high-end spreadsheet to low-end machines. Those users will have to accept some performance trade-offs, of course.

Quattro Pro is a joy to use. Its mouse support extends beyond simple pointing. The interface includes scroll bars and a user-programmable mouse palette for negotiating keys such as Escape and Enter without resorting to the keyboard. Once you've used a mouse for spreadsheet manipulation, you may never want to go back to your arrow keys. Borland includes a Lotus-style interface and Quattro's own interface. If you don't like either of those, you can define your own. Yet even with a custom interface defined, you can still run Lotus macros directly. You also have the option of switching



With Quattro Pro 1.0, you can embed graphs into your spreadsheets and update them dynamically. Note the convenient mouse palette.

from a character-based interface to a true graphical interface with icons and other aesthetic perks. You can open up to 32 windows under Quattro Pro and then link

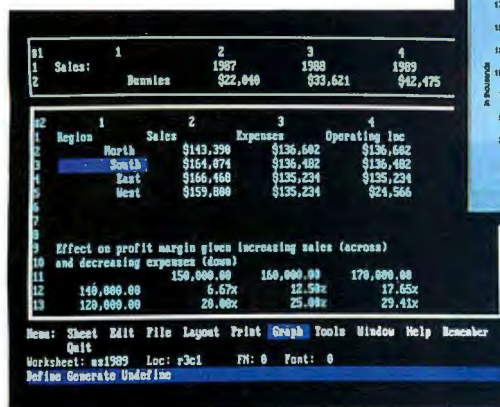
files by pointing and clicking. It lacks true 3-D capability, however.

Quattro Pro easily negotiated our pet store project, producing the kind of output you might expect from a Mac. Pull-down menus led us through the database and what-if tasks. A few clicks of the mouse built the graph, and a couple more clicks placed it in the file. Quattro offers a wide assortment of fonts and typefaces. A full-page preview gives you a look at the output before you print it.

The graphing module has been improved. Not only can you embed a graph into your spreadsheet, but you can also change your data and see the changes immediately. Lotus 1-2-3 release 3.0 makes it easier to view "live" updates, but it doesn't let you place the graphs into your worksheet.

Quattro Pro also lets you embellish your graphs with advanced drawing features. You can then save the graph as an Encapsulated PostScript file for output to PageMaker or other .EPS-format programs. You can also easily link data into your graph from a different spreadsheet or many different spreadsheets. Borland has covered all the bases and should have a big winner with Quattro Pro.

SMARTWARE SPREADSHEET



SmartWare Spreadsheet 1.0 boasts exceptional performance and some impressive features, such as support for up to 50 windows.

We did not include integrated packages in this review, but we allowed SmartWare Spreadsheet (a part of SmartWare II, an integrated package for DOS machines), since it is also available as a stand-alone spreadsheet. It ran fine without the other SmartWare modules (word processor, database, and communications), but some features, such as database functions, were left up to supporting programs. The full SmartWare suite would let you pass spreadsheet data to the database program or to the word processor for final-quality output.

SmartWare can load and display up to 50 windows, and it's easy to switch from one window to the next and to pass data between them. Linking, too, requires

continued

little effort. You just include an external file reference and cell reference. Enclosing row or column numbers in brackets marks them as an absolute reference. Multiple file references can be combined into a single-cell formula. SmartWare's linking suffers from one glaring weakness: It won't link to files on disk. Each

referenced file must be loaded to an open window. If you open a spreadsheet with linked references and fail to load the referenced sheets into memory, SmartWare retains the latest numbers. A simple recalculation, though, triggers an error.

Although SmartWare includes some powerful matrix features, including re-

gression, we had to type in multiple formulas to generate our what-if table.

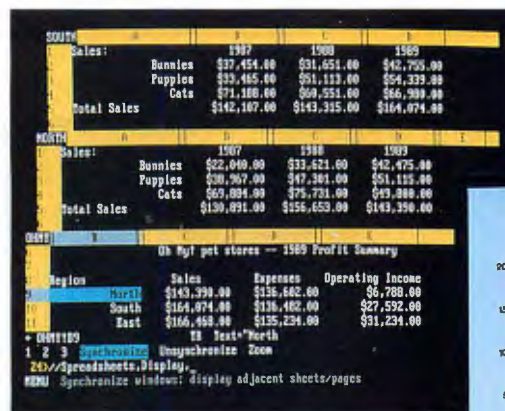
The graphing module produces some very nice output, including 3-D graphs. You can add or modify legends, titles, colors, fonts, and other attributes from a graph definition screen. The graphs are regenerated only on command.

SUPERCALC 5

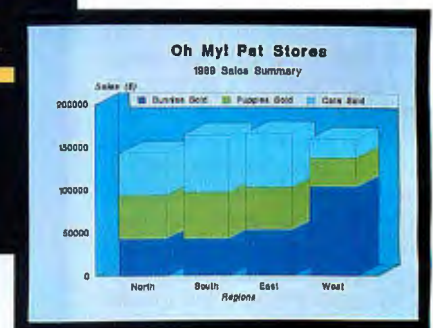
Computer Associates' SuperCalc 5 (for PCs) offers many of the same capabilities as 1-2-3 release 3.0, but a few features have key differences. Your opinion of SuperCalc 5 will depend primarily on how you weigh the relative importance of three factors: performance, 3-D capability, and report presentation.

Speed is not SuperCalc's strong suit. Our benchmarks put SuperCalc 5 consistently near the back of the pack, except on the Savage benchmarks. Performance was especially disappointing on the Mathmix test.

SuperCalc offers true 3-D sheets as well as interfile linking, but the 3-D implementation is not quite as sharp as 1-2-3's or ProQube's. SuperCalc's pages are not treated exactly like rows or columns; interpage references are always absolute. If you copy a range on page 2 that references pages 1 through 3, the block will continue to reference page 1, not page 2, as you might expect.



SuperCalc 5's interface is very similar to 1-2-3's, but its graphing capabilities are somewhat stronger.



If good graphs and stylish reports are more important than speed or seamless 3-D, however, SuperCalc has your application covered. The package offers an extensive range of graphs, from mundane bars to high-low graphs and polar charts. You can create combination graphs or add 3-D perspective.

Text layout options allow for shading and border special effects. You can also

select fonts and point sizes (if your printer supports them) of up to 20 points.

Other features, including database management, are similar to those of 1-2-3 release 3.0. Data commands aren't as 3-D as they are in 1-2-3 (e.g., there's no equivalent of a three-variable what-if).

20/20

The 20/20 spreadsheet on the PC is a port of a popular spreadsheet for the VAX/VMS environment. Access Technology sells the PC version primarily as an adjunct to sales of its product for larger systems. It may not be quite as

snazzy as 1-2-3 or Quattro Pro, but it offers solid functionality and compatibility with a broad range of computing environments.

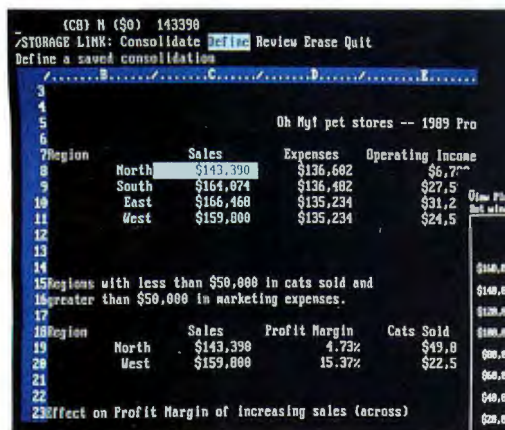
The usual complement of macro commands, functions, and graph support make for functionality comparable to 1-2-3's. But some features, especially

linking and database management, are not as advanced as they are in the other packages that we looked at.

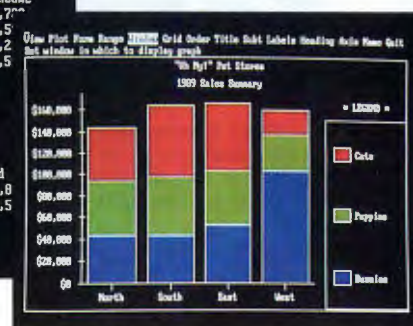
File linking is 20/20's weakest point. Only one file can reside in memory at a time, so all links must be to disk. In addition, links are hard-wired spreadsheet features that cannot be moved or copied conveniently. External references can't be used in formulas, although you have the option of applying one of several operations to the linked reference at link time. All links are resolved when the spreadsheet is loaded.

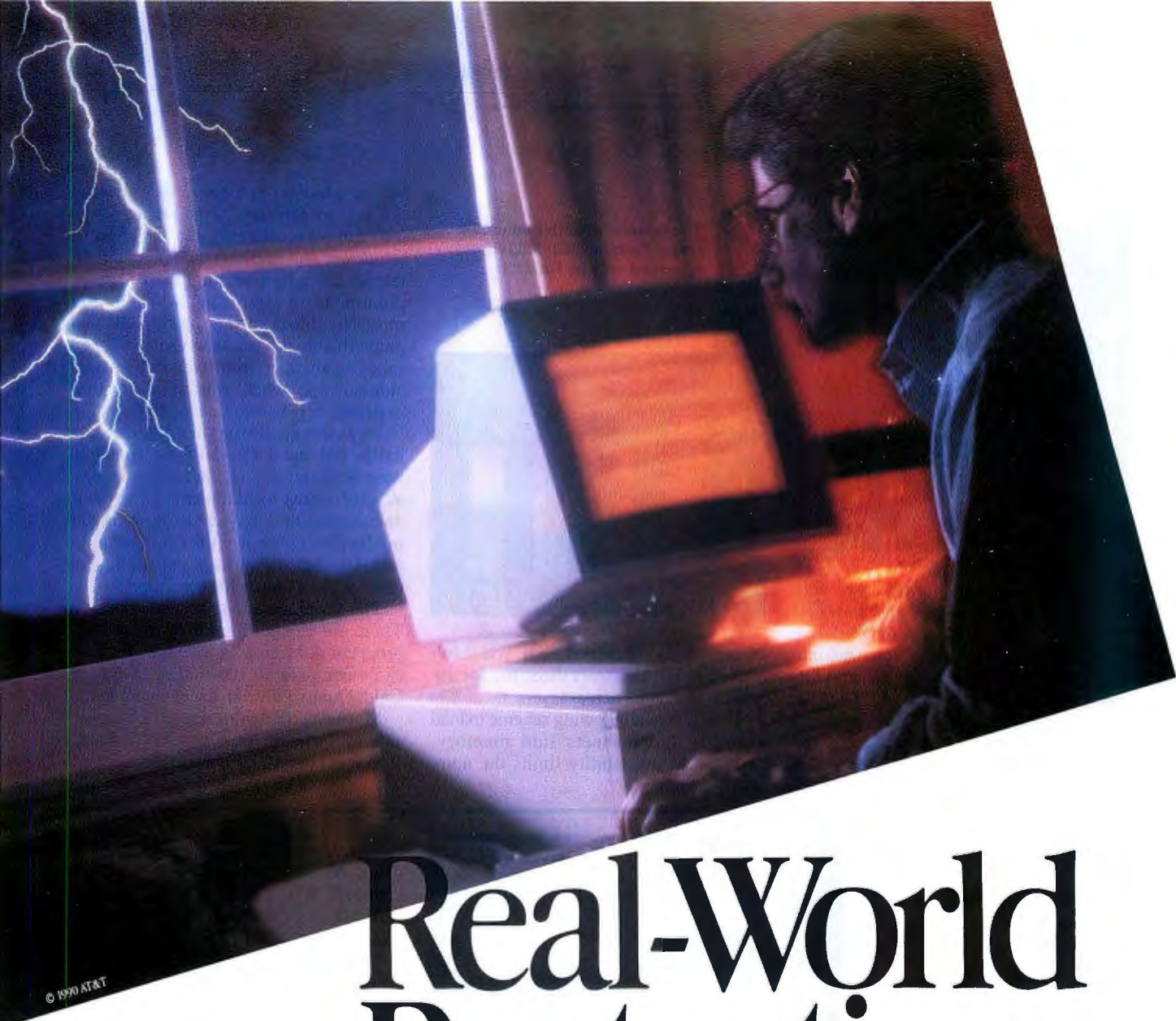
For software ported from a terminal environment, 20/20's graphics capability is surprisingly good. In addition to standard graphs, you can print and view scatter plots and mixed charts. Text output is limited to a single font, and no text special effects are supported.

On the plus side, 20/20 can exchange worksheets with its VMS, Unix, IBM mainframe, and other counterparts via a common data file format.



20/20 allows only one sheet in memory at a time, but it supports links to disk files.





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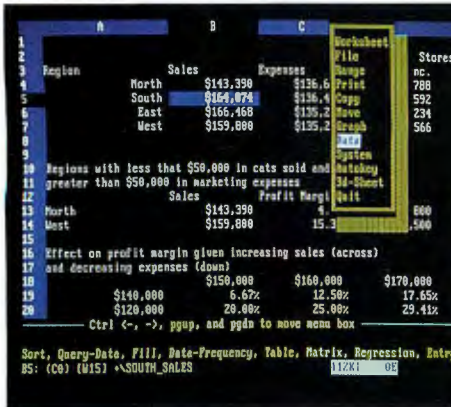
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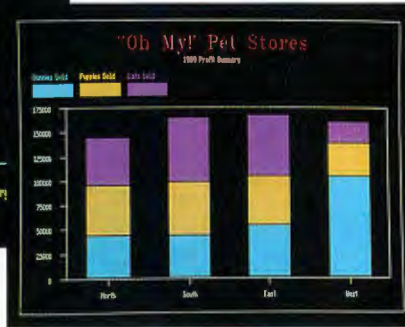
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TWIN LEVEL III



The number of active windows under Twin Level III 3.03 is limited only by RAM.



If Twin is still trying to keep pace with Lotus, it has lost a few steps. Level III (for PCs) is not release 3.0. Still, for \$219, Twin packs a lot of features into the familiar Lotus interface. As with Lucid, Mosaic calls its product 3-D, although it really provides file linking, not true 3-D spreadsheets. A workgroup option lets you save all your related sheets

in one quick operation, but you can't slice through the worksheet to, for instance, sum cells across layers.

Twin uses a windowing scheme to load multiple spreadsheets into memory. Only RAM availability limits the num-

ber of windows you can open. You can hot-key to different windows or zoom into any one. Given these overlapping windows, you might think you could establish links by selecting a window and pointing to an external cell. Not so. You must first block off a range of cells and name the block. You then use the named range as an external reference. This gets cumbersome when you need to name multiple cells before linking them.

We had to create the what-if table manually, but the Twin database functions were well developed, including the creation of forms for data entry. The Twin documentation lets you see how far the product has come over the course of three releases, but it can be a pain to search three separate manuals for a topic.

The graphics are fairly rudimentary. There are plenty of graph types, and the program does an adequate job, but they can't compare to the output of SuperCalc, Quattro Pro, or Excel on the PC.

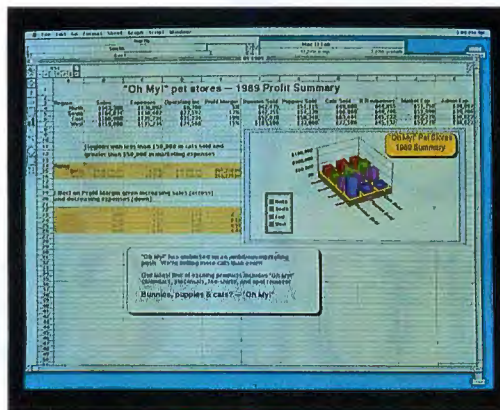
Mosaic recently distributed a beta version of Twin for Windows (Twindows). It appears to be a notable product.

WINGZ

It's hard not to like WingZ on the Macintosh. It's fast, it handles insanely large spreadsheets, and it produces stunning graphs. It consistently outperformed most of the spreadsheets in our tests, regardless of operating environment.

If we dislike anything, it has to be the user interface. The learning curve on this product is steep—it will take most people a fair bit of time to become comfortable with WingZ. Of course, most people would also need time to learn how to fly an F-16 fighter, and WingZ is relatively as sophisticated.

There are a few things we'd like to see in future releases: We missed the search-and-replace function that Excel offers for modifying groups of formulas. A more intuitive graphics editor would be wonderful. Generating the data is easy, as WingZ's interface is almost standard



WingZ 1.1 has charting functions normally found only in dedicated graphics packages. Even a neophyte user can get astonishing results.

Macintosh. On the other hand, selecting and modifying individual chart elements can be maddening. To select an individual element, such as an axis, you first have to select the whole chart and disable

the "automatic layout" feature. Then you click on the element that you want changed. It's not that the procedure is difficult, it's just that it's complicated, and the manual isn't of much help.

If we could change just one feature, however, it would be to add a "paste absolute" feature to the Edit menu. In most spreadsheets, you have the option of pasting a range in a new position with exactly the same formulas that it had in its old form. Not so with WingZ. WingZ insists on making each reference relative, requiring you to go back and edit each one. This can be particularly annoying when you're copying cells from one sheet to another or when you're duplicating a range of cells in order to draw a series of graphs. Both Excel and Full Impact give you the option of keeping your cell references absolute.

Despite these problems, WingZ is sure to please even the most power-hungry user. It's fast and capable. Choosing WingZ as your spreadsheet is sure to give you data many happy landings.

Adding Up Your Options

Whether you need a spreadsheet for accounting or for presentations, any of these packages will probably do the job for you. Which one you pick will be determined in part by your experience and

your work environment. As we noted, some packages may be easier to use than others. A novice trying to learn a complicated package might easily become frustrated at the learning curve. Also, if your office or colleagues have standardized

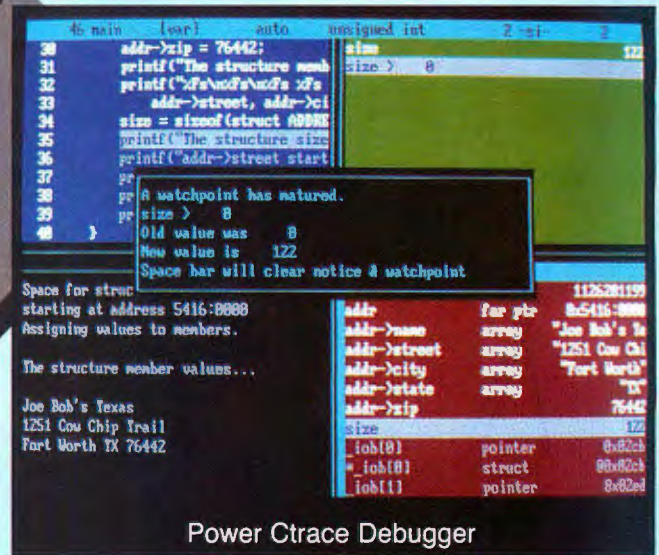
on a particular spreadsheet vendor, it may be best to stick with the latest offering from that vendor. While all the products include data conversions, it's best not to rely too heavily on them. Ideally,

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you can select a spreadsheet purely on its own merits—and here, we can offer a few suggestions.

On the PC, stick with those that are either 3-D or handle linking well. Quattro Pro and Excel have excellent linking capability. In particular, we like Lotus 1-2-3 for its speed and Excel for its ability to span Mac and PC operating systems. Lucid 3-D, at \$99.95, was an unexpected find. While it's not another Lotus 1-2-3, it's easily worth the price. Finally, our hats are off to Quattro Pro—it's sure to be a feather in Borland's cap.

On that note, it should be no surprise that WingZ was our choice on the Mac. Full Impact ran a very close second, but WingZ finally won out because of its

ability to handle larger spreadsheets, and more of them. And, while both had excellent graphics capabilities, WingZ is the obvious choice for putting glitz into a presentation.

These advanced spreadsheets resemble VisiCalc—the pioneer product—only in that they come on floppy disks. It's easy to confuse these products with databases, word processors, and desktop publishing packages. Numbers never looked so good. ■

Steve Apiki, Stanford Diehl, and Howard Eglowstein are testing editors for the BYTE Lab. They can be reached on BIX as "apiki," "sdiehl," and "heglowstein," respectively.

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Hit the Road, Mac

The Mac Portable's
pluses outweigh
its minuses

Don Crabb

The Macintosh Portable is Apple's long-awaited and much-delayed attempt to crack the lucrative portable computer market. Since its announcement, it has generated much criticism for its weight, size, and price. Nevertheless, the Portable has many pluses that make it worthy of consideration.

BYTE has already covered the technical aspects of the Portable and its slightly modified System software in the First Impression "The Portable and the Powerful" (October 1989). Therefore, I'll discuss system details only briefly and concentrate on my experiences with the machine.

A Quick Rundown

The Mac Portable includes a 68000 processor that runs at 15.67 MHz—twice the speed of the Mac SE. It comes with a single SuperDrive 1.44-megabyte floppy disk drive that reads Mac or PC disks, and 1 megabyte of 100-nanosecond static RAM for \$5799. Adding a 40-megabyte internal SCSI hard disk drive brings the price up to \$6499. A second floppy disk drive (\$499) and an internal 2400-bps modem (\$449) are also available, as is a second megabyte of SRAM (\$649).

The Portable's active-matrix LCD screen has a wide viewing angle and is the sharpest display that I've seen on any portable computer. The backlit LCDs that I love on the Zenith SupersPort and TurbosPort portables seem crude and



blurry by comparison. But the lack of a backlight on the Mac Portable means that you can't use the machine in a darkened airplane cabin or in other areas that are poorly lit.

The keyboard is pure Macintosh and works as well as the Apple Standard and Extended keyboards. It lacks a numeric keypad, but you can add one for \$69. The arrow keys aren't well positioned; they sit at the lower right side of the keyboard, in keeping with the standard Mac SE keyboard.

The Portable includes the standard Macintosh connector ports, including two AppleTalk/serial ports, one SCSI port, and one Apple Desktop Bus port. Apple includes a low-power ADB mouse with the Portable, but none was ready in time for this review. The main pointing device is a built-in mini-trackball located

on the keyboard. If you're a southpaw, you can switch the location of the keyboard and trackball in the keyboard chassis. But if you need the optional numeric keypad, you should plan on using the ADB mouse. The keypad replaces the trackball.

The Portable also includes special power management circuitry that can extract 8 or more hours of battery life out of its 6-volt lead-acid gel-cell battery. During my month of tests, I got at least 8 hours of battery life, even with heavy disk access. My best battery times were in the 10-hour range. You can recharge the Mac Portable's battery by plugging in its external power supply, or you can buy a separate charger (\$99). Extra batteries are \$35 each and are quite easy to install. The lead-acid battery adds 2

continued

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Macintosh Portable

Company

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

Components

Processor: 15.67-MHz Motorola 68000
Memory: 1 megabyte of 100-ns static RAM, expandable to 2 megabytes
Mass storage: 1.44-megabyte 3½-inch floppy disk drive that reads several Apple and IBM PC formats
Display: Built-in flat-panel, active-matrix-reflective LCD; 10-inch-diagonal screen; 640 by 400 pixels
Keyboard: 63-key standard keyboard with built-in mini-trackball; numeric keypad option
I/O interfaces: ADB port (mini-DIN-4 connector); internal ADB port for mini-trackball; two RS-232C/RS-422 serial ports (mini-DIN-8 connector); internal 2400-bps modem connector; DB-25 SCSI connector; internal SCSI connector; stereo sound port; DB-19 external floppy disk drive port

Size

15¼ × 14¼ × 4 inches (height tapers to 2¼ inches at front); 13¾ pounds (15¾ pounds with hard disk drive)

Options tested

40-megabyte 25-ms internal SCSI hard disk drive: \$700

Price

Base system: \$5799
System as reviewed: \$6499

Inquiry 851.

pounds to the machine, but it lasts far longer than nickel-cadmium batteries and doesn't require the deep discharge that nickel-cadmium batteries need before recharging.

Apple bundles System 6.0.4, Finder 6.1, and MultiFinder 6.1 with the Portable. System 6.0.4 has a few unique features, such as a Portable cdev that controls the machine's power management circuitry. The Portable also comes with HyperCard 1.2.5 (made to work especially with the Portable) and the usual Macintosh printer drivers, system resources, and system utilities.

Road Test

My review unit included the hard disk drive, the SuperDrive, and 1 megabyte of

RAM. It came packaged with a well-made and attractive carrying case that also holds a spare battery, the power supply, manuals, disks, and other computing desiderata. The carrying case has a padded round handle and an adjustable padded shoulder strap. It wasn't too much of a burden to carry the Portable around in airports, but if you're also carrying a briefcase, you'll want to strap the thing to a luggage cart.

The machine also came with a power supply, a setup guide, 10 software disks, six manuals, a Macintosh quick-reference card, and a set of luggage tags. The software includes three getting-started disks that will help Mac novices. Apple backs the machine with its usual pathetic 90-day limited warranty.

I carried the Mac Portable with me on several business trips (in airports, airplanes, rental cars, and hotels) over the course of a month, as well as toting it back and forth between my home and office. I accidentally dropped the machine more than once while it was operating; once I knocked it off my desk, and it fell 3 feet onto a carpeted floor. It never failed.

I also tested the machine's "sleep" mode, a low-power mode that kicks in automatically after several minutes of inactivity (the time interval is selectable). When you select sleep mode from the Desktop's Special menu, the Portable will shut down most subsystems after a few minutes, but it retains all your open applications in memory in their current states. Hit any key, and you're instantly back where you left off. This feature is slick and effective, but it's not new to portable computers.

The 25-millisecond hard disk drive was sufficiently fast, but 1 megabyte of RAM just doesn't cut it for everyday use. I use MultiFinder, and I like to keep several applications open simultaneously, especially the Nisus word processor and the VersaTerm Pro communications program. I can't fit both of these into a single megabyte of memory under MultiFinder. And you can forget about doing anything really meaningful with HyperCard 1.2.5 in 1 megabyte of RAM. So if you buy the Portable, shell out the extra dough for the SRAM upgrade; you'll need it. When SRAM upgrade cards become available, you should consider upgrading to 5 or 9 megabytes—if you can afford it. SRAM is expensive: An upgrade to 9 megabytes could cost as much as you will initially pay for the entire Portable.

While First Impression authors Tom

continued

Mac Portable

APPLICATION-LEVEL PERFORMANCE

Mac Portable **9.3***

WORD PROCESSING

MacWrite 5.0 Medium/Large

Load	0:04/0:08
Search/replace	1:06/8:02
End of document	0:02/0:04
Merge small	0:12/0:13
Store	0:11/0:31
Spelling check	1:28/N/A

MultiWord 2.1

Word count	0:06/0:36
------------	-----------

Microsoft Word 3.01

Cursor down	2:20
Search and replace	1:07
Store	0:19

Aldus PageMaker 2.0a

Load document	0:09
Change/bold	0:39
Align right	0:36
Cut 10 pages	0:22
Place graphic	0:16
Print to file	1:17

Index: **1.53**

SPREADSHEET

Microsoft Excel 1.04

Fill right	0:15
Undo fill	8:37
Recalc	0:05
Load rlarge3	0:21
Recalc rlarge3	0:03

Index: **1.88**

DATABASE

McMax 87.2

Copy	0:14
Index	0:08
List	10:11
Append	0:15
Delete	0:01
Pack	0:06
Count	0:04
Sort	0:28

Index: **1.51**

SCIENTIFIC/ENGINEERING

MiniCAD 3.15

Load	0:10
Hide and shade	3:08
Redraw	4:52

Data Desk 1.2

Regression	2:47
Correlation	3:04

Index: **2.49**

COMPILERS

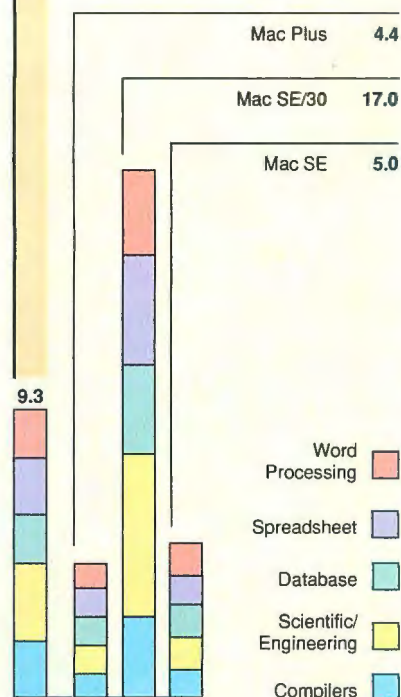
Lightspeed C 2.11

XLisp compile	1:15
---------------	------

Turbo Pascal 1.00a

Pascal S compile	0:08
------------------	------

Index: **1.85**



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

All times are in minutes:seconds. Indexes show relative performance; for all indexes, a Mac SE=1.

LOW-LEVEL PERFORMANCE¹

Mac Portable

CPU

Matrix

String Move	34.10
-------------	-------

Byte-wide

174.60

Word-wide

87.30

Long word-wide

59.80

Sieve

84.10

Sort

76.90

Index: **1.96**

FLOATING POINT²

Math

Error	N/A
-------	-----

Sine(x)

Error	N/A
-------	-----

e^x

Error	N/A
-------	-----

Index: **N/A**

DISK I/O

SubFinder Seek

1 block	16.30
---------	-------

SCSI

32 blocks	45.90
-----------	-------

Floppy

1 block	
---------	--

File I/O (SCSI)³

32 blocks	
-----------	--

Seek

0.30

Read

0.02

Write

0.02

1-megabyte (SCSI)

Write	4.30
-------	------

Read

4.40

Index: **2.51**

VIDEO

Text

TextEdit	9.90
----------	------

DrawString

3.20

Graphics⁴

Slow test	57.00
-----------	-------

QuickDraw

0.70

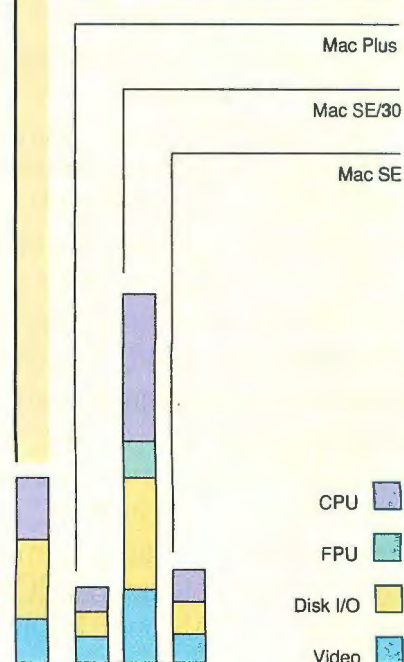
Index: **1.43**

CONVENTIONAL BENCHMARKS

LINPACK	1154
---------	------

Double LINPACK	2107
----------------	------

Dhrystone (Dhry./sec.) ⁵	1633
-------------------------------------	------



N/A=Not applicable.

¹ All times are in seconds. Figures were generated using the 68000 version of Small-C.

² The Floating Point benchmarks use the SANE library.

³ Read and write times for File I/O are in seconds per 64K bytes.

⁴ The Slow test uses code written in Small-C to perform the circle draw and fill. The QuickDraw version uses QuickDraw commands to draw and fill the circle.

⁵ For the Dhrystone test only, higher numbers mean faster performance.

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Benchmark	Microsoft BASIC	Microsoft QuickBASIC	Borland® Turbo Pascal*
SAVAGE	129.1	449.9	281.0
FILE I/O	49.7	72.8	51.5
HAT	183.8	568.5	303.8
SCREEN	2.4	4.3	15.8
Matrix Ops	13.2	66.2	56.5
QuickSort	1.6	2.5	2.3
4P CALLS	0.3	1.0	0.6

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 - Double permitted number of watch expressions.
- Microsoft Editor and CodeView® debugger allow mixed language and OS/2 programming.

Thompson and Frank Hayes found the trackball easy to use, I did not. I found it hard to position the cursor using the trackball, and the placement of the selection button makes it necessary to use the heel of your hand. It's just not easy to use, despite all of Apple's research into perfecting it.

My evaluation machine didn't have a modem, but my WorldPort 2400 external modem worked fine. Apple's internal 2400-bps modem should be available by the time you read this.

I copied to the Portable (using Apple-Talk and TOPS) virtually all the software that I use on my Mac II. This included some four dozen applications, languages, and utilities, plus a slew of cdevs and INITs to make the Portable's environment similar to that of my office and home Mac IIs. With the exception of the usual and known resource conflicts among some cdevs that you must install in a particular order, I had no problems running all my Macintosh software. I also copied large chunks of data and edited those files on the Portable without incident.

Benchmark Performance

BYTE's benchmark tests reveal that the Mac Portable is up to twice as fast as a standard Mac SE and has a much faster hard disk drive. What the benchmarks don't reveal is how these numbers relate to everyday use. The Portable simply feels much faster than it is.

The Portable compared favorably to the accelerated 8-megabyte color Mac II that I normally use. I almost never found myself wanting more speed for basic operations like file copying and deleting, PostScript page printing, or working with everyday documents using Nisus, Excel, Lightspeed Pascal, VersaTerm Pro, and HyperCard. Unlike the Mac SE that I've lugged with me on trips, the Portable's speed was more reminiscent of my Mac II's, although it falls short of my accelerated (25-MHz 68030) Mac SE's. Still, I was pleasantly surprised at just how fast the Portable felt. The combination of a clear, fast screen, a 15.67-MHz CPU, some custom application-specific integrated circuits, and a fast hard disk drive all conspire to make the Portable a pleasant traveling companion.

Portable in Perspective

All this circuitry, the fancy display, the disk capacity, the full-size keyboard, and the trackball don't come without some negatives. Those negatives are price, size, and weight. The Mac Portable is expensive. You start at \$5799; if

you add a hard disk drive, a modem, and an extra megabyte of RAM, you're up to \$7497. The machine is also large—definitely too big to fit comfortably on a lap or on a coach-class tray table. And it's heavy, at about 16 pounds for a hard disk drive unit.

The question for potential Portable buyers is whether the Portable's technoglitzy adds up to something worth buying, despite these negatives. The answer is yes. It performs well, and the Portable is one beautiful machine. The design, both inside and out, is truly a work of art. It's that impressive.

The Portable's nonbacklit screen doesn't handle lousy lighting conditions well, but it's the sharpest, clearest display you'll see on a portable computer. Its fancy power management circuitry and lead-acid battery help the Portable operate for long periods without external power.

Whether or not you buy a Mac Portable also depends on how important it is to you to remain in the Mac environment while you're on the road. On a cost basis, DOS-based portable computers are far better values. Many 80286-based machines run from \$3000 to \$5000. But if you need a Mac on the road, the choice is clear.

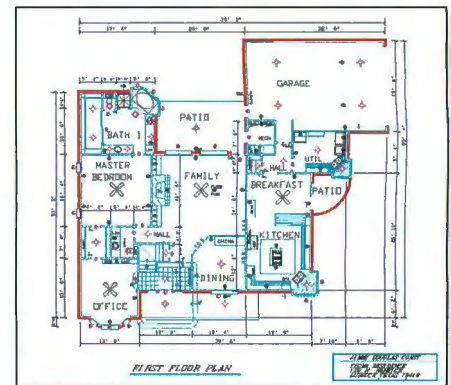
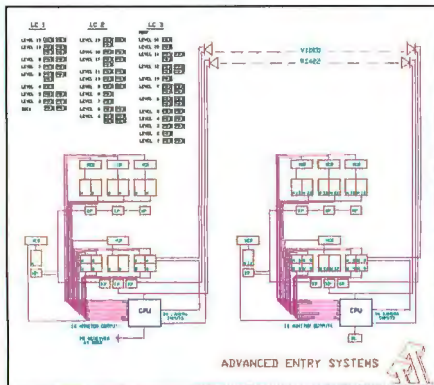
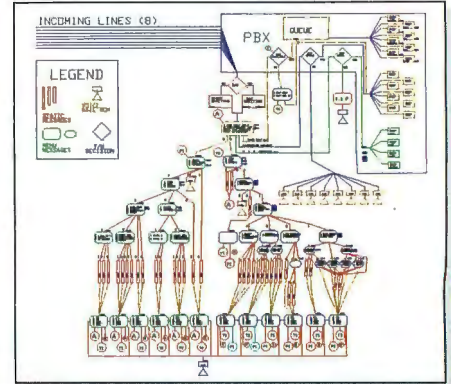
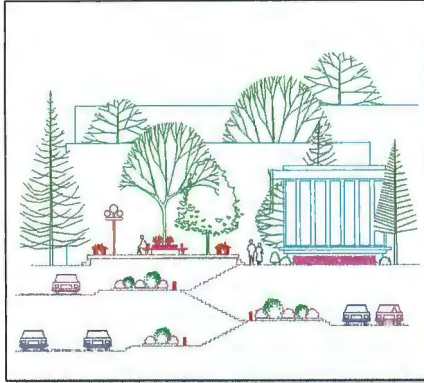
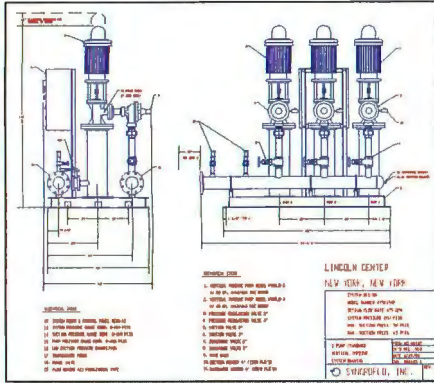
If you use a Mac at home or in the office, then having one on the road is worth the sacrifices you'll make to your sacroiliac (carrying the thing over your shoulder in its fancy carrying case), to your traveling lifestyle (you'll have to fly first class to get a tray table big enough to hold it), and to your wallet.

Sure, the Portable isn't perfect. It should have been lighter, smaller, and cheaper. Considering the time that it took for Apple to get it to market, it should have included more jazzy and innovative circuitry. But it's a *real* Macintosh. It doesn't require pulling the ROMs out of your Mac SE, like the Wallaby does. It's clearly superior to the DynaMac and the Colby. And it's a heck of a lot easier to carry around than a Mac Plus or SE.

With the Macintosh Portable, you can get your Macintosh computing done on the road, and get it done in style and for hours on end. That's the bottom line that Apple shot for, and the company has succeeded admirably. ■

Don Crabb is the director of laboratories and a senior lecturer for the University of Chicago department of computer science. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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A Good Sport

Zenith's MinisPort proves a roadworthy companion

Robert Mitchell

If the TurbosPort 386 is the Arnold Schwarzenegger of Zenith's portable computer line, then the MinisPort is its Baryshnikov. The notebook-size machine doesn't have the muscle of its 80386-based counterpart, but it's light on its feet and puts in a good performance for its size.

Driven by an 8-MHz Intel 80C88-2, the MinisPort offers all the amenities for light-duty computing in transit: small size and weight, a backlit LCD that rotates 180 degrees, 1 megabyte of RAM (384K bytes of which you can configure as a nonvolatile RAM disk), a 720K-byte 2-inch floppy disk drive, a slot for an internal 1200-bps modem, and DOS 3.3 and Rupp Corp.'s FastLynx LX file transfer program tucked neatly away in ROM. What's not small, however, is the price. \$1999 gets you started; add a modem and an extra megabyte of memory (you'll need it), and the price goes up to \$2998.

A Solid Model

The MinisPort feels and looks solid. The chassis won't twist in your hands, as those of some laptops do. The display's metal latches click firmly into place, and a metal carrying handle snaps out from under the front of the case. The keyboard is sturdy and responsive. Zenith backs the machine with a one-year parts and labor warranty.

The system has a clamshell design; the display opens up to reveal an 80-key key-



board. A set of LEDs sits just above the keyboard, and the sliding contrast and brightness controls are easily accessible just under the screen. On the left side of the case are slots for a tiny 1200-bps modem and the MinisPort's nickel-cadmium battery. Both devices slide easily in and out of the chassis. The battery cover has a cutout for the DC power input jack. The modem has a line jack, but (as on most laptops) it lacks a handset jack. A recessed power button and a 2-inch floppy disk drive sit in the right side of the machine.

The display is a 25-row by 80-column, blue supertwist reflective LCD with electroluminescent backlighting. The screen measures 9 inches diagonally (8 1/4 by 3 1/4 inches square) and supports CGA graphics with eight gray scales.

A hinged door on the MinisPort's back panel hides four I/O ports. In addi-

tion to standard parallel and serial ports, Zenith includes connectors for an external CGA monitor and a floppy disk drive. My test machine included an external 720K-byte 3 1/2-inch floppy disk drive. The drive measures a compact 7 1/4 by 4 3/4 by 1 1/4 inches and pulls its power from the MinisPort. Zenith also offers external 360K-byte 5 1/4-inch and 720K-byte 2-inch versions for \$399 and \$349, respectively.

Another storage option is to allocate extra memory as a silicon disk. My review machine included 2 megabytes of RAM—the maximum configuration. The MinisPort doesn't use RAM cards, as NEC's UltraLite does; instead, it has surface-mounted DRAMs on the motherboard. A memory upgrade requires returning the machine to the dealer.

Using Zenith's bundled MFM-180

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Components

Processor: 8-MHz 80C88-2, switchable to 4.77 MHz

Memory: 1 megabyte of 100-ns surface-mounted DRAM chips (2 megabytes maximum); 832K bytes of ROM containing DOS 3.3 and FastLynx LX file transfer program

Mass storage: Internal 720K-byte 2-inch floppy disk drive; memory above 640K bytes is configurable as battery-backed RAM disk

I/O interfaces: 25-pin parallel port; 9-pin serial port; 9-pin external monitor connector; external floppy disk drive interface; internal 1200-bps modem slot; DC power adapter socket

Options tested

External 720K-byte 3½-inch floppy disk drive: \$299

Internal 1200-bps Hayes-compatible modem: \$199

Starter kit (10 2-inch floppy disks, FastLynx cable, slipcover): \$139
1 megabyte of RAM: \$800

Size

12½ × 9½ × 1¾ inches; 5½ pounds

Price

Base system: \$1999

System as reviewed: \$3436

Inquiry 852.

utility, you can assign RAM above 640K bytes as extended memory or as a RAM disk. MFM also lets you enable or disable the ports and set backlight time-out to save battery life. (For a more in-depth description of the MinisPort, see "The Ever-Shrinking, Ever-Expanding Laptops," August 1989 BYTE.)

Field Test

When you first turn on the MinisPort, it boots from its ROM disk—drive C—which contains MS-DOS 3.3 and the FastLynx LX file transfer program. To set up the silicon disk, you press Ctrl-Alt-Ins and select Setup. The silicon disk becomes drive D. The floppy disk drive is drive A. Two nonrechargeable 3-volt lithium batteries back up the RAM disk when the main batteries run out; they sit in a small compartment on the underside of the case.

The next step is to run FastLynx to get your programs to drive D or drive A.

FastLynx installs itself on the host computer, and its menus make the program easy to use. But Zenith doesn't include the necessary cabling. You buy it as part of an optional starter kit, which includes a 6-foot, three-headed serial cable, a slipcover for the MinisPort, and 10 2-inch floppy disks.

The MinisPort's keyboard isn't full travel, and the numeric keypad is an overlay that you use with the Fn key. But the keys aren't jammed together as on some laptops, and the response is adequate for use on the road.

The display is less accommodating. The screen has a wide viewing angle, but it appears washed out and is hard to read under some lighting conditions. I found myself continually repositioning the screen and fiddling with the contrast and brightness controls as I used the machine. Like the NEC UltraLite, the MinisPort's squat display distorts the aspect ratio.

It's too early to say whether the 2-inch floppy disk format will catch on, but its incompatibility with desktop systems is a disadvantage. FastLynx works fine for serial-port file transfers, but it's more convenient to pop a floppy disk out of your laptop and into your desktop system. At \$99 for a box of 10, the disks are also expensive. The RAM disk is so much faster that I recommend buying the maximum RAM and working from the silicon disk as much as possible.

Zenith rates battery life at 3 hours, but your mileage may vary. If you use the modem or the external disk drive, battery life plummets. I got from 1½ to 3 hours between charges. If you use a word processor with the backlighting on, expect to get about 2½ hours of battery life. That makes the machine fine on, say, a New York-to-Washington flight. But for longer trips, you'll want to bring an extra battery (\$79). An off-line battery charger (\$109) is also handy.

When you get where you're going, you'll need the external power supply (a 2¾ by 7¼ by 1¾-inch brick) and its 6-foot power cord. The MinisPort warns of a low battery by beeping intermittently and flashing the power indicator light. You then have 5 to 15 minutes to get to a power source or plug in a fresh battery before the machine shuts itself off. The battery takes about 3 hours to recharge.

Performance

Like the UltraLite, the MinisPort lacked the disk space to run the PageMaker and dBASE III Plus tests in BYTE's application benchmark suite. The MinisPort

continued



Zenith MiniSport

APPLICATION-LEVEL PERFORMANCE

Zenith MiniSport

1.9†

WORD PROCESSING

XyWrite III + 3.52	Medium/Large
Load (large)	:16
Word count	:13/1:40
Search/replace	:25/1:19
End of document	:06/46
Block move	:26/:25
Spelling check	:42/5:40
Microsoft Word 4.0	
Forward delete	1:36
Aldus PageMaker 1.0a*	

Index: 0.68

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:19
Recalc	:08
Load Monte Carlo	N/A
Recalc Monte Carlo	N/A
Load rlarge3	:17
Recalc rlarge3	:06
Recalc Goal-seek	:20
Microsoft Excel 2.0	
Fill right	:29
Undo fill	11:48
Recalc	:10
Load rlarge3	2:01
Recalc rlarge3	:08

Index: 0.47

DATABASE

dBASE III + 1.1*

Index: N/A

SCIENTIFIC/ENGINEERING

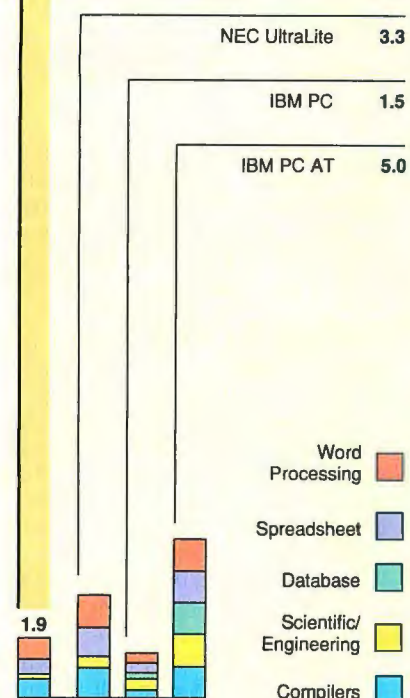
AutoCAD 2.52*	
STATA 1.5	
Graphics	5:01
ANOVA	3:20
MathCAD 2.0	
IFS 800 pts.	6:56
FFT/IFFT 1024 pts.	8:22

Index: 0.15

COMPILERS

Microsoft C 5.0	
XLisp compile	16:26
Turbo Pascal 4.0	
Pascal S compile	:17

Index: 0.63



All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.

*Due to the MiniSport's limited disk space, we were unable to run every application test of the BYTE benchmarks. Tests using Aldus PageMaker, dBASE III Plus, and AutoCAD were omitted. We also omitted the results of those tests for the systems used for comparison and adjusted their cumulative application indexes accordingly.

†Cumulative application index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE¹

CPU		DISK I/O		VIDEO	
Matrix	38.20	Hard Seek³		Text	
String Move		Outer track	0.42	Mode 0	25.83
Byte-wide	214.56	Inner track	0.44	Mode 1	25.85
Word-wide:		Half platter	0.46	Mode 2	18.15
Odd-bnd.	157.53	Full platter	0.46	Mode 3	18.18
Even-bnd.	157.53	Average	0.45	Mode 7	N/A
Sieve	166.81	DOS Seek		Graphics	
Sort	136.69	1-sector	3.07	CGA:	
Index: 0.40		32-sector	16.74	Mode 4	11.15
FLOATING POINT		File I/O⁴		Mode 5	11.13
Math	N/A	Seek	0.67	Mode 6	11.70
Error ²		Read	0.54	Mode 13	N/A
Sine(x)	N/A	Write	0.61	Mode 14	N/A
Error		1-megabyte		Mode 15	N/A
e^x	N/A	Write	4.47	Mode 16	N/A
Error		Read	3.27	VGA:	
Index: N/A		Index: 2.86		Mode 18	N/A
				Mode 19	N/A
				Hercules	N/A
				Index: 0.49	

N/A=Not applicable.

¹ All times are in seconds. Figures were generated using the 8088/8086 versions (1.1) of Small-C.

² The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

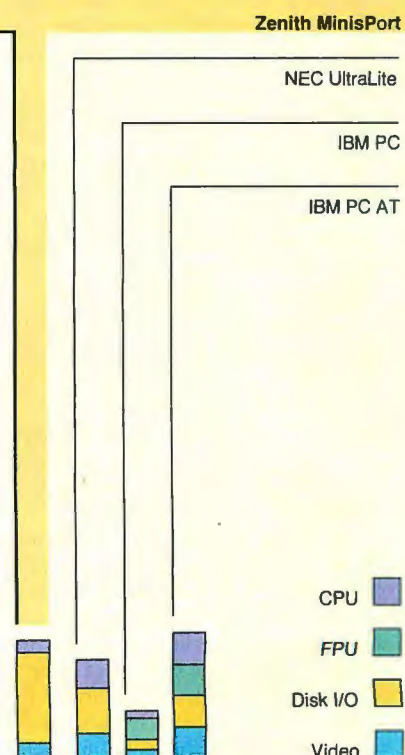
³ Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

⁴ Read and write times for File I/O are in seconds per 64K bytes.

⁵ For the Livermore Loops and Dhystone tests only, higher numbers mean faster performance.

CONVENTIONAL BENCHMARKS

LINPACK	13453.83
Livermore Loops⁵	
(MFLOPS)	0.00
Dhystone (MS C 5.0)	
(Dhry./sec.)	692



Tandy's WP-2: DOS, Shmos

Ben Smith

Before you shell out \$3000 or more for a state-of-the-art notebook-size computer, consider this: Many people use their laptops for only basic word processing and telecommunications tasks. If that's all you need on the road, think about Tandy's \$349 WP-2.

The WP-2 isn't a DOS machine. It's a portable word processor that includes a 100,000-word spelling checker, a 200,000-word thesaurus, and telecommunications functions. The WP-2 measures 8½ by 1 by 11¾ inches and weighs just over 3 pounds. It stores documents in RAM and runs for up to 12 hours on four AA alkaline batteries. A lithium battery maintains the RAM storage. An optional battery eliminator/charger is \$6.95.

The machine comes with 32K bytes of RAM, 22K bytes of which is available for data storage—enough for about seven pages of single-spaced text. You can buy another 32K bytes of internal RAM (\$49.95). There is a slot for removable 32K-byte external expansion cards (\$119.95 each), which perform the functions of a floppy disk. You can connect a \$219.95 Tandy hard disk drive through the 9-pin serial port, and there's a parallel printer port and a port for connecting a cassette tape drive.

The display is an 8-row by 80-column nonbacklit yellow LCD that measures 8¾ by 1¾ inches. Tandy includes a 62-key QWERTY keyboard. The keys are set at a slight angle so that if you prop up the WP-2 on its fold-out feet, you have a keyboard with the same angle and feel as that of a desktop PC.

The word processor software is simple but complete. It uses two function keys (F1 and F2), combined with the top-row (number) keys, to invoke word processing operations: Find, Replace, Select (set block), Copy, Cut, Paste, and Insert/Overwrite. Function keys combined with alphabetic keys let you center, underline, boldface, and change the text font in which you print. (You enter the actual printer control strings in the printer setup screens.) Function keys and standard keys bring up the spelling checker and synonym finder.

Tandy gives a detailed setup for the standard AT 9-pin asynchronous serial port: direct connect/modem line moni-



WP-2

Company

Tandy Corp./Radio Shack
One Tandy Center
Fort Worth, TX 76102
(817) 390-3011

Components

Processor: 5.5-MHz Z80
Memory/mass storage: 32K bytes of battery-backed RAM (96K bytes maximum)
Display: 8-row by 80-column yellow LCD
Keyboard: 62-key QWERTY
I/O interfaces: RAM expansion card slot; 25-pin parallel port; 9-pin serial port; cassette port; external power jack

Size

8½ × 1 × 11¾ inches; 3 pounds

Software

Word processor; 100,000-word spelling checker; 200,000-word thesaurus; telecommunications program; phone list/dialer; appointment list

Price

\$349

Inquiry 853.

toring, 75- to 9600-bps communications, and 5- through 8-bit characters, with a variety of other standard settings that include XON/XOFF and CR character remapping. You can download and upload using either straight ASCII files (use the XON/XOFF in this case) or XMODEM file transfer communications. The dialer/modem control is eas-

ily configurable. However, you can't set up your parameters from within the telecommunications operations without hanging up your modem connection.

The word processor includes two other standard extensions: an appointment list and a phone list/dialer. These appear to be afterthoughts. They're severely limited and in no way integrated with the rest of the WP-2 operations. If you use the dialer to dial up a computer, you must exit the dialer, go to word processing, and then go into telecommunications. This process hangs up the modem, terminating your remote session before you even start. The appointment list doesn't include a calendar, and there's no real-time clock.

Besides the deficiencies in integration between the various operations, the Tandy WP-2 has two major flaws: It doesn't support file transfers faster than 1200 bps, and it drops characters if the input is too fast. The first problem is probably a bug in the communications program. The second problem is most noticeable when you are communicating with a remote system, even when using XON/XOFF handshaking. Once the input buffer is full, it starts losing characters. Since the LCD scrolls very slowly, it isn't immediately apparent what's happening. File transfers go directly to memory without being echoed to the screen, so they don't have this problem.

The WP-2 has similar problems in word processing. If you are even a moderately fast typist, you'll discover that inserting text within a paragraph is visually very slow. It's easy to fill the keyboard buffer, at which point the WP-2 ignores keystrokes until the buffer has space. The WP-2 beeps when the keyboard buffer is full.

The WP-2's problems are all software-related, and updates are unlikely, since the ROMs are surface-mounted. But if you can work around these problems, you'll find the machine easy to use, physically well designed, very light, and easy to tuck into the pocket of an attaché case or a large purse—and it's refreshingly inexpensive.

Ben Smith is a BYTE technical editor. He can be contacted on BIX as "bensmith."

also couldn't run BYTE's AutoCAD tests. For consistency, some adjustments were made to the cumulative application indexes of the machines used for comparison.

The MinisPort was substantially slower than the UltraLite overall (see "The Painlessly Portable PC," August 1989 BYTE). The MinisPort's CPU index of 0.40 is considerably slower than the 0.93 that the UltraLite's 9.83-MHz V30 CPU attained. The UltraLite was also nearly twice as fast on the video tests and on most of the application-level tests. The MinisPort's one saving grace was the silicon disk, which proved to be nearly twice as fast as the UltraLite's in the low-level disk tests.

The Verdict

Compared with the UltraLite, the Zenith MinisPort is noticeably slower, slightly larger, and nearly 1½ pounds heavier. The UltraLite also has a bigger, better-quality display and includes a 2400-bps modem. But the MinisPort is much sturdier and has a superior keyboard and a longer battery life. The display is acceptable. And it includes a parallel port, which the UltraLite lacks (an optional external floppy disk drive does include a parallel port). Comparably equipped, the two machines are about the same price.

If you can live with a nonbacklit display, a smaller RAM disk, and a 4.77-MHz CPU, you can buy a Toshiba T1000 for less than half the price of the base model MinisPort. If all you do is basic word processing and telecommunications on the road, perhaps you don't need an MS-DOS machine at all (see the text box "Tandy's WP-2: DOS, Shmos" at left).

The biggest problem with the MinisPort is that newer machines may upstage it by the time you read this. Toshiba's new T1000SE offers a similar base configuration with a standard 1.44-megabyte 3½-inch floppy disk drive for \$1699. Compaq's LTE is another strong alternative. It includes a 1.44-megabyte 3½-inch floppy disk drive and 640K bytes of RAM for \$2395. Both machines weight about the same as the MinisPort and are about the same size (see "Laptops Forever," December 1989 BYTE, for a first look at these machines). But you can't go wrong with the MinisPort. If you can afford it, it's certainly worth a look. ■

Robert Mitchell is a BYTE technical editor. He can be contacted on BIX as "rob_mitchell."



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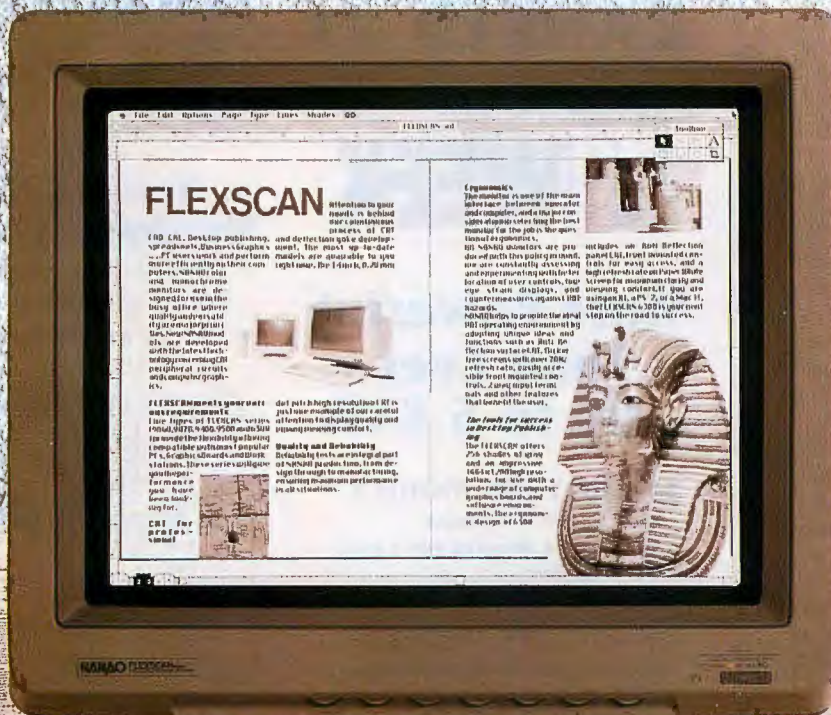
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The LaserJet IIP: Inexpensive, Not Cheap

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to the desktop

Alan Joch

L leading the vanguard of affordable laser printers, Hewlett-Packard's LaserJet IIP realizes an elusive dream: putting 300-dot-per-inch print quality and a range of fonts on the desktop at a realistic price.

The \$1495 IIP, with a standard 512K bytes of memory and no accessories, was selling for \$950 from some mail-order companies at press time. Because of the reputation and installed base of the IIP's ancestors, notably the LaserJet Series II, the smaller cousin by default provides a standard with which to compare downsized laser printers. In that role, the 4-page-per-minute, 300-dpi IIP performs admirably, as long as you're a laser-printer user with time on your hands. If not, you may be inclined to believe the *P* in IIP stands for "pokey."

Better to Be Seen, Not Heard

Aesthetically, the IIP may be HP's most pleasing design. The cube measures only 13½ by 8¼ inches and stands 16 inches high (see figure 1). But even more important for a printer meant to sit at your side day in and day out, the IIP is refreshingly quiet. It's rated at 44.1 decibels during printing. To my ears, it was louder than the fan on the BYTE Lab's 33-MHz 80386 PC, but quieter than the fan on the Macintosh II next to me.

HP conveniently grouped the six control-panel keys on the top of the printer.



They're more like oversize keyboard keys than the squishy touch-sensitive buttons on the Series II, and they provide a pleasing click. A blinking black square in the nearby command window clearly shows when the printer pauses for data from the computer. (You can program command-window messages to appear in four other languages besides English, which is helpful for bilingual offices and HP's overseas marketing plans.)

Unfortunately, some menu items, including font selection, require you to hold down Alt while pressing a second command key. Even with the handy tear-out reference card that came with the manual, I needed time to learn the key combinations required for some menu selections. Also, because the keys and the command window sit on top of the unit, they're hard to read from a sitting position if the printer is on your desktop.

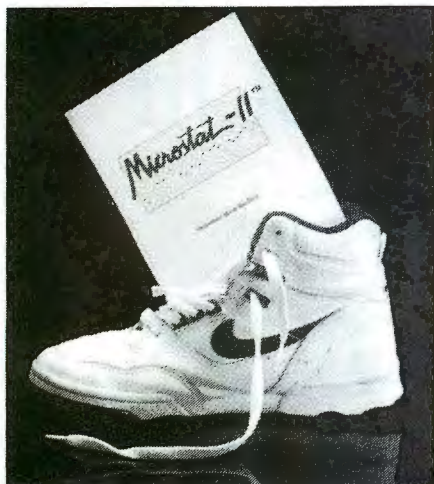
Those who place the printer on a lower credenza may not have this problem.

The printer's top also sports a shallow saucer that collects printed pages. Retractable paper stops in the saucer keep letter-, legal-, and A4-size pages in place. But the flimsy stops and the saucer are the two most obvious corners HP cut to design this lower-priced laser printer. I missed the Series II's deep, well-defined paper bin that holds printouts in tight, compact stacks.

I noticed the difference especially when I printed large text files. Paper in the IIP's saucer collected in messy piles, although the pages never clogged the exit. Paper in the top-exit path forms an inverted S as it travels through the printer (see figure 1). HP also includes an output tray that attaches to the front of the printer to collect media that travel in a C

continued

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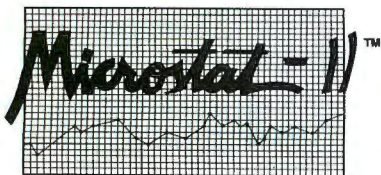
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ECOSOFT

LaserJet IIP

Company

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

Size

13½ × 8¼ × 16 inches; 30 pounds

Software Needed

Applications that support HP PCL

Documentation

Quick Start guide and owner's manual

Price

\$1495

Inquiry 854.

shape to a second face-up exit. The company recommends that envelopes, labels, and transparencies travel the latter path.

Also lightweight is the standard input paper tray. When not in use, it folds neatly into the front of the printer; when you're ready to print, it swings open to a 75-degree angle. In the open position, the printer's footprint increases by 10 inches. Usually, that extra space had already become home to manuscripts, file folders, and coffee cups, so before I could print anything, I first had to rearrange my desk to accommodate the paper tray. This seemed like a lot of trouble for a tray that holds a maximum of 50 sheets of paper. I preferred the optional \$195 tray that attached to the printer's underside; it held 250 pages and increased the unit's height by only 2½ inches.

Font Selection

Seven standard fonts reside in the printer's ROM: six Courier typefaces in various sizes and styles, and an 8½-point line-printer font. The printer can produce each of these fonts in portrait (vertical) or landscape (horizontal) orientations. In addition, the IIP accepts HP's LaserJet font cartridges. I tested two such cartridges, one with Times Roman fonts in both portrait and landscape orientations, and the second with Helvetica fonts in portrait only. Interestingly, when I told PageMaker to print a text file in landscape mode using the Helvetica cartridge, the IIP merged the landscape command with the proper font and then printed the text horizontally. The cartridge won't allow this on the Series II.

HP Printer Control Language emulation comes standard with the IIP. An optional cartridge for both Epson FX and IBM Proprinter emulation was scheduled to ship at the end of last year (pricing wasn't determined at press time, but it was expected to be less than \$200). HP says that a similar cartridge with licensed Adobe PostScript fonts will be available in the first quarter of this year for about \$1000. PostScript compatibility will also require additional memory, bringing the price of a PostScript-compatible IIP to around \$3500.

Canon's LBP-LX engine lies at the heart of the IIP. A 10-MHz 68000 processor drives the printer. Two open memory slots accept optional 1- or 2-megabyte memory boards, for a maximum of 4.5 megabytes. The 512K bytes of standard memory can generate a half-

continued

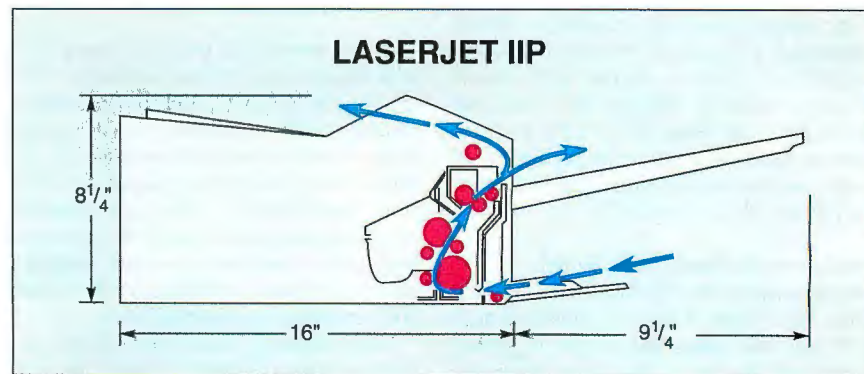


Figure 1: The LaserJet IIP is designed to be a welcome guest on your desktop or credenza. Smaller than the LaserJet Series II, the IIP makes some trade-offs, primarily with its humble output trays, to accommodate downsizing. But the IIP balances its shortcomings with some added capabilities, including internal fonts that can be printed in portrait and landscape orientations. The IIP offers two paper paths and exit choices. The more complicated inverted-S path brings printouts to the top of the printer and stacks pages (face-down) in proper order. The C-shaped front exit is a must for envelopes and adhesive labels that wrinkle easily.

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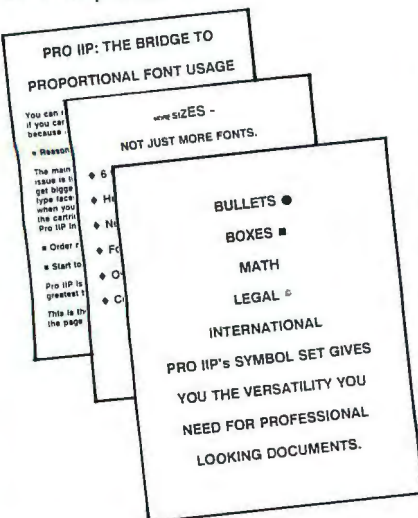
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- 9 point medium, **bold, italic**
- 10 point medium, **bold, italic**
- 11 pt medium, **bold, italic**
- 12 pt medium, **bold, italic**
- 14 med., **bold, italic**

24 pt bold

Swiss type face in:

- 8 point medium, **bold, italic**
- 10 point medium, **bold, italic**
- 12 pt medium, **bold, italic**
- 14 med., **bold, italic**

24 pt bold
30 bold

Prestige Elite in: 10 pt/12 pitch med.,
bold and italic 7 pt/16.66 pitch medium

Letter Gothic in: 12 pt/12 pitch med.,
bold, and italic

Presentation in **14 point bold**
18 point bold

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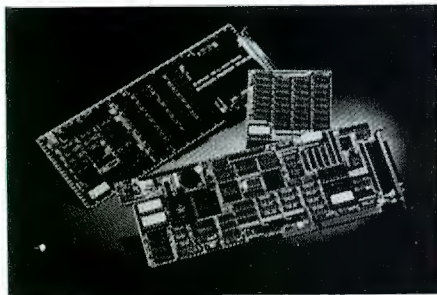
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Head to Head

I tested speed and print quality with four test files that were run at least three times each on the IIP and a Series II. Two of these files consisted entirely of text generated from XyWrite III Plus 3.51. The first file was a single page of single-spaced text; the second, 15 single-spaced pages. I also designed a 1-page newsletter using Aldus PageMaker 3.0. It included a masthead with boldface and outline type, a 4½-inch-square line drawing, and 12½ column inches of text. Finally, I created two Harvard Graphics 2.1 pie charts on a single page, with a bold title and subtitle and no text other than chart labels (see figure 2). I chose 300-dpi resolution when printing the newsletter, and standard quality to print the pie charts. (The IIP's 512K bytes of standard memory was enough to print the charts in high-quality mode, but the overburdened Series II was unable to do this. For consistency, therefore, I used standard quality for my time tests.)

As table 1 shows, the IIP lagged be-

hind the Series II in all four tests. In some cases, such as the 14-second difference in the 1-page file, I could ignore the slower speed. But when that was multiplied over 15 pages, the difference rose to almost 2 minutes. Mixed text and graphics, as in my newsletter example, showed only moderate time differences.

The IIP's 300-dpi output exhibits the quality you'd expect from a laser printer. If you shuffle together printouts from the IIP and the Series II, you probably won't be able to tell the difference. Text printed crisply in roman, italic, and boldface, as well as in large and small point sizes. My sample line drawing looked equally well defined, as did thick and thin rules and pie-chart circles generated from Harvard Graphics. The hash marks that differentiated pie slices were sharp in even the most intricate patterns when I printed in high-quality mode. Standard and draft modes (chosen through the software—the printer doesn't offer these selections) showed relatively more broken lines and fuzzy curves, but not unexpectedly so. None of my test printouts produced print-quality problems like staining, unwanted vertical lines, or toner blotches.

I also printed mailing labels and envelopes. The HP manual cautions you to

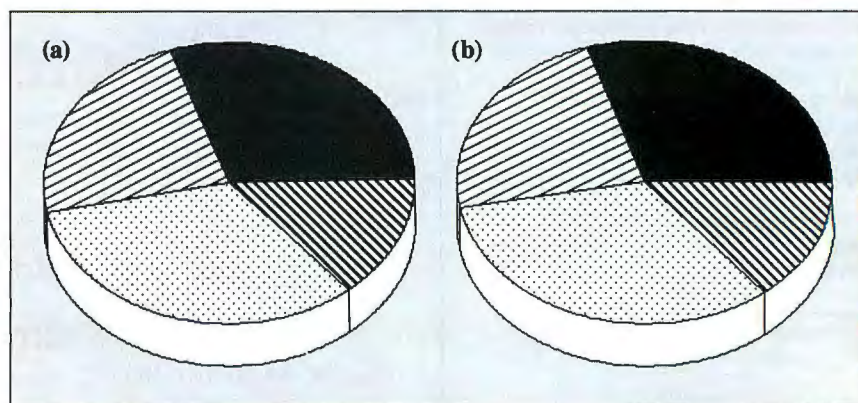


Figure 2: Outputs of this Harvard Graphics-generated pie chart showed virtually no difference in quality between the one produced on the LaserJet IIP (a) and the one produced on the LaserJet Series II (b).

Table 1: Although the LaserJet IIP's speed lagged behind that of the LaserJet Series II in all four time tests, printing large text files produced the greatest discrepancies. Times are the average of three trials, in minutes:seconds.

Printer	TIME TRIALS			
	1-page text file	15-page text file	Combined text and graphics	Pie charts
LaserJet IIP	0:36.71	3:57.13	4:28.15	1:13.43
LaserJet Series II	0:22.47	2:07.58	4:07.99	0:49.59

use only laser-quality adhesive-label stock—specifically, stock that can withstand the printer's 392°F fusing temperature. My sample stock met this requirement and worked flawlessly, both in terms of print quality and in its ability to pass through the paper path without hanging up. Envelopes had to travel through the front exit or else they'd become so wrinkled you'd think the post office had already gotten its hand on them. With this condition, envelopes printed fine and were aided by the retractable guides on both the standard and optional paper trays.

Easy Assembly

Setting up the IIP is simple. A Quick Start guide is meant to ship along with the standard, well-written user's manual; it focuses on setup procedures. My review unit lacked the guide, but I didn't miss it. The EP-L toner cartridge slips easily into place once you've opened the IIP's front cover. Toner didn't leak from the cartridge even after I broke the seal and rocked the cartridge as directed to disperse the toner.

Serial and parallel ports sit on the unit's back. You plug in the proper cable (cables cost extra), make sure the control window displays the correct interface, change AUTOEXEC.BAT, and you're in business. The IIP can even accommodate serial RS-442 cabling if you need to use a cable more than 50 feet long. You remove the back cover and reposition the serial interface jumper block—nothing a novice can't do with the manual at hand. Attaching the optional lower paper tray is similarly straightforward and only requires turning a few screws.

A nice touch that's unique to HP's printer line is the cleaning paper to maintain rollers. You generate the paper by instructing the printer to perform a self test; it creates a page of sample fonts with a wide black band. HP suggests that you run this page through the print cylinders each time you replace the cartridge, which has a life of 3500 pages.

However, I'd dock design points for the placement of the density-adjustment lever, which sits inside the front cover. To reach it, you have to open the printer's folding panel, which is a little out of the way. Also, the printer's heating element rests near the exit of the front paper tray and therefore close to fingers that may be gathering printed pages. Warning labels caution against touching it.

Economical Extravagance

Lower-cost desktop laser printers won't replace brawnier and speedier printers

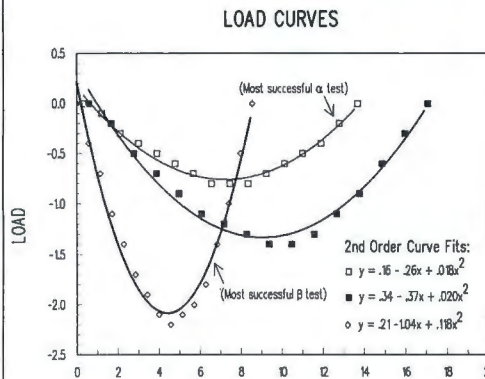
like the Series II as a shared peripheral on a network. For example, HP rates the IIP at a 6000-page volume per month, while the Series II logs in at 12,000 pages. Nor will the downsized version take over in commercial desktop publishing shops, where speed and volume equal profits. But the IIP may be ideal for a small business's correspondence. Also, departments within large corporations can tap the IIP to print correspondence and company newsletters and

avoid bottlenecks at the network printer.

For once, a laser printer can be dedicated for specific tasks like these without seeming like an unjustifiable extravagance. And thanks to the relatively few shortcuts that the company took in designing the IIP, HP has proved that desktop lasers don't have to be cheap to be inexpensive. ■

Alan Joch is a BYTE technical editor. He can be reached on BIX as "ajoch."

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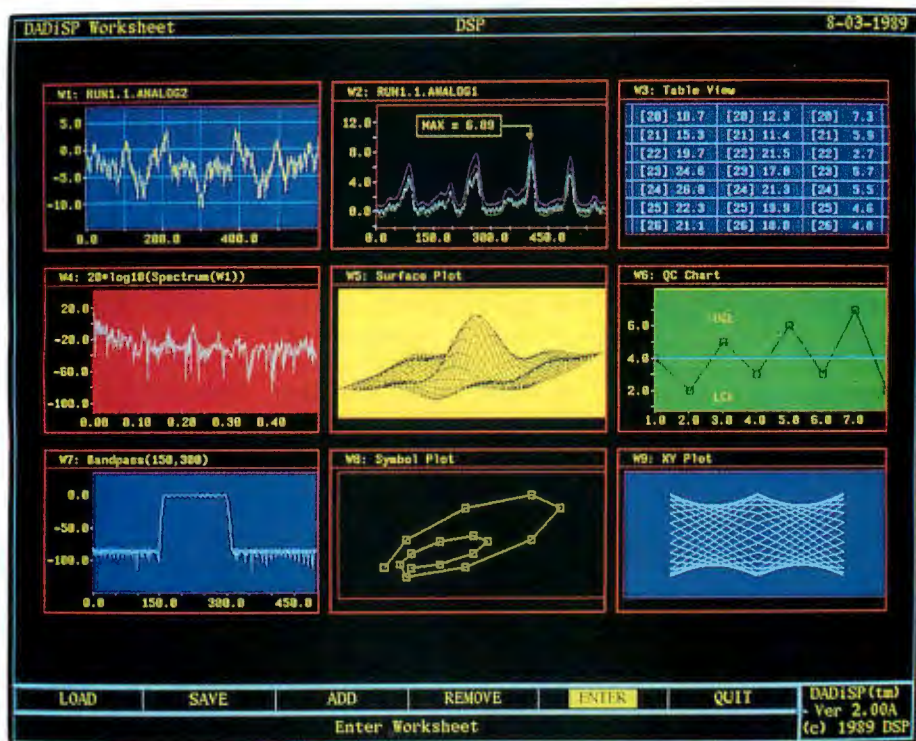
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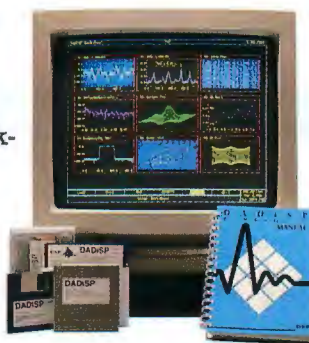
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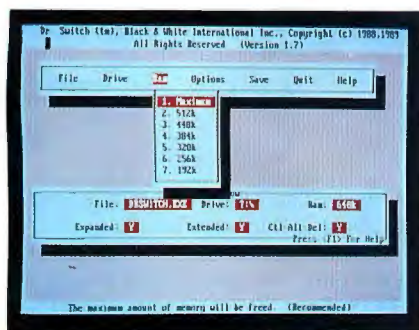
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Time to Switch



DOS application switchers bring help for the hurried

Stan Miastkowski

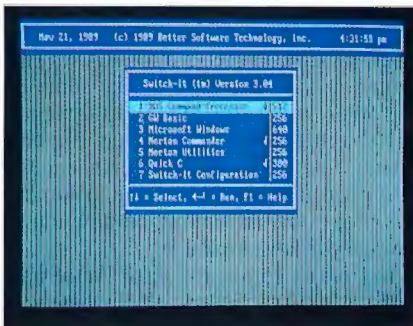


Photo 1: Dr. Switch's setup screen lets you customize the program (top left).

Photo 2: One of HeadRoom's application setup screens (center).

Photo 3: With Software Carousel, you can fine-tune partition sizes (top right).

Photo 4: An application menu is integral to Switch-It (bottom).

If you're like most users, you're hearing the siren call of operating systems like OS/2 that do multitasking and easily switch between applications. Normally, the process of switching between DOS applications can be painful, especially when you need to run three or four applications on a regular basis, with each application taking up most (if not all) of your available RAM space. You must store the file you're working on, exit the application, and then start the next one.

DOS shells, such as XTree and Norton Commander, and menu programs have helped a bit, allowing you to switch between applications a little more quickly. But it still takes time (and lots of key-strokes).

The Shell Game

One solution for the problem—in some applications—is to “shell out” to DOS,

leaving all or part of your application still in memory. But this DOS EXEC ability often can't be used, because once you're running a major application, there's very little RAM space left to run another.

Several utilities, called application switchers, try to overcome these problems. An application switcher takes your running application, stores an image of its state in extended or expanded RAM or even on a hard disk, and immediately loads another application to take its place. This process theoretically leaves maximum RAM space for each application, letting you run even the most RAM-hungry programs without having to completely shut down your other program.

I took a look at five different packages: AutoSwap 1.2, Dr. Switch 1.7, HeadRoom 2.0, Software Carousel 3.0, and Switch-It 3.0. While these are all

switch applications, they are vastly different programs. Some are simple and inexpensive, but a couple are extremely complex.

None of these packages brings true multitasking to DOS. As switchers, the images of the nonrunning programs that they switch to the background are held in a state of suspended animation. For this reason, I did not review programs, such as DESQview, that offer complete environments for running applications as well as limited multitasking.

I ran all the programs on a 10-MHz AT clone with a 66-megabyte (29-millisecond) hard disk drive. The system had a total of 3.5 megabytes of RAM. Using the All Charge Card and its device driver, I configured the additional memory (above 1 megabyte) as 512K bytes of extended memory and 2 megabytes of expanded (EMS 4.0) memory. The 512K

continued

	AutoSwap 1.2	Dr. Switch 1.7	HeadRoom 2.0
Company	The Lambda Group, Inc. 555 DeHaro St. San Francisco, CA 94107 (415) 626-4545	Black & White International, Inc. P.O. Box 1040, Planetarium Station New York, NY 10024 (212) 787-6633	Helix Software Co., Inc. 83-65 Daniels St. Briarwood, NY 11425 (718) 262-8787
Hardware Needed	IBM PC, XT, AT, PS/2, or compatible with 6K bytes of RAM and a hard disk drive	IBM PC, XT, AT, PS/2, or compatible with 25K bytes of RAM and a hard disk drive	IBM PC, XT, AT, PS/2, or compatible with 256K bytes of RAM and a hard disk drive
Software Needed	DOS 2.0 or higher	DOS 2.0 or higher; applications that can run external programs	DOS 2.0 or higher
Documentation	User's manual	User's manual on disk	User's manual; on-line help
Price	\$49	\$59.95	\$129.95
	Inquiry 884.	Inquiry 885.	Inquiry 886.

bytes of extended memory is required to speed up Windows/286, which I also tested with the switchers.

AutoSwap

At \$49, The Lambda Group's AutoSwap is the least expensive of the group reviewed. It's simple to install and use, but it also has some limitations.

AutoSwap works only with programs that directly shell out to DOS without ending. Most major applications can do this, including dBASE, Paradox, Lotus 1-2-3, WordPerfect, Microsoft Word, and XyWrite. But if you want to use it with a program that won't shell out to DOS, you're out of luck.

Installing AutoSwap is a snap; there's an installation program on the distribution disk. When it's done, AutoSwap's installation leaves a tiny (6K-byte) file, called AS.EXE. All the installation files on the distribution disk, however, take up over 250K bytes.

Although the company says AutoSwap is not copy-protected, you can only use the installation program once. When I attempted to install AutoSwap on a different machine in the BYTE Lab, it gave me an "already installed" message and then aborted. To get the program to work, I just copied the AS.EXE file to the new system. The experience would have been considerably less frustrating if the process had been explained in the manual.

Because it's small and simple, using AutoSwap doesn't take much effort. For example, while running the XyWrite program, I shelled out to DOS using the DOS command. Normally, I'd try to start the Paradox database by typing PARADOX. Then I would get a message from Paradox saying there wasn't enough memory to run it. But with AutoSwap in-

stalled on my disk, all I had to type was AS PARADOX. The image of the XyWrite file was immediately saved to expanded memory, and Paradox had all the room it needed.

I then shelled out to several other programs through AutoSwap. Each time I started another program, AutoSwap left a new 6K-byte kernel in main RAM. The program is smart, too. Unlike some of the other switchers, AutoSwap dynamically allocates RAM space for the image. This makes the most efficient use of storage and lets you shell out to numerous programs, depending on how much storage you have available.

My major complaint about AutoSwap is that it's easy to lose track of where you are and just how many levels you have shelled out to. AutoSwap lacks a pop-up menu to tell you where you are, which makes it impossible to switch directly from application to application. If I wanted to run XyWrite after shelling out to three other programs, I had to exit (and unload) each program in the reverse order from which I opened them before I could get back to the word processor.

AutoSwap is best if you only want to work with two or three programs. Essentially, it simply extends the DOS EXEC facility. AutoSwap isn't a do-all, end-all utility, but what it claims to do, it does well.

Dr. Switch

The interestingly named Dr. Switch is also inexpensive at \$59.95. In the way it operates, Dr. Switch closely resembles AutoSwap, but with some crucial differences.

Like the other programs here, Dr. Switch has a standard installation program. You can install it as many times as

you wish. The actual program is small, too: about 25K bytes of RAM.

As with AutoSwap, you can use Dr. Switch only with programs that shell out to DOS. From XyWrite's command line, I typed DRSWITCH PARADOX to start Paradox. Each time that I shelled out to a new application, Dr. Switch left a 14K-byte kernel behind while it stored my initial application's image in expanded memory.

But I was in for a surprise. When I shelled out to my fourth program, there was a long delay and lots of activity on my hard disk drive. What had happened is that I had run out of memory space, so Dr. Switch stored the image on the disk. Unlike AutoSwap, which dynamically changes the size of the image, Dr. Switch uses a full 640K-byte partition for each image. If you have enough expanded (or extended) memory and you switch between only two or three applications, that shouldn't be a big problem, but it is a disadvantage.

Like AutoSwap, Dr. Switch doesn't have an application menu, although its setup routine asks whether you want to use expanded or extended memory or the hard disk for storing application images (see photo 1).

Dr. Switch's user manual, available only as a READ.ME file on the hard disk, makes it clear that the program is optimized for use with dBASE and its clones. You can use dBASE's RUN command to shell out immediately to another program.

Dr. Switch also has two other important features that AutoSwap lacks. It lets you load and unload TSR programs. For example, I use SideKick's Notepad along with Procomm, my communications program, but I don't use the Notepad at

Software Carousel 3.0

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other times. So I wrote a small batch file that loaded SideKick with Procomm. When I exited back to XyWrite, Dr Switch unloaded SideKick along with Procomm.

Dr. Switch also has the cutely named program, Scalpel. This is an extended version of the program's ability to swap out TSRs. But unlike the batch file above, Scalpel unloads all TSRs that have been loaded *prior* to the program you shell out to. Scalpel is handy for using TSRs that don't normally opt for peaceful coexistence.

HeadRoom

Helix Software's HeadRoom, which has been available for almost two years, now comes in version 2. It is a complex program with a raft of features and extra utilities. At \$129.95, it's also the most expensive of the programs reviewed here. Although it does an outstanding job of swapping applications, its real forte is in handling TSRs. It can swap virtually any number of TSRs to extended RAM or to the hard disk, leaving a tiny kernel in base RAM. It also lets you pick and choose among individual or combinations of TSRs.

HeadRoom is also one of the largest programs here, taking up about 51K bytes of RAM at all times. Unlike AutoSwap and Dr. Switch, HeadRoom can work with *any* application.

It is relatively simple to set up applications to switch from using HeadRoom. The program's application setup screens (see photo 2) are straightforward. HeadRoom essentially turns your applications into sophisticated TSRs by letting you specify a hot key to call each application. If you haven't previously started the application, the hot key will start it; if you

Switch-It 3.0

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have, the hot key calls up the image.

The version of HeadRoom that I tested used a fixed partition size of a full 640K bytes for each image. So once again, my 2 megabytes of expanded memory were sufficient to store the images of only three programs. But HeadRoom's setup let me specify whether to use RAM or the hard disk for swapping images, so I got around the problem by telling the program to swap my less-used applications to the hard disk instead of RAM. It's a slow solution, but it works.

The issue may become moot, though. Helix Software says that by the time you read this, an updated version of HeadRoom will let you determine the size of the partition for each application. The company also says that this version will have a "cut and paste" feature for copying data between applications.

Like Dr. Switch, HeadRoom also lets you couple TSRs with specific applications. It's a simple matter of assigning a batch file (instead of the application itself) to a partition. HeadRoom's other (and separate) TSR-control features let you load and unload other TSRs at almost any time.

Software Carousel

SoftLogic Solutions' Software Carousel (\$89.95) sits in the middle of the programs reviewed here. But it's also the most difficult of the programs to learn and to use. Much of the blame rests squarely with the manual.

Software Carousel is powerful, but much of its power lies hidden behind numerous confusing screens, not to mention on-line help that is so sparse that it's seldom any help at all. But of the full-featured application switchers, Carousel is the most powerful because it lets you

determine how much memory each application partition should use. This is far better than the current versions of Dr. Switch or HeadRoom, which grab 640K bytes of RAM whether an application needs it or not.

Carousel's setup screen (see photo 3) allows you to enter the amount of RAM needed for an application. Powerful applications like Ventura Publisher or Paradox require full 640K-byte partitions, but if you can get by with less, so much the better. Fortunately, this is one area where the manual is helpful. To store data, most applications need more space than the size of their command (or executable) files; the problem is finding out exactly how much space. SoftLogic Solutions has provided a list of many common applications and the space that they require. (For applications not on the list, you'll need to experiment.)

After you've set up the partitions, swapping applications is a simple matter of pressing hot keys. I found it hard to get used to the blank screen pauses while the swap took place. A miniature gas gauge finally appears on the screen to show progress, but only after a couple of seconds have passed.

Carousel has its quirks. It essentially takes over your system's base RAM, with its huge 540K-byte kernel always resident. This method, with applications sitting within the kernel and being swapped into and out of it, is a far cry from the tiny kernels the other programs here use. But it works.

Carousel can also work with specific TSRs by using batch files within partitions. In fact, the manual suggests that you load only global TSRs (e.g., disk-caching software) before you start Carousel.

Switch-It

In some ways, Switch-It is the sleeper of this bunch. It's a program that I liked immediately and liked even more as I got to know it. It is full of thoughtful little touches that show that its developers didn't just rush something out the door.

The program, which costs \$79.95, has something of a dual personality. You can use it as a plain-vanilla automatic menu program (if you would rather not swap images), or you can use it as a full-fledged application swapper. In addition, you can use it as a combination of the two.

Of the programs here, Switch-It is the only one that pops up a menu on the screen when you're between applications (see photo 4). I found this handy, but if

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you're fond of DOS shell programs, regular use of Switch-It might become annoying.

One of Switch-It's nicer features is its installation. The program searches your entire hard disk (or multiple disks, if you have them) for common applications and then presents you with a list asking you which of them you want added to the Switch-It menu. Like Carousel, Switch-It uses variable-size partitions for its application images and *knows* exactly how large the partitions for common applications should be.

A separate configuration program lets you add just about any application. You can specify the particulars for each, and the setup even checks to see if the path names and command filenames that you enter actually exist. If they don't, you are told immediately.

You do, however, need to specify the partition size for applications that you add to the memory. This requires a bit of experimentation—and a trade-off. If you have plenty of RAM (or don't mind slow-speed image transfers to and from the hard disk), you can be sloppy and just specify a large partition size. Once you are set up, Switch-It lets you use hot keys either to go directly to your applications or to choose the applications from the menu.

Unlike the other programs here, the amount of main memory that Switch-It requires varies depending on the application you are running. In addition, Switch-It switches its own code in and out of your expanded memory (or your hard disk). That's not necessarily a disadvantage, just a different way of doing things.

Switch-It is also the only program here that currently has a built-in cut-and-paste capability. You can also choose several different formats for the text, depending on the application into which you'll paste it. The cut-and-paste feature works flawlessly; it alone is almost worth the price of the product. And like the other programs, Switch-It can also include specific TSRs within application partitions, swapping them in and out along with the program.

Of course, Switch-It isn't perfect, and its one glaring shortcoming is in the graphics realm. Switch-It is the only program here that blew up when switching from a Microsoft Windows partition to a nongraphics partition. In fact, the whole system just locked up and required rebooting. It wasn't happy with other graphics-based programs, either. If you need graphics, you'll have to choose another application switcher.

Making the Switch

Even though all the programs reviewed here have their particular idiosyncrasies, they all do what they claim. If you constantly work with two or three different applications and need to switch regularly among them, the simple programs that use the DOS EXEC function aren't a bad choice. They're inexpensive and easy to use. Conversely, HeadRoom, Software Carousel, and Switch-It make the most sense if your hard disk is filled with numerous applications and multitudes of TSRs.

But the main question is, should you even buy an application switcher? That depends. None of these application switchers works wonders if you have a system with little RAM and a slow hard disk drive. Although all the manufacturers claim that you don't need a full 640K bytes of RAM to use them, I found it's the only way to go. Extended or, preferably, expanded RAM is another necessity, and the more the better.

Switching programs to and from a slow hard disk drive is something you'll want to avoid. I tried the programs on a BYTE Lab AT clone with a slow (65 ms) hard disk drive using a 3-to-1 interleave controller. The results were discouraging. Swapping applications on that hard disk typically took 20 to 40 seconds. In that time, I could have quit one application program and loaded a new one. Even on my fast hard disk drive the switchers took 5 to 15 seconds to swap applications.

There are exceptions, though. A few programs go through a lengthy setup as they load (such as building extensive indexes) and can take a minute or more to start. If you use such a program, a 20- to 40-second wait for switching applications may not be so bad.

Finally, if what you really need is multitasking, an application switcher can't help you. You cannot switch, say, from a communications program doing a file transfer to another application. The transfer will be suspended, and you could lose the communications link.

The fact is that application switchers aren't for everyone, and some users may even be disappointed. But if you don't expect more than it promises, and if your situation warrants one, an application switcher can be a handy tool. ■

Stan Miastkowski is a BYTE consulting editor, managing director of K+S Concepts (a documentation and consulting firm), and editor of the OS Report newsletter. He can be reached on BIX as "stanm."

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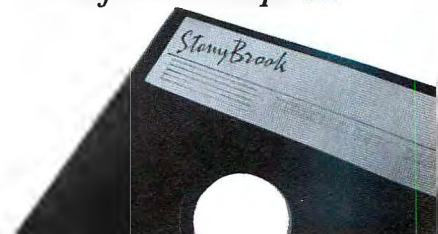
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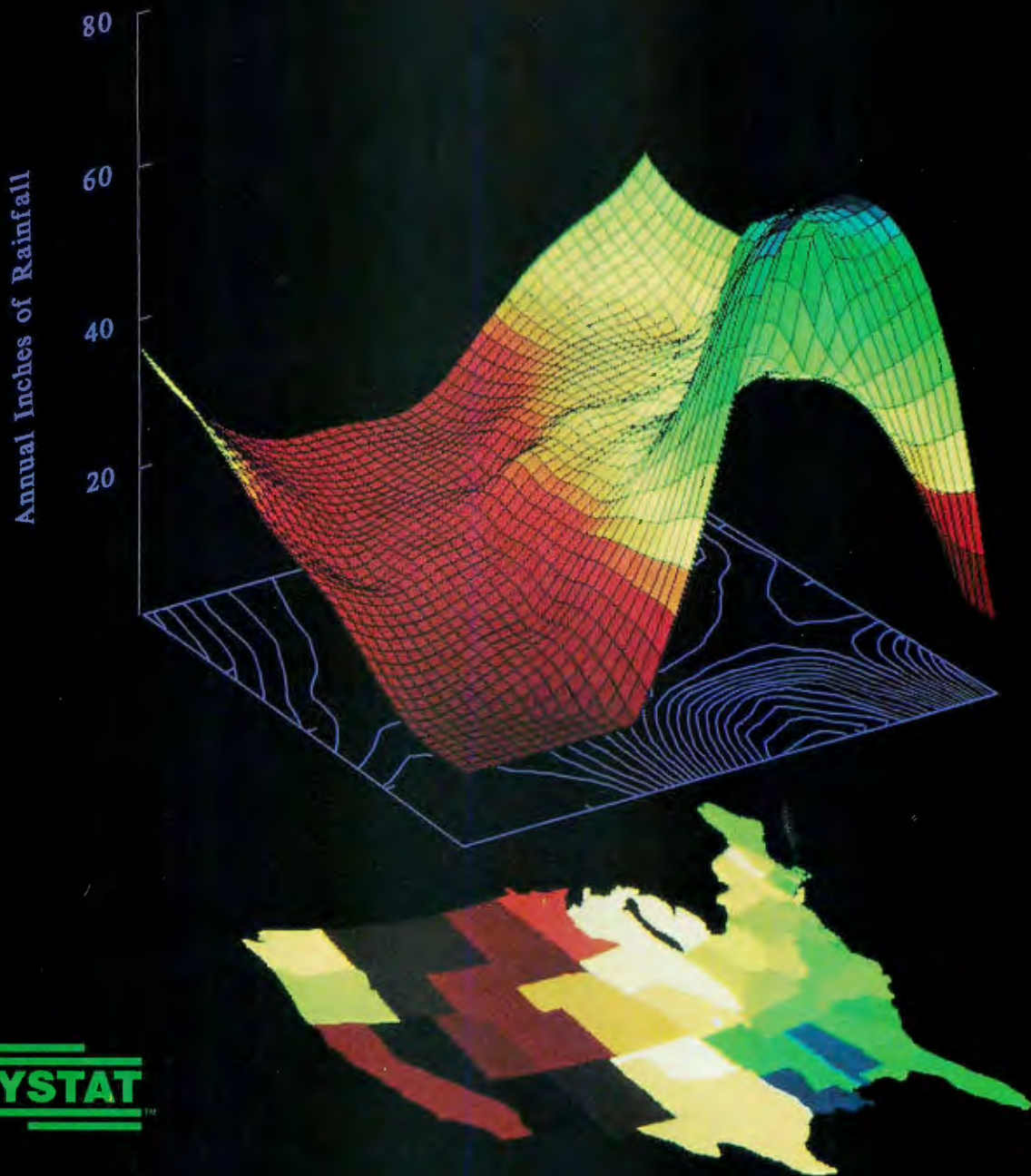
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Alex Lane

Even though your 80386 microprocessor's 8086 emulation mode can address a full megabyte of memory, MS-DOS artificially limits you to only 640K bytes of conventional memory. That's a real loss, since most 80386 systems come with several megabytes of memory. There is an answer, though, with 386Max. It maximizes your machine's performance by making available unused portions of RAM that lie in the 384K-byte region between 640K bytes and 1 megabyte.

You can use the memory recovered by 386Max either to store TSR programs, such as SideKick, or to store device drivers that normally would be loaded into high conventional DOS memory.

I worked with 386Max Professional 4.07, which also included a copy of 386Load 3.01, a program loader that works with 386Max. That package costs \$129.95, but you can also buy 386Max without 386Load for \$75.

Unlike most software, 386Max is particular about the machine it runs on. As its name implies, it works only on 80386-based microcomputers and requires a minimum of 256K bytes of extended memory. (A version for 80286-based machines, called Move 'Em, should be available by the time you read this.)

I ran 386Max on a 16-MHz ARC 386i microcomputer with DOS 3.3, 512K bytes of memory on the motherboard,

1.5 megabytes of extended memory, a VGA display, and a 40-megabyte hard disk drive that behaves (with the help of a device driver) like two 20-megabyte hard disk drives.

Flexible Options

Installing 386Max is easy; you just copy the two files 386MAX.SYS and 386MAX.COM to your hard disk drive. You then edit your CONFIG.SYS file to include the device path for 386MAX.SYS.

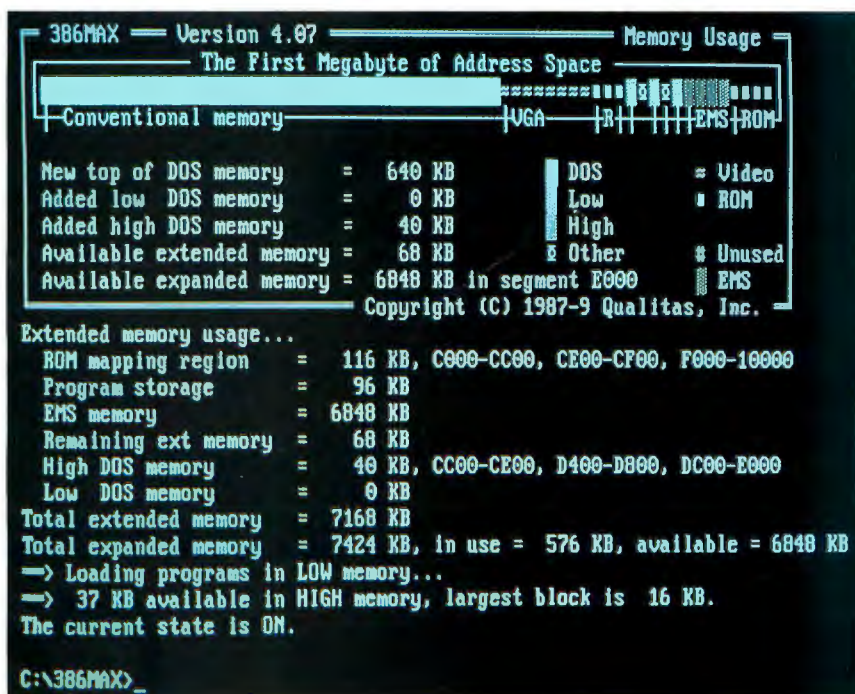
If no options are supplied in this line, then all extended memory is allocated as EMS, and the 64K-byte segment starting at address E0000 is used as the EMS page frame. In addition, 386Max copies the contents of all ROMs into areas of RAM, which are then remapped so that when the original ROM code is executed,

it is read from the faster RAM instead of the slower ROM. Finally, any memory "gaps" between the highest system board memory address up through address FFFFF are filled in. These defaults should be adequate for most needs.

The basic options 386Max provides concern specifying how to map extended memory, what page frame segment to use for EMS, and whether to swap conventional and extended memory. You can pass many advanced options to 386Max by specifying the name of a file containing them on the driver installation line.

Advanced options let you prevent 386Max from automatically doing things, such as swapping ROM for RAM or filling in high memory above the display adapters. Other options specify memory

continued



386Max includes a utility that lists how your system allocates DOS and extended memory.

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areas as either ROM or RAM, instruct 386Max to reclaim shadow RAM from systems using the Chips & Technologies' AT/386 chip set, and enable or disable the Weitek 1167 math coprocessor.

When I ran 386Max with no options,

the program found 96K bytes of free, high conventional DOS memory and reserved 64K bytes of memory starting at E0000 for EMS. When I specified EMS=0 as an option, no EMS memory was allocated, so I got 160K bytes of high conventional DOS memory available. Interestingly, when I replaced the VGA monitor and card with a CGA monitor and card, 386Max did not detect what should have been a gap in memory between 640K bytes (address A0000) and the start of CGA memory (address B8000). I could, however, make 386Max aware of the gap by adding a RAM= option statement to the device driver line in the CONFIG.SYS file.

Another option, called SWAP, is useful for 16-bit machines with installed 80386 accelerator cards and 32-bit extended memory. This option permits conventional memory to be swapped for the same amount of extended memory.

One nice feature incorporated into the design of 386Max is the ability to prevent installation of the 386Max driver by pressing the Control, Alt, and left Shift keys while rebooting. This feature can be a nerve-saver if you have trouble during

installation and can't find a DOS system disk with which to boot your system.

Loading in High RAM

With 386Load, you have to enter three commands to load a program into high memory. First, you "activate" loading into high memory by running the program 386MAX.COM with the parameter LOADHIGH. You then invoke the memory-resident program by name. Finally, you "deactivate" loading into high memory by running 386MAX.COM with the parameter LOADLOW.

To load a device driver with 386Max, you need the driver 386LOAD.SYS. You start by modifying the CONFIG.SYS file and replace each line that loads a driver with a line like the following:

```
DEVICE=C:\386LOAD.SYS
GETSIZE PROG=C:\DRIVER.SYS
[arguments]
```

When you have finished modifying the configuration file, you reboot the system; 386Load pauses at each line and informs you whether you need to include

continued



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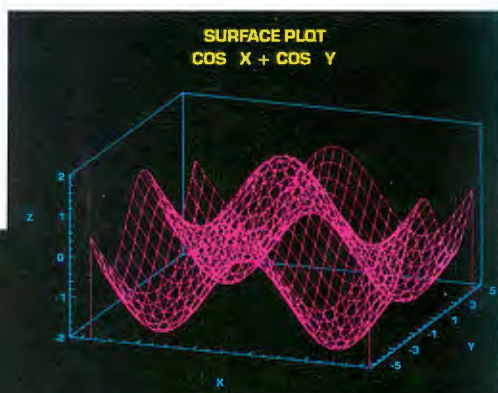
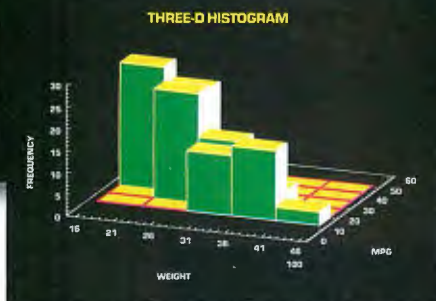
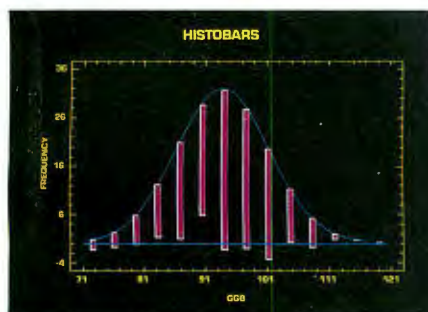
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the keyword SIZE= followed by a number for any particular driver.

For example, when 386Load loaded my hard disk device driver, it told me that no SIZE= keyword was needed. However, when it came to install the driver that allows my debugger to run in extended memory, 386Load indicated that the keyword SIZE=10048 had to appear on the line. After 386Load determines the initialization and resident sizes of the device drivers in this pass, you edit the CONFIG.SYS file to make the requisite keyword changes, and you're done.

Finding What's What

In addition to recovering stray chunks of RAM above 640K bytes, 386Max can display various statistics regarding memory use in your system. A utility provides a detailed memory map of resident programs that you can analyze to help optimize memory utilization. You can also generate reports to show EMS usage, memory-access times, the locations of ROM in memory, and an overall map of system memory usage.

The major problem with using 386Max in any but the most plain-vanilla configuration is the degree of expertise you must possess to properly determine what will and won't work with it. For example, many programs, such as Windows and Software Carousel, get confused if memory allocation chains extend up above 640K bytes.

Qualitas supplies a large amount of information pertaining to the use of its product with, for example, DOS 4.0, AutoCAD's AutoLisp, and PS/2 computers. Unfortunately, it's not easy reading for the nontechnically oriented user.

In general, the documentation is adequate. Product support from Qualitas requires you to have the disk serial number at hand before talking with a technician. My experience on the phone confirmed the strictness of this policy.

The only degradation in performance I noted was a slight pause after keying Ctrl-Alt-Del to reboot the machine when using 386Max. Otherwise, the software worked fine.

If you operate an 80386 system with unusual characteristics or unusual software and you need a flexible piece of software to deal with the problem of reclaiming and using high memory, 386Max is the right choice. ■

Alex Lane is a senior knowledge engineering consultant for Technology Applications, Inc., and lives in Jacksonville, Florida. He can be reached on BIX as "a.lane."

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Two Mac Hard Disk Drives Deliver Speed



Thanks to the Macintosh's built-in SCSI port, Mac users can pick and choose among feature-rich external hard disk drives. I recently looked at two newcomers: Toshiba's MacKit 140E, with 140 megabytes of formatted storage for \$1695, and Rodime's Cobra 210e, a \$2549 drive with 210 megabytes of formatted storage.

The two external hard disk drives have a lot in common. Both sport disk-access indicator lights, two SCSI connectors, and a handy push-button SCSI ID selector switch. Each uses embedded SCSI controllers to avoid complications involved with using a SCSI-to-ESDI or SCSI-to-ST506 drive interface.

Each drive supports the full SCSI disconnect/reconnect command set, so that in a lengthy I/O operation the drive will disconnect from the SCSI bus, giving another SCSI peripheral access to the bus until the drive has data ready for the Mac. At that point, the drive arbitrates and then reconnects to the bus.

The Cobra uses zoned-bit recording, a format in which more sectors exist on the outer tracks of the disk platter than on the inner tracks. This format allows more data to be crammed on the disk and provides for faster transfer rates. The MacKit uses a spiraled format on its platters that accomplishes the same purpose.

Both drives have internal look-ahead

buffers to speed sequential read operations (the MacKit's buffer is 32K bytes; the Cobra's is 48K bytes). Finally, both feature removable internal resistor packs that terminate the SCSI connector. This lets you use the drive as a stand-alone SCSI peripheral or, if you remove the resistor, as a drive in a chain of SCSI devices.

The Cobra uses a 3½-inch hard disk drive with an 18-millisecond access time. It's a fast drive in a svelte housing; it weighs about 6 pounds. The MacKit, with a 5¼-inch 23-ms hard disk drive, weighs 11½ pounds. Each is designed to be tucked under a Mac Plus or SE.

The Cobra includes two 300-watt filtered power outlets, controlled by the drive's power switch. You can hook the Mac and an external monitor into these outlets. If the Cobra has a hardware problem, an I/O light flashes an error code that indicates which component failed. The MacKit doesn't offer additional outlets or indicators, but Toshiba mounted the fuse externally for easy access.

Rodime bundles Fifth Generation Systems' Fastback backup software with the Cobra. Utility software formats the hard disk (the interleave is user-selectable), tests it, lets you build partitions, and installs the driver. Rodime provides its own software; the MacKit's software comes from Universal Mac Products.

I used both drives on a Mac II for several weeks and had no problems. The Mac II had an Apple internal 40-megabyte hard disk drive, 5 megabytes of RAM, a SuperMac 19-inch monitor, and System 6.0.3. I ran the BYTE low-level benchmarks and an abbreviated set of the optical storage benchmarks (see "The Optical Option," October 1989 BYTE) to simulate file operations. The results (see table 1) show that the Cobra drive's faster access time and larger look-ahead buffer improve hard disk drive performance. The Toshiba is no slouch, either;

Table 1: Benchmark results.
The Cobra's larger look-ahead buffer and faster access time speed up read operations. Times are in seconds, except for those for the optical test, which are in minutes:seconds.

BENCHMARK RESULTS

Test	Cobra	MacKit
Seek		
1-sector	10.9	14.75
32-sector	25.32	31.67
File I/O		
Seek	0.14	0.26
Read	9.44	19.14
Write	8.07	8.02
1-megabyte		
Write	3.45	3.62
Read	1.32	4.37
Optical	25:39	27:52

it matches the Cobra on disk writes.

Because of their size and speed, both drives are suitable mass storage devices for a file server. In addition, the Cobra 210e offers several conveniences that can make it a useful second hard disk drive for your Mac.—Tom Thompson

Cobra 210e

Rodime Systems
901 Broken Sound Pkwy. NW
Boca Raton, FL 33487
(407) 994-5585
\$2549
Inquiry 855.

MacKit 140E

Toshiba America Information Systems, Inc.
Disk Products Division
9740 Irvine Blvd.
Irvine, CA 92718
(714) 583-3150
\$1695
Inquiry 856.

CocoNet Unites Unix, Novell, and DOS

Imagine hooking your AT-compatible computer into a network that offers powerful 32-bit server-based applications in addition to the usual file- and print-sharing services. NetWare 386 and OS/2 LAN Manager developers are scrambling to provide a robust, multitasking, protocol-independent network operating system that can nurture and sustain such applications. CocoNet delivers it now.

The secret? The Santa Cruz Operation's (SCO) Xenix-Net, a Xenix implementation of Microsoft's MS-Net. Xenix-Net is the core of CocoNet. It enables CocoNet to link a Xenix server to DOS clients through the NetBIOS and server message block protocols, using the familiar MS-Net net start, net share, and net use commands. Clients can map virtual DOS drives to Xenix subdirectories and use the connection to establish fast virtual terminal sessions with the Xenix host.

If you haven't heard much about Xenix-Net, you're not alone. The product has been around for several years, but it's suffered from a lack of support for popular network hardware. In addition, the necessary MS-Net software has normally been bundled with complete MS-Net-based products and not sold separately.

CocoNet solves these problems and adds some polish to Xenix-Net. One nice touch is that CocoNet can coexist with Novell. I'm writing this on a machine that's both a Novell and a CocoNet workstation. With CocoNet's packet driver interface, the Ethernet adapter in my computer runs two protocols: the CocoNet-supplied version of Novell's IPX and CocoNet's NetBIOS. Novell links me to two file servers that I share with PC and Mac users (the latter by way of NetWare for Macintosh and AppleShare), and a couple of laser printers. CocoNet adds another file server (the Xenix machine). That is also what CocoNet's PC and Mac LAN counterparts are struggling to become: an application server.

What applications? For starters, there are SCO applications that are just like Lotus 1-2-3 and FoxBASE+ except that they run in the 80386's native mode under a secure, multiuser, multitasking operating system. The CocoNet (and Xenix-Net) `int5c` library provides one way to build server-based applications that speak NetBIOS to DOS clients. CocoNet's decoupling of the client's pro-

TOCOL stack from its network hardware suggests an even more interesting possibility: TCP/IP. Support for this protocol, which could link DOS workstations to mainstream Unix LAN activity, is high on CocoNet's agenda.

CocoNet could help break down the barriers that separate Unix and DOS communities. It makes Unix less of a threatening, all-or-none alternative and more of a complement to what PCs and PC LANs do well. Think about it. Do you build a multiuser database on top of a new operating system like NetWare 386 or LAN Manager, or do you use tried-and-true Unix? Because it adds Unix

A Pip of a Utility

Back in my CP/M days, I was a master of the PIP (peripheral interchange program) command. I copied files from disk to disk and accomplished a great deal with this simple command and some well-chosen options. When I changed to MS-DOS, I missed the convenience of PIP—until I got a copy of Zeamon.

DOS limits you to a few wild-card options, used with the asterisk and question mark. Zeamon is a utility program that adds new commands and wild-card options to the standard DOS and OS/2 command processors. It lets you copy and delete files, display formatted directories, generate a formatted list of specific files, move and update selected files, or execute a command string for each file that matches a set of criteria or filters.

A sample Zeamon command, including all the options, looks like this:

```
Z COMMAND [d:]source [+/-filter]
[d:][target] [/a/b/c/d/e
/f/k[RH]/m/n/o/p/q/r
/s[NESD][+/-] /t/v/w/x].
```

Brackets enclose the options. You enter Z, the command (copy, delete, dir, execute, list, move, or update), the drive/path name, and the name of the source files. The plus and minus signs are inclusion and exclusion filters that designate a path name, filename, extension, or wild card that should be included or skipped over in a directory search of the source.

The alphabet soup of options controls the sort order, processing of files by dates, running in batch mode, subdirec-

connectivity without compromising your PC's role as a DOS-based LAN workstation, CocoNet makes the latter a more likely choice. Users don't want to give up their personal computers, but they'd like those PCs to share central data and central processing of that data. That's not a new problem, and CocoNet isn't a new solution. But it's a good one.—Jon Udell

CocoNet

CocoNet, Inc.
4275 Aurora St., Suite E
Coral Gables, FL 33146
(305) 447-4608
Server adapter and software, and DOS client software: \$2595
Inquiry 857.

tory creation, screen display, and whether you want to confirm each file operation, to name only a few possibilities. I did need a bit of practice to remember all Zeamon's options, but just typing Z displayed a sample command line and a list of all the choices.

The Zeamon reference manual is adequate. It could use some more examples and a fuller explanation of the delete and execute commands. I had no problems, but I had the advantage of working with programs similar to Zeamon in the past.

Unlike many DOS shell programs that are TSR programs, the Z.EXE program requires RAM only when you run it. Zeamon uses a 63K-byte buffer for copying, moving, and updating files. You can shrink the buffer by setting an environment variable to specify size in K bytes.

There are two versions of Zeamon. Z.EXE is a dual-mode program for OS/2 and DOS 3.x and higher. If you are running a lower version of DOS, you must use ZD.EXE, the DOS-only version.

Programs like Zeamon aren't new. Several DOS shareware or public domain programs do much the same job. However, Zeamon is easy to use, and all the commands use the same syntax for all options. It is ideal for users like me who are addicted to using the command line.

—Stanley J. Wszola ■

Zeamon 1.0

SoftCare Systems, Inc.
925 Clifton Ave.
Clifton, NJ 07013
(201) 473-2002
\$69
Inquiry 858.

BIX CALENDAR

FEBRUARY

F E B R

Display this month's
BIX activities

Y

BIX to hold "sum-it" conference—and other animated discussions.

If numerical methods, symbolic algebra, Wffs and Pffs, mathematics teaching, and equation layout with Tex, Eqn and Manuscript are among the pressing issues in your world, you'll want to attend BIX's new mathematics conference. (join mathematics)

And if computer animation is what moves you—or if you're just into old comic books and political cartoons—our new animation conference is the place for you. (join animation)

FRIDAY, 2/9, 8 PM EST. Computer animation for kids of all ages.

Steve Segal, creator of the well-known Amiga-animated film "*Dance of the Stumblers*," joins our new animation conference in a CBix session. Mr. Segal is presently working with American Interactive Media, where he's directing interactive, computer-animated stories for children that will be released on CD-ROM. (join animation/cbix).

Exchange Updates

Amiga Exchange—Multimedia and the Amiga will be explored during February in the "multi.media" topic of the "amiga.arts" conference. And more specifically, you can discuss the use of optical drive file systems in the "amiga.hw" conference.

IBM Exchange—This month, Colin Sampaleanu, author of Telix, visits BIX to discuss his popular telecommunications program. You'll also find in-depth discussions on hard drives, OS/2, communications programs in general, and LANs.

CBix sessions are held every weeknight at 10 PM EST in the IBM Exchange. Beginning and intermediate PC-users may be especially interested in the *question-and-answer sessions* that are held every Wednesday night in this time period.

Look for a schedule of upcoming CBix sessions in the topic "info.cbix" in the "ibm.exchange" conference.

Mac Exchange—In "mac.products," we'll look into on-line multimedia, consider the new products recently introduced by MacroMind, and examine the question of Mac hardware as a multimedia platform.

Meanwhile, the Mac Exchange will continue its discussion on Mac hardware and software.

And the tutorial on C programming will continue in the "mac.novice" conference.

Writers Exchange—Three new conferences have been added to this exchange:

new.writers, where aspiring writers can turn for insights and tips on getting started,

write.fiction, for people who are specifically interested in writing fiction, and

writers.talk, for those who just want to talk one-on-one with professional writers. At the moment, Greek and Latin classics are hot topics here.

Interactive Games Exchange—Now you can invite your children to join you on Sunday afternoons for 90 minutes of on-line fun and activities at the gazebo/town.hall. The activities, which are designed for children between ages 5 and 10, will include kiddie trivia, on-line typing lessons, and ASCII art. (You'll also find inspiration here for *off-line* arts and crafts activities.) You'll enjoy story hours, during which you can read stories to your children and help them interact with others. And you'll be able to chat with people from around the world. A program for teenagers is also in the works. (join gazebo/town.hall)

Elsewhere in the Interactive Games Exchange:

Richard Pini, co-creator and publisher of ElfQuest, will answer questions about Elves and their world. (join eq)

Programs and applications related to on-line gaming are discussed in the dd conference. (join dd)

There's a whole lot of on-line socializing going on at the gazebo. (join gazebo)

BIX Conference News

Two more companies now offer customer support in BIX Technical Conferences:

Rational Systems, which will support its incremental C compiler and development environment, Instant-C (join rational.ic), and

The Periscope Company, which will support its debugging programs. (join periscope)

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Multimedia

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This is it! The big moment has arrived. You have been working on this project for months, and the time has come to present it to the decision makers. They will decide whether you have wasted your time or whether your idea can go into production. Your stomach is doing flip-flops. All eyes are on you. You reach for your flip charts and overheads.

Flip charts? Overheads? Isn't this the computer era? Surely, with all the high-speed machines, CD-ROMs, synthesizers, and image-processing capabilities available, there must be something that will convey your message better than flip charts and overheads.

Well, there is. It's called multimedia, and it marries the best of image, voice, text, and video processing. It's the subject of this month's In Depth section.

In "The Four Multimedia Gospels," Phillip Robinson looks at multimedia through the eyes of the players. He discusses what it is according to Apple, IBM, Sony, and others. Strangely enough, the definition varies depending on whom you talk to, but there are similarities.

Then, in "Beyond Hype," Rob Lippincott discusses multimedia today and tomorrow. Where is it now, and where is this new merger of technologies going? Currently, a lot of multimedia is hype. Although the technologies exist, the bridges between them are still largely mythical, holding off a potential explosion of applications. Will you ever see them?

Next, in "Birth of the BLOB," Tim Shetler delves into the database design issues for multimedia. He shows how you can save digitized images and sounds in a relational database as though they were normal fields in the file, right alongside text fields. Multimedia databases might change the way you do business.

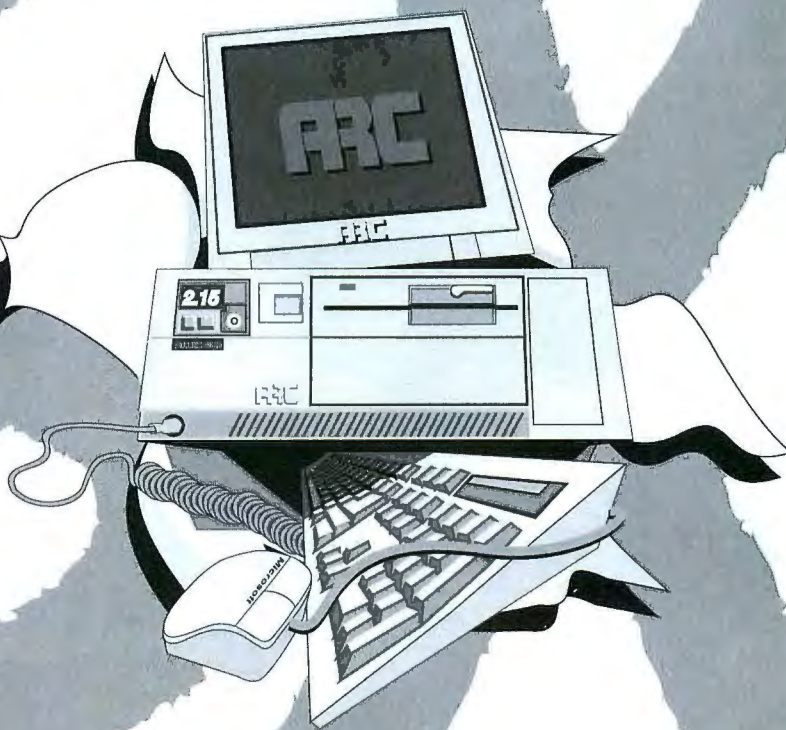
And in "Desktop Video Studio," Rick Cook explores how you can make that presentation more exciting now, before the multimedia revolution becomes widespread. He looks at the hardware and software available today for your current microcomputer to enable you to create videos to replace those flip charts and overheads in your next presentation.

In the final analysis, the name of the game today seems to be integration. The industry has all kinds of incredible technologies available to it, but trying to pull them together and use them in conjunction with one another is still relatively uncharted territory.

It's no different for multimedia. The beginnings of an integrated approach are in place, but, right now, that's all you have. Using multimedia today is far from instinctual, and in some cases, it's downright difficult. The technology is there, but it still has a way to go before it is easily accessible.

—Jane Morrill Tazelaar
Senior Technical Editor, *In Depth*





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The Four Multimedia Gospels

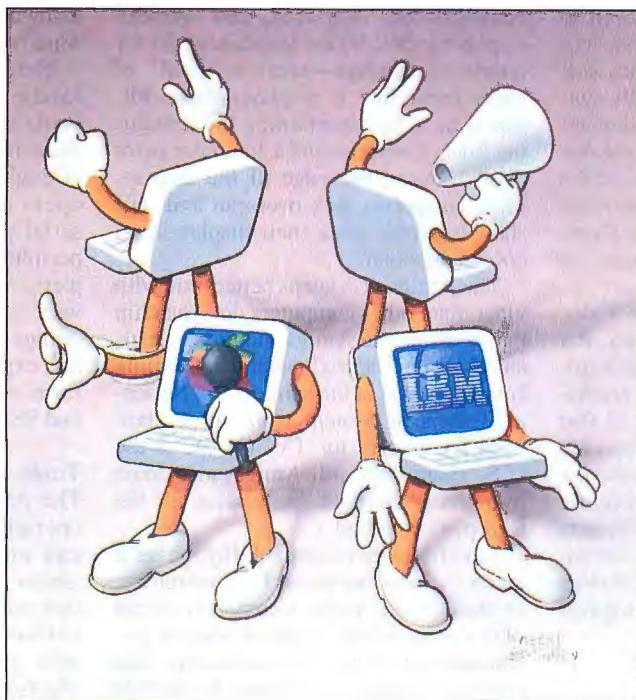
*According to Commodore, Apple, IBM/Intel,
and Sony/Philips*

Phillip Robinson

Even if you're not sure what multimedia is, you probably know it when you see it (and hear it). If a computer is showing a graph, formatting a page, playing a tune, or even shading a three-dimensional model, that's not multimedia. If it's showing a graph in one window and rotating a three-dimensional model in another while playing a tune, you're in the right neighborhood. But if it plays music from a compact disk (CD) while animating the graph and superimposes the result on a prerecorded video—that's multimedia.

When you combine standard data processing with graphics, animation, speech synthesis, audio, and video, you're part of a phenomenon in computing. Multimedia uses the computer to integrate and control diverse electronic media such as computer screens, videodisk players, CD-ROM disks, and speech and audio synthesizers. If you make logical connections between those elements and make the entire package interactive, then you're working with hypermedia.

The people who are inventing multimedia computing really don't have any better definition than that. Computers



vary in their abilities to handle the various elements of multimedia and hypermedia. Naturally, the computer manufacturers like to accentuate the positive aspects of their own systems. So they tend to define multimedia in terms of what their own systems do best. (This creates a technological version of the tale of nine blindfolded experts and the elephant. Each expert gives a different de-

scription of the animal at hand, based only on the feature he can feel.)

Just about any modern computer can handle text processing and produce basic sounds. Most computers can handle graphics pretty well, too, although they differ in details such as display resolution, color selection, and performance. (Such details can sometimes be quite important.) But the different computers start to spread apart when you look at animation—which is essentially high-performance graphics. When you examine high-quality audio, they move even further apart. And they are radically separate in their abilities to handle video—importing video signals from tape or camera, editing and merging video and computer-generated graphics or text, and exporting the resulting mix to videotape.

Finally, different strains of computers have quite different abilities to integrate all those elements. Each offers different operating-system and “authoring-system” software to create, read from peripherals (e.g., videodisk players, CD players, optical disk drives, and video cameras), combine, edit, and produce

continued

multimedia or hypermedia presentations. This software is as critical to practical multimedia as the sophisticated video, audio, and graphics hardware.

In the future, the different approaches to multimedia may converge. File-format standards may well emerge, and authoring-system conventions may congeal. Until then, however, you can't understand the state of multimedia without knowing the four multimedia gospels according to Commodore, Apple, IBM/Intel, and Sony/Philips.

COMMODORE

Amiga: The Pioneer

While multimedia may be a new term to most computer users, the idea is business as usual to Commodore Amiga enthusiasts who believe the market is finally catching up with them. Even at its introduction back in 1985, the Amiga was touted by some as the best personal computer for video, audio, and graphics. The hardware of every Amiga is tailored to working with graphics and video—co-processors flying through graphics calculations, and display circuits easily synchronizing to the speed of standard video signals. That core strength may be responsible for the Amiga's survival in the U.S. Unable to rack up the volume sales of the Mac and IBM PC families, Commodore has sold a million Amigas, in part, by targeting the video niche.

When Commodore talks about multimedia, it emphasizes desktop video. But the relatively inexpensive Amiga hardware is also adept at graphics, animation, and sound manipulation. And that hardware is inhabited by a multitasking operating system that can interweave the various media. Commodore has recently added new, powerful authoring-system software to the mix, a package it intends to back (along with the latest Amiga hardware) with an advertising campaign centered on multimedia.

Multimedia Built In

You can get the no-frills Amiga 500 with its 68000 processor and 512K bytes of RAM for just over \$500. The high-end Amiga 2500 boasts a 68020 processor with at least 1 megabyte of RAM and expansion slots for lots more. Several developers offer 68030 add-in boards for the Amiga, and Commodore had its own \$2000 25-MHz 68030 board (with a math coprocessor and 2 megabytes of 32-bit RAM) at Fall Comdex 1989.

Much of the Amiga's muscle for video and audio work comes from three custom chips named Agnus, Paula, and Denise. They accompany the standard 68000, 68020, or 68030 CPU and perform graphics, sound, and various I/O duties while the CPU attends to other tasks.

Agnus, for instance, is a graphics co-processor that includes dedicated circuitry called a *blitter* for quickly altering areas on the display. Denise has animation *sprites*, graphical shapes that you can define and move across the display background with simple commands.

Paula is involved in the Amiga's multichannel stereo sound. Paula also helps to shuttle information through the Amiga's bus network. Careful attention to timing lets the Amiga rapidly move lots of data (e.g., video, sound, and text) during the intervals between processor and video activities. That's vital for any multimedia machine because of the huge sizes of sound and video files.

But custom processors and quick data transfer aren't the Amiga's only hardware advantages. The display system is also cut to fit a video world: It packs in noninterlaced, interlaced, and overscan display modes. Video standards call for interlaced displays—where a "field" of every other line is displayed first, followed by a field containing the remaining lines. Overscan lets a computer paint pixels beyond the edge of the display. Most computers lack overscan and will show a border when their display is recorded on video.

The Amiga also keeps better time with video than other computers do. The chip that controls the Amiga monitor's vertical blanking interval generates a timing frequency that is the same as the National Television System Committee standard frame rate for TV. (NTSC is the U.S. video standard. Amigas also come in a phase alternate line version for the European standard.)

This frequency compatibility makes it much cheaper and easier to synchronize, or *genlock*, the Amiga's computer output with a video signal. Without genlocking, you can't edit video signals directly. You can buy Amiga genlock boxes for as little as \$200. Add one to an Amiga 500, and you will have by far the least expensive computer that can synchronize with video.

If you start with an Amiga 2500 and add one of the more expensive genlocks available, you can synchronize with just about any video, from 8mm and VHS to Super VHS with yellow/cyan, ED-BETA, Hi8, and even broadcast-quality NTSC RS-170A.

The only display facet of the Amiga that comes up short for multimedia is the number of colors and display resolutions available. Even at its maximum overscan resolution of 768 by 480 pixels, the Amiga can't compete with the latest Mac and PC displays.

Although it can store 24-bit color images, the Amiga can display only 32 colors at a time when using its graphics hardware (one color must be transparent to merge with video). You can use all the colors from the 4096-color palette if you use the hold-and-modify mode, or 64 colors with the Extra_HalfBrite mode, but these modes slow down the processing and use more RAM.

Third-party frame buffers for still images with greater color depth exist, and Commodore has produced an add-in high-resolution display adapter with a 16-million-color palette from which you can display 256 colors at a time. In addition, the video strengths of the Amiga have attracted a host of video peripherals, including frame buffers, digitizers, time-base correctors, and special-effects devices. The Amiga 2000 even has its own video slot for adding video hardware boards.

The Amiga's custom processors can handle four channels of stereo sound. Paula contains sound- and speech-synthesizing hardware, including a full set of English phonemes. Third-party developers offer MIDI access through the serial port and many music and sound peripherals such as digitizers and samplers. Since more of the necessary hardware is already in the computer, these Amiga peripherals can be simpler and less expensive than peripherals that perform comparable functions on the PC and PS/2 systems.

Tools—Old and New

The Amiga begins with a multitasking operating system, a great multimedia tool when you're working with different media sources and the relevant application programs. This operating system is hidden by the WorkBench user interface, with pull-down menus and icons à la Macintosh, Windows, or Presentation Manager (PM). Every Amiga uses the same system.

Although it took some time to debug the operating system, the Amiga is now surrounded by many graphics, animation, audio, and video software tools. These start with painting packages such as NewTek's Digi-Paint and Electronic Arts' Deluxe Paint III. Audio tasks can be tackled with Music-X from MicroIllusions (which supports MIDI sequencing)

and AudioMaster II from Oxix (which is used for sampling and editing digitized sounds).

Sophisticated animation programs such as Photon Cel Animator from MicroIllusions bring motion to Amiga graphics and control genlocks or videotape editing. NewTek's Digi-View lets you capture real-world images for graphics manipulation. VIVA from Michtron provides you with multimedia authoring capabilities.

Shereff Systems' Pro Video CGI is a character generator for the Amiga, one of the programs that has made the Amiga a big hit with both corporate and broadcast video professionals who need to add titles and logos to tape. All these programs are aided by the Amiga's single interchange file format standard, which enables almost any program to accept and edit files from almost any other program.

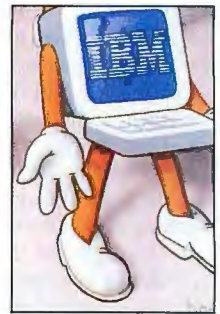
But the big news for multimedia is Commodore's new authoring system for the Amiga. Seen only in the beta stage by BYTE, the package (unnamed at press time) debuts this month. It links all the elements of multimedia development, offering a complete iconic programming language for welding various media and applications together. It uses the Amiga's multitasking ability, along with support for the ARexx interprocess language, to call other applications. It is built on a relational database that is compatible with dBASE.

By drawing a flowchart of icons and selecting choices in dialog boxes, using BASIC-style programming structures, you can create a new, independent, multimedia application. The new application will have its own icon and can be run without using the authoring package. It will be event-driven, not time-driven like the "movies" that simpler authoring systems create. And the new multimedia applications can be completely interactive, branching and looping as the original author intended. Commodore intends to offer templates for the authoring system that will pave the road to a variety of common presentations: annual reports, school courses, and the like.

A Multimedia Architecture

The Amiga has impressive hardware for multimedia: graphics coprocessors, display hardware that synchronizes with video and can overscan, and stereo-sound and speech-synthesis circuitry. The only real drawbacks are the limited resolution and color depth of the graphics displays, the lack of hardware protection for multitasking memory, and the ab-

Commodore
*believes multimedia is a theory of
machine architecture, and that the
Amiga embodies that architecture.*



sence of a compression scheme for motion video.

The Amiga also has lots of software for multimedia: a multitasking operating system, a graphical user interface, scores of graphics, animation, audio and video applications and peripherals, a standard file format, and a new authoring system that can iconically create event-based, independent, multimedia productions.

On top of all that, the Amiga has a long history in video and graphics. It's no wonder that Commodore believes that multimedia is a theory of machine architecture, and that the Amiga embodies that architecture.

APPLE

Macintosh: A Graphical Nature

The Apple Macintosh has proved itself by becoming the premier desktop publishing and desktop-presentation machine. The graphical interface allows printers and publishers to create and edit their work on-screen before committing it to paper or film. The Mac OS allows them to cut and paste information easily and smoothly between various programs. Apple sees multimedia, which it calls desktop media, as the logical next step, adding high-quality sound, live-action video, and animation to that base.

The glue that can bind all these elements together is HyperCard, which combines elements of a simple database, a hypertext program, a programming language, and an authoring system into one fast, free package (it comes with every Mac). To smooth the information path between HyperCard and the many Mac peripherals, Apple has announced the Apple Media Control Architecture (AMCA), a standard set of protocols and drivers.

Apple has also looked beyond Macintosh desktop multimedia to the Knowl-

edge Navigator. The Navigator, which is not a reality yet, will be a portable computer that will combine multimedia databases with artificially intelligent agents. An agent could search through incoming and stored information and select nuggets of interest to the individual user, using previous inquiries and work as a guide.

Processors and Peripherals

The two main members of the Mac family that apply in the multimedia arena are the Mac SE and the Mac II. The same 68030 processor now powers the latest system in each line that can directly address 8 megabytes of RAM (something a PC or PS/2 can do only under OS/2). The larger differences between the Macs now lie in expandability and display ability.

The Mac II line can accommodate color displays, with 8-bit or 24-bit color supplied by add-in video-adaptor boards. (The Mac IIci 8-bit color video is part of the main processor board.) Mac IIs can show 256 colors from a palette of 16 million with 8-bit adapters. The 24-bit adapters actually use 32 bits—24 bits for the full 16 million colors and 8 bits for overlay details. (Support for 32-bit color was added to the Macintosh System software in 1989.)

Macs drive multiscan monitors with analog RGB inputs. To synchronize RGB with video, you need an encoder to combine the RGB components and convert the scan rate by adding synchronization pulses. Genlocking cards and digital-video-effects cards are available. A range of add-in boards and peripherals gives the Mac more video power.

For example, Mass Microsystems Color Space FX can capture and modify color video images. Aapps's Micro TV can show monochrome motion video in a window on the Mac screen. And Apple actually produced a video-overlay card for the Apple II line in early 1989, before making any such move for the Mac. The \$549 Apple II Video Overlay Card is a

continued

genlock for the IIe and IIGS.

The Mac clearly has enough color and, if you want to spend the money, enough resolution for multimedia work. It does not have dedicated graphics chips to speed up graphics processing, such as you'll find in the Commodore Amiga and on some PC graphics boards, but there's a reason for that. All graphics are run through the System software's QuickDraw routines. In late 1989, several firms, including Radius, announced add-in coprocessor boards to accelerate QuickDraw.

Apple has yet to develop a data compression/decompression technology for video data. The company is looking to future high-speed, broadband networks for exchanging video information and "symmetrical" video compression so that the Mac can handle both sides of the work. Its Advanced Technology Group has been producing prototypes for such compression. This symmetry is important to Apple's multimedia plans. Unlike the IBM/Intel strategy that sees a big market for canned presentations and productions created and compressed by a larger computer system, Apple places more emphasis on the ability of users to create and edit their own productions.

The Mac display is not interlaced, which makes it difficult to convert to video. For instance, you can't just alternate lines into one of the two fields of a video frame, because what falls into the fields isn't consistent: The picture flickers and jumps.

To compete with the sound hardware of an Amiga, the Mac must call on peripherals and add-ins. Apple offers a MIDI output option for the Mac that attaches to a serial port. You can also find third-party add-ons for sound, such as Farallon's MacRecorder, that can capture and digitize sound for use in other applications. Apple's own CD-SC is a CD-ROM drive that can also play CD audio disks.

The new Audiomedia add-on board and HyperCard-compatible software package from Digidesign can add 16-bit, CD-quality audio, including voice, music, and sound effects, to multimedia productions. More experimental peripherals include The Voice Navigator from Articulate Systems, a voice-recognition system that you can use in place of a mouse or keyboard, and MidiDancer, an experimental system developed at the California Institute of the Arts in Valencia. MidiDancer is a package of position sensors, radio transmitters, radio receiver, and MIDI instruments that sense motion and convert it into music.

Stacks for Macs

The Mac OS and HyperCard are the heart and soul of Macintosh multimedia. The operating system itself, along with the Finder and MultiFinder interfaces, provides a graphical display and an environment in which programs can swap data. In addition, it includes some useful tidbits, such as the MacinTalk driver, in which any program can call on to synthesize speech through the Mac's built-in speaker.

Version 7.0, scheduled for release this year, will add an Interapplication Communications Architecture facility to allow programs to actively share information. In multimedia, this facility could help to tie disparate applications into one production.

HyperCard was the first hypermedia program to receive widespread attention. It can be used to run multimedia productions, to customize them, or to build them from scratch. The individual logical "cards," on which HyperCard stores its information and links, are gathered into "stacks." These stacks can include information from many media. They can also use external links—XCMDs—to reach out to other applications and peripherals. (XCMD stands for *external command*, a term in the English-like HyperTalk scripting language. It is implemented in C or Pascal and adds two functions to HyperCard.)

Although its database is not sophisticated, HyperCard is compatible with just about all the Mac data formats. Successive versions of HyperCard have been graced by direct links to optical scanners and CD-ROM drives. The Apple Programmers and Developers Association has a videodisk driver set of HyperCard XCMDs. The Voyager Corp. has similar toolkits for controlling videodisks and CDs (audio and ROM).

HyperCard's popularity has even prompted the development of some compatible packages, such as Silicon Beach's SuperCard, that add features such as color. At Fall Comdex 1989, Spinnaker introduced Plus, a toolkit that runs on the Mac, Windows 3.0, and PM. Plus can access HyperCard stacks from the IBM or the Mac.

Apple is currently working to define the AMCA, a system-level architecture or framework for accessing information from videodisks, CD audio disks, and videotapes. AMCA could rescue software developers from having to write custom drivers for each multimedia peripheral. The specifications for AMCA are still in the brain-storming stage according to Apple, but will be issued as a

kit with sample device drivers and user-interface guidelines for writing new drivers when they are ready.

Various application programs for the Mac are useful for multimedia. To create the elements of multimedia, there are drawing and modeling tools, from the original MacPaint and MacDraw to Electronic Arts's Studio/8 with its sophisticated color mixing and special effects. Paracomp's Swivel 3D creates hinged and jointed three-dimensional figures for animation. Farallon Computing's MacRecorder and ScreenRecorder capture sound and moving screen images, respectively, and play them back from inside a HyperCard stack.

For video manipulations, Avid Technology has a video editing system that runs on a Mac II. It digitizes and compresses video for real-time editing, losing quality but gaining interactivity. When the edit is complete, it can be used as a basis for actually editing tape—such as by Mac-controlled dual tape decks.

Then, there are the "authoring" programs, which connect and combine various clips of sound, graphics, and video. American Intellware has Storyboarder, which produces black-and-white animated storyboards from MacPaint images. MediaMaker from the BBC's Interactive Television Unit was developed in collaboration with Apple's Multimedia Lab. It can sequence up to 10 minutes of graphics, video, and CD audio using graphical "picons" to represent the elements. You can play and edit the picons using traditional Macintosh point-and-click operations. Also available are Course of Action and Authorware Professional from Authorware, and others.

The premier authoring package for the Mac outside of HyperCard, however, is probably MacroMind's Director. The successor to VideoWorks II, Director uses a metaphor of actors and a "score." It can create text, sound, graphics, and animation or import them. The score is time-based, dictating which elements happen and in what order. You can call Director from HyperCard and play its productions with the MacroMind Player, which comes free with Director. An advanced package called Director Interactive Toolkit combines Director with a HyperTalk-like language.

Cautiously Optimistic

Apple has identified multimedia as an education, training, and presentation market where it has the lead over IBM by a couple of laps: the Mac's graphical nature and HyperCard's quick adaptability

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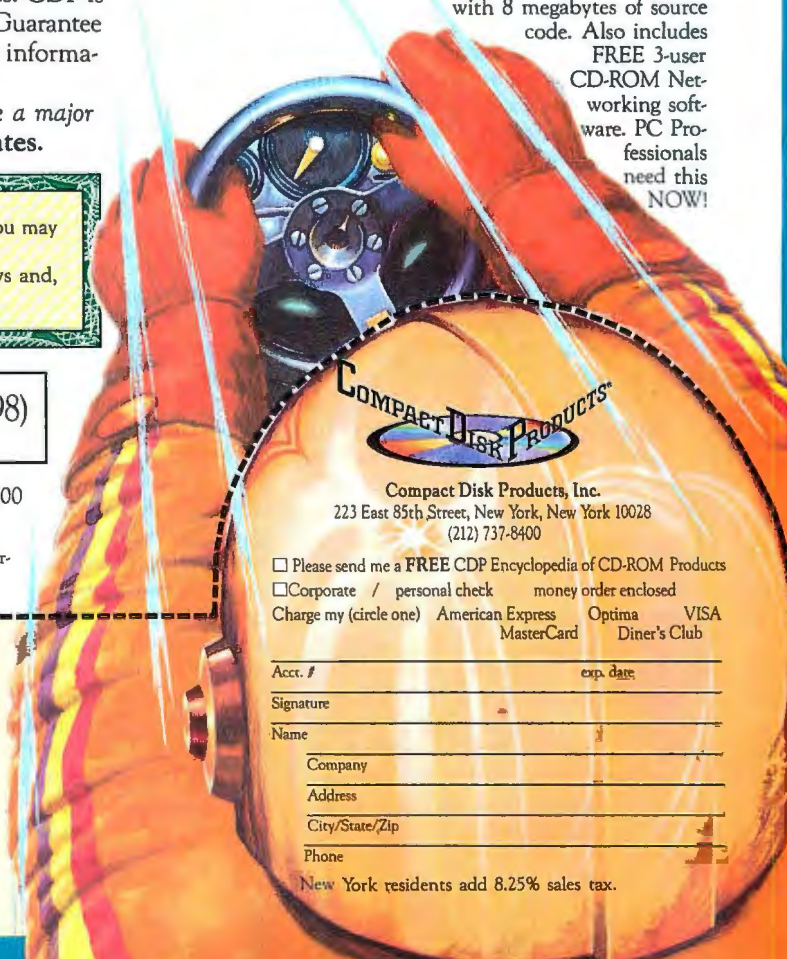
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to authoring. Apple is unlike Commodore, which pushes the current video abilities of the Amiga, and IBM and Intel, which talk about video presentations compressed off-line and then played back in real time. Apple spends more time talking about the future and "symmetrical" data compression that will allow you to create and edit multimedia presentations on the Mac.

Apple has an active Multimedia Lab, it publishes a catalog of development tools (*Wings for the Mind*) and a guide to courseware authoring, and it is working with developers to establish driver standards and an operating-system foundation that can support real-time video editing in the future.

Although it's already advertising the Mac's multimedia strengths, Apple is moving somewhat cautiously into the market.

IBM/INTEL

DVI and Full-Motion Video

People are accustomed to watching full-motion video from broadcasts or VCR tapes. The restriction of many multimedia systems to partial-screen video or still images is immediately apparent. Even video-oriented computers, such as the Amiga, don't handle full-motion video on their own screens as digital information. The best they can do is to overlay their own graphics on top of full-motion video that remains in analog form, recorded on a tape.

To actually edit the video signal in real time, a computer must read, display, and store many megabytes of data every second. Microcomputers don't have the processing power or the storage. For example, a typical CD-ROM disk can store 74 minutes of audio, but only 90 seconds or so of video, and it cannot send a full 30 frames per second of full-screen, full-motion video data to the computer. Instead, it might send only a few frames per second, yielding a jerky, unrealistic motion picture.

This problem has two solutions. One is to speed up the computers and increase their storage capacity. This trend is already part of computing, but it's not enough. To handle full-motion video in real time as digital information, computers also need compression and decompression. They need to cut down on the size of video images and files by intelligently eliminating redundant information.

IBM and Intel have a technology that promises to do exactly that: DVI (digital video interactive). Although it's still in development, DVI, or a compression technology similar to it, may affect every multimedia system in the mid- to late 1990s.

Not a Natural

The IBM PC and PS/2s are not as suited to audio and video work as the Mac or the Amiga. They do offer more processing power, however, with 33-MHz 80386 and 20-MHz 80486 machines available from dozens of firms. The PS/2 line did jump to higher resolution and color with the VGA and 8514/A display adapters. And there are scores of specialty video-adaptor cards from other companies, some offering graphics coprocessors for fast, high-resolution displays.

On the software side, the PC has some weapons, too. Although the original DOS is not oriented to graphics and doesn't have a standard graphics file format, Microsoft's Windows add-on is and does. So does the PM interface for OS/2, which brings multitasking, access to 16 megabytes of RAM (DOS is limited to 640K bytes), interprocess communications, windows, and icons. (Windows 3.0 may bring some of these same benefits to DOS users.) There are also audio add-ons for PCs and compatibles, from MIDI cards to digitizers.

Even without multimedia-quality built-in hardware, the PC and PS/2 families have staked out some multimedia territory. Their popularity has seeded the largest third-party software and hardware add-on market for any computer. For example, Video Charley is a \$750 genlock, encoder, and character generator from Progressive Image Technology. Truevision makes a variety of "Targa" boards for video capture and editing.

Willow Peripherals makes VGA-TV, a VGA card that can convert VGA output to NTSC video to show VGA presentations on a TV or record them on standard videotape. At Fall Comdex 1989, VideoLogic showed its DVA-4000 digital video adapter board, which supports VGA graphics and real-time manipulation of moving video images. Logos Systems International announced the DoubleTake AV audio/video digitizer, an add-in board that can digitize NTSC, PAL, or SECAM (the TV standard in France and the U.S.S.R.) video still images and can also digitize and compress audio input with 7-bit resolution.

Most of the programmable videodisk players in the U.S. are hooked up to con-

trolling IBM PCs or compatibles. IBM's InfoWindow is a popular authoring program for such videodisk systems. The PC can also run Owl's Guide, a hypermedia program with windows, graphics, and limited animation. And Intel has announced an authoring package, called Authology: Multimedia, designed exclusively for DVI.

IBM's Audio Visual Connection program runs on PS/2s with video-capture and audio-adaptor cards from IBM. AVC runs under either DOS or OS/2. It can capture and edit sound and images and add special effects to build presentations. Using IBM's KnowledgeTool expert-system package, AVC can call on other applications.

Spinnaker's new hypermedia toolkit, Plus, runs under OS/2 and Windows 3.0, as well as on the Mac. It promises to access HyperCard stacks from IBM or Mac versions. Autodesk, home of the dominant PC CAD program, AutoCAD, has a new, inexpensive animation program called Autodesk Animator. It has tweening (automatic shape transformation), pathing, and other sophisticated animation routines. Microsoft has created a new division just for multimedia publishing. Through DOS, a PC can use CD-ROMs, and Microsoft and IBM have endorsed CD-ROM XA.

Squeezably Snug

But the real news for the PC is DVI. Invented by General Electric and RCA (now the property of Intel), DVI is a compression/decompression scheme that can squeeze video files to 1 percent of their original size. That means you can have an hour of digital, full-screen, full-motion (30 frames per second) video on a single, standard CD-ROM disk. (DVI can also squeeze audio files.) You can then display that motion video on the PC screen, and combine it there with text and graphics. The resulting video doesn't have all the quality of the original (it smears colors somewhat and loses some focus), but no other technology yet comes close for putting full-screen, full-motion video on a PC.

DVI is the work of a pair of chips: the i750 chip set. One is the 82750PA Pixel Processor, a 12.5-million-instruction-per-second chip (an AT runs at about 2 MIPS) with its own parallel-processing architecture and on-chip RAM for quick reprogramming. The other chip is the 82750DA Output Display Processor, which can serve up several different resolutions, from 256 by 200 pixels to 1024 by 512 pixels in 8-, 16-, or 24-bit color.

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(See "Digital Video Interactive," May 1989 BYTE, for more details.)

Intel sells the \$16,000 Pro750 Application Development Kit for DVI work. The kit starts with a 25-MHz 80386 PC and adds three AT-compatible boards (with video digitizer, audio digitizer, video and audio signal processor, CD-ROM interface for a Sony 6100, and 2 megabytes of video RAM).

The kit also contains a bundle of software such as run-time libraries, authoring tools, drivers, diagnostics, and demos. The run-time libraries have a real-time executive that adds multitasking to DOS. The authoring toolkit has edit-level video for real-time video compression directly on a PC. Intel and IBM have agreed to develop Micro Channel boards with similar abilities for the PS/2 line. Time Arts has ported its Lumena paint program to the Pro750.

The three drawbacks of DVI have been asymmetrical compression, degraded image quality, and high expense. Compression on today's Pro750 achieves a 40-to-1 ratio, which is equivalent to approximately 10 frames per second of full-screen video. To reach 30 frames per second, people have had to send their videos to Intel's Compression Services, which charges \$250 per minute to process the video through a more powerful computer. The resulting data can then be decompressed in real time by any DVI-equipped PC.

A Video Victory

In late October 1989, Intel's DVI operation, the David Sarnoff Research Center in Princeton, New Jersey, announced new software for DVI called RTV (real-time video). Version 1.5 of RTV permits full-screen, 30-frame-per-second, near-VCR-quality video compression and decompression on an AT. That means symmetrical compression and decompression on the AT. Symmetrical compression is a necessary feature for full interactivity and editable video. Because you can reprogram the DVI chips instantly, they offer on-the-fly special effects and the ability to assimilate the latest, swiftest algorithms for compression and decompression.

DVI images aren't as sharp as broadcast TV—yet. RTV 1.5 offers near-VCR quality, and PLV (production-level video for off-line compression) offers VCR quality. By 1992, PLV is targeted at TV-to-high-definition-TV quality and RTV at near-TV quality, with PLV reaching to HDTV quality soon thereafter as the i750 chip set doubles its processing speed and uses better algorithms.

The high-quality audio and video files of multimedia work can be enormous. To store them, you will need to rely on optical storage.



Volume production of the DVI chips would certainly cut their current high price (\$7000 to add DVI to an AT today), but getting the chips down to consumer prices could take a while. An interesting aside: IBM has licensed special graphics coprocessors from graphics-workstation maker Silicon Graphics. These coprocessors may also play a role in putting multimedia on the PC and PS/2s.

Still Under Development

IBM PCs and PS/2s can already push laser disk multimedia and offer a range of authoring tools, from IBM's InfoWindow and AVC to Autodesk Animator. There are also rumors that IBM will offer an inexpensive CD-ROM computer system in 1990, something like Fujitsu's FM-Towns system (available only in Japan). Microsoft is adding multimedia extensions to DOS, Windows, and OS/2.

SONY/PHILIPS

CD-I and Optical Disks

The high-quality audio and video files of multimedia work can be enormous. To store them, you will need to rely on optical storage. Two of the leaders in optical storage are Sony and Philips, companies that also have a large share of the world's consumer electronics market.

Sony and Philips are approaching multimedia from three directions. First, they are working with IBM, Apple, Commodore, and other computer companies to provide the optical disk drives necessary for multimedia systems. Second, they are pursuing compact disk interactive (CD-I), a technology that could provide multimedia without a computer. Third, they are exploring how new audio, video, and computer technologies will blend with consumer electronics to create new markets such as video conferencing.

CDs Take Over the World

Lasers can read and write vast amounts of data because they can focus on minute areas of a disk or tape. Sony and Philips came up with the CD—a 12-centimeter-diameter optical disk that can store information as tiny pits on a rotating surface. If the information is in the form of music, the disk is called a CD-DA (digital audio) and can play up to 74 minutes of high-quality sound. (CD-DA player and disk prices fell quickly; after just a few years, they have driven vinyl LPs nearly out of the market.)

If the same disk is used to store the bits of computer data—programs, text, and graphics—it's called a CD-ROM. CD-ROMs can pack about 550 megabytes of data, many times what a conventional hard disk can hold, although it's also much slower to find and read that information than on a hard disk. (A CD-ROM has an access time of about 1 second instead of the hard disk's approximately 20 milliseconds.)

With the right physical connection (through a SCSI or serial port) and file format, operating-system drivers (which both DOS and the Mac OS have), and relevant applications (to search through, read, and display the data), you can use CD-ROMs with almost any computer. The data can be text, numbers, graphics, or anything else a computer understands.

The physical format for the disk is set out in the Philips and Sony "Yellow Book." (A "Red Book" covers CD-DA.) The logical-file standard format is the High Sierra Group ISO 9660 standard. A newer CD-ROM XA standard adds interleaved audio and video to CD-ROM.

CD-ROMs are relatively cheap to reproduce at a stamping plant, but the individual computer can't write to them. Thus, they make a good publishing medium, but they don't work as a replacement for magnetic disk drives. There are WORM (write once, read many times)

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and fully erasable optical disk drives available, too, from firms such as Sony and Philips, but the disks hold less than CD-ROMs (about 200 megabytes compared to 550 megabytes) and are much more expensive than CD-ROM drives.

Forget the Computer?

Both Sony and Philips have a direct interest in systems that combine computers and optical disks. Philips has a division called Headstart Technologies that claims "the first line of personal computers with a built-in CD-ROM drive and CD software" at a consumer price—under \$2000. Sony makes a computer-laser disk training system that's similar to IBM's InfoWindow packages.

But Sony and Philips don't think every multimedia application needs a full-blown computer. The CD-I standard, described in the "Green Book," lays out a plan for a low-cost, independent CD player. (There's also another format called CD-V, which puts five minutes of TV-style video on a CD, playable only by CD laser disk drives.)

The CD-I player, or "decoder," could be used at home just as a VCR or video game is today, and wouldn't demand a computer or the training that most computers require. The disk format would be compatible with the High Sierra Scheme, but it would have more detail. It would be aimed at a specific 68000 microprocessor-based decoder running the CD-RTOS operating system and relying on at least 1 megabyte of RAM and custom VLSI video and audio processors. RTOS is descended from OS-9, a multitasking operating system for the 68000 family that was used in the Tandy Color Computer and some industrial systems.

The decoder wouldn't necessarily have a keyboard and would interface to a monitor or to a standard TV. It would provide four different sound modes, with a range of quality and memory demands, and five video modes, with a range of colors, resolutions, and memory demands. Full-screen, full-motion video performance is ruled out by the data rate from the CD-I disk and the lack of hardware to decompress images in real time.

For instance, the RL (run-length) mode uses highly compressed images but can reproduce only 10 frames per second with 128 colors. Changes to these modes in future CD-I systems would require changes to the custom VLSI chips. The interactive nature of the system would allow you to play games, answer questions, and otherwise react to and influence the sequence of images and sounds from the disk and decoder.

Only Time Will Tell

Philips, Sony, and Matsushita (for the video processing) have all worked on CD-I's development. The several hundred companies that have licensed CD-DA automatically have a license to use CD-I, and many firms have produced CD-I prototype titles that combine sound, voice, still pictures, cartoons, text, and partial-screen motion video.

No one knows yet whether CD-I will capture a large market. If it does, the CD-ROM XA standard will allow you to read both CD-ROM and CD-I disks if you are willing to upgrade your CD-ROM drives. The lack of full-motion video in CD-I is lamented by some who see compression technologies like DVI forcing CD-I off-track within a couple of years. Either way, Sony and Philips are sure to sell lots of optical disk drives.

Four Roads Met in a Wood

Multimedia definitions run from combining text, sound, and animation on-screen to full digital video for editing and storage.

For Commodore, multimedia is a graphically potent, video-compatible machine architecture that is backed up by a multitasking operating system and topped off with a thorough and easily understood authoring system.

For Apple, it's the next step after desktop publishing and presentations, using HyperCard and some new peripheral control standards to tie together a variety of interactive graphics, sound programs, and peripherals.

For IBM and Intel, multimedia begins with today's authoring software and laser disks and moves toward a future of full-screen, full-motion digital video through DVI compression technology.

For Sony and Philips, multimedia is the convergence of consumer electronics, communications, and computers. It represents the certainty of selling optical disks, and the possibility of creating a new market with CD-I.

As processors get faster and capacity grows, microcomputers will grow more capable of multimedia. For now, the big names are taking different paths. ■

Phillip Robinson is an editor for Virtual Information, a publishing company in Sausalito, California, where he researches and analyzes trends in the computer and workstation industries. He is a consulting editor for BYTE and can be reached on BIX as "robinson."



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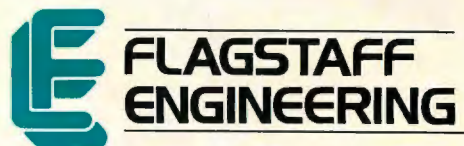
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Beyond Hype

Multimedia currently occupies that gray area between potential and reality. Will it ever see the light?

Rob Lippincott

Multimedia—the synthesis of interactive computers with full-motion video and compact-disk-quality sound—may transform the way you use computers. Then again, it may be just a fad, like Pong. Some call multimedia the “next revolution in microcomputers”; others describe its market potential as “dazzling” and “explosive.”

A recent *Business Week* article claims that “the biggest names in computing—and some in television, too—are agog” over the prospect of a colossal multimedia market. One computer consulting firm, Information Workstation Group, predicts a \$17 billion market for multimedia by 1994. Yet Steve Jobs, computer pioneer and founder of NeXT, warns that multimedia may become the “artificial intelligence” of the 1990s—that is, a new technology without a commercial home.

Truth and Beauty

As usual, when hysteria and hype outpace the facts, the truth lies somewhere in between. Multimedia may become the technological darling of the 1990s. If it does, it will be through evolution rather



than revolution. Beyond the hype (and the skepticism) are four fundamental principles that must be considered when forecasting the future of multimedia and planning multimedia strategies. The first two I classify as “truths” about multimedia; the latter two encompass the “beauty” of this technology:

- **Utility.** The key to the success of multi-

media; it has to be a technology that provides solutions.

- **Incrementalism.** Market growth will be mainly incremental, taking place in measured, sequential stages instead of revolutionary leaps and bounds.

- **New markets.** Multimedia will allow microcomputers to reach new groups of users by helping to remove the inherent complexities of using more powerful applications.

- **Information appliances.** Personal computers will become as simple to use—and as widespread—as, for example, TV sets. In turn, this expanded base of microcomputers will form the basis for whole new categories of applications and appeal to a whole new class of users.

First and Foremost

The advancement of hardware technology is certainly central to the success of multimedia. However, application developers must keep their feet on the ground and concentrate their efforts on delivering real utility.

As is the case with AI, multimedia will rarely if ever be the primary selling feature for computer applications. Instead, it will be embedded, in increasing

continued

Avoiding the Pitfalls

Pat Maupin

One of the primary business uses of multimedia to date has been training. I've seen some very good applications of multimedia for training—and some very bad ones. The good ones range from slick, sophisticated presentations down to fairly crude programs that aren't much more than computer-controlled videotapes. The bad ones cover the same ground.

What's the difference? Usually, the bad ones exhibit a misuse of the technology, caused by a misunderstanding of what it's actually good for and how it can benefit the application. This misuse is most often caused by pushing technology for technology's sake and rushing headlong to be at the forefront without stopping to analyze exactly what it is and what it does. Here are some of the problems.

Grasping Its Limitations

Some subjects and teaching methods are much more amenable to multimedia than others. Multimedia is a good tool for teaching basic familiarity with almost any subject in an informal way. It can also be good at "what if" educational scenarios, where you can make decisions and then see the results of those decisions.

One of the real benefits of multimedia is that you can't take a multimedia course passively. You must interact with it, and the direction and depth of the course change with that interaction. Another real benefit is that you can easily gear the pace of the course to match a student's capabilities.

For some subjects, multimedia actually seems to be the best teaching method available. For others, it can deliver a course that is "almost as good" as alternative teaching methods that may be

prohibitively expensive (e.g., Tank Driving 101 or Nuclear Power Plant Operations 203). You can usually achieve a good, cost-effective balance with the proper mixture of multimedia and live practice.

Bad applications can result, however, when you use multimedia as the primary (rather than supplemental) teaching method for courses covering complex subject matter. Multimedia can work well for multiple choice tests, but it can't grade an essay. And you can't expect all the students to have the typing skills necessary to compose an essay on-line.

Applying Its Capabilities

Because of the mad rush to become involved with the technology, not only is multimedia sometimes used for things it shouldn't be, but sometimes the things it *can* do are ignored or missed. For example, whether you're working with a CD or a laser disk, some information is processed at production time and some when the course is actually run. Proper partitioning of this information is critical to developing a successful, cost-effective course.

Too often, information is processed at the wrong time. Fades, which the computer can handle very easily, are frequently etched into the laser disk, wasting valuable audio and video time. I have seen a screen full of "buttons" for touch screens etched into a videodisk, with one frame for all buttons off, and a separate frame highlighting each button in its activated state. Sometimes this is done for nonoverlay systems or for an aesthetic effect with very nice buttons.

However, this particular course was authored for an overlay system, designed to take advantage of graphics

over video. And the buttons weren't all that great. The authors spent a lot of money on video production to put the buttons there. They also needed to write code to make the laser disk player seek to highlight the correct button. This task isn't really any easier than using a graphics library to reshape the button. And if any changes were necessary after production, they'd have to use computer graphics to modify the button screen, anyway.

Information is often processed late that should have been included at production time. One of the great things about multimedia is that you can fix a lot of problems post-production. After spending thousands of dollars producing video and audio, companies tend to treat the CD or laser disk as difficult and expensive-to-change hardware, while the programmers, as is frequently the case, must modify their software to fix the hardware.

Unfortunately, in some cases, the ability to fix and enhance after the fact is abused. This happens for several reasons: time and budget pressures, lack of planning, or even lack of confidence that the information is correct and pertinent. Whatever the reason, it's a waste to distribute a course on a laser disk that isn't even half full along with over 2 megabytes of .PCX files that will never change. These files could have contained prettier pictures and been drawn faster if they had been created on the laser disk initially.

Enough Is Enough

Some courses go overboard with flashy displays and sounds that actually detract from the point they're trying to make. Everyone has seen computer programs where the fancy user interface actually

degrees of integration (and inspiration), in future generations of applications. Eventually, multimedia capabilities will be sprinkled through almost all layers of software, offering new interfaces, new business applications, redefined programming tools, and possibly even new operating systems.

As an example, consider how utility is moving the personal computer industry from the traditional character-based user interfaces to the now-popular graphical

user interfaces, with their windows, icons, mice, and pull-down menus. It's not just that GUIs are more fun to use; they are being adopted where they can make you more productive and will eventually become standard features in new applications.

With the advent of multimedia, I predict that we will have a third interface: the video user interface. Windows will be filled with stills and motion video, high-resolution icons will become ani-

mated graphics, and audio will be a standard accompaniment to text.

As for programmer's tools and operating systems, multimedia-assisted tools will prove to be as helpful to program developers as interfaces will be to end users. Object-oriented programming will grow to include more media-rich objects; programming tools will offer diagrammatic control of code. Here again, utility will pay off in programmer productivity.

gets in the way. Multimedia is no different.

This problem becomes worse when the overkill starts to cost real money. Just recently, a laser disk-based multimedia course was launched that required a math coprocessor to run. Why did it need the math coprocessor? For the animations. Animations? I thought you used the laser disk for all the moving video. We do, but we have a really nice attract loop with a wonderful animation sequence. . . .

Technology over Substance

Then there's the trap of substituting technology for substance. The point of multimedia training courses is, obviously, to teach something. However, I've seen some courses where the video production and computer programming were more than adequate, yet the final outcome was truly awful.

There are also courses that do an adequate job of teaching, but they teach the wrong things. These courses are insidious and potentially much more damaging than the really bad ones because they're harder to identify. In the midst of the TV generation, "It must be true; I read it in the newspaper" has been largely replaced by, "It must be true; I saw it on the news." And multimedia's use of video puts it in the believable TV category.

I saw a course in England last month that was designed to train sales clerks. One of the units was for cash-register-type math. One question read, "What is 13p times 5p?" Unfortunately, *p* isn't a variable. It stands for "pence," the approximate British equivalent of "cent," and 65p² was not among the four choices. A minor annoyance? Perhaps, but if you know the correct answer, you

are likely to lower your estimation of the course and the value of any information to be gained from it.

I don't advocate teaching that "13 pence per orange times 5 oranges equals 65 pence—please note that the oranges cancel out." Quite the opposite. Being able to multiply 13 times 5 is a valuable skill that more sales clerks should have. But they already *know* it's about money, so why add extra, confusing, and incorrect units to the calculation?

Focus on Accuracy

When you teach a live course, you can have a bad day. You may be confused or forget your facts. You may unwittingly present them in an ambiguous manner. Hopefully, one of your students will help you out, either with a question or a challenge. And when you correct or clarify your statement, the whole class benefits.

Multimedia, on the other hand, must be accurate. The situation is entirely different. You don't have the same real-time feedback mechanism to keep you on track. You do, however, have the opportunity and the responsibility to get your facts absolutely, unquestionably correct, to take advantage of the best aspects of computers. The computer will tirelessly teach your students using your best effort. It will not forget or be annoyed at repetitive questions.

No course is ever perfect. But if you spend several worker-years developing one, you should also spend the extra money necessary to ensure that it is accurate. Otherwise, what's the point?

Pat Maupin works in systems design, programming, and customer service at Video Associates Labs (Austin, TX). He can be reached on BIX as "pmaupin."

The March of Multimedia

As multimedia proves its utility, commercially successful applications will evolve in a logical progression, moving from sales tools to training aids to fully integrated Help features in applications.

These stages will parallel the three basic questions you ask of any product:

1. Why should I buy it?
2. What are the benefits?
3. How does it work?

Lotus's first multimedia "product" is an example of how the first stage of commercialization addresses the first question: "Why should I buy this application?" It is called MM3D (Multimedia release 3 demonstration). It is a powerful demo for Lotus 1-2-3 release 3.0.

In convincing you to buy a software product, the seller has maybe 30 seconds to present its case and hook you. Multimedia can pack that 30 seconds with a dazzling sales presentation.

The 30-minute, CD-based MM3D program is fully interactive, allowing you to select which 30 seconds you wish to see next. It uses screen shots, audio, graphics, and video stills to demonstrate, animate, and explain features and benefits of Lotus 1-2-3 release 3.0. MM3D is being used at trade shows, in dealer showrooms, and in sales training. If the first use for multimedia is for selling application programs, the next one is for training new users.

Up to Speed

Training is a major expense for corporations. As a result, application developers are constantly working to reduce the amount of time and money customers spend beyond the selling price of the software—thus reducing the "real" cost of a product. An issue today, training will be even more important in the future, as applications become more and more complex. (See the text box "Avoiding the Pitfalls.")

Multimedia is a natural for initial training, providing a level of interaction and feedback not possible with a paper manual. Beyond initial training, multimedia Help functions will be closely integrated with applications, simulating instructors who can guide you through the application via voice output. "Just in time" (JIT) learning will prove far more effective than today's too-often frustrating Help features and documentation.

In fact, JIT learning will also be helpful to people besides users. Most of us know a coworker who is the de facto software expert. If you're stuck, you simply call the expert and say, "Hey Ed, how do I get to such and such a screen?" I do it; everyone does it. And it works well.

The trouble is, Ed is usually getting paid for more than just giving advice, and so these questions place a serious imposition on his time. When a multimedia Help facility can finally take Ed's place, Ed will be able to do the work he gets paid for, and the company will benefit.

Multimedia Platforms

Today, multimedia simply refers to a range of capabilities that include interactive digital audio and video and are usually delivered on CD-ROM.

To run a basic multimedia program today, you can use an 80386 with a VGA monitor and a CD-ROM reader, along with an additional high-quality audio speaker or two. This setup—which I call a "premium vanilla" platform—will do a respectable job of mixing high-quality audio and color video together as a kind

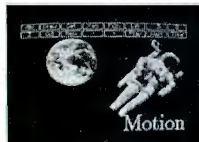
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In the future, multimedia will benefit from an expanding suite of capabilities, thanks to coming hardware developments in data-processing and compression technology.

New Flavors

The key performance-limiting item for multimedia is the bandwidth between the CPU/main memory and external storage. Full-range audio gobbles megabytes of data, as does full-motion color video. Providing interactivity compounds the problem of shipping data back and forth between main memory and disk.

Beyond the premium vanilla platform, the first major development will be the use of digital signal processing (DSP) chips to permit interleaving of full-range audio with text and image data. The most promising format is known as CD-ROM-XA (extended architecture), which was jointly announced by Philips, Sony, and Microsoft in September 1988.

The second development concerns video compression. The data space that is needed for full-motion, full-screen, full-resolution video is much too large to allow it to be stored, moved, and displayed easily. Therefore, each image must be compressed. Many companies (from giants such as Philips and Apple to tiny C-Cube, to name a few) are developing similar kinds of technologies that will soon be reduced to silicon.

Most promising is a hardware-based technology called DVI (for digital video interactive) that can compress video data by a factor of more than 100 and play it back in real time. DVI is owned by Intel, and IBM has already announced plans to market it.

I expect it will be possible to buy a CD-ROM-XA-equipped PC or an upgrade board sometime in the next 18 months, and a DVI-equipped machine or replacement board perhaps six to 18 months after that.

New Markets

DSP and video compression will help remove the technological barriers to multimedia advancement and will help pave the way to the third multimedia principle—opening new markets. You will be getting greater utility from multimedia-aided applications; therefore, software developers should have a somewhat easier time selling the next generation of products.

For instance, it is a disconcerting fact that as applications become more complex and powerful, use of their features tends to decrease. The multimedia bene-

fits mentioned earlier—in training and Help systems—are intended to stimulate the use of complex features.

In fact, within the next five years, I predict that customers will have the opportunity to buy most of the popular PC applications with all the built-in training a person new to computers will need to use them efficiently.

In the long run, this will make it easier to sell—and to buy—much more powerful applications. It will make it easier to identify and explore entirely new product concepts and market ideas. As multimedia functions become more closely integrated with the sales, training, and Help aspects of programs, you will get more out of your applications and spend less time on learning curves.

Information Appliances

Sometime after the next wave of standards in hardware and software has settled, the PC will become an "information appliance." By combining the power of sophisticated audio, video, and computing technology with the ease-of-use of a toaster, multimedia will capture a significant number of new users and will go beyond office desktops and into homes and schools.

As we combine multimedia with some aspects of expert systems and advanced circuit technology, the result may be a "gestural" interface, one that can understand a nod or shake of your head or a movement of your hand.

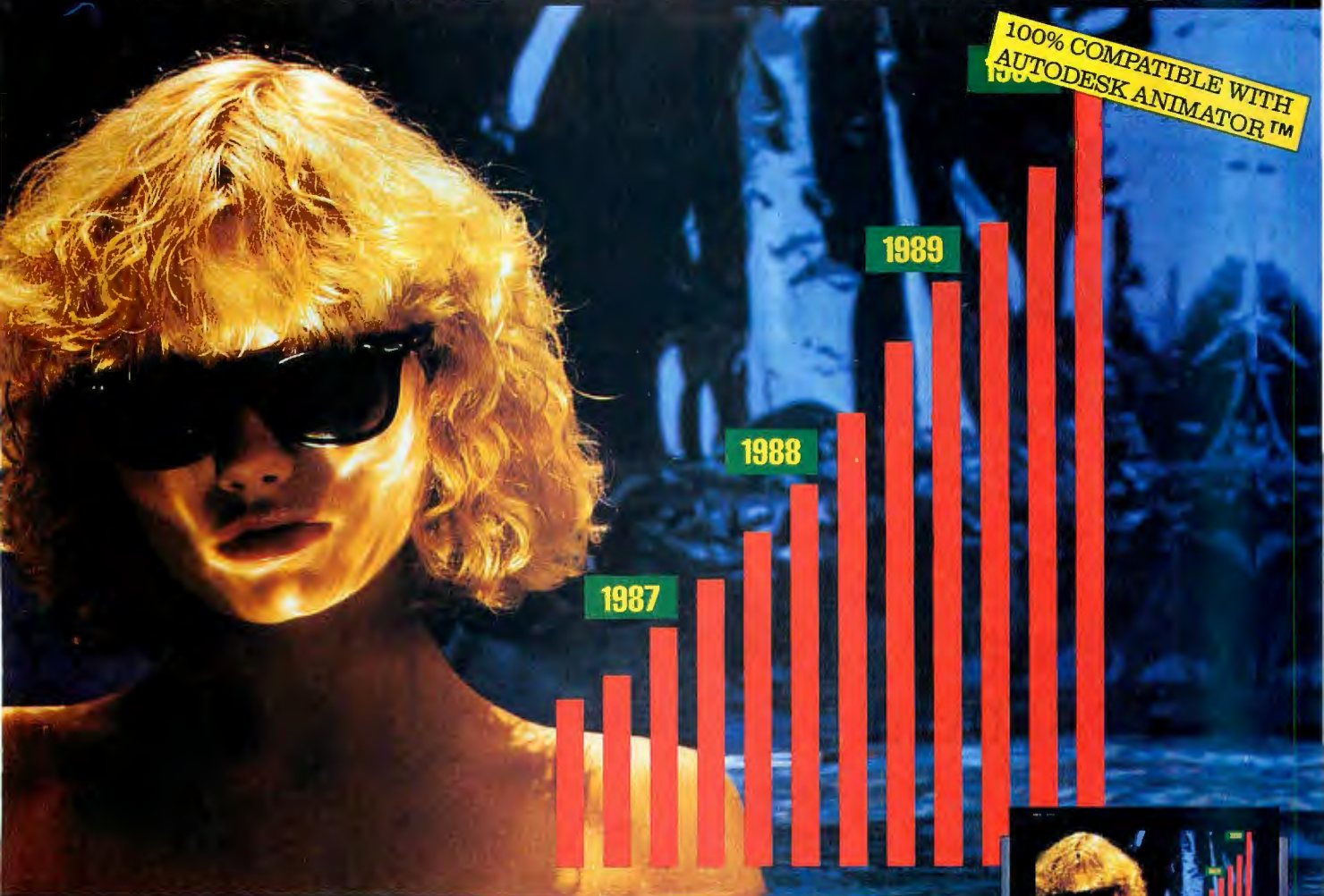
Applications will also progress—permitting, for instance, the integration of audio and high-resolution video into PC presentations, E-mail, workgroup tasks, and personal information managers.

Most important, multimedia—which today is hardly more than a set of technical attributes—will dramatically enrich the quality of personal and business communications. It promises to be nothing less than a paradigm shift.

Sounds wonderful, doesn't it? What can go wrong? Plenty. If you put the hype before the work and worship at the altar of technology and potential, you can miss the point. It will take all the parts of the formula—technologies, applications, and real, cost-effective utility—before multimedia can begin to deliver some of what it now only promises. ■

Rob Lippincott is director of business development for the information services group of Lotus Development Corp. (Cambridge, MA). Previously, he worked on interactive technologies for WGBH-TV (Boston, MA). He can be reached on BIX c/o "editors."

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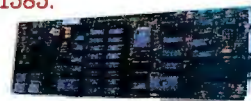
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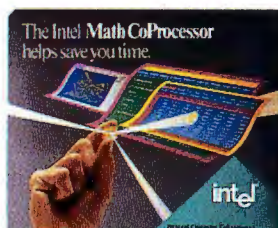
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Birth of the BLOB

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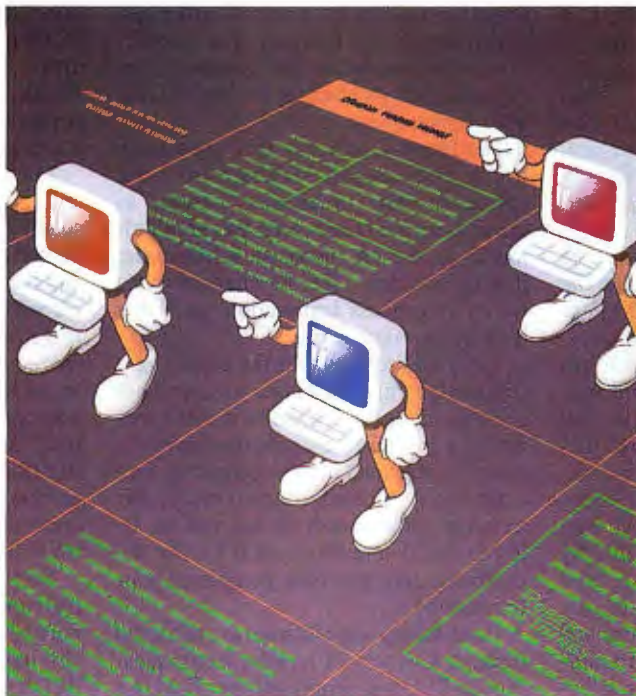
Tim Shetler

There's a revolution afoot. It's called *multimedia*, and it's changing your databases. In fact, it will completely revise the way you store, access, and manipulate information. In conjunction with windowed graphical interfaces, image scanners, optical character recognition devices, mass storage devices such as optical disks, and other advanced technologies, multimedia opens the door to a revolution in corporate computing.

Multimedia databases can handle more than character fields. They can also store scanned forms and photos, text documents, program source code and object modules, spreadsheets, and digitized voice. In fact, multimedia databases can manage just about any object that you can store on a computer or use in an application.

The Theory of Relativity

An expansion on the usual relational database, a multimedia database is capable of storing large, unstructured data objects as just another field in a database record. The standardization of the structured query language for DBMS applica-



tions makes it imperative that you be able to create and manipulate objects for multimedia databases through extensions to standard SQL.

As with any other data type, these objects are considered part of an atomic unit of work (i.e., a transaction), and they are archived, restored, and recovered through the normal mechanisms that the DBMS supplies. A multimedia

database application can present you with any combination of data fields, images, and text objects. It can even capture voice or sound as an object and "display" it back to you through a speaker.

This form of multimedia database uses a new category of data types, called *binary large objects* (BLOBs), to define those fields in a record that will contain the objects. The two BLOB data types are text and byte.

Text BLOBs contain valid text characters, such as memos, chapters of a manual, contracts, and source code. Byte BLOBs are binary data streams that can contain any object, such as a spreadsheet, graph, fax, object-code module, satellite data, voice pattern, or any digitized data.

Since a BLOB could be very large (up to 2 gigabytes), a multimedia database must allow you to place the entire BLOB column—relational databases define information in terms of rows and columns—on a separate partition of a disk, or on its own magnetic or optical disk. The term *blob-space* denotes a logical region of the database that contains columns of BLOBs. A blob-space can be located on any device or

continued

across multiple devices. When a BLOB column is placed in the blob space, the corresponding field in the record will point to its location.

The location of the BLOB is transparent to an application, just as the locations of all the other data fields in a relational database are. The ability to store a BLOB in a location that is separate from the record that contains it offers two benefits. First, it ensures that you can still perform high-volume applications without large objects at optimal speeds. Second, it lets you use low-cost storage media to store BLOBs.

Mix and Match

Multimedia databases open up a much wider world of application opportunities, particularly for those whose operations are based on documents or drawings. Insurers, financial institutions, regulatory agencies, parts distributors, libraries, transportation companies, legal institutions, and research centers can all automate large portions of their businesses with this technology.

Some companies could change the entire nature of their operations with a multimedia database and effect significant cost savings. Realtors, for example, could take clients on a tour of homes without ever leaving the office. You could scrutinize photos, floor plans, and area maps and eliminate undesirable properties without having to visit each house.

Not only is a multimedia database able to store and protect these objects, but the indexing ability inherent in a DBMS enables you to locate them immediately. Since an object is presented as just another data field in a database record, you can query all the other fields in that record that are not objects through SQL's search facilities. Once the search is complete and has returned one or more records that match the search criteria, then you can access the object fields. By contrast, stand-alone graphics or word processing applications store information only by the name of the object and provide no other way to locate it. In multimedia databases, full SQL text retrieval, which allows indexing into text objects based on significant words or word combinations, extends this indexing power even further.

A multimedia database is not the same as an object-oriented database, however. In general, multimedia databases are designed for applications where including some objects, such as drawings or contracts, adds substantial value.

Object-oriented databases, on the

other hand, consist almost entirely of objects, and they support a variety of complex relationships among them. Although multimedia databases can implement some relationships between objects or support objects that have a greater degree of self-definition, they are more general-purpose than their object-oriented cousins.

The ACID Test

You have to implement a multimedia DBMS so that a BLOB column looks the same as any other data type would—that is, like a regular field. This leads to a great many design issues, primarily because of the potentially large size of the BLOBs.

DBMSes are designed to guarantee that all transactions adhere to the ACID properties: atomicity, consistency, isolation, and durability. Atomicity requires that either all or none of the changes made during a transaction be reflected in the database. This means that if a transaction is in progress when a system failure occurs, *none* of the changes that the transaction made before the failure should remain in the database after system recovery. If, however, the transaction completed before the system failure occurred, *all* its changes should be present after recovery.

Consistency requires that processing transactions take the database from one consistent state to another, insofar as other users are concerned. You aren't allowed to see an inconsistent database; that is, you don't see the changes made by an in-process transaction until that transaction completes.

Isolation requires that the effects of a transaction in a multiuser environment be the same as they would be if that transaction were run in a single-user environment. If you read all the personnel records for a specific department, for example, other users should not be allowed to add or delete records for that department until you have completed your transaction.

Consistency and isolation are achieved through a variety of locking techniques. Since a BLOB is simply another field in a data record, you lock BLOBs in much the same way that you lock other fields. When a row is locked, access to the BLOB is also locked.

Finally, durability requires that a database system ensure that once a transaction completes, its changes must be permanently reflected in the database even after subsequent system and media failures. Durability is usually accomplished with a rollback recovery mecha-

nism and either roll-forward recovery or mirroring, or both.

Most DBMSes use similar locking, logging, and recovery processes to guarantee the ACID properties. In a multimedia DBMS, however, these processes must be modified to handle potentially large objects efficiently. In addition, archiving operations and the use of memory and disk space also require special handling.

Log Rolling and Recovery

Because a BLOB can be very large, the usual logging and recovery processes aren't practical in a multimedia database. For instance, if a transaction inserted several large BLOBs into the database, an extremely large log file would be necessary to hold these insertions. In addition, since logging operations are often buffered in memory until a transaction commits, logging a large BLOB could cause frequent flushing of the buffer and result in substantial performance degradation.

For these reasons, the BLOB itself is not logged. Instead, when you modify or insert a BLOB, the change is written directly to the database at that time. In addition, when you modify or delete a BLOB, the old image is not overwritten. A free-space map tracks the blob space as it is used or freed up.

The ability to roll back the change is still guaranteed, however, because the space that the old BLOB occupied is locked for the duration of the transaction, and the changes to the space map and the record containing the BLOB are logged. If you need to perform a rollback, the free-space map is restored so that the pages in the blob space where the change was written are once again marked as free, and the record that contains the BLOB once again points to the prior occurrence of the BLOB (after rolling back updates and deletions), or is removed entirely (after rolling back insertions).

Roll-forward recovery is also slightly different in a multimedia database. It is normally supported by periodically archiving the log to tape. However, since BLOB changes aren't logged, the archiving process must be modified.

When the log is archived to tape, the archive process locates all the instances where a BLOB was modified or inserted, and retrieves that BLOB from the database at that time. Before you can reuse a BLOB page, you must have written it to the log on tape.

Thus, the archiving process is certain to find the BLOB when it attempts to

continued

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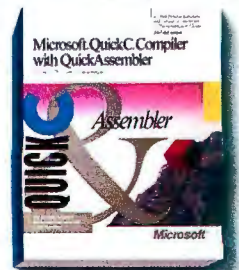
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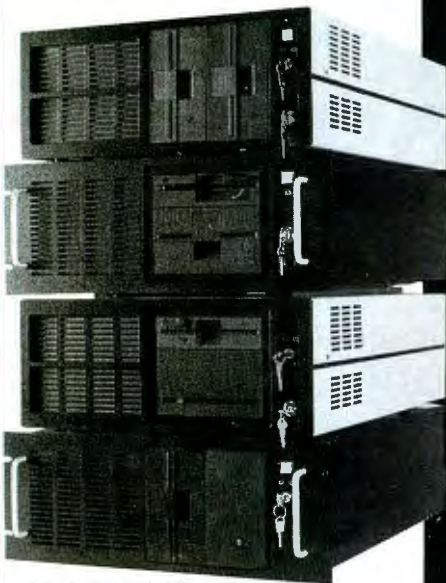
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Listing 1: *This is a sample of an embedded SQL for a C program that reads a scanned photo from a multimedia database. (The definition of the locator structure itself has been omitted.)*

```
$char name [20];
$struct locator photo;
photo.loc_loctype=locmemory;
```

```
$SELECT name, photo from employees
INTO $name, $photo
WHERE empno = 125;
```

archive it. Throughout this process, all the changes to the database, including BLOBs, are logged on the roll-forward tape, without requiring the BLOBs to be logged to disk.

In the Archives

Periodically, you should archive every database to establish a fallback point in case of a catastrophic system failure. Usually, archiving is performed so that a roll-forward recovery can occur after a media failure. Disk mirroring solves the media failure problem, but archiving is still prudent in case data becomes corrupted through an error or a breakdown in security.

In a multimedia database with many BLOB occurrences, the database or a single table could be enormous, so that a full archive of the database could take hours. Such a DBMS should provide an on-line archiving mechanism so the data can be archived while the system is still in use. However, since BLOBs tend to be static in nature, an incremental archiving capability that backs up only the changes since the previous archive can reduce the backup time considerably. Therefore, it becomes imperative for a multimedia DBMS to provide both on-line and incremental archiving capabilities.

Memories...

Because a BLOB can be very large, memory usage is another important consideration. Most DBMSes today buffer many records of data in a shared segment of memory for as long as possible, and then flush changed records to the disk during periodic checkpoints. One large BLOB could easily fill all these memory buffers and leave little room for other data, thereby nullifying the performance advantages of shared buffering.

A multimedia database should provide options so that very large BLOBs don't have to be put into shared memory when they are read or written to. In many cases, you simply need to extract a BLOB

from the database and pass it via regular memory to another program (such as a word processing program or a user-written function that performs an operation like decompression on it) before displaying it. You can also read it from the database directly into a system file to use it with applications that work only on flat files, like word processors or graphics packages.

You can store a BLOB on disk near the other data in the record, or you can store BLOB columns separately in a blob-space. If a BLOB is likely to be many times the size of the rest of the record, or if the same record contains multiple BLOB columns, I would recommend that you store the BLOBs in their own blob-space. Then you could store the BLOBs on another device, such as an optical disk, that has much greater storage capacity and is more cost-effective than a magnetic disk.

To reduce the amount of I/O necessary to read and write to BLOBs, the page size of a blob-space is user-configurable. For example, if a blob-space will hold a drawing that is, on average, 7K bytes to 8K bytes in size, you can set the page size for its blob-space to 8K bytes; then you need only a single I/O request for each read or write. Also, since a program can act on an object as it is stored and retrieved from the database, you could employ user-written routines to compress and decompress a BLOB and substantially reduce the disk space required to store the BLOBs.

SQL for BLOBs

The SQL statements SELECT, UPDATE, INSERT, and DELETE can access a BLOB that's stored in a multimedia database. However, because a BLOB isn't a single value, like an integer, using these SQL statements is more restricted. You can't use BLOB data items in arithmetic, string, or Boolean expressions (except to see if a BLOB is equal to null). Also, you can't reference BLOB fields with clauses, like GROUP BY and ORDER BY, or with qualifiers, such as DISTINCT and UNIQUE. These options don't make sense with a BLOB.

Most often, applications insert and retrieve BLOBs from the database and display them in conjunction with other data fields from the same record. Updates to BLOBs are less likely to occur unless the BLOB contains a text document or a spreadsheet.

When a C program accesses a BLOB, a locator structure manages the location of the BLOB. The object isn't stored

continued

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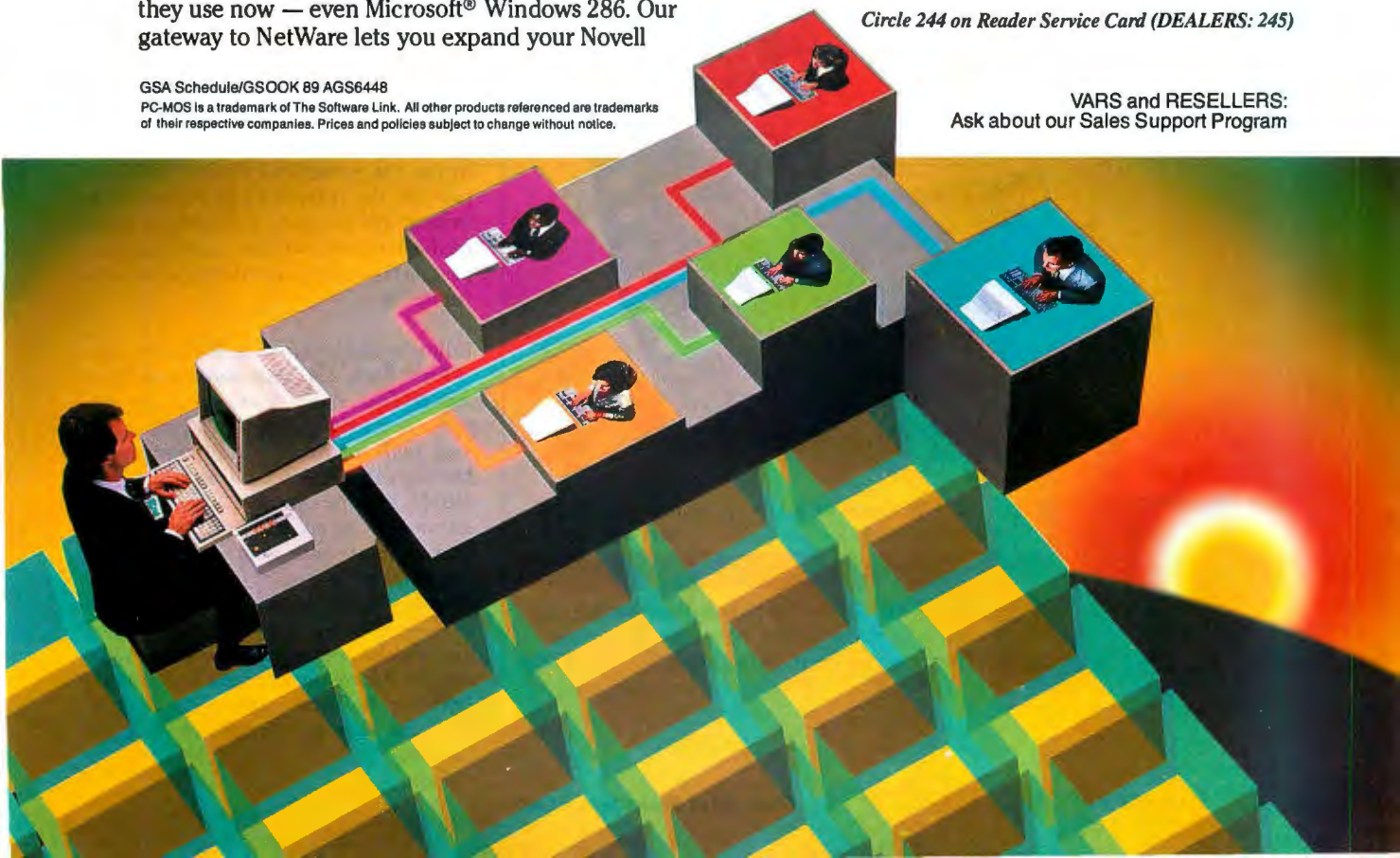
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in the structure itself; rather, it is stored in memory or in a file, and the locator structure references it. This structure contains fields for the return status of BLOB operations, the type of BLOB (i.e., text or byte), the size of the object, its location, and so on.

In listing 1, the database engine reads photo into a location in memory and returns locator information into the structure. The program can then display the BLOB, edit it in some fashion, or

pass it to another program. If the database engine reads photo into a system file, the program simply indicates the filename in the locator structure prior to the SELECT. Then the engine places photo into the file instead of into memory. Using a fourth-generation programming language, you can read a BLOB into a defined field in the program in the same way that you would read in any other variable.

A BLOB is never extracted from the

database until the application specifically references it. If a SQL operation requires searching through several pages of a table, for instance, and a BLOB column is defined in that table, the BLOBs will not be read into memory at the time that the operation searches the pages. Instead, a pointer to the appropriate BLOB will be read in with each record. Then, when the program specifically requests a BLOB from one of the records, the object will be read into memory or into a file at that time.

Thus, the presence of BLOBs in a table doesn't affect the performance of the operation. It operates as if there were no objects in the database at all.

On the Evolution Spiral

As multimedia database systems evolve, locating and processing objects will be refined and made easier. Relationships between different objects could be supported, as in an object-oriented database system. In addition to a full text-retrieval capability accessible via extended SQL, it may be possible to perform searches through byte objects.

For example, you might write a function that searches through a specific graphics format and determines whether a particular company logo is included in the picture. Then, you could store that function in the database engine and perform a SQL request that will locate all the pictures in the database with the same logo in them.

There are many possibilities for extending multimedia database technologies in various directions for use in commercial applications. As users begin to use the power that these capabilities provide, the potential will become more evident and products will evolve. Multimedia databases will have a profound impact on how companies do business in the future. ■

Editor's note: Informix Software, Inc. (Menlo Park, CA), has introduced Informix-OnLine, a database engine that supports multimedia database applications and fault-tolerant on-line transaction processing. A Unix-based relational DBMS, OnLine can store SQL-accessible documents, spreadsheets, graphs, faxes, images, and voice information up to 2 gigabytes in size as objects in a regular field in a database record.

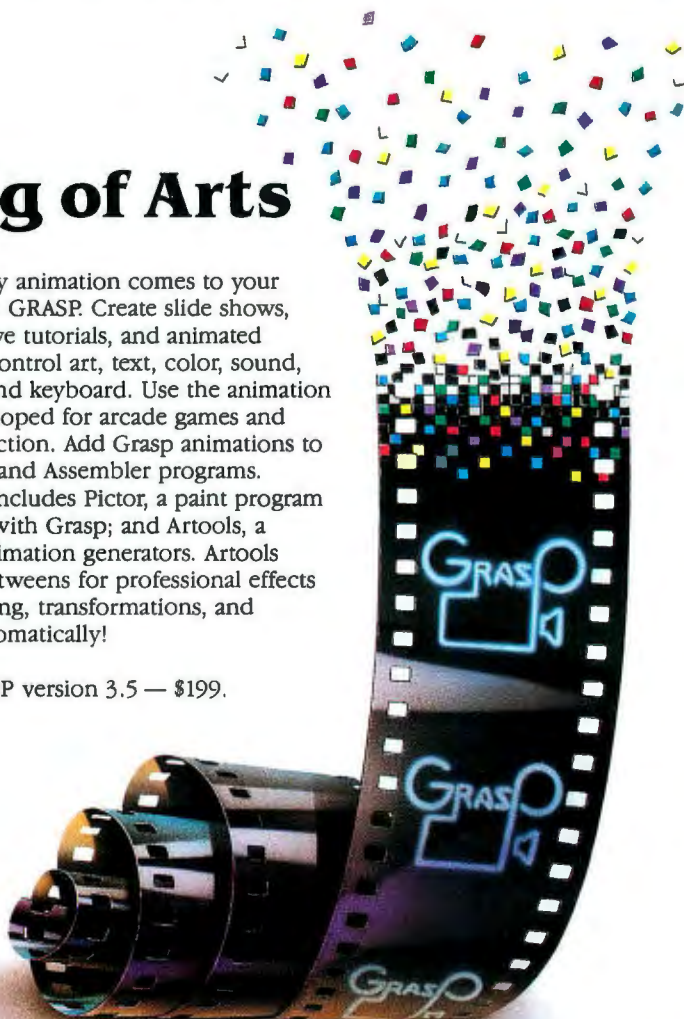
Tim Shetler is a product marketing manager for the advanced products division of Informix Software, Inc. (Menlo Park, CA). He can be reached on BIX c/o "editors."

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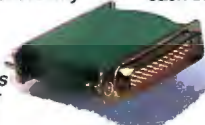
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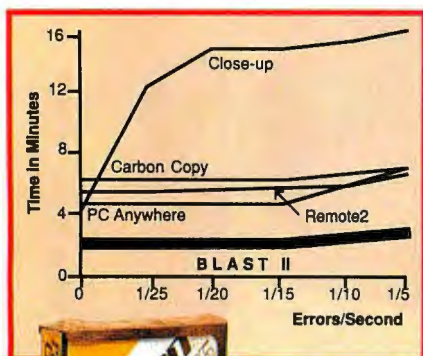
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Remote control speed tests run using the DOS "TYPE" command for an 18K "C" source file at 1200 bps between IBM-XTs.

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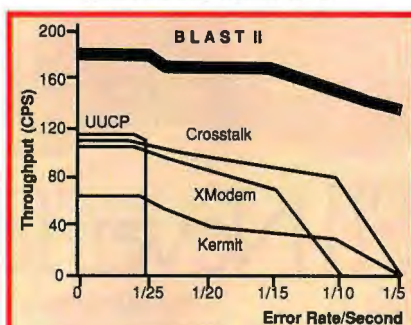
And since noisy phone lines, static, and defective modems are a fact of life—so are errors! While most remote control programs bog down under poor conditions, BLAST keeps going!

Some remote control applications require full control at each end of the link. And BLAST is perfect for those jobs! But the majority of applications only require a central host to control multiple remote sites. So, unlike the others, BLAST offers a low-cost satellite version for one-way control of remote PCs by central systems.

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Noise simulation tests run with a 30K binary spreadsheet file at 1200 bps with IBM-ATs.

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What's It Good For?

In general, any kind of presentation that moves is a candidate for desktop video (see the photo on page 230). One common use is in professional video production. A lot of video makers and video studios have recognized that desktop video can save them time and money. Commercials, trailers (those short movie previews), and TV shows use it. In fact, there's an excellent chance that the lines and arrows on the weather maps on your TV news were produced with a desktop-video system. (For an actual application of a desktop-video system, see the text box "Tethered



Satellites Made Easy" on page 233.)

However, most users of desktop video are people who have realized that it can give them advantages in conveying information to peers, supervisors, clients, and others. Architects can take clients on tours of buildings before they are built and show how new construction will fit on a proposed site. Planners can show how buildings will affect flight paths at

airports. Attorneys use video presentations to present evidence and show judges and juries their versions of what happened. Engineers and scientists use desktop video as a powerful alternative to conventional presentations of dynamic systems, especially complex ones.

The Process

Most desktop video involves two basic operations: overlay and animation. Overlay means putting a computer-generated image on top of an image from a camera or on videotape. This is most commonly used to superimpose titles or animation over a live-action picture.

Overlaying an image requires a device called a *genlock* to synchronize the computer's output with the video signal. More sophisticated

genlocks have controls to fade images in and out, enabling you to produce simple special effects. Technically, genlocking refers only to synchronizing the signals. In practice, in desktop video, a "genlock" refers to a combination genlock and encoder.

An encoder converts the RGB output from a computer into a U.S.-standard

continued

National Television System Committee (NTSC) composite video signal that your TV can transmit and your VCR can record. If you don't need the overlay capability, a video encoder can substitute for a genlock. While you can't overlay an image on existing video with it, you can put the computer output on tape. However, the overlay capability of a genlock is preferable.

Animation involves making a series of images, each slightly different from the last, and displaying them in succession so rapidly that they appear to show motion. Usually, it requires at least 25 frames (images) per second; 50 to 60 is better for smoother animation. Consequently, it takes many frames to produce even a short animation.

Desktop-video workstations need lots of memory and disk space to deal with this requirement. Not only does the finished product take up a lot of memory, but animations are usually built in small sections and spliced together. Even with a good animation package, there is a certain amount of cut-and-try, which usually requires keeping several versions of a sequence on disk.

Although you can create animation with almost any draw or paint program, or even CAD software, the trend is toward specialized animation programs. At their most elementary, animation programs can define several frames at once, copy parts of images from one frame to another, and display the sequence. Almost all of them let you define a complex object as a "brush" and move it as a unit, and most of them can do more complicated things, too.

Animation programs are usually also paint programs. You can use them to create images, as well as to manipulate those images already on the screen. Most of them can also import images from other programs. For example, you might bring a CAD image into an animation program and color, shade, and animate it to show what the object would look like in motion.

Functionally, you can divide paint and animation programs into two-dimensional and three-dimensional classes. A two-dimensional program creates and manipulates what are essentially flat objects, while a three-dimensional program builds up solid models and works with them. Frequently, three-dimensional programs are able to use ray tracing or other sophisticated rendering techniques to make the results look more real. But you sacrifice some computing power and ease of use.

There are all kinds of subtleties in a



While it is impossible to portray animation in a single picture, this screen, created with Autodesk Animator, does a good job. It takes little imagination to see the hummingbird on the left move across the screen, changing as it goes, to become the kite on the right. (Photo courtesy of Autodesk, Inc.)

satisfying animation. For example, an object dropped from the top of the screen should move slowly at first and then pick up speed as "gravity" accelerates it. Thus, the images of the object need to be close together on the early frames and to move farther apart in the later ones. When an object like a ball bounces off a surface, it deforms and then regains its original shape. Some animation programs automate these processes.

Three Architectures

Although a great deal of computer video is done on workstations from companies such as Sun Microsystems and Silicon Graphics, most desktop video is done on Amigas, MS-DOS machines, and Macintosh IIs. All three have different strengths and weaknesses as desktop-video machines.

The easiest microcomputer to use as a video workstation is probably the Commodore Amiga. It was designed for graphics and video compatibility, and there is a large selection of inexpensive video hardware and software for it.

Like a TV, but unlike most computers, the Amiga has an interlace mode in which each screen is composed of two frames containing alternating scan lines. Also, the Amigas sold in the U.S. have a horizontal scan frequency of 15,750 Hz, the same as the NTSC TV standard. These features make it easier and cheaper to build genlocks and other video equipment for the Amiga. The Amiga also has an overscan mode, which ex-

tends the picture beyond the edge of the screen. This eliminates the border around a conventional computer-generated image when it is displayed on videotape.

The Amiga 2000 and 2500 have two video outputs, one for analog RGB signals and the other for the digital signals before they are converted to analog. The RGB port is preferred for monitors and less expensive video equipment, while the digital video slot is used with higher-quality equipment.

One nice thing about Amiga software is that it tends to consider the inexperienced user. Many of the animation, paint, and titling programs have user-friendly interfaces and fairly easy-to-understand manuals. Because Amigas have been widely used for video since they first appeared, the software is somewhat more advanced than that available on the other two architectures.

The major drawback to the Amiga is that it runs out of headroom at about the point where professional video quality starts. Although some Amiga models have slots, the machine's display processing is done by a custom VLSI chip set on the motherboard. Those chips limit the number of colors and resolution available. They also limit the display memory to 1 megabyte, although the Amiga can have up to 9 megabytes of RAM.

The basic Amiga display is limited to 640- by 400-pixel resolution (704 by 480 pixels using overscan) and 32 colors.

continued



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(The Amiga has a couple of special modes called half-bright and HAM [hold and modify] that can display up to 64 and 4096 colors, respectively, but these have limitations. In half-bright mode, 32 of the colors are half-intensity shades of the other 32. In HAM mode, it can take as many as 3 pixels to go from one color to another.) Several companies, including Commodore, are working on high-resolution video boards for the Amiga based on the Texas Instruments 340x0 family of graphics processors and the INMOS transputer RISC processor. These video boards will offer more resolution and more colors than are currently available.

If the Amiga has the architecture best suited to desktop video, the IBM PC and its compatibles probably have the worst. The combination of limited display adapters and a segmented processor architecture make the stock AT a poor choice for high-quality graphics work. But, unlike the Amiga, MS-DOS and OS/2 machines are easy to upgrade. Video-compatible display cards, math coprocessors, and faster 80286 and 80386 processors can turn a PC into a powerful and effective video workstation. In fact, PCs are numerically the most popular machines for desktop video today.

Because MS-DOS is the dominant microcomputer architecture and companies have been producing high-resolution video cards for MS-DOS machines, there are several options for desktop video on DOS systems. The most common video standard for MS-DOS desktop video is probably VGA. The hardware is relatively inexpensive, the 640-by-480-pixel resolution and 256-color palette are adequate, and a lot of computers are sold with VGA capability. A number of VGA boards now come with an NTSC output jack to put images directly onto videotape.

Besides VGA, several other display boards offer even higher resolutions and more colors. Boards from companies like Truevision can provide over 16 million colors at resolutions of 512 by 482 pixels and higher. Some of the boards double as frame grabbers and can digitize a picture from a video camera or videotape for computer manipulation.

Although some of these boards have been available for several years, desktop-video software for nonprofessionals started to arrive only in the last year or two. For example, last year, Autodesk announced its Animator program, offering animation at 320- by 200-pixel resolution with 256 colors for \$299.

The Mac II is the latest microcomputer

family to enter the desktop-video business. The original Macintoshes with monochrome displays and no expansion slots weren't suitable for desktop video, but the Mac II family is, and a number of manufacturers have introduced video products for it.

Another major factor is Apple's 32-Bit Color QuickDraw, introduced last year. It provides a standard programming interface for color graphics applications with 24-bit color (16.7 million shades) and an 8-bit alpha channel. The alpha channel can be used for special effects such as setting the transparency level.

Several companies have come out with sophisticated animation and rendering programs for the Mac II, including Super 3D from Silicon Beach Software and Swivel 3D from Paracomp. Byte by Byte has brought a version of its Sculpt-Animate 4D to the Mac from the Amiga.

Apple's main focus for desktop video is as part of multimedia presentations. Apple has paid a lot of attention to integrating video with HyperCard and other presentation products. Thus, Apple has a compact disk player for the Mac, but it doesn't offer a genlock. Genlocks are available from third parties, however.

What Do You Need?

The general rule is: The more memory the better for video applications. The absolute minimum is 1 megabyte; 4 to 8 megabytes is better. Likewise, a computer used for video work needs a powerful processor and a math coprocessor, if possible. Going from a 68000 to a 68030 can reduce the time needed to process an image by a factor of eight or more. In the MS-DOS world, an 80286 system is the slowest one recommended; a 33-MHz 80386 is preferred. Finally, you should have a large, fast hard disk drive. An 80-megabyte unit with a 28-millisecond or less seek time is good, and people who do a lot of video work use 150- or 300-megabyte hard disk drives.

If the video is going to be put on tape, you need video equipment as well. At a minimum, this means a VCR, something capable of genlocking the computer to a VCR, and a way to produce NTSC output. Although any VCR capable of recording can be used for desktop video, some features are especially useful. One is "flying" erase heads for cleaner edits. Another is the ability to connect to an external video editor. An accurate frame counter is also useful. Overlays and editing require two VCRs; three are preferable.

A good-quality encoder or combination encoder/genlock is also important.

The genlock's performance is critical to the quality of the finished tape, so most desktop-video makers advise getting the best one you can afford. Unlike film, which is edited by cutting and splicing, video is usually edited by rerecording onto another tape. An edit controller is very useful for making seamless cuts in editing and generally making editing faster and easier. Another useful device is a switcher for switching among the computer, the VCR, and other signal sources. Finally, you need a camera set-up to record video in the first place. In addition to a video camera or camcorder, this setup should include lights, lenses, and other equipment.

A complete set of equipment like this is expensive and probably overkill for a lot of desktop-video jobs. Many desktop videos have been done with just a VCR, a genlock, and a computer.

But How Good Is It?

The standard for comparison in video work is "broadcast quality"—images with the sharpness, clarity, and purity of color found on major network broadcasts. Like desktop publishing's "typeset quality," broadcast quality is a nebulous term signifying some truly professional standard of output. Desktop video does not measure up to such a standard any more than desktop publishing does.

The quality of desktop video can be good, but for a variety of reasons, it will never be as good as what a studio full of professional equipment will produce. Most of these reasons are in the hardware, but users do some things that make the problems worse, such as using saturated colors that smear, high-contrast colors with borders that "crawl," and thin, 1-pixel-thick lines that flicker. You have to learn some techniques to get the best from your system.

Choosing the right tape format also minimizes troubles. Few of us have access to the expensive 1-inch reel-to-reel videotape machines used by large broadcast studios, or even the ¾-inch tape used in many newsrooms. VHS is much more common, but it produces only fair recording quality. The recently introduced Super VHS gives measurably better quality.

As in the photographic process, every generation away from the original suffers from degradation. The 1-inch tape and the equipment that uses it are of very high quality and introduce very little distortion during subsequent copying. Even when a tape is originally recorded in VHS format, if you copy it to ¾-inch or 1-inch tape and do the production work

Tethered Satellites Made Easy

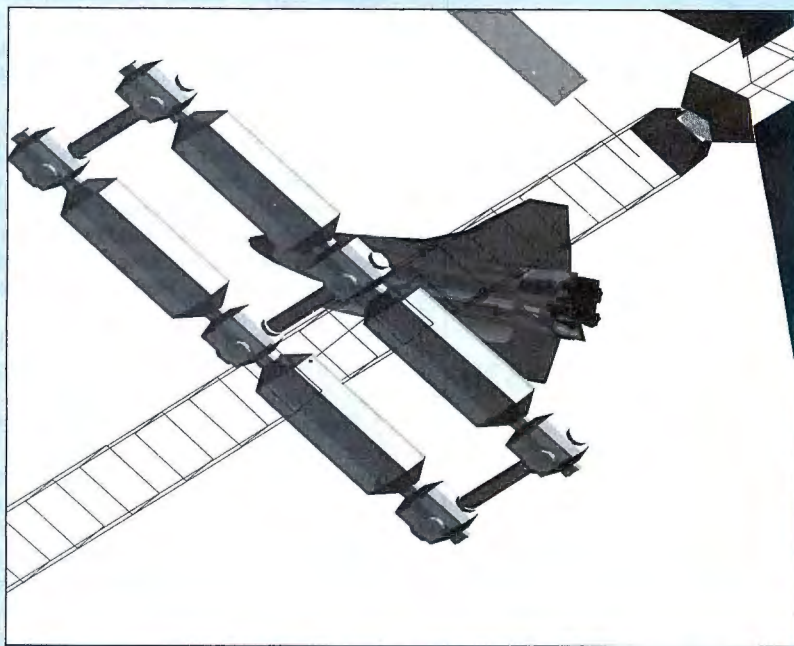
For David Lang, desktop video is a standard tool. Lang, who runs his own consulting company out of Mercer Island, Washington, is a specialist in tethered satellites (two or more satellites joined by a cable). He wrote a program called the Tethered Orbiting Satellite Simulator, or TOSS, which calculates and displays the motions of tethered-satellite systems (see the photo at right).

For a variety of reasons, this is an area of considerable interest to NASA and companies involved in the space program. But it's not an easy one to understand. By their nature, tethered satellites are dynamic. Their motions are complex and sometimes counterintuitive. The usual way to describe the dynamics of tethered satellites is with systems of equations. While this is accurate, it is meaningless to anyone who doesn't understand the mathematics. But if you can see the motion of the satellites, what is happening becomes fairly obvious. You may not gain as much knowledge as you would if you studied the equations, but for a nonspecialist, this method is often adequate.

Lang's first desktop video came about when he was asked to do a tape for an open house at Johnson Space Center showing some of the basics of tethered-satellite systems. Lang had no previous video-production experience. But he had a Macintosh II, and he knew where he could get a genlock board for his machine.

"The whole thing was pretty much a low-budget operation," Lang said. "I did the animation, the narration, the video production, dubbed in the music, the entire deal." The result was "Tethers for Novices," a videotape that shows what happens when you tie two orbiting objects together. Over background music, the narrator describes how tethered objects interact. On the screen, a space shuttle reels a satellite in and out while the earth spins below.

Lang used Super 3D from Silicon



One frame of a motion simulation created by TOSS (Tethered Orbiting Satellite Simulator), a program that calculates and displays the motions of tethered-satellite systems. This simulation includes the space shuttle. (Photo courtesy of David Lang)

Beach Software to create the animation. His TOSS program provided the basic motion of the shuttle, tether, and satellite, and he did the images of the parts with Super 3D. "The solid models of the shuttle and the space station I got from the Design Edge people in Houston," he said. He imported the models into Super 3D to be animated.

Starting with the earth, Lang had a globe painted to resemble the planet and taped that while it was spinning. He used that tape as a background and overlaid the animation using the genlock.

The cost of the equipment was fairly low. "The software was \$250 list; the genlock board was on the order of \$1100 or \$1200," Lang said. "Then I used a standard VHS VCR. The only other thing I had to get was a Tascam Porta II audio mixer for about \$400.

"The biggest expense by far was a 300-megabyte hard drive. In order to do an effective presentation, you want to have enough hard disk capacity laying around so you can keep a number of animations at your fingertips when you start the production process."

However, the process was time-consuming. "It probably took a couple of months to write the code to take the data out of the tether simulation and put it in the form Super 3D wanted to see," he said. "Once it was in motion, it took just a few hours to create the animation."

The result was so successful that Lang used video animation to present the result of an engineering study to NASA. "For complex dynamic motion, animation can show you things you couldn't possibly describe otherwise," he said.

on the larger tape before copying it back to VHS for distribution, the result will look much better than one processed entirely on VHS.

Trouble in TV Land

The fundamental difficulty in getting inexpensive and high-quality video lies in

the differences between a computer video signal and a TV signal—especially in some of the peculiarities in the latter. A computer display is digital, and a TV's is analog. Further, a TV picture, especially a color TV picture, is a very complex signal composed of two half frames interlaced.

The NTSC standard is just over 35 years old. It is an analog standard, and everything is held together by a precisely timed sequence of synchronizing pulses in the signal. When color TV became available in the 1950s, the standard was modified to allow compatible color—

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images that you could view on either black-and-white or color TVs. Essentially, the modification consisted of adding a second signal, called *chrominance*, to the picture information, or *luminance*, needed for black-and-white reproduction. This was something of a kludge, and the result is tricky.

This kludge has serious implications for desktop video. The quality of the final picture depends in large part on how carefully the computer output device adheres to NTSC standards for timing and waveform and how faithfully the signal is recorded. Both present challenges to desktop-video equipment. If the timing is off, the color shifts. Color shift is much more obvious to viewers than degraded resolution is.

Timing isn't the only problem, however. Computer video signals tend to have fast rise times and sharp edges, causing a lot of high-frequency harmonics in the signal and "ringing" in the circuits. The ringing can show up as fringes of color around objects. This creates a special problem when the signal is put on VHS or other inexpensive-format tape, and the design of the recorders exacerbates the problem. It also tends to grow worse each time the tape is copied.

Relative signal strengths are another consideration. If the RGB outputs don't have the same amplitude, the colors, especially the light ones, shift. If there is too much amplitude on the red signal, whites become pink.

Getting the video-output signal really right is not cheap. Most genlock manufacturers use a single IC for genlocking and RGB-to-composite NTSC conversion. The chip doesn't produce the same quality signal as the analog circuits in professional equipment. On the other hand, a genlock built around a single chip can sell for 10 percent of the cost of a professional-quality genlock.

The bottom line: Desktop quality is good enough for many kinds of video in the same way that 300-dot-per-inch laser printing is adequate for a lot of published material. Also, the signal that goes into a TV transmitter may be broadcast quality, but what we watch often isn't. The reproduction ability of most TV sets and VCRs is, to put it charitably, mediocre.

A Technology for the Future

Desktop video is still in its infancy. Desktop publishing took off not with the invention of the laser printer, which made the technology possible, but with the release of the Macintosh and the Apple LaserWriter printer, which made it easy. Today, desktop-video technol-

ogy is possible, but it's not yet easy. It's still waiting for its equivalent of the Mac.

Probably the biggest need is to integrate the systems and make them easier to use. The individual components, especially the software, are powerful and fairly easy to use, but the overall process isn't; you may need half a dozen programs to do one presentation. In particular, the video transfer and editing need to be made easier. Ideally, you should be able to plug a video camera and recorder into a computer and turn out images as easily as you turn out laser-printed pages today.

Some progress has occurred in that direction, however. There is a strong trend toward standardization in file formats for video software. For example, most Amiga programs, except those for three-dimensional modeling, use a standard file format, called IFF, for graphical images. This standard makes it easy to move an image back and forth among Amiga applications and use each program to do whatever part of the task it is best suited to. Similar standards or quasi-standards exist for the Macintosh and MS-DOS machines.

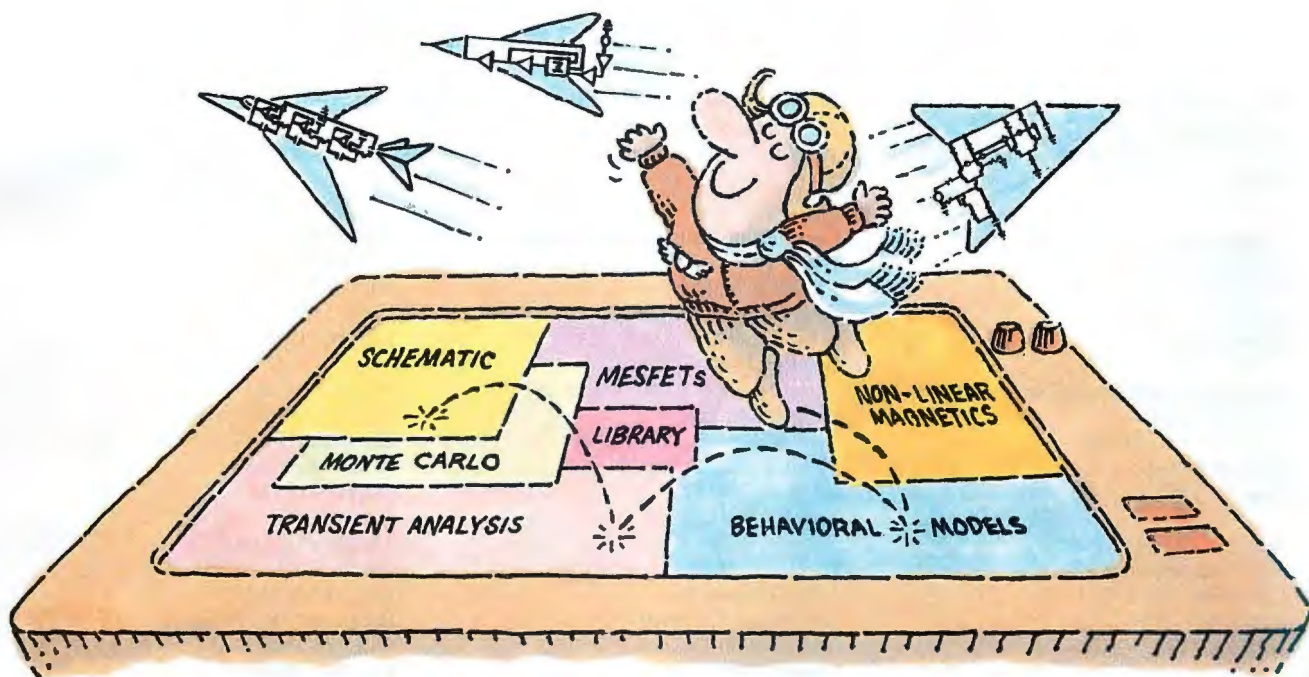
A number of companies, especially in the Amiga market, are working on video authoring systems to make the whole process easier. The aim of these programs is to give users a consistent interface for managing text, graphics, and audio. At least some of the Amiga programs should be out now.

One particularly interesting product is from the BBC. MediaMaker is for the Macintosh and works with 8-mm videotape to let you define key frames in your video, graphics, and sound sequences and designate each key frame and the attached sequence with an icon. Then you can edit the presentation by manipulating icons in typical Macintosh fashion.

The hardware is improving as well. Genlocks and editors are getting better, if not necessarily cheaper. New formats, like Super VHS, offer better picture quality at lower prices. And video equipment manufacturers are adding features to make their products more useful for amateur and desktop-video production.

Desktop video may never be as widespread as desktop publishing. But as we move from computer graphics into multimedia, it seems certain to become more popular. Desktop video is a powerful tool for communications of all kinds. ■

Rick Cook is a freelance writer in Phoenix, Arizona, specializing in computers and high-technology subjects. He can be reached on BIX as "rcook."



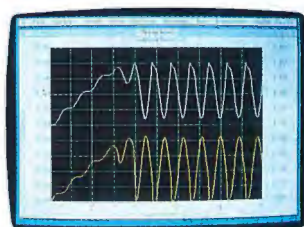
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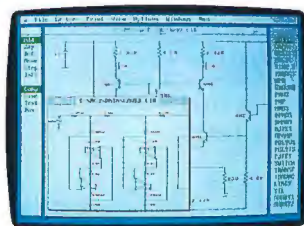
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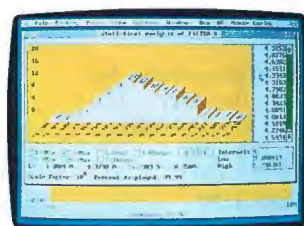
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Multimedia Makers Mentioned

The number of companies working in multimedia and related fields is enormous. It includes those involved in graphics software and hardware, animation, speech synthesis, music, video boards, genlocks, CD-ROMs, video cameras, videodisk players, and more. Therefore, of necessity, this listing contains only those companies mentioned in the various articles in this In Depth section.

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THE ART OF RAY TRACING

*Generating realistic 3-D images is a natural
for the parallel-processing power of transputers*

Owen F. Ransen

The earliest three-dimensional computer graphics were simple wire frames—stick-figure representations of the real world. Then, in 1968, a researcher named Arthur Appel published a paper on ray tracing—a three-dimensional-rendering technique to reproduce realistic shadows, reflections, and refractions.

Working at the IBM Research Center at Yorktown Heights, New York, Appel improved on simple wire-frame drawings by hiding invisible lines and adding shading and shadows. The technique made solids appear more solid and gave a better idea of the relative three-dimensional position of objects.

Early images were black and white, but researchers soon realized that ray tracing could also render reflections and transparency, and in full color (see photos 1 and 2).

Apart from creating interesting pictures, ray tracing can be used to perform volume calculations and optics simulations, and to represent fields in physics simulations. Photo 3 shows an industrial application that helps the user select the colors of plastic extrusions.

Catching Rays

Basic ray tracing is actually very simple. Instead of think-

ing of a traditional camera where light enters a lens and hits film, think of a computer simulating a camera that sends rays from the film out into the world. Imagine lines from the center of each pixel passing through an imaginary lens (usually a pin-hole) and out into space (see figure 1). If the ray hits an object, the pixel where the ray originated takes on the color of that object. The place (in x,y,z coordinates) where the ray hits the object is called the *ray-object intersection*. If the ray hits an object

with a shiny surface, you can calculate the reflected ray and see if it hits a second object. If the second ray (the reflected ray) hits a second object, you can see a reflection of the second object in the first.

To produce realistic and accurate shadows, ray tracing uses *shadow rays*. A shadow ray is a straight line drawn from a point on a specific object to the light source. If the line reaches the light source without hitting an intervening object first, then the original point is not in shadow.

The problem with ray tracing is the amount of time it takes. An image of 512 by 512 pixels requires that at least 262,144 pixels be calculated, and antialiasing (a process that smooths jagged edges in computer-generated images) requires even more than that. In spite of much fruitful research into developing fast ray-tracing algo-



Photo 1: This image, using 16 T414 transputers in a ring, illustrates how ray tracing can reproduce reflections and shadows.

rithms, rendering currently takes hours per image.

Fortunately, ray tracing lends itself to the sort of parallel processing supported by the transputer, a family of processors designed and manufactured by INMOS for parallel-processing applications.

Parallelism and Transputers

The top of the transputer line is the INMOS T800, a single chip containing a 32-bit microprocessor, an FPU, four communications links, 4K bytes of fast internal static RAM, and a memory interface that can address up to 4 gigabytes of external RAM. It was designed specifically for multiprocessor systems. (See "T800 and Counting," November 1988 BYTE.)

One of the simplest transputers is the T212, with a 16-bit processor, 2K bytes of internal RAM, and four communications links. The T212 can access up to 64K bytes of external memory. The T414 has no FPU and only 2K bytes of internal RAM but is otherwise identical to the T800. Transputers also come in application-specific varieties, such as the M212, which has extra hardware to deal with disk drives. Any type of transputer can communicate with any other type using the communications links.

A single transputer can run two or more parallel processes. This *internal* parallelism allows the FPU and the CPU to work on separate data at the same time and allows the four communications links to run independently of the FPU and CPU. It also features hardware support for multitasking as well as multiprocessing so that several processes can run simultaneously on a single transputer.

This internal parallelism allows buffers to be created in software. They act very much like a buffer in a printer. One transputer can send another transputer a message over the links, much as you can send a long file to a printer. If the printer has a large buffer, you can download the whole of the file into it and carry on with another job while the printer prints out the file. If a receiving transputer has internal buffers, the sending transputer can transmit its message quickly and get on with its job, even though the receiving transputer may not be ready to react to the message.

The links enable *external* parallelism—the ability for two or more transputers to work simultaneously on the same problem. External parallelism allows hundreds and thousands of transputers to be connected simply and efficiently. Each T800 has four

links, which allow it to be connected directly to four other transputers. Thus, you can make pipelines, rings, and square arrays. Each link runs at 20 megabits per second and is bidirectional.

Ray Tracing and Transputers

Transputer systems are flexible in the way that they implement parallelism. The most popular technique is the "farm" method. Each transputer has the same program but runs with different data. When the transputer has finished its job, it sends back the results and starts work on new data. A main controlling processor (often a transputer, too) organizes the sending of jobs and reception of results.

Figure 2 shows a layout with some transputers connected in a ring configuration. The lines between each transputer represent the communications links. Photos 1 and 2 were generated using a ring of 16 transputers connected as shown in figure 2. In a typical transputer-based ray-tracing system, the IBM PC contains an IMS B004 board (or compatible) used for the Transputer Development System. A ring-controller transputer allocates jobs to, and receives replies from, the transputers in the ring. The replies are usually graphics data to plot on the graphics board. Within each ring transputer, two parallel processes run—one handles command and result routing, and the other does the actual ray tracing (see figure 3).

For ray-tracing applications, you can get each transputer to work on a single pixel. This method is acceptable but carries with it a high communications overhead. If the screen size is 512 by 512 pixels, then 262,144 job messages and 262,144 result messages have to be handled.

You must also consider antialiasing problems when organizing and distributing the jobs. Usually, you use antialiasing only where absolutely necessary—that is, where jagged edges would be most visible. To know where to do the antialiasing, the transputer must have knowledge of the pixels above and below (and to the left and right of) the pixel it is currently working on. A transputer working on a single pixel at a time does not know anything about surrounding pixels.

If, instead of giving each transputer a single pixel to work on, you give it a whole row of pixels—a *scan line*—then you can greatly reduce the communications overhead. An image of 512 by 512 pixels is made up of 512 scan lines of 512 pixels each.

continued

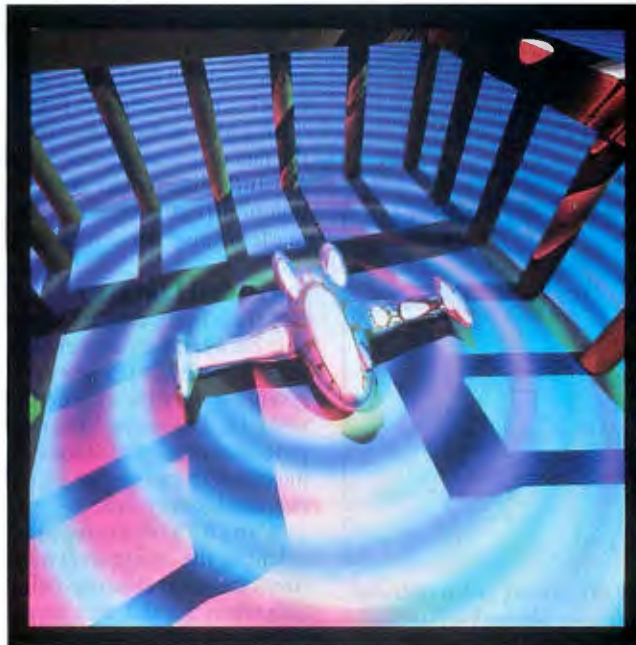


Photo 2: By distorting the field of the soft objects using rotation and stretching, you can create any number of smooth, streamlined shapes, such as the spaceship seen here.

Linearity refers to the relationship between number of processors and speed. A perfectly linear system with 16 processors will complete a job 16 times faster than a single-processor system.

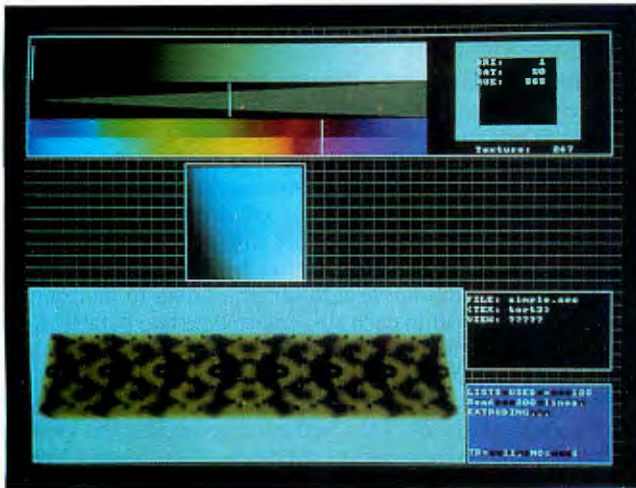


Photo 3: This image is taken from a Meiko computing surface configured as 24 T800 transputers in a ring. The system predicts how different colored plastic layers will look in a final extrusion.

THE GEOMETRY OF RAY TRACING

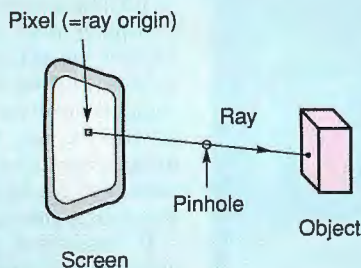


Figure 1: Like a camera in reverse, ray tracing calculates the path of a ray from each pixel in an image, through a fixed point representing a pinhole in the "camera," and out into the world. If the ray hits an object, the pixel is assigned the color of that object. Rays that do not hit objects are given some arbitrary background color.

Thus, instead of a command and reply for every pixel (262,144 messages per image), you have a command and a reply for every scan line (512 messages per image).

A typical command sent from the controlling transputer around the ring would look like this (in plain English): "Transputer number 9, ray-trace the scan line at $y = 100$." A typical reply sent back to the controller would be, "This is a message from transputer number 12. I have worked out scan line 133; here it is. Now I am free to accept another job."

There's still a problem with antialiasing, though. Each transputer can perform antialiasing in the horizontal direction because it has a whole scan line of the image and so knows the color of the pixels to the left and right of the current one. It does not know, however, the color of the pixels above and below it. They are in separate scan lines, being calculated by other transputers. You can resolve this by getting each transputer to work on a *subscreen*—a small rectangular area of the main screen. Most pixels in a subscreen have neighbors in the same subscreen, so the transputer can antialias them. Pixels on the edge of the subscreen may require extra work to antialias properly.

If your images are part of a sequence for computer animation, another obvious way to distribute the tasks is to hand each transputer a single frame. The problem here is that each frame will take a different amount of time to calculate, and there's no guarantee that the first frame of the video will be completed first. In animations I created, I divided the image into a 16 by 16 grid, with 16 transputers sharing the 256 separate subscreens. On average, each transputer would calculate 16 subscreens. Obviously, however, some subscreens take longer than others; an area of the image where there are no objects will not take as long as an area where there is a silver spaceship, for example. This imbalance in the time a transputer takes to complete a subscreen can be quite a problem.

If 15 transputers have finished their jobs and are all waiting for the sixteenth transputer to complete its final subscreen, those 15 idle transputers are wasted. When I created an animation, I overcame this by getting the controlling transputer to predict where the image would take the longest to calculate. The master transputer records the time it takes to complete each subscreen and notes the parts of the screen that require a greater effort. On subsequent frames, the calculation starts on these "difficult" subscreens first. This method takes advantage of the fact that in a sequence of images for animation, there is usually little difference between one image and the next in the location of difficult areas. Thus, as the animation progresses, the master transputer can easily track the areas of difficulty.

Speed and Linearity

In parallel-processing systems, *linearity* refers to the relationship between the number of processors and the speed of the system. A perfectly linear system of 16 processors will complete a given job 16 times faster than a single-processor system (see table 1). Losses in linearity usually occur because of inter-processor communications overhead. The transputer's communications links operate in parallel with the processor, so this overhead is very low.

With 16 T414s arranged in a ring, it took about 25 minutes to calculate the image shown in photo 1. (The T800 is about eight times faster on floating-point calculations, but it was not available when the test was carried out.) The image size is 512 by 512 pixels and includes antialiasing, shadows, and reflections.

I worked out the linearity of the system by timing it with the same image on different sizes of rings. As you can see from table 1, the linearity is very good (even up to 16 transputers, it is within 1 percent of perfect linearity).

Occam vs. C

Many people are waiting for C compilers before using the transputer. This is justified when you are porting software. But for creating new programs, you may want to consider Occam. It offers a simple, secure way to do parallel programming. (See "Configuring Parallel Programs, Part 2," January BYTE.)

No programming language is perfect, and Occam's most obvious drawback is that recursion is not possible. Further, it allocates memory statically (e.g., there is no Occam version of C's Malloc). Static memory allocation is not a problem if you want to build secure systems. You'll never run out of memory at run time. If you can live without recursion, you may find Occam a useful high-level language. I made the images in this article using programs written entirely in Occam.

Occam Constructs Used in Ray Tracing

Figure 3 shows the internal software structure of the ring components. There are two parallel processes—a router and a ray tracer. These parallel processes are not hard-wired in the transputer but are created by the program. The router takes in commands and data from Link0In, looks at each command, and decides if the message is for its own transputer. All the transputers have unique identifiers, and the routers know what identifier their transputer has. Then the command is passed down to the ray tracer. If the command is for another transputer, or if it is a data packet (a subscreen completed by another transputer), the router passes the packet out to Link1Out. In this way, there is a flow of commands and subscreens around the ring.

Since the transputer's links run independently of the processor itself, this constant flow of data only minimally slows down the processing. When there are 16 transputers in the ring, each transputer has to handle not only its own packets but also the packets of the other 15 transputers that pass through it. Table 1 shows that this overhead accounts for less than 1 percent of the total processing time. The longest possible message in this application is a single subscreen 3072 bytes long (32 pixels wide by 32 pixels deep by 3 bytes per pixel), plus a few bytes of control and address information.

The transputer is more efficient with long messages than short messages because the main overhead in message passing is getting the link hardware running. Once the transputer has started the link, though, its operation interferes very little with the processor. Here is the Occam for the ring component:

```
CHAN OF RtCommands In,Out:
PLACE In AT Link0In :
PLACE Out AT Link1Out :
CHAN OF RtCommands FromRT,ToRT:
```

```
PAR
  router (In,ToRT,FromRT,Out)
  tracer (ToRT,FromRT)
```

An Occam *channel* is the software equivalent of a transputer link. CHAN OF RtCommands declares channels with a type, RtCommands, which is defined elsewhere as a protocol required for the ray-tracing commands and results. The channels In and Out are *hard* channels—with the two PLACE statements, they are actually mapped to the hardware of the transputer's links.

The channels FromRT and ToRT are *soft* channels and are used for communication between processes within a single processor. PAR means "run the following (indented) processes in parallel." So router and tracer are two processes that run in parallel and communicate using two soft channels. These two

continued

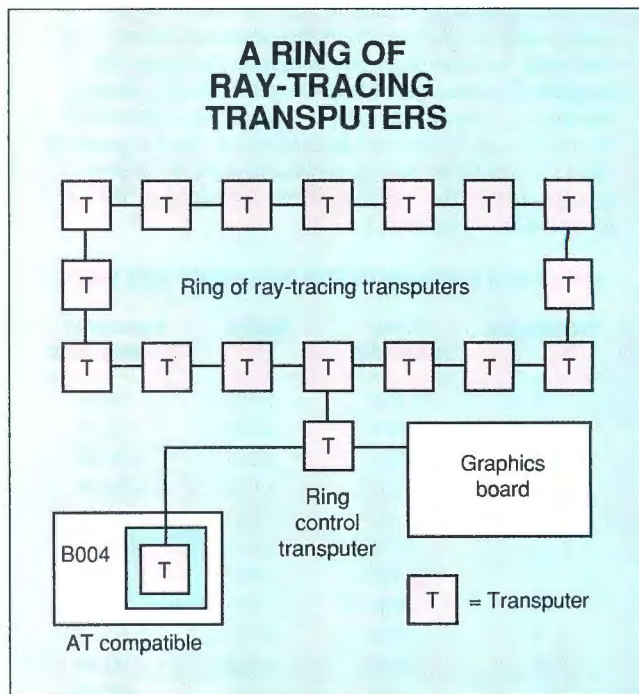


Figure 2: This arrangement of transputers was used to produce the ray-traced images in the accompanying photos. Since all transputers communicate using links, the controlling transputer sends out ray-trace commands to the ring and receives completed subscreens, which it displays on a graphics board. The Transputer Development System runs on the INMOS B004 situated inside an IBM PC.

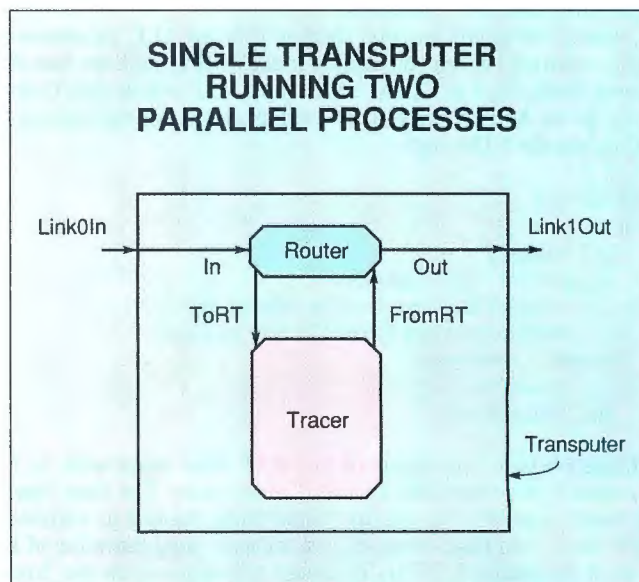


Figure 3: A single transputer can simultaneously run any number of parallel processes. This image shows two parallel processes that run inside the ring transputers of figure 1. The router is used to direct the messages coming into the transputer, and the tracer does the actual ray tracing of a small area of the final image.

Table 1: This table shows the time it took a ring of transputers to calculate the image shown in photo 1. A ring with only one processor is assigned a speed of 1. Note the almost perfect linearity of the results: That is, the time to complete the task is directly proportional to the number of transputers assigned to it. An x,y graph of this table would be very close to a straight 45-degree line. (Note that the processors were T414s; the T800 is about eight times faster.)

SPEED MEASUREMENTS FOR DIFFERENT-SIZE RINGS

Processors	Time (seconds)	Speed	Percent of linearity loss
1	23,838	1.000	00.00
2	11,909	2.002	-00.10
3	7944	3.001	-00.03
4	5955	4.003	-00.08
5	4764	5.004	-00.08
6	3976	5.995	00.08
7	3407	6.997	00.04
8	2981	7.997	00.04
9	2653	8.985	00.17
10	2388	9.982	00.18
11	2174	10.965	00.32
12	1996	11.943	00.48
13	1840	12.955	00.35
14	1709	13.949	00.39
15	1598	14.917	00.55
16	1498	15.913	00.54

processes are defined elsewhere in the program, much like Pascal procedures or C functions.

Inside the router process, there will be an ALT, or alternative construct. When you need to make a selection from two or more inputs but don't know which input will receive data first, you use an ALT. It can also be used as a mixer or multiplexer. Consider the following:

```
WHILE TRUE
ALT
  In ? command
  ...process the command...
  ...eg send command down to tracer or...
  ...send subscreen directly out to link1...
  FromRT ? subscreen

  Out ! subscreen
```

There are two components of this ALT. One starts with In ? command, the other with FromRT ? subscreen. The first component, channel ? x, means "input from channel to variable x"; the second part, channel ! x, means "send the value of x out of the channel." This fragment will input from the first channel, In or FromRT, to receive a message and then either process the command or output the variable subscreen. (Occam can output large arrays of data using a single statement.) The enclosing WHILE TRUE ensures that the ALT is repeated forever, constantly selecting from the two inputs.

Figure 3 shows that the two inputs to the router are from the ring (In) and the tracer (FromRT). The messages that come from

the tracer are always subscreens, ready to be routed back to the master transputer and displayed. The messages coming from the ring are commands or subscreens computed by other transputers. Obviously, you don't know the timing of the messages, and this is where ALT shows its usefulness. It helps handle indeterminacy. For a more detailed explanation of the latest version of Occam, see "Occam II," October 1989 BYTE.

Hardware Simplicity and Power

There are now processors that offer roughly the same performance as a single T800 transputer. What they do not offer, however, is the simplicity of design and unlimited expansion of processing power. Communication between transputers is via two wires and a ground plane. The external clock for any number of transputers is a single 5-MHz crystal.

The hardware design does not change if the system has 10 or 100 transputers (apart from the power supply, of course). The transputer's internal RAM and the loading of programs via link means that you can easily debug transputer boards. As long as the transputer chip itself, the power supply, and the clock are all working, you can run a test program on internal RAM and use it to debug the external components.

When INMOS created the transputer, it created a Pandora's box of complexities that needed to be addressed before the transputer could take off on its own. At first, there was no floating point, the parts didn't work, deliveries were a problem, and there was no software. Most of those problems have been solved.

Then INMOS created Occam, which does a good job of utilizing the computing model of the transputer. But mainly because of the difficulty of making devotees to new programming languages, Occam didn't become an instant hit. Now, however, programmers have begun to appreciate the language's unique capabilities for synchronizing processes and for inter-processor communication. So that hurdle isn't much of a barrier anymore.

Since the development of ray tracing, there has been a need for algorithms that will speed up the process. Researchers have made progress in this area. Ray tracing is easily distributable on multiprocessing networks. It has potential for some industrial applications and for any user who needs to follow rays of light through complete optical systems.

Today, there are even some very inexpensive ray-tracing programs (under \$100) with which high-school students can experiment. Thus, now that the pieces are in place to perform ray tracing on personal computers, it takes little imagination to see how you can use ray tracing to visualize real three-dimensional fields. ■

FOR FURTHER READING

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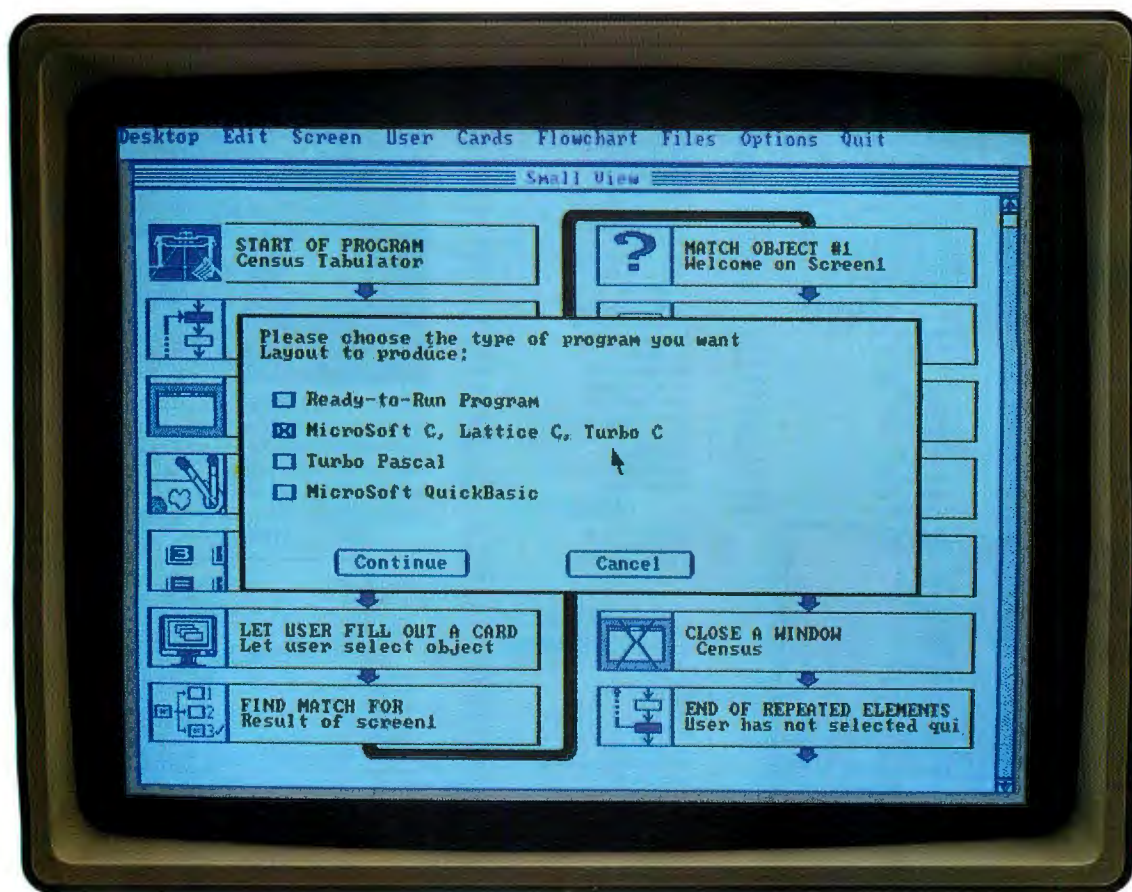
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MICRO EDSELS

A look back at 15 years of the good, the bad, and the marketing bombs of the microcomputer revolution

Kenneth M. Sheldon

I

t has been called the most expensive flop in automotive history, the triumph of market research over changing consumer tastes, Dearborn's million-dollar baby. It was the Ford Edsel.

Several years and hundreds of millions of dollars in the making, the Edsel was released in 1958. The Edsel had distinctive styling, such as a grill that some said looked like a horse collar and futuristic gadgetry including "Teletouch" automatic transmission with push buttons in the center of the steering wheel.

Unfortunately, 1958 was a recession year, and compact cars were just catching on. After three years of intense marketing and meager sales, Ford had sold fewer than 30,000 of the cars—barely 10 percent of what it had hoped to sell. The word *Edsel* became synonymous with "commercial fiasco."

Of course, those of us in the computer field have to be careful when it comes to throwing stones at the Edsel. We have our own memorable mistakes to keep us humble—systems that were highly touted, long-anticipated, and now long-gone.

But not forgotten. Herewith, we present a nostalgic look at some of the fabulous flops of the computer industry that we've covered over the past 15 years.

Apple Crumble

Apple Computer, the company that led the microcomputer revolution, also provided the first major casualty. When Apple realized that many people were buying the popular Apple II for small businesses, the company threw all its efforts into a new, improved system aimed specifically at the business market—the Apple III. In spite of the company's efforts, however, the

continued



Apple III shipped late and experienced what cofounder Steve Wozniak called a "100 percent failure rate." While Apple promoted its new business machine, it hobbled the Apple II so that it wouldn't compete with the Apple III. Unfortunately, the stunted Apple II also couldn't compete with the IBM PC, which promptly took over as the top-selling microcomputer. The Apple III dropped from sight shortly thereafter.

Having ceded the first round to IBM, Apple took a different tack. With advanced technology borrowed from the Xerox Palo Alto Research Center, it released the Lisa, the first commercial system to feature windows, icons, pull-down menus, and a mouse. At \$10,000, the Lisa was the DeLorean of the computer world, and few people could afford it. When Apple later released the Macintosh, with similar features to the Lisa and a price tag that was affordable to mere mortals, Lisa's slim sales became anorexic. Apple eventually dropped the price of the system to \$3995 and changed its name to the Macintosh XL—a bit like calling the DeLorean the "Mustang XL."

The tactic didn't work. Apple put Lisa out to pasture in the summer of 1985, and its successor went on to set records and sire numerous offspring.

Shakedown and Outs

Back when the first microcomputer operating systems were fighting it out for supremacy, several computer companies tried to cover their bets with systems that ran more than one operating system or used two different processors. The most interesting of these was the Dimension 68000 from Micro Craft. The Dimension was a be-all and end-all computer that

would supposedly run Apple, IBM PC, TRS-80, CP/M, and Unix programs, using coprocessor cards. It didn't. The Dimension entered the Twilight Zone in October 1984 as Micro Craft entered Chapter 11.

Smelling gold in the microcomputer hills, everybody tried to get into the act. But for some reason, large companies (other than IBM) seemed congenitally unable to market a microcomputer successfully. Wang, Xerox, and Data General all tried and failed to make significant inroads into the IBM PC's territory. But the most memorable failure was the DEC Rainbow, which ran both MS-DOS and CP/M programs. When first shipped, however, the Rainbow wouldn't let you format disks—you had to buy them preformatted from Digital Equipment Corp.—a "feature" that cast a pall over the Rainbow from the start.

The Rainbow was especially interesting in light of a question asked by DEC president Ken Olsen in 1974: "Why would anyone need a computer of their own?" Apparently, consumers couldn't imagine why anyone would need an MS-DOS computer that wasn't compatible with the IBM PC; sales were underwhelming, and few were surprised when DEC ceased production of the Rainbow in February 1985.

After a while, IBM PC compatibility became the sine qua non of personal computers, and other computers had to have something special to set them apart. Enter the Mindset, a graphics-oriented semicompatible whose case was so unique that it was chosen for display in the Museum of Modern Art. In fact, it may be the only place that you can find one now, unless you happened to be at the auction at the Mindset headquarters,

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when everything including the furniture was up for grabs. (Interestingly, the Mindset presaged two later systems that were heavily graphics-oriented: the Amiga and the Atari ST.)

The Problems with Portables

While the GRiD Compass was the first true laptop computer, it was an expensive system sold mostly to government contracts (and now owned by Tandy). At the first Spring Comdex in 1983, a former president of Zilog took dozens of members of the press hostage for a tour of Atlanta, during which he unveiled the Gavilan computer, an affordable laptop with built-in software, an eight-line LCD screen, and a touchpad "mouse." In spite of massive media attention, Gavilan was never able to get its manufacturing act together, and the curtain came down on its mobile computer in the fall of 1984.

Of course, you didn't have to be a newcomer to stumble in the portable field. Adam Osborne, the man who invented the portable computer, scoffed at IBM's entry into personal computers. His company stayed on the sidelines while newer companies, such as Compaq, wrestled with the problems of PC compatibility. Osborne finally did announce a PC compatible called the Osborne III, along with the Vixen (a new version of the original Osborne I) but didn't ship them on time. Sales of the original Osborne portables plummeted as customers awaited the new models, and Osborne went under in September 1983. The company came up for air briefly but then sank from sight in 1984.

Oddly enough, even IBM had a hard time marketing a portable that was compatible with its popular PC. Remember the

IBM PC Convertible and PC Portable? That's all right; neither does anyone else.

Breaking into Homes

As noted in "A Report on the Consumer Electronics Show" in the September 1983 BYTE, "a single event dominated the show: the introduction of the Adam, Coleco's personal computer." Coleco, you will recall, marketed the phenomenally successful Cabbage Patch Kids. The Adam, with such features as a full-size keyboard, "digital data packs," two game controller units, bundled software, and a daisy-wheel printer—all for a price of \$599—sent shivers through the ranks of other companies that were making or planning home computers. They warmed up, however, when reports of problems with Adam's tape drive, printer, and built-in software began pouring in. (The problems were later blamed on inadequate documentation and technical support.)

One of the companies spooked by Coleco's announcement was Texas Instruments, which had introduced the TI-99/4A in 1979 at a price of \$1150. At that price, sales were sparse, and they weren't helped by an innovative marketing strategy that consisted of discouraging anyone else from creating software for the machine. When TI dropped the price to \$150, sales of the TI-99/4A took off. Unfortunately, a dangerously flaky power supply squashed sales, just as the bottom was falling out of the mythical home computer market and dragging systems from Timex, Atari, Mattel, and others with it. TI eventually decided to give up on low-priced systems. Oddly, the orphan

continued

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99/4A thereafter became a best-seller, with a street price of \$49. A short time later, the Adam was also retired.

Of course, the demise of these systems was hastened by rumors that a killer home computer, compatible with the IBM PC, was about to emerge from the Big Blue womb—the PCjr.

Requiem for a Lightweight

It is perhaps fitting that the consummate micro Edsel was produced by the company that dominated the microcomputer world in the 1980s. The IBM PCjr, heir apparent to the IBM PC, was perhaps the most anticipated personal computer ever (only the Macintosh generated a similar amount of rumor and speculation prior to its release). The "Peanut" (as it was called during development) was IBM's attempt to make a home computer that was compatible with the IBM PC but wouldn't co-opt its sales. To that end, IBM hobbled the PCjr with a toy keyboard (which, nevertheless, featured an Edsel-like high-tech infrared keyboard connection), a single disk drive, and a maximum of 128K bytes of RAM. These "features" were designed to guarantee that no one would ever use it in an office.

As it turned out, not that many people wanted to use the PCjr at home, either. If you wanted a system to play games on, others were available at less cost and with more games. If you needed IBM PC compatibility, you could buy a fully equipped PC clone for less. And as for IBM's attempt to sell the PCjr to the education market—well, if business belonged to Big Blue, education belonged to Apple; the PCjr barely got in the schoolhouse door.

IBM commenced damage control, substituting a genuine

keyboard and lowering the price of the PCjr during the 1984 Christmas season. Sales quickly surged but came to a screeching halt when the discount ended.

In April 1985, IBM pulled the plug on the PCjr. When the press reported that IBM was abandoning the system, the company reacted defensively, noting in a *Wall Street Journal* ad that it had simply produced all the PCjrs that it needed (or would ever need, apparently).

Computer Collectibles

Space prohibits describing some of the other microcomputer misses of the past 15 years: the TI-99/2—produced, promoted, and withdrawn before it ever saw daylight; the Data General/One, first of the PC-compatible laptops, with a screen that was almost visible under certain conditions; the Spectravideo; the Workslate; the Jupiter; the Commuter; and dozens of others, gone now, except for occasional reappearances in discount catalogs and on home shopping programs.

In all fairness, many of the computers I've mentioned were actually very good machines, often attempting to blaze some new trail of features, technology, or price/performance ratio. Some of them were simply sunk by circumstances or mangled by marketing errors: the right machine at the wrong time—or from the wrong company.

So if you have one in your attic, don't be too quick to discard it. Like the Edsel, it may be a collector's item someday. ■

Kenneth M. Sheldon is a senior technical editor for BYTE. He can be reached on BIX as "ksheldon."



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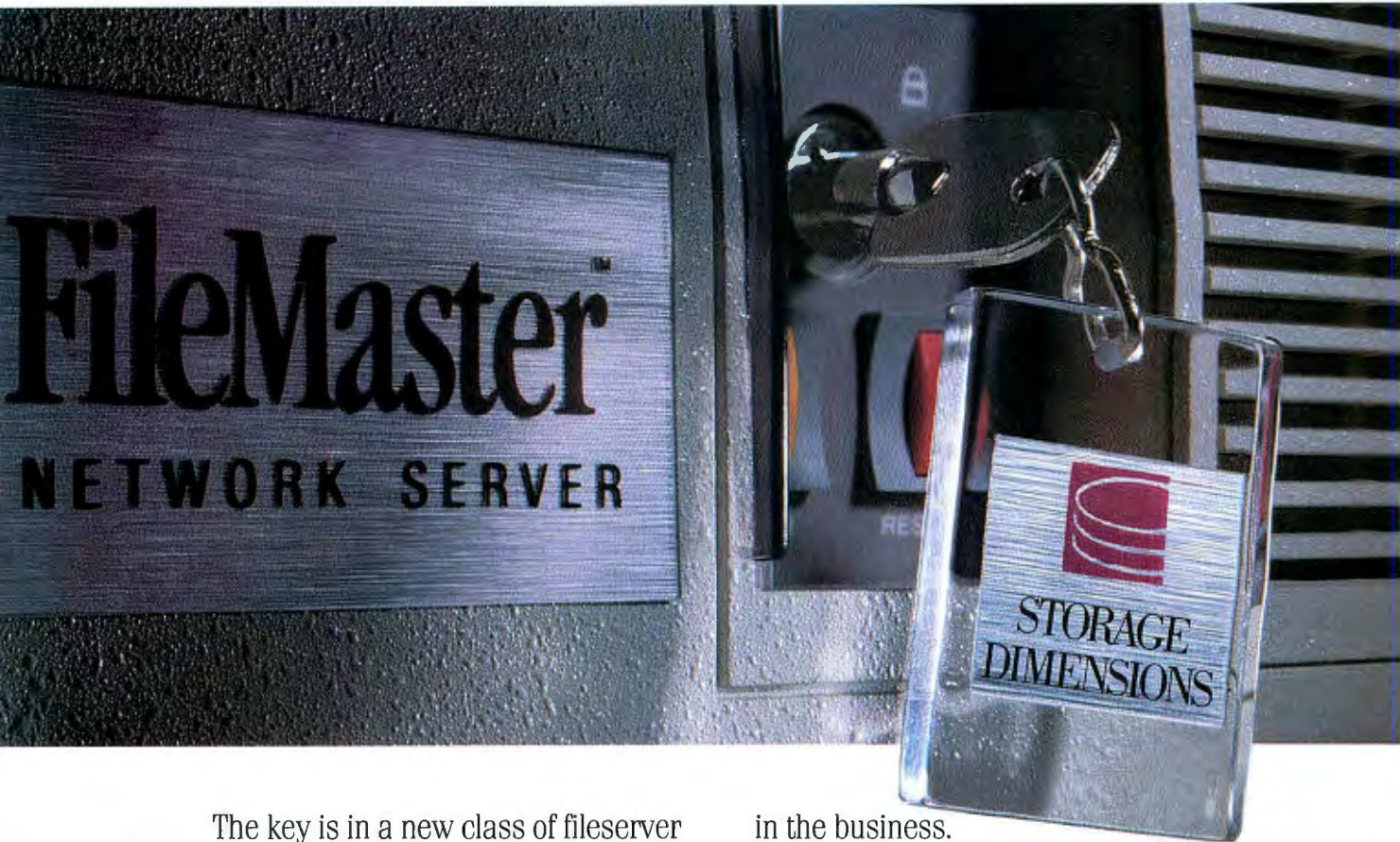


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STORAGE DIMENSIONS

DROWNING IN DATA

The gathering deluge of information calls for new approaches to data storage

Peter Vogelgesang

If recording devices had existed when Abraham Lincoln delivered the Gettysburg Address, his speech certainly would have been recorded for posterity. While Lincoln's speech required only 5 minutes to present, the person who spoke before him talked for an hour and a half—driving away half the audience before the president spoke. The half that left early simply could not endure the volume of words that preceded what they had come to hear.

That event of long ago typifies a problem of today—namely, what information is worth keeping, and what should be thrown away? Often, you don't understand the value of information until sometime in the future, so you must keep all of it in order to have the important stuff when you need it. For example, what airplane pilots and control-tower personnel say to each other is of lasting importance only on those few tragic occasions when an airplane goes down. The only way to ensure that those critical conversations will be preserved is to record everything.

The logical extension of that scheme—assigning a discrete recorder to every information source in the world—is a logistical impossibility. Developing an information classification system that facilitates rapid and accurate retrieval of so much stored in-

formation is equally impossible.

One way to acquire a large store of information without using a large number of recorders is to record a part of the electromagnetic spectrum. If you record antenna signals that cover the part of the spectrum most useful for communications (10 kHz to 200 MHz), then you capture long-wave communications, AM and FM radio, several TV channels, and emergency radio services. In the same way, you can also capture private telephone calls, radio teletype, aircraft and control-tower conversations, point-to-point communications, and every other kind

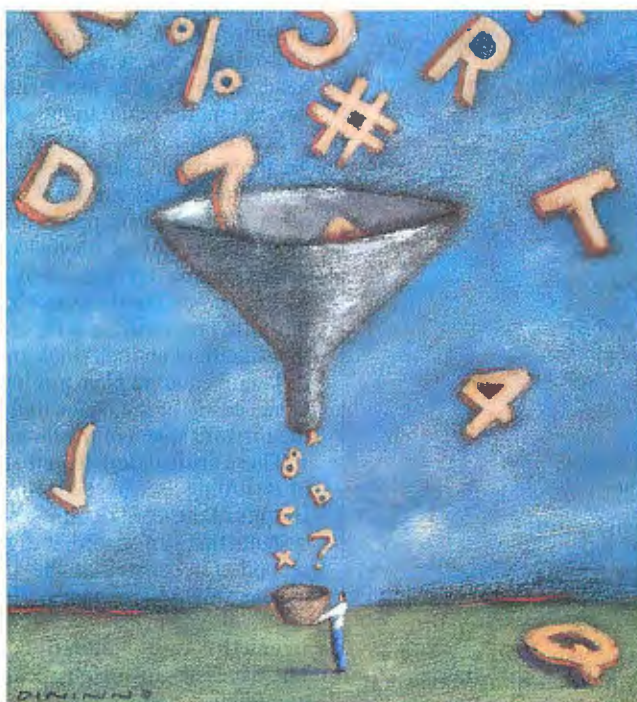
of information that hits the airwaves. All this could be accessed on the basis of time of occurrence and the approximate geographical location of the signal sources.

You could record a sizable piece of the electromagnetic spectrum for a year (from an antenna at one point on earth) on an area of recording medium about the size of 36 city blocks. To put it another way, you would need 16 million 12-inch optical disks, which, if stacked vertically, would be 68,000 feet high. The same number of disks in 8-foot stacks would take up over 10,000 square feet of floor space, allowing a little extra for aisle access.

Three Major Concerns

There is nothing new about the increasing demands for

continued



recording more and more on less and less (the ultimate consequence of which will be to record everything onto nothing). For the past 40 years, the recording industry has responded to this need by learning how to use a smaller area of a medium for recording each bit of information. Both magnetic and optical recording methods currently assign submicron dimensions to recorded bits. Regarding future recording systems, the three major concerns will be to increase the rate of writing and read-

ing bits, increase the capacity to store bits, and access the recorded information faster.

Recording is a two-dimensional process—you record on surface areas. Thus, you must scan across the areas, either by moving the recording transducers relative to the medium, or moving the medium relative to the transducers, or both. The ultimate limit regarding how fast you can record and read data is established by how fast you can move these elements. Some digital recorders are already moving rotating heads at a hundred miles an hour over a tape surface. It is unlikely that data transfer rates will be increased by further increasing the speed of media and transducers.

You can, though, boost the capacity of a recorder either by writing smaller bits (which are already submicron) or by using

*It is unlikely
that data transfer rates will be
increased by further increasing the
speed of media and transducers.*

more surface area. However, as you increase the surface area, the time required to access a specific point on this larger area also increases, so it takes longer to retrieve information. Thus, the rate, capacity, and access time tend to be mutually exclusive.

One answer to this dilemma is to record simultaneously on different parts of a surface. This approach increases the recording rate by the number of parts employed. The head wheel of a high-performance helical-scan magnetic tape recorder can contain a number of heads that are simultaneously in contact with the tape and that write and read data in parallel. The recorder's data rate, of course, is increased in proportion to the number of heads used. Tracks are written as interleaved diagonal paths having lengths equal to the circumference of the head wheel.

Scanning the tape in this manner requires mechanisms of great precision. The tracks, which are only one one-thousandth of an inch wide, must be written precisely adjacent to each other without overlapping or having excessive space between them. Then, during playback, the heads must follow the same tracks with no deviation exceeding about 10 percent of the track width, or one ten-thousandth of an inch. The unit must maintain this precision on a flexible tape that is less than one one-thousandth of an inch thick and that has a width variation along its length equal to plus or minus one one-thousandth of an inch. Congruency of the heads and tracks is obtained by controlling the forward speed of the tape.

These critical dimensions show that most existing limitations of recording are, instead, limitations of mechanical precision. In spite of these difficulties, however, manufacturers have built systems that can record at digital rates as high as 1 gigabit per second. Of course, at the moment, such systems are quite expensive.

Breakthroughs Needed

The necessity for mechanical precision and the complexity of recording systems could be circumvented by an all-electronic

AN IDEAL BINARY STORAGE DEVICE

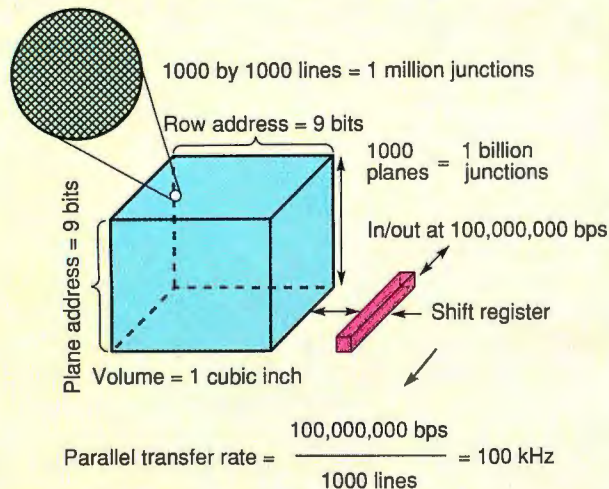


Figure 1: An "ideal" binary storage device packs bits into three dimensions and avoids the mechanical scanning methods used with disks and tapes.

A PROPOSED SERIAL MEMORY SYSTEM

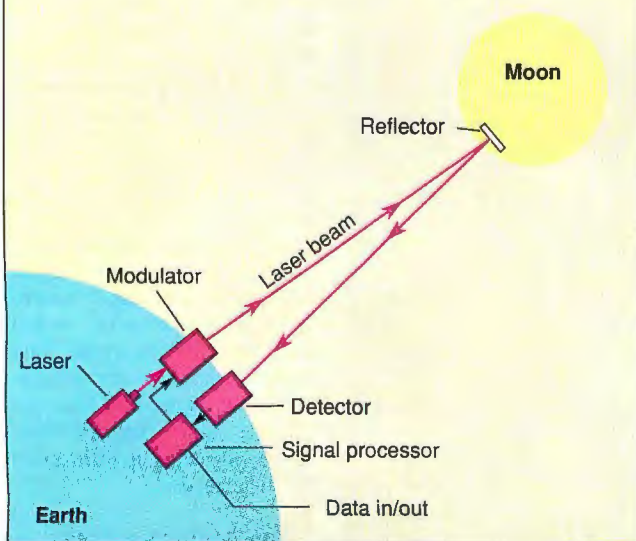


Figure 2: A modulated laser beam uses space as a recording medium, obtaining very high data rates in a volatile memory.

recording method that gets away from scanning and that uses three, instead of two, recording dimensions. In a way, tape recording uses a volume instead of a surface because the tape surface is wound on itself to create closely packed layers. But the surface is narrow and extremely long, and it takes a long time to scan from one end to the other. Historically, tape has been used only for applications where access times are not critical.

Use of the depth dimension of a recording medium could be very powerful. Imagine a two-dimensional matrix as shown in figure 1, where each junction is a switch that is closed for a 1 and open for a 0. If each junction has a volume of a 1/1000-inch cube (25 micrometers), then a 1-inch square (2.5 centimeters) would contain 1 million junctions and 1 million bits. If, however, you add layers of equal thickness (in the depth dimension) to form a cube, the capacity increases a thousandfold to produce a potential capacity of 1 billion junctions.

The old magnetic core storage used in early computers was organized in this cubic fashion. The problem was, a core measured an appreciable fraction of an inch. Not only was the core assembly large, but it was invariably accompanied by at least two even larger racks of switching circuits used to drive the cores.

A cubic volume having 1/1000-inch dimensions is about 300 times greater than the volume of magnetic material devoted to recording a bit on magnetic tape. There ought to be some kind of simple switch that fits within such a comparatively large volume, yet this technology has eluded researchers for decades. ICs come closest to the ideal. IC technology may ultimately provide the capacity and cost-effectiveness needed to replace disk storage and even some tape storage.

High-Speed Serial Memories

The Apollo astronauts left an array of optical reflectors on the surface of the moon. Any beam of light that strikes this array will return along the same path to the source of illumination. Imagine a laser beam, digitally modulated at a rate of 2 gigabits per second, projected from the earth to this array of reflectors.

The beam's round-trip transit time is 2.58 seconds, so 5.16 gigabits are contained within the beam before the first bit is returned to earth. In other words, 5.16 billion bits are spread out as 1/2-foot-long bundles of photons between the earth and the moon.

After completing a round trip, the pulses are detected, regenerated, and used to modulate the laser beam again. The stored information circulates in a never-ending stream of light pulses. Information is erased, added, and extracted simply by momentarily interrupting the beam in the right places and then making the desired changes. Now you have a 5.16-gigabit memory system with an average access time of 1.29 seconds, and it is totally nonmechanical. This concept is illustrated in figure 2.

If you use 100 different light wavelengths simultaneously,
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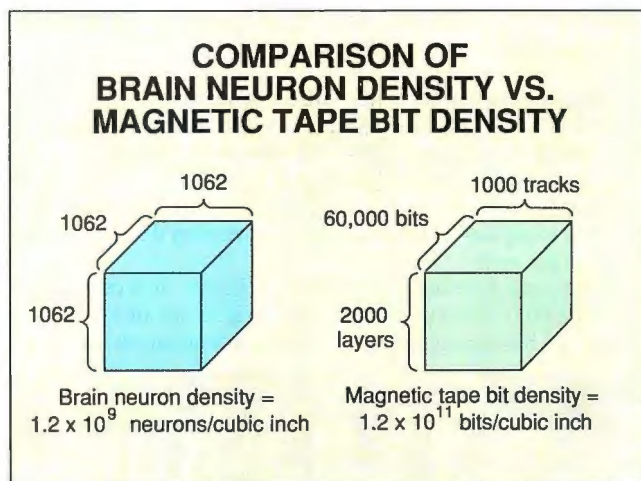


Figure 3: Modern digital tape recording achieves a bit-storage density that is two orders of magnitude greater than the neuron density of the brain.

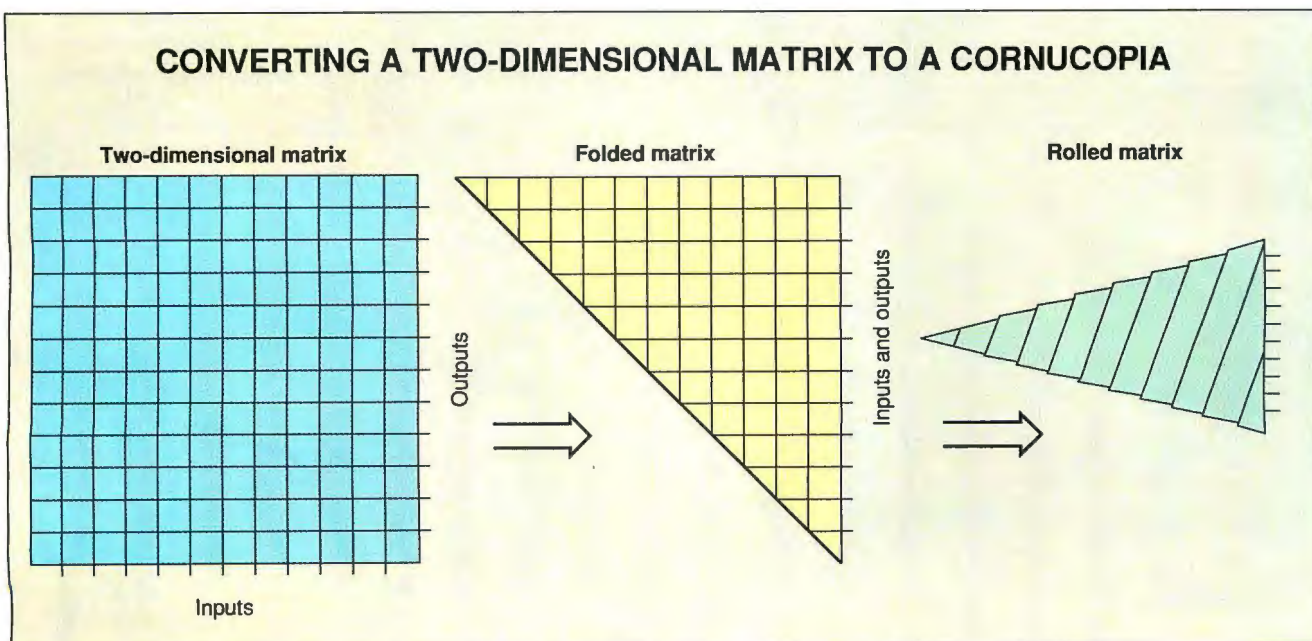


Figure 4: Could the cornucopia structures found in the brain be folded, rolled matrices?

you increase the system's capacity to half a terabit. The data transfer rate is increased to 200 gigabits per second, but the access time remains 1.29 seconds. Not bad. And you must admit that the recording medium is inexpensive.

Obviously, this system is impractical for several reasons, but it could be a practical means of storing volatile information aboard a *synchronous* satellite that has a continuous view of the moon. Nevertheless, the concept shows that a serial memory is useful if the string is long enough and the propagation fast enough.

A fiber-optic cable as long as the distance to the moon would be too expensive as a transmission medium because half a foot of fiber-optic material per bit is not economical. Besides, light attenuation over such distances is excessive, and light pulses would not remain coherent over that distance in any medium other than space. We need a form of energy that propagates much slower than light and much faster than sound and that remains coherent over long distances.

Recording Technology vs. Nature's Memory

The human brain weighs about 3 pounds and has a volume of approximately 85 cubic inches. Researchers estimate that the brain contains between 10 billion and 100 billion neurons. If you use the larger number and apply it to a unit cube (see figure 3), then along any axis of the cube the neuron density is 1062 neurons per inch.

A magnetic tape has about 1000 tracks per inch of width. It can store 60,000 bits per linear inch, so it has an area density of 60 million bits per square inch. Tape is wound on itself within a

reel, and since many tapes are only one two-thousandth of an inch thick, a density of 2000 layers per radial inch can be achieved.

The storage density of current magnetic tape is about two orders of magnitude greater than the estimated neuron density of human brain tissue. Of course, human brain tissue performs many more functions than memory. Also, the brain probably receives much more memory than 1 bit per neuron.

Scientists estimate that the human brain has a digital storage capacity equivalent to 10^{14} bits, a number that represents a storage density an order of magnitude greater than magnetic tape. Regardless of the comparative merits of living and nonliving memory systems, the use of three dimensions is a great aid in achieving high volumetric storage density.

Magnetic tape provides three-dimensional storage, since it winds onto itself as the spool turns. But you can access data only by unwinding the reel until you reach the place where your specific information is stored, a process that can require minutes. A disk, on the other hand, provides rapid access to data, because the whole surface moves by the head with each rotation. But there is only one disk to a drive—there is no third dimension (depth)—so disks have limited capacity.

A New Era

Big, fast, number-crunching computers that provide fast access to vast quantities of information are not well suited to certain applications. Robot control and machine vision, for instance, could be handled more efficiently using a different kind of computer architecture. Carefully programmed digital computers

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can adequately control simple robot arms and highly specialized machines, but general-purpose robotic devices need to "see" what they are working with so that they can adapt to a constantly changing environment. Ideally, computers should make sense of TV images in real time, respond to human voice instructions, and communicate using language.

One architecture that offers such potential is constructed of neural networks, which, like the brain, don't give numerical answers accurate to the tenth place, but rather deal in approximations, guesses, probabilities, and generalizations. Why use such an architecture? There are several reasons.

First, the logic must be adaptive rather than programmed. Whereas digital computers require precisely organized programs that control and sequence every internal operation, neural network machines will modify their internal logic based on external stimuli and experience. In other words, they will learn. Second, the computer must be capable of providing its own input from scanned images, sounds, and tactile sensors. Third, the controlled machine must respond in real time to external stimuli. Finally, the machine's internal logic must adapt to changes in external conditions and to differences in the missions it is assigned.

Language is a good example for illustrating the uses of neural networks. It is, after all, a relatively simple audible code that describes objects (nouns), actions (verbs), and modifiers (adjectives and adverbs). Primitive languages start as utterances of sequences of sounds wherein the combination and order of the sounds are used to denote things and actions. Later, as a civilization develops, its people visually code the words by

substituting written symbols for the sounds. The dictionary is really a codebook.

Most images contain complex combinations of lines, curves, angles, spots, highlights, shadows, and other characteristics too numerous to list. The challenge in developing machine vision is to learn what features of images are important for comprehension and then to develop neural networks that process images in real time. Digital techniques are simply too complex and too slow. One reason for making neural networks internally adaptive is so that they can be taught to recognize images rather than being hard-wired or rigorously externally programmed.

Sound interpretation is just as complex a task. People who develop speech privacy systems are constantly amazed at the brain's ability to make sense of distorted, inverted, or frequency-modified speech.

Imagine a two-dimensional matrix folded so that the inputs and outputs are on the same side of the sheet (see figure 4). Roll the folded matrix until it is a three-dimensional object. Such cornucopian structures are present in the brain in large numbers. It seems probable that a large part of the brain is a giant folded sheet in which three-dimensional logic operations that take place through the thickness of the sheet may be confined to only a few hundred. The brain derives its speed not by running with a fast clock, but by using a logic that deals with visualizations, sounds, sensations, tastes, and smells that are coded at a much higher level than the bits that rush around in a digital computer.

continued

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Memory and Logic

If you set out to build electronic machines that deal with sounds and images, and if you design these machines to use that information to perform work in real time, the circuits you use would probably not distinguish between memory and logic. Indeed, memory and logic would be one and the same. Instead of being hard-wired, the memory/logic would adapt to stimuli by producing the required responses and then locking in those responses, preventing further change. In other words, the machines would be programmed by experience.

Human beings shopping for a new computer of this kind would use different criteria than they use when buying a digital computer. They would measure its efficiency by its intelligence quotient and the amount of training it had had, as opposed to its word-length mastery, memory size, and clock speed. In the future, you may encounter a "computer resumé"—a statement of

*In the future,
you may encounter a "computer
resumé"—a statement of the kinds of
training the machine has received.*

the machine's inherent capability (its intelligence) and a listing of the kinds of training it has received.

New architectures will require new technology regarding switching phenomena, switching devices, structures, interconnects, and packaging. While solid-state electronics and magnetic and optical recording may play a part in such architectures, other technologies, such as electrochemistry, may play the dominant role.

Hazarding a Prognostication

Predicting technological progress can be hazardous to one's reputation, what with unforeseen breakthroughs always possible. Nevertheless, I predict that unless computer scientists learn how to record information on molecules, the trend toward smaller and smaller bits will come to an end in the foreseeable future. Emphasis will switch from media improvements to system improvements in order to meet the burgeoning demands of the information age.

Data rates will increase, and access times will decrease, through the use of simultaneously active transducers arranged in clever and economical arrays. Capacity can be increased by using larger surface areas that are scanned by the arrays in novel ways. New recording systems will hold larger numbers of media packages that can be loaded quickly without human intervention. The tape format, because of its high volumetric storage density, will probably never go away.

Once these successes have been achieved, look for the emergence of a new kind of computer—one that may sit at a nearby power source and have lunch with you. ■

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OBJECT-ORIENTED PROGRAMMING

*You can use Turbo Pascal 5.5 to learn
the principles of OOP*

Dick Pountain

Last year, interest in object-oriented programming exploded, and now major language vendors race to add object-oriented extensions to their products. You already have a choice of object-oriented C and Pascal compilers, and soon even BASIC is to get the OOP treatment. Yet only two years ago, OOP was still an avant-garde technique, largely confined to a subculture of Smalltalk users. Its utility was seriously questioned by professional programmers. Why this intense new interest, and is it justified?

The Invasion

The interest in OOP is partly due to manufacturers hyping it as a value-added ingredient to expand sales. But such hype is usually based on a substratum of fact. The fact in this case can be summed up in a single word: graphics. The widespread introduction of graphical user interfaces during the 1980s has increased the size and complexity of programs to a point where conventional structured-programming techniques can't manage them effectively. A stronger methodology is needed, and OOP provides just that. There is another connection; much of the pioneering work on both OOP systems and GUIs was performed at Xerox's Palo Alto Research Center. For a decade, PARC "graduates" have been dispersing throughout the industry, to Apple, IBM, Microsoft, Hewlett-Packard, Adobe, and others, taking the OOP message with them.

This historical conjunction of OOP systems and GUIs has led to the widespread misunderstanding that "object-oriented" has something to do with graphical objects on a screen. Some manufacturers perpetuate this confusion by describing quite conventional applications as "object-oriented" because they display a couple of icons. The unfortunate choice of this same term to differentiate vector-based from bit-mapped drawing programs has only stoked the confusion.

OOP is a general-purpose programming methodology (just like structured programming) that can just as well be applied to a disk operating system or a payroll program as to a graphics

program. Its purpose, like that of structured programming before it, is to help programmers write more stable, intelligible, and maintainable programs in less time. An application developed using an OOP system need look no different from one written in an ordinary language. If the programmer chooses to make an application's underlying object-oriented characteristics available to the user (say through a programmable user interface, or for updating purposes), only then does it deserve to be advertised as object-oriented.

In addition to this terminological confusion, there seems to be apprehension on the part of many programmers that OOP systems are difficult, obscure, or inefficient. I hope to show that this need not be the case. OOP can be viewed as the next logical step beyond structured programming, and objects are best understood as an extension of the familiar idea of records and structures. I'll use Borland's Turbo Pascal 5.5 to illustrate the points, because it provides an easy transition from the old style to the new.

Objects and the Real World

Most computer programs exist in order to replace or to assist manual operations on real-world objects. In some sense, they contain models of the real world. In a payroll program, numbers might represent checks or wads of bank notes. In a word processor, strings of ASCII codes represent words that will eventually be printed on paper. Even an operating system is in some sense modeling the real physical resources of the computer itself, the memory and disk space.

Modern programming languages provide an expressive way to model real-world objects in the form of user-defined data types built with aggregates of simple data types representing attributes of the object. For example, in Pascal you might represent spherical objects using variables of a record type:

```
TYPE Sphere = RECORD
  { Position in coordinate space }
```

continued


```
x,y,z: INTEGER;
radius: REAL
END;
```

```
VAR Balloon1,Balloon2: Sphere;
```

The record encapsulates all the data relevant to a particular spherical object. When you are dealing with the whole object, you can refer to `Balloon1`, but if you wish to see its internal details, you can refer to, say, `Balloon1.radius`. The implementation of user-defined data types is a big step forward from using an unconnected bunch of variables. To some extent, it mimics the cohesion of the real object itself.

The impression of cohesion can be carried through into the actions and behavior of the object if you write procedures to manipulate the record fields in such a way that they clearly “belong” to the type:

```
PROCEDURE Inflate( ball: Sphere; ratio: REAL);
BEGIN
    ball.radius := ball.radius * ratio;
END;
```

Here, parameter type-checking ensures that operation `Inflate` can only be used on type `Sphere`. To perform the operation, you could say `Inflate(Balloon1, 1.5)`. Notice that you do not need to mention the name of the field `radius` explicitly, except in the definition of `Inflate` itself. By writing a procedure for each operation to a record type, you need never refer to actual field names in the main part of your program. If you decide to change the definition of a `Sphere` (e.g., by adding or subtracting fields), only a few operation procedures would need to be changed. The main program would be insulated from the alteration. When you are developing large programs, this concept can save plenty of programming time and forestall many errors. Unfortunately, ordinary Pascal and C can't enforce this programming style. There is nothing to stop you from writing procedures like this:

```
PROCEDURE MessyStuff(....
BEGIN
    .....
    Profit := Revenue - Cost;
    Wallpaper := green;
    Balloon2.radius := Balloon1.radius * 2.3;
    .....
END;
```

Object-oriented languages encourage clean encapsulation of the operations (usually called *methods*) associated with a data type by making them part of the definition of the type itself. User-defined types become active entities containing both data and operations on the data. This is nicely illustrated in Turbo Pascal 5.5 because the syntax remains almost the same as above, with the word `OBJECT` replacing `RECORD`:

```
TYPE Sphere = OBJECT
    x,y,z: INTEGER;
    radius: REAL;
    PROCEDURE Inflate(ratio: REAL);
END;

VAR Balloon1,Balloon2: Sphere;

.....
```

```
PROCEDURE Sphere.Inflate(ratio: REAL);
BEGIN
    radius := radius * ratio;
END;
```

The type `Sphere` tells us not only what a sphere looks like (its position and size) but also what it can do (it can inflate itself). The variables `Balloon1` and `Balloon2` are called *objects*, and they are *instances* of the type `Sphere`; the type is like a mold, and its instances are castings from the mold.

Only the header of `Inflate` appears in the type definition; its body is defined anywhere later in the program, just like the implementation section of a unit. This means that the body has to be called `Sphere.Inflate` to distinguish it from the body of any other `Inflate` belonging to another type.

This unfortunate syntactic requirement is a potential source of confusion. Just remember that the method's real name, in the type definition and when it is invoked, is simply `Inflate`, and that any number of other types can also have a method called `Inflate`.

Notice that the first parameter to `Inflate`, “ball,” has been eliminated, as there is no longer any need to tell `Inflate` what object to work on; it works on the instance that invoked it. The boot is on the other foot now.

Instead of procedures doing things to passive data objects, the objects themselves order the doing. For example,

```
Balloon1.Inflate(1.5);
Balloon2.Inflate(1.25);
```

Because it is bad practice to access data fields in an object directly, you should always provide a method for initializing new objects rather than using direct assignment to their fields:

```
Balloon1.Init(0,0,0,10.25);
```

instead of

```
Balloon1.x := 0; Balloon1.y := 0; .....
```

In a strictly object-oriented language like Smalltalk-80, you aren't allowed to directly access the data fields in an object at all, so you can only manipulate them via methods like `Init` and `Inflate`. To find out how big a sphere is, you would have to add a method that returns the value of `radius`. Turbo Pascal 5.5 and C++ are both less strict than this and let you access fields directly, just like an ordinary record (e.g., `Balloon1.radius`). This means that you can still write procedures like `MessyStuff` if you really want to. C++ at least offers the “private” keyword to bar such access, but it's still up to you to decide whether you use it or not.

Users of Modula-2 (and versions of Turbo Pascal lower than 5.5) may be muttering that they can achieve a similar encapsulation of procedures with their data structures by using modules or units. This is perfectly true. The module mechanism is a valuable tool that effectively localizes program changes. OOP goes further, though. If, in addition to spheres, you create some new types, say cylinders and toruses, an object-oriented system will let you use the same method name (e.g., `Inflate`) for all three types, whereas in a module or unit this would cause name clashes, forcing you to choose unique names or qualify them (e.g., `TorusInflate` or `Torus.Inflate`). The significance of this goes beyond mere convenience. Given run-time binding (of which more below), an object-oriented program can apply the method `Inflate` to objects whose type is not known in ad-

vance, leaving it to the object to work out how best to Inflate itself.

It is this feature of OOP, called *polymorphism* (from the Greek for “many shapes”), that constitutes the real programming revolution. Programming is turned inside out; ask not what you are going to do to an object, but ask what the object can do for you. More and more of the intelligence is moved out of the application program and into reusable “smart” objects.

Given sufficiently large object libraries, programming can be reduced to little more than clicking objects together like plastic bricks. But to gain the full benefits of polymorphism, some way is needed to manage the potentially huge proliferation of object types. The answer lies in *inheritance*—the ability of object types to inherit properties from a parent type.

Inheritance

One of the most powerful tools for managing complexity is the hierarchical structure (tree structure). I’m writing this article on a computer with 1287 files on its hard disk. I never need to see that many files, because DOS’s tree-structured directories let me deal with just the few files of current interest.

The biological sciences discovered the power of hierarchical description centuries ago. The Linnaean classification of living things must rank as one of science’s greatest achievements. For example, the common frog can be named by following one path through the tree:

```
Kingdom:   Animalia
Subkingdom: Metazoa
Phylum:  Chordata
Subphylum: Craniata
Class:     Amphibia
Order:     Anura
Family:    Ranidae
Genus:     Rana
Species:   temporaria
```

Just nine statements identify one kind of creature from tens of millions. Using a DOS-like syntax, you might locate an instance of a frog called Kermit as follows:

```
c: \ Animalia \ Metazoa \ Chordata \ Craniata \
  Amphibia \ Anura \ Ranidae \ Rana \
    temporaria \ Kermit.
```

OOP uses a similar principle, except that instead of classifying discovered objects, you are creating new classes of objects to fit the application. Encapsulation of objects and methods is a boon to good program structure and effectively localizes program changes, but if your program requires hundreds of different object types, it can still become unmanageable. An inheritance hierarchy can be used to dramatically reduce the number of types that need to be defined by factoring out their common features, just as the Linnaean classification can home in on the common frog with only nine labels.

For example, spheres, toruses, and cylinders share the property of having a position in space. To factor this out, you might define a parent type called *Location* with only this property:

```
TYPE Location = OBJECT
  x,y,z: INTEGER;
END;
```

and then define spheres, toruses, and cylinders as child types that inherit this position property:

```
TYPE Sphere = OBJECT(Location)
  radius: REAL;
END;

Torus = OBJECT(Location)
  major_radius, minor_radius: REAL;
END;

Cylinder = OBJECT(Location)
  length, radius: REAL;
END;
```

In the Turbo Pascal 5.5 syntax, the statement *OBJECT(Location)* denotes inheritance from the parent type *Location*; all three child types automatically possess data fields called *x*, *y*, and *z*, even though they are not declared explicitly. Methods can be inherited in just the same way. For example, *Location*

You might use
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data-structuring class,
such as a stack, linked list, or queue.
Inheriting from this class would
confer the properties of stackability
and listability on the child type.*

might have three methods that move the object along one of the axes, and these could happily be inherited by *Sphere*, *Torus*, and *Cylinder*, all of which are potentially movable:

```
TYPE Location = OBJECT
  x,y,z: INTEGER;
  PROCEDURE x_move( distance: INTEGER);
  PROCEDURE y_move( distance: INTEGER);
  PROCEDURE z_move( distance: INTEGER);
END;
```

On the other hand, the method *Inflate* cannot so easily be factored out, because inflating a torus is rather different from inflating a sphere. Each child will need its own version of *Inflate*. *Location* happens to be a useful type in its own right. You might want to create instances of *Location*, but they are not required.

Abstract types exist for the sole purpose of providing inheritance. From the biology example above, there is no such animal as a *Craniata*; similarly, there are no instances of abstract types.

Designing good inheritance hierarchies is the essence of good OOP. If you choose sufficiently flexible and generic types for the root of the tree, you can reuse a large percentage of your

continued

code. Writing new programs reduces to merely creating a few child types. Smalltalk-80 exemplifies this idea with its huge database of existing classes or types. For example, in Smalltalk a String is a subclass (i.e., child) of ArrayedCollection, which is a subclass of SequenceableCollection, which is a subclass of Collection, which is the abstract type for a group of anything. At this point in studying programming, you put down Knuth and reach for Kant.

C++ and some object-oriented variants of Lisp support multiple inheritance, where a type may inherit data and methods from more than one parent. This sounds like a very powerful idea, but it should be used with great care and restraint. The whole point of a hierarchy is that it tames complexity by restricting the paths you can follow from the root. Adding cross-linking paths from branch to branch produces a network. Networks do not have this complexity-taming property, but instead get you lost or cause you to go round in circles. A torus shouldn't be defined also as a "payroll record" any more than a frog should have feathers.

You might use multiple inheritance safely when one of the parents is a highly generic data-structuring class, such as a stack, linked list, or queue. Inheriting from this class would confer the properties of stackability and listability on the child type.

Binding Time

New object types sometimes find that they have inherited methods that require modification to be useful. A child type can always "override" an inherited method by redefining it. Often,

all that is required is the addition of an extra action to the method. In this case, the child can call the original inherited version (by qualifying it with the parent's name) and then add its own new code. For example, suppose that Sphere might want to alter the `x_move` method it inherited from Location in order to keep a tally of total distances moved. The overriding definition might look something like this:

```
PROCEDURE Sphere.x_move(distance: INTEGER);
BEGIN
    Location.x_move(distance);
    tally := tally + distance
END;
```

Calling the parent method is not done in this way just to save effort; it is an important part of the OOP style. It ensures that any alterations made to methods near the top of an inheritance family propagate down to all the descendants. In other words, any changes you make to `Location.x_move` will automatically be passed on to `Sphere.x_move` and to any child types that inherit it.

The ability of descendant types to override inherited methods introduces a potential ambiguity. Say you give Location a new method called `knight_move`, which calls `x_move` as one of its actions:

```
PROCEDURE Location.knight_move;
BEGIN
```

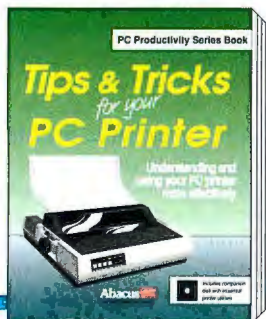
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Listing 1: Sphere, Torus, and Cylinder can inherit the Cost function unchanged by supplying their own method for computing volume.

```

PROGRAM BindingDemo;

TYPE Location = OBJECT
    x,y,z: INTEGER;
    PROCEDURE Init(ix,iy,iz: INTEGER);
END;

Solid = OBJECT(Location)
    CONSTRUCTOR Init(ix,iy,iz: INTEGER);
    FUNCTION Volume: REAL; VIRTUAL;
    FUNCTION Cost: REAL; VIRTUAL;
END;

Sphere = OBJECT(Solid)
    radius: REAL;
    CONSTRUCTOR Init(ix,iy,iz: INTEGER; rad: REAL);
    FUNCTION Volume: REAL; VIRTUAL;
END;

Torus = OBJECT(Solid)
    major_radius, minor_radius: REAL;
    CONSTRUCTOR Init(ix,iy,iz: INTEGER; marad,mirad:
        REAL);
    FUNCTION Volume: REAL; VIRTUAL;
END;

Cylinder = OBJECT(Solid)
    length, radius: REAL;
    CONSTRUCTOR Init(ix,iy,iz: INTEGER; len,rad:
        REAL);
    FUNCTION Volume: REAL; VIRTUAL;
END;

PROCEDURE Location.Init(ix,iy,iz: INTEGER);
BEGIN
    x := ix; y := iy; z := iz;
END;

{===== Solid =====}

FUNCTION Solid.Volume;
BEGIN END;

CONSTRUCTOR Solid.Init(ix,iy,iz: INTEGER);
BEGIN
    Location.Init(ix,iy,iz)
END;

FUNCTION Solid.Cost: REAL;
BEGIN
    Cost := Volume * 0.036 + 2500.00
END;

{===== Sphere =====}

FUNCTION Sphere.Volume: REAL;
BEGIN
    Volume := 4/3*pi*radius*radius*radius
END;

CONSTRUCTOR Sphere.Init(ix,iy,iz: INTEGER; rad: REAL);
BEGIN
    Solid.Init(ix,iy,iz);
    radius := rad;
END;

{===== Torus =====}

FUNCTION Torus.Volume: REAL;
BEGIN
    Volume := 2*pi*radius*major_radius*minor_radius*minor_radius
END;

CONSTRUCTOR Torus.Init(ix,iy,iz: INTEGER; marad,mirad: REAL);
BEGIN
    Solid.Init(ix,iy,iz);
    major_radius := marad;
    minor_radius := mirad;
END;

{===== Cylinder =====}

FUNCTION Cylinder.Volume: REAL;
BEGIN
    Volume := pi*radius*radius*length
END;

CONSTRUCTOR Cylinder.Init(ix,iy,iz: INTEGER; len,rad: REAL);
BEGIN
    Solid.Init(ix,iy,iz);
    length := len;
    radius := rad;
END;

{=====}

VAR Balloon: Sphere;
    Tire: Torus;
    Sausage: Cylinder;

BEGIN
    { These initializations MUST be done!}
    Balloon.Init(10,10,10,100);
    Tire.Init(20,20,20,24,120);
    Sausage.Init(5,5,5,180,120);
    writeln(Balloon.Cost:10:2,Tire.Cost:10:2,Sausage.Cost:10:2)
END.

```

```

x_move(2); y_move(1)
END;

```

This new method will be inherited by all Location's descendants. The question is, when Sphere executes its inherited knight_move, which x_move will be called? Will it be Location's x_move or Sphere's own overriding version? In other words, when do method names get "bound" to the code they execute—at compile time or at run time? If they get bound at compile time, the address of Location.x_move is permanently compiled into knight_move, and this version is always used, even when it is a descendant invoking knight_move. However, if method names get bound at run time, then knight_move can look around, see who is calling it, and check whether each has its own version of x_move to call.

Late binding (also called run-time binding) opens up the potential of polymorphism and truly generic programming. When binding is left until run time, your program doesn't need to know the type of the objects it is working on. Your program can invoke a method, and each of the receiving objects will execute its own version of the method to achieve appropriately cus-

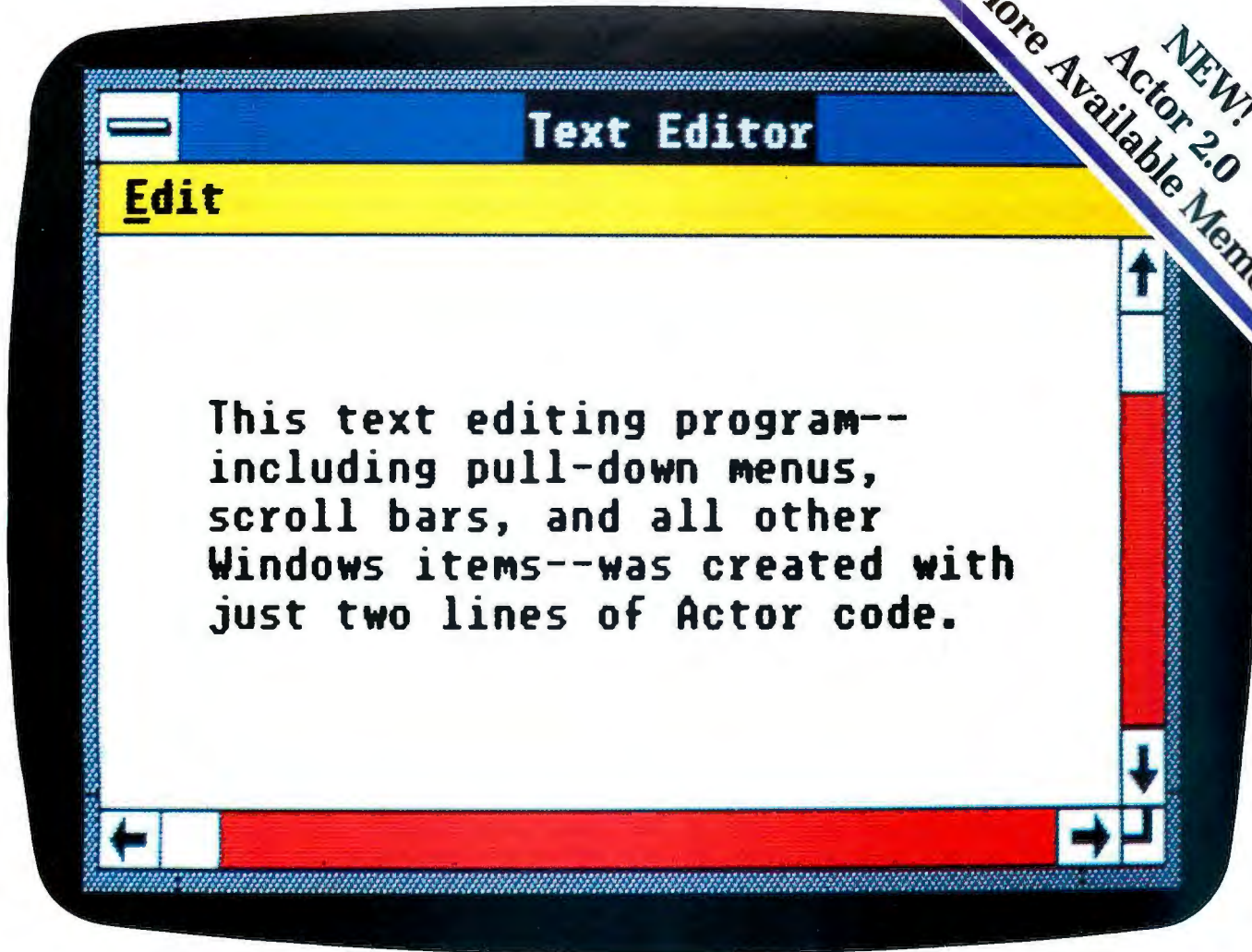
tomized actions. On the other hand, early binding (compile-time binding) causes the same parent method to be invoked on all objects, and this removes the possibility of any customization.

As is so often the case, a trade-off is involved. Early binding produces no execution time overhead, the method being executed exactly like a normal compiled procedure call. This means that you get all the benefits of encapsulation and some of the benefits of inheritance (but not polymorphism) for free. Late binding involves setting up a run-time table search to match method names to local method code, thereby imposing some performance overhead.

Smalltalk-80, being semi-interpreted and strictly object-oriented, uses only late binding. C++ and Turbo Pascal 5.5, being fully compiled and hybrid languages, offer you the choice of early or late binding. With them, you can develop programs using late binding and then optimize performance using early binding on just those methods that do not need polymorphic behavior. However, the rewards of late binding are so great that it should never be relinquished lightly.

continued

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An Example

To demonstrate late binding in Turbo Pascal 5.5, I've modified my previous example somewhat (see listing 1). I've added a new type called `Solid`, which inherits from `Location` and adds a function that computes volume. `Solid`'s own version of `Volume` is a dummy function that exists only to be inherited, since `Solid` is an abstract type with no instances. `Solid` also contains a function, `Cost`, which uses the volume in a rather arbitrary formula to calculate the cost of an object. The point of the demonstration is that `Sphere`, `Torus`, and `Cylinder` (and any other shape) can inherit the `Cost` function unchanged merely by supplying their own method for computing volume. In a real application, `Cost` might be a hugely complex method that you have no wish to repeat in every child type. By using late binding, you don't need to.

Turbo Pascal 5.5 borrowed the keyword `VIRTUAL` from C++ to indicate those methods that are to be bound late. (Note that all the overriding versions of `Volume` must be declared virtual, too.) When late binding is used, the `Init` method has to be a special kind of method, a `CONSTRUCTOR`, which builds the run-time method tables as well as initializing the object, and it must be invoked before any other methods can be called. To see the effect of early binding, try removing the keyword `VIRTUAL` wherever it appears and then run the code. The cost for `Balloon`, `Tire`, and `Sausage` will always result in 2500, because the dummy version, `Solid.Volume`, is used in each case and returns nothing. When you replace the `VIRTUAL`s, the costs are calculated using each object's own volume function. You get different results from each.

You can add any new type of solid, such as `Ellipsoid`, and it will automatically inherit the `Cost` function as long as you provide it with a method to calculate its own volume. You can do this without ever seeing the source code for `Solid`; indeed, `Solid` might exist only as part of a compiled library.

Coping with Complexity

As we enter the age of WIMP interfaces, multivendor network transparency, remote procedure calls, multilayer communications protocols, and the rest, programs can only get bigger and hairier. OOP seems like the best chance we have of coping.

Is there a downside to OOP? Larger source files, the run-time overhead of late binding, and the difficulty of learning large class or type libraries have been cited. Frankly, with languages like Turbo Pascal 5.5 and C++, the first two are not serious problems. Learning library routines cuts both ways. When you build more and more reusable types (which you can extend thanks to late binding), your programming tasks become lighter as your libraries grow heavier. Some implacable law of conservation of information seems to say that you can't kill complexity but only shovel it from one place to another. The crucial point is that the code in the library that you are learning is tried, tested, and debugged. You may never need to reinvent a wheel, but you do need to be able to find the right one in the storeroom. ■

Dick Pountain is a BYTE consulting editor, technical author, and software consultant living in London, England. You can contact him on BIX as "dickp."

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THE SCSI BUS

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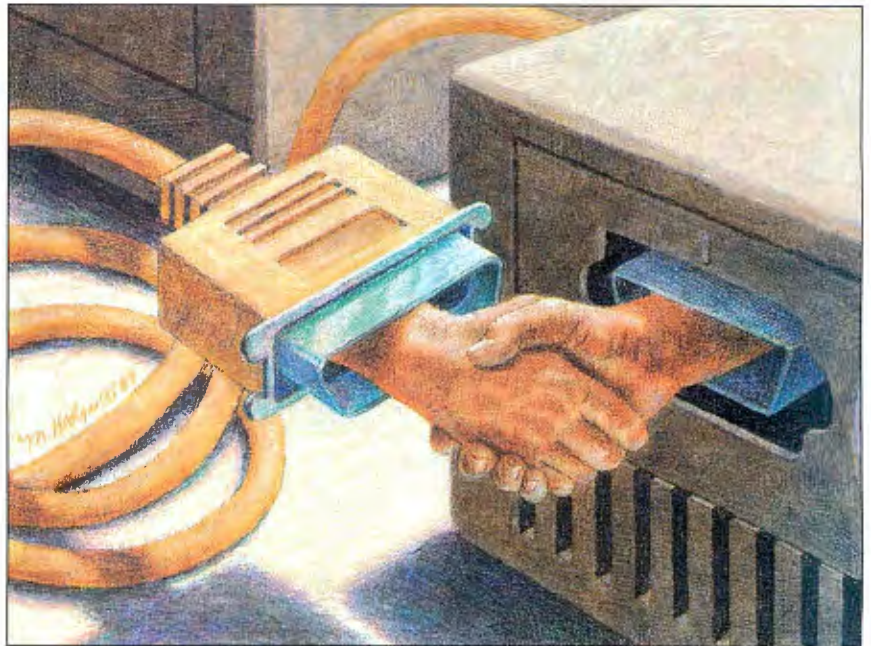
The small computer system interface is a parallel, multimaster I/O bus that provides a standard interface between computers and peripheral devices. Despite its misleading name (which incorrectly implies that it's useful only for small computers) and unflattering appellation (most people pronounce it "scuzzy"), SCSI is fast becoming the method of choice for connecting disks, tape drives, CD-ROMs, WORM (write once, read many times) drives, communications devices, and even bar code readers to computers of all sizes.

A SCSI disk drive that can provide screamingly fast I/O to a Sun SPARCStation or a NeXT cube will work just as well (although more slowly, of course) on an 8-bit Atari 300XL.

In this two-part article, I'll first cover the history of SCSI. I'll then move on to describe the technical details of this versatile interface.

A Brief History of SCSI

SCSI has been an official ANSI standard (ANSI X3.131-1986) since 1986, but its roots go back to the I/O buses used on IBM mainframes as early as the 1960s. The IBM 360s (with the exception of the 360/20) had a byte-wide, parallel I/O bus that could do fast block transfers to and from peripherals. In the earliest models, this bus was called the *selector channel*, and it could talk to only one logical device at a time. This bus later became the *block multiplexer channel* and gained the capability to keep several conversations with different peripherals going at one time.



This IBM bus, also known as the *OEM channel*, was the most common way for third parties to interface peripherals to IBM equipment. It became so popular, in fact, that the U.S. government made it Federal Information Processing Standard 60. Other computer manufacturers promptly sued the government, claiming that this gave IBM an unfair competitive advantage. They didn't win the suit, but they were able to exert sufficient political pressure to keep ANSI from adopting the bus as a standard with no changes.

ANSI, however, did want to create a standard for a nonproprietary parallel I/O bus. Therefore, in the early 1980s, the ANSI X3T9.3 committee began work on a bus called the intelligent peripheral interface (IPI), which provided a superset of the OEM channel's capabilities.

Like the OEM channel, IPI made the host CPU the sole bus master and had similar states and state transitions. But unlike the OEM channel, it could transmit 16 bits at a time instead of just 8. (As

a concession to the de facto standard, IPI had a mode in which it could split those 16 data lines into two unidirectional 8-bit buses and work similarly to the OEM channel.)

At about the same time, engineers at Shugart Associates (a disk drive maker) were taking a different tack. They also saw the need for a flexible parallel I/O bus that wasn't tied to standards from the 1960s, but they designed their own interface, called the Shugart Associates system interface. Unlike the OEM channel or IPI, SASI was intended to be a low-cost peer-to-peer interface. The initial specification was straightforward and a little more than 20 pages long. Three manufacturers—DTC, Xebec, and Western Digital—embraced SASI as a practical standard and built controllers for it. Within only a few years, there were many units in the field.

When proponents of SASI approached ANSI with the suggestion of making it a

continued

standard, they found IPI competing with another high-level interface, called the intelligent system interface (ISI), for the attention of the X3T9.3 committee. Rather than becoming a third contender in this battle, the SASI proponents opted instead to work with the X3T9.2 committee, which dealt with low-level interfaces, and called the new standard SCSI to set it apart from the others.

In retrospect, this was more a political ploy than a true distinction. SCSI and its

soon-to-be-finalized successor SCSI-2 have most of the capabilities of IPI and a few that IPI lacks. But the maneuver worked. The X3T9.2 committee completed the specification in 1984, and it was published in its approved form in 1986. Even before the specification was finalized, SCSI began to see much more widespread acceptance than IPI, whose use is still largely limited to the main-frame world. Figure 1 shows the chronology of SCSI's evolution.

SCSI Principles

As mentioned earlier, SCSI was designed to be an improvement over the OEM channel. Two improvements were of special importance. First, the OEM channel consisted of two unidirectional 8-bit data paths, rather than a single bidirectional one. Why the duplication? It turned out that the two paths were necessary to minimize the *channel turnaround time*, the time it took to change the direction in which information was sent. Most bus drivers can change the direction in which they carry data within hundreds of nanoseconds, but this wasn't fast enough for the OEM channel.

Why was timing so critical? Because the commands used to control disk drives via the OEM channel were low-level. The CPU might issue a Find Sector ID command, and then—when the disk drive signaled that the sector had been found—it needed to issue a Read Sector or Write Sector command before the disk head could traverse the short gap between header and sector. There was no time to turn the bus around during this gap. SCSI's designers eliminated the need for such fast turnaround by implementing complete logical commands—commands that contained both the address of a sector *and* instructions about what to do with that sector.

SCSI improved on the OEM channel in a second way. Systems using the OEM channel could talk to one another and/or share peripherals only if they were connected via an expensive (\$60,000 or more) multichannel switching unit. By contrast, SCSI implements true peer-to-peer communications; it can accommodate connectivity among multiple CPUs and multiple peripherals.

Like the OEM channel, SCSI makes it possible for several commands to peripherals to be in progress at the same time. The host that initiates a command can disconnect after issuing the command, freeing the bus until the peripheral is ready to respond. In the meantime, the same host can talk to other peripherals, or other hosts can use the bus. Thus, a SCSI system can perform complex concurrent I/O operations with ease. When a peripheral is finished with the command, it can reconnect to the host to transfer data or status information.

SCSI was an early peripheral interface to use logical, rather than physical, addressing. A typical modified-frequency-modulation (MFM), run-length-limited (RLL), or ESDI disk drive controller requires the host to know where bad blocks are on the drive and avoid them. MS-

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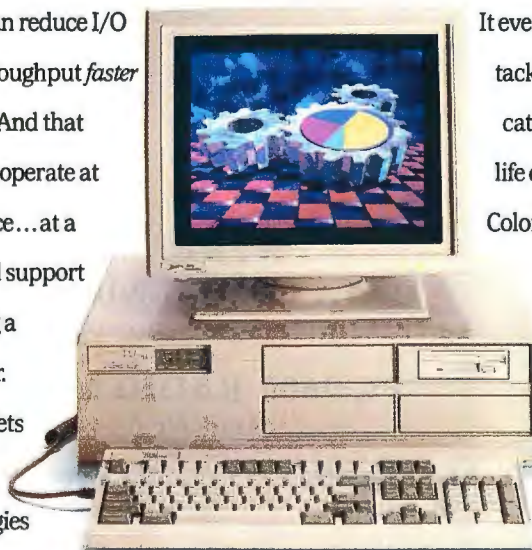
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DOS, for instance, encodes this information in the file allocation table.

SCSI disk drive controllers, however, can take care of this bookkeeping chore themselves, making storage appear to the system as one continuous sequence of good blocks. Since the controller (especially an embedded controller) is likely to be able to take advantage of special knowledge of the drive's characteristics when handling defects, it is likely to do the job better. And because the system doesn't need to devote cycles to the problem, this concurrent-processing feature will generally make things run faster.

Command queuing is another important SCSI feature. If one or more hosts make many requests of a peripheral device, that peripheral (if it implements queuing) can queue up commands for later execution. This can let a controller

optimize I/O by implementing strategies like elevator seeks.

Targets and Initiators

The SCSI bus can support up to eight devices (i.e., host adapters or peripheral controllers). At first blush, this seems rather limiting, but it really isn't; each device can in turn have eight *logical units*, and each logical unit can have 256 *logical subunits*. Thus, there can be—at least in theory—a total of 14,000 peripherals on the bus if there's one host and each peripheral is a logical subunit.

Each SCSI device can be an *initiator* (i.e., a device that issues commands), a *target* (i.e., a device that performs commands), or both. A SCSI bus must always have at least one initiator and one target to be useful, but it can have multiple initiators and/or targets (see figure 2).

Two Flavors

The SCSI bus comes in two flavors: *single-ended* SCSI, in which each signal's logic level is determined by the voltage of a single wire relative to a common ground, and *differential* SCSI, in which the level is determined by the potential difference between two wires. Differential transmission is more robust and less subject to electrical noise.

The SCSI specification states that a single-ended bus can be no more than 6 meters long and should be used to connect devices within a cabinet only. A differential bus can be up to 25 meters long and can be used to connect devices in different cabinets. (Some manufacturers, like Apple, use single-ended SCSI to connect devices in different cabinets. While this isn't, strictly speaking, a violation of the specification, it isn't what its design-

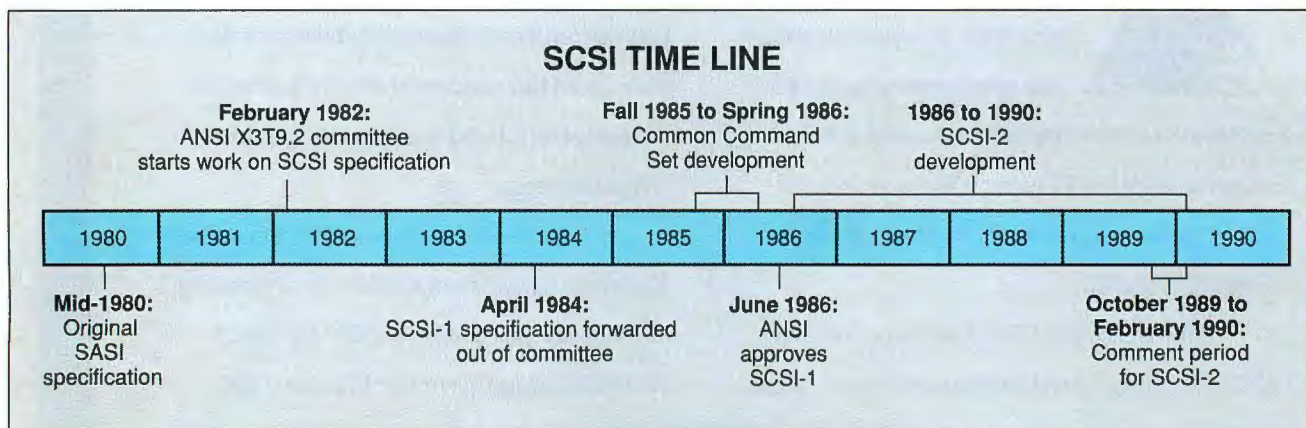


Figure 1: How SCSI has evolved throughout the 1980s.



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ers intended.) Differential and single-ended devices shouldn't be mixed on the same bus. The text box "The SCSI Signals" on page 272 describes what each signal does and shows the SCSI pin-outs.

Just a Passing Phase

When the SCSI bus operates, it makes orderly transitions between bus states known as *phases*. The phase determines the direction and content of the data lines. The eight possible phases are BUS FREE, ARBITRATION, SELECTION, RESELECTION, COMMAND, DATA, STATUS, and MESSAGE. The last four of these are called *information transfer phases*.

The phase diagram in figure 3 shows the relationships between the phases and the possible phase transitions. The system always comes up in the BUS FREE phase or reenters this phase after the bus is reset. In the BUS FREE phase, the BSY signal isn't asserted (it is in all the other phases).

In the ARBITRATION phase, all would-be bus masters compete for control of the bus. This phase begins when an initiator, or a target that wants to get back in touch with an initiator after being disconnected, attempts to gain control of the SCSI bus. Each potential master asserts the BSY signal (which is a wired OR, so there's no electrical conflict) and sets the data bit (0 through 7) corresponding to its SCSI ID. The device with the highest ID wins, and the others then back off.

In the SELECTION phase, an initiator selects a target for a command by placing the target's ID on the data lines and as-

serting the SEL signal. (If the system is nonarbitrating, the initiator doesn't need to compete for the bus and can skip to this phase from the BUS FREE phase.) At the end of this phase, the target (if it exists) takes over control of the bus timing and phase transitions for the remain-

der of the transaction.

The RESELECTION phase occurs when a target wins the arbitration and re-establishes contact with an initiator that previously sent it a command. The target places the initiator's ID on the data lines

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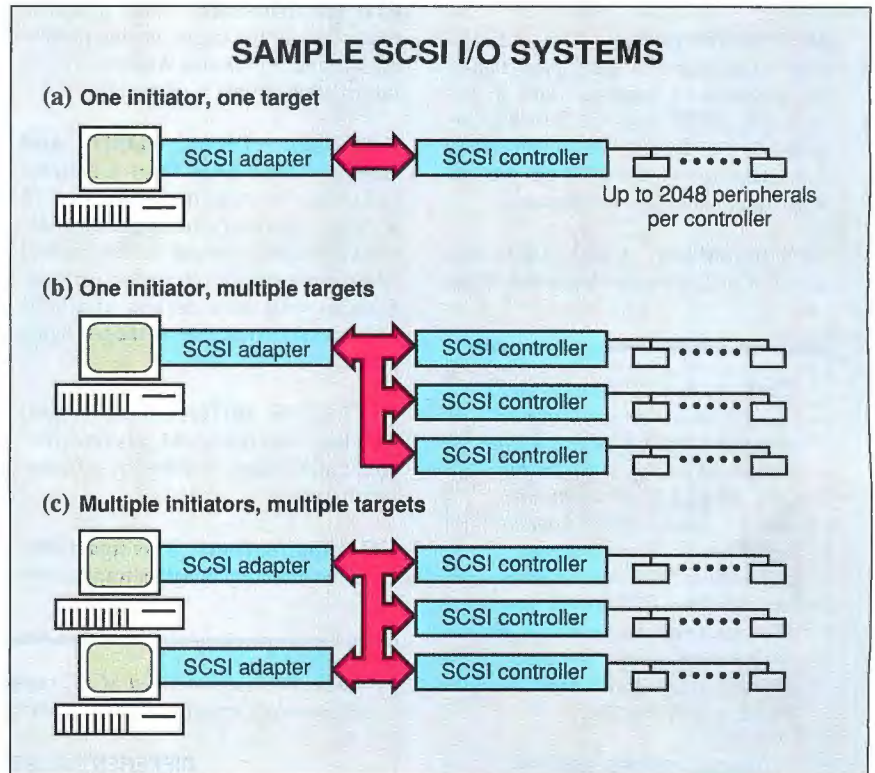
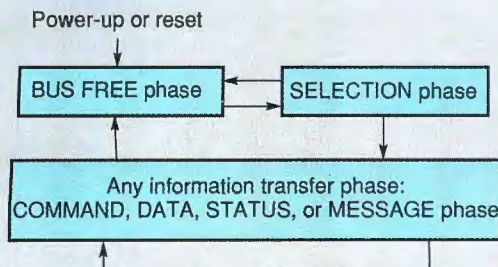


Figure 2: A SCSI I/O bus must have at least one initiator and one target (a) to be useful. It can also have multiple targets (b) and multiple initiators (c). SCSI provides commands that let initiators share peripherals safely.

SCSI BUS PHASES WITH AND WITHOUT ARBITRATION

(a) SCSI phases without arbitration



(b) SCSI phases with arbitration

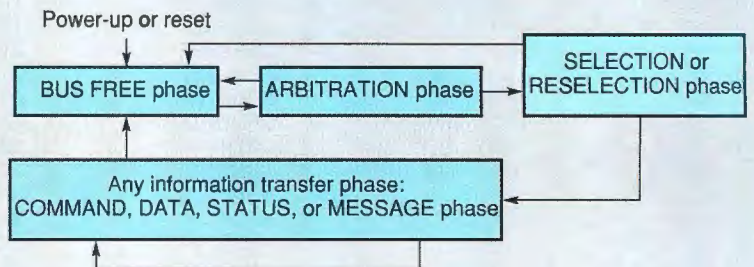


Figure 3: The SCSI bus always comes up in the BUS FREE phase. A system can be nonarbitrating (a) or arbitrating (b); if arbitration isn't implemented, there's no ARBITRATION or RESELECTION phase. Nonarbitrating systems usually consist of a single host and a single peripheral controller; ARBITRATION and RESELECTION aren't necessary because the host is always in control, and there's no need for a disconnect/reconnect operation.

The SCSI Signals

SCSI is simple compared to most computer and peripheral buses; it has only nine data lines and nine control signals. Table A shows the pin assignments for single-ended SCSI; table B shows the assignments for differential SCSI.

The signals are as follows:

ACK (acknowledge) The initiator asserts this line to acknowledge that it has accepted or supplied data in response to the REQ signal (which is asserted by the target). All asynchronous data transfers over the SCSI bus use the REQ/ACK handshake sequence.

ATN (attention) A host asserts this signal to let a controller know that it has

a message for it. The controller can then ask for the message using the MESSAGE OUT bus phase.

BSY (busy) This signal is asserted by one or both of the parties to a transaction to indicate that the bus is in use.

C/D (control/data) This signal is controlled by the target during a transaction, and it indicates whether control information or data is on the bus.

data lines -DB(0), -DB(7), and DB(P) These lines form a bidirectional data bus with optional parity. In addition, they carry the SCSI IDs of devices when they contend for the bus and when they establish (or reestablish) connections with other devices. (Each ID corresponds to one line on the bus being active.)

DIFFSENS (differential sense) This line, which is found only on differential SCSI buses, enables the differential drivers.

I/O (input/output) This signal indicates the direction of a data transfer rel-

ative to the initiator (host). It's driven by the target and also distinguishes between the SELECTION (done by the initiator) and RESELECTION (done by the target) bus phases.

MSG (message) This signal, which is controlled by the target, indicates when a message is on the bus.

REQ (request) The target asserts this signal to begin an asynchronous bus transfer using the REQ/ACK handshake sequence.

RST (reset) This signal resets the bus. Any device can assert it; it is normally used only at power-up time or when a selected device isn't responding.

SEL (select) A host uses this signal to specify the controller that it wishes to talk to or vice versa. (The ID of the device being selected appears on the data lines.)

TERMPWR (terminator power) This line provides power to the termination resistor networks at either end of the bus.

Table A: In single-ended SCSI, the odd-numbered pins are all grounded (except for pin 25) to provide shielding between the lines. Pin 25 is left open, so that if a single-ended device is accidentally plugged into a differential SCSI bus, it does not short the TERMPWR line to ground and potentially blow out a power supply. A minus sign before a signal name means it's active low.

SINGLE-ENDED SCSI PIN ASSIGNMENTS

Pin number	Signal
2	-DB(0)
4	-DB(1)
6	-DB(2)
8	-DB(3)
10	-DB(4)
12	-DB(5)
14	-DB(6)
16	-DB(7)
18	-DB(P)
20	GROUND
22	GROUND
24	GROUND
26	TERMPWR
28	GROUND
30	GROUND
32	-ATN
34	GROUND
36	-BSY
38	-ACK
40	-RST
42	-MSG
44	-SEL
46	-C/D
48	-REQ
50	-I/O

Table B: In differential SCSI, many of the odd-numbered pins form differential signal pairs with the corresponding even-numbered pins.

DIFFERENTIAL SCSI PIN ASSIGNMENTS

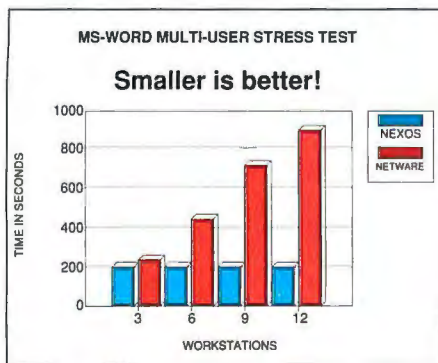
Signal	Pin number	Pin number	Signal
SHIELD GROUND	1	2	GROUND
+DB(0)	3	4	-DB(0)
+DB(1)	5	6	-DB(1)
+DB(2)	7	8	-DB(2)
+DB(3)	9	10	-DB(3)
+DB(4)	11	12	-DB(4)
+DB(5)	13	14	-DB(5)
+DB(6)	15	16	-DB(6)
+DB(7)	17	18	-DB(7)
+DB(P)	19	20	-DB(P)
DIFFSENS	21	22	GROUND
GROUND	23	24	GROUND
TERMPWR	25	26	TERMPWR
GROUND	27	28	GROUND
+ATN	29	30	-ATN
GROUND	31	32	GROUND
+BSY	33	34	-BSY
+ACK	35	36	-ACK
+RST	37	38	-RST
+MSG	39	40	-MSG
+SEL	41	42	-SEL
+C/D	43	44	-C/D
+REQ	45	46	-REQ
+I/O	47	48	-I/O
GROUND	49	50	GROUND

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Table 1: *The combinations of signals used to denote each phase.*

INFORMATION TRANSFER PHASES AND SCSI CONTROL SIGNALS

MSG	Signal C/D	I/O	Phase name	Description
0	0	0	DATA OUT	Initiator sends data to target.
0	0	1	DATA IN	Target sends data to initiator.
0	1	0	COMMAND	Initiator sends command to target.
0	1	1	STATUS	Target sends status to initiator.
1	0	X		(Reserved)
1	1	0	MESSAGE OUT	Initiator sends message to target.
1	1	1	MESSAGE IN	Target sends message to initiator.

and asserts the I/O signal, as well as SEL, to distinguish this phase from a SELECTION phase.

Finally, the system cycles through one or more information transfer phases. The target uses the MSG, C/D, and I/O signals to guide the system through the phases (see table 1 for the combinations of signals used to denote each phase).

In the COMMAND phase, the target requests a command from the initiator. In the DATA IN or DATA OUT phase—as you might expect—data is transferred. In the STATUS phase, the target sends the initiator a status byte indicating the success or failure of the command, and in the MESSAGE IN or MESSAGE OUT phase, a message passes between the two devices. Typical messages would include "Command Complete," in which the target indicates to the initiator that it's finished performing a command, and "Initiator Detected Error," in which the initiator signals that it has detected a par-

ity error during a data transfer.

A typical SCSI transaction would consist of a COMMAND phase, followed by a series of DATA IN or DATA OUT phases, followed by a STATUS phase and a MESSAGE IN phase (in which the target sends the mandatory "Command Complete" message). However, the initiator can cause the target to enter the MESSAGE OUT phase (and accept a message) by asserting the ATN signal on the bus. It can also reset the bus at any time by asserting RST.

Commands and data can be transferred either asynchronously or synchronously during the information transfer phases. During an asynchronous transfer, the REQ and ACK signals operate in lockstep with the transfer. On a transfer from initiator to target, the target asserts REQ when it's ready for data, and the host asserts ACK when the data is on the bus. The target deasserts REQ when it latches the data, and the initiator, seeing

this, deasserts ACK. When data is sent from target to initiator, the REQ line indicates that the target has placed data on the bus, and ACK indicates that the initiator has latched the data.

If the target and initiator agree, however, they can avoid waiting for handshake signals by "windowing" the transfer. The target pulses REQ for each byte of data, and the initiator will eventually pulse ACK the same number of times, but they're allowed to get ahead of one another. This is a synchronous transfer.

In SCSI-1, a synchronous transfer can take place at a predetermined maximum rate of 4 megabytes per second. In SCSI-2, however, the target and initiator negotiate a rate that may be considerably faster than the highest SCSI-1 speed.

More to Come

This concludes my low-level tour of SCSI and the signal lines it uses. In next month's installment, I'll cover the high-level aspects of SCSI. I'll show how the bus phases I've described here fit together into a complete SCSI transaction, give overviews of the common command set and common access method, and describe how SCSI is used in some real-world systems. ■

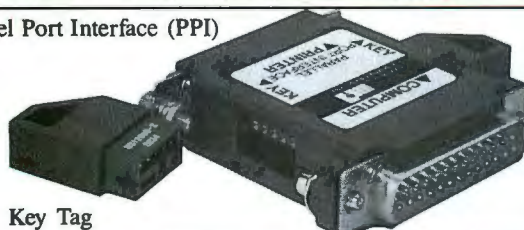
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MULTITASKING FOR THE MASSES

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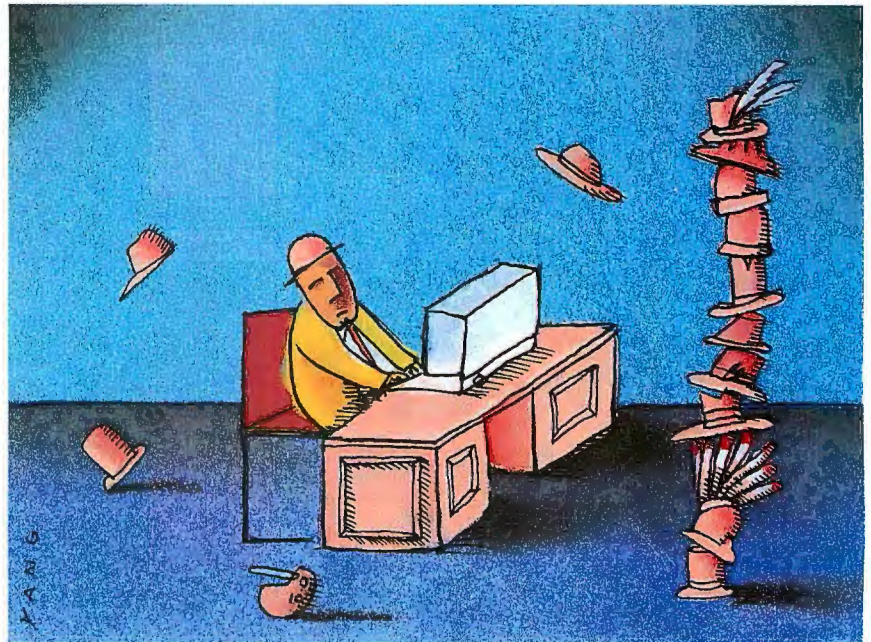
My mission this month is to inject some enthusiasm into those of you who may have slumped into a depression. I know why it's happening: You've been reading those computer magazines that tell you of the wonders of multitasking and how you need *at least* a \$5000 investment in a 2-megabyte, 25-MHz 80386 machine to share in those wonders. So you look over at your XT clone or your Mac Plus and begin wondering if it isn't time to send that old workhorse to the glue factory. Maybe you could get a second mortgage on the house to pay for an 80386 clone or a Mac II; after all, you've got to have that kind of hardware to do multitasking, right?

Not so fast. To quote Mehitabel the cat: "There's a dance in the old girl yet." There are ways to enjoy the paradise of multitasking on your XT or Mac Plus. You'll have to work a little harder at it than if you had a Sun workstation, but multitasking beyond simply hanging a background print task on a timer interrupt is not out of reach.

What Is Multitasking, Really?

Multitasking is often incorrectly defined as running multiple programs (tasks or procedures) simultaneously. But that can't be; unless you're lucky enough to own a coprocessor board or a cluster of transputers, you've only got one CPU in your machine, and it can only work on one program at a time.

Of course, the trick is that the CPU switches rapidly from task to task so that the system appears to be running several tasks at once. It's like Superboy playing



baseball alone, but rushing from position to position so quickly that he becomes the whole team. This task switching is often referred to as *context switching*. There are two major varieties of context switching: preemptive and cooperative. (As you'll see, there are numerous variations on these themes.)

Preemptive context switching usually occurs at a level so low that the application is largely unaware that it's taking place. A hardware interrupt—usually triggered by the system's real-time clock—causes processing to transfer to a routine associated with the timer interrupt (see figure 1). This routine (usually referred to as the *scheduler*) saves the system state of the currently executing program, selects another program from a queue of programs waiting their turn, and transfers control to the one selected.

When a program is selected to run, the system (all the CPU's registers and flags) is returned to the state it was in when that program was interrupted, so processing

continues right where the program left off—the program has no idea it was interrupted at all. The transparency that this approach provides means that, unless you want your program to communicate with other processes running on the system, you don't have to include any special code to support task switching.

In cooperative task switching, the program takes an active role in providing multitasking. Simply put, the program explicitly says: "Okay, someone else can have the CPU now." There's an understanding of civility here; a program that gives up the CPU presumes that, ultimately, it will be given its turn again.

Just as there are ways to accomplish multitasking at the machine level, there are various ways to bring multitasking to your computer. The spectrum ranges from complete multitasking environments—some that try to maintain DOS compatibility, others that give up the idea of wrestling with DOS and define a

continued

completely new operating system—to multitasking within the confines of a programming language. I'll wade into the heavyweights first.

Love Me, Love My DOS

DESQview is well known in the pages of this magazine. It has acquired the reputation of an interim solution for those wait-

ing for OS/2. In fact, some suggest that DESQview is powerful enough to suffice in place of OS/2.

DESQview's claim to fame is its success in running off-the-shelf DOS applications. I have run DESQview for some time now on my 4.77-MHz XT clone, and although I encounter an occasional problem with programs that play illegiti-

mately with the screen, DESQview typically never breaks stride. (I have a Definion DSI-32 coprocessor board that runs Unix System V. With DESQview, I can open a 64K-byte window to run the communication routine that handles the DSI-32's disk and keyboard requests and still have plenty of room for XyWrite or Turbo C or whatever. The result: I get Unix running concurrently with DOS on a little XT clone.)

But DESQview is more than just a means of running multiple DOS applications (several multi-DOS products exist, such as PC-MIX from Proware). Quarterdeck provides a complete application programmer interface tool set that allows you to create programs that make use of DESQview's multitasking capabilities (Quarterdeck refers to such programs as DESQview-specific applications). These capabilities are surprisingly extensive. The DESQview API toolkit consists of a library of assembly routines and macros that allow access to DESQview's functions through its Int 15H software interrupt hook.

Programs can spawn concurrent processes through the NEWPROC macro. A process is defined by its program information file (PIF), which serves as a kind of program segment prefix and defines parameters such as the amount of memory required by the program, where its window (if any) will initially appear on-screen, whether the program writes directly to video memory, and so forth. You load a PIF into memory and then activate it via NEWPROC as follows:

```
MOV ES,<segment of PIF>
MOV DI,<offset of PIF>
@CALL NEWPROC
```

where @CALL is a macro that sends the NEWPROC command to DESQview. When NEWPROC returns, the top of the stack holds a 32-bit identifier—referred to as a handle—to the new process. This handle is a means of referencing the process in the future. So, for instance, if you wanted to suspend a process, you would execute

```
MOV ES,<high word of handle>
@CALL STOP
```

(Notice that you need only supply the upper 16 bits of the process handle; this is because the lower 16 bits of a process handle are always 0s.)

DESQview's interprocess communications are handled by objects referred to as mailboxes. The DESQview mailbox is

continued

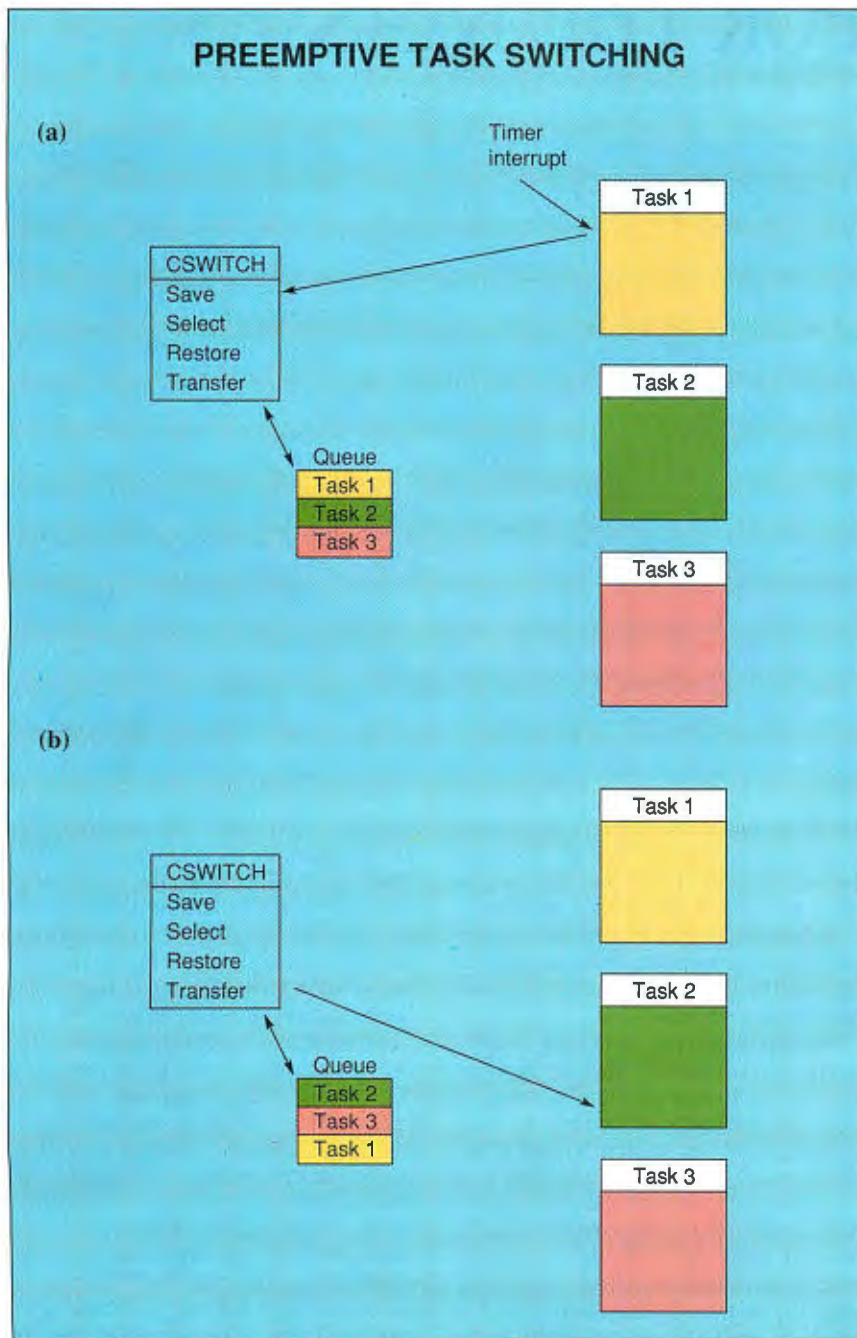


Figure 1: (a) A timer interrupt transfers control to the context-switching routine (CSWITCH). CSWITCH saved the machine state when Task 1 was interrupted. The state is saved onto the rear of the queue. (b) Task 2 moves to the head of the queue, and it restarts where it left off.

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general-purpose; it allows tasks to send messages of arbitrary length to one another (the typical job of a message queue). A task can lock a mailbox, causing subsequent tasks that try to lock the mailbox to be suspended until the lock is removed. So, mailboxes can also do the job of semaphores.

When a new task is created, DESQview automatically builds a new mailbox, which becomes the task's default mailbox. But if one per task is not enough, programs can create additional mailboxes with the NEW command. Once a mailbox is created, your program can associate a symbolic name with it using the SETNAME command. This allows other processes in the system to locate the mailbox by name.

Finally, if you can't see yourself writing piles of assembly calls, you'll be happy to know that an API C Library package is available. It is compatible with most of the popular compilers, and if that's not enough, the source code is included so you can rebuild the library for whatever compiler is your favorite.

Wendin-DOS

Wendin-DOS, like DESQview, is noteworthy because it supports many of the features of MS-DOS. However, it seems less tolerant of "ill-behaved" programs (loosely defined as any programs that circumvent DOS and BIOS calls to talk to the hardware). TSR programs also usually go blooey under Wendin-DOS. Finally, Wendin-DOS is a separate operating system; when you boot your system, you boot up in Wendin-DOS. (With DESQview, you boot under DOS.)

When you set Wendin-DOS's configuration for boot-up time, you select an interface that is either windowed or switched. The windowed interface allows multiple windows on-screen simultaneously, each running either another program or a shell. The switched interface is for those applications that write directly to the video memory; in this interface, the currently active task has control of the entire screen. The remaining tasks are kept "asleep." To awaken another task, you enter a hot-key sequence, and the current task is put to sleep, its screen is saved, and the new task wakes up and takes over the display.

Happily, Wendin-DOS uses the standard DOS file structure, so you don't have to erase everything to install the new operating system. Wendin-DOS also supports the standard DOS Int 21H interrupts up through DOS 3.3. This translates to less work on your part getting programs running under Wendin-DOS.

Also, Wendin provides an application developer's kit with a library of C routines for calling the operating system's services (the code in the library is compatible with Microsoft C 3.0 or greater).

Processes under Wendin-DOS communicate via global memory blocks and mailboxes. Global memory blocks are similar to Unix V's shared memory capabilities: Your program asks the operating system for a section of memory that, once allocated, can be accessed by other processes if they know the block's name. Your process can create a global memory block using the following system call:

```
returncode=sys_cregbl(blname,  
&pages,&address)
```

Happily,
*Wendin-DOS uses
the standard
DOS file structure.*

where blname is a pointer to a character string that will become the block's identifying name. The pages variable indicates the size of the block in 512-byte increments. Finally, address is a pointer to a doubleword location into which the operating system will store the segment and offset of the allocated block.

Once the block is created, any other process can gain access to it using the following code:

```
returncode=sys_acgbl(blname,  
&address)
```

where blname and address have the same meaning as above.

The Wendin-DOS mailbox (you'll be reading about a lot of mailboxes in this article) is a kind of pseudofile that you access through the operating system's record management system routines. (The RMS calls are the entry into Wendin-DOS's file handling routines. These are separate from the DOS Int 21H calls you're probably already familiar with.) Physically, a mailbox exists as a region in memory; logically, it looks like a file on drive MB.

The mailbox is the Wendin-DOS message queue. Once a process creates a mailbox with

```
returncode=rms_create(NULL,  
"MB:MYBOX",&channel,0);
```

and writes into it, other processes can open the mailbox and read from it in sequential fashion:

```
returncode=rms_read(NULL,  
&channel,buffer,&length);
```

where buffer is a pointer to the character array for holding the input, and length specifies the number of bytes to read. The RMS calls that I've shown have the same format for creating and reading files. This universality lifts some weight off programmers' backs.

A Different Drummer

Theos 86 is an operating system all to itself. At least, I don't recognize Theos as being a clone of anything. This is both a strength and a weakness: The designers of Theos were able to extend the file system to include features not found in MS-DOS. On the other hand, you have to learn all this new stuff.

Theos is billed as a multiuser operating system, but it does sport plenty of multitasking features. From the user's standpoint, you can launch a task to run in the background with the START command. So, entering START SPOOLER would return a prompt immediately, but it would cause SPOOLER to begin executing concurrently with whatever you're doing from the console.

Theos provides BASIC and C languages for program development. In BASIC, your program can create a subtask using the ACTIVATE command. Thereafter, tasks can communicate with one another through semaphores or common variables. Common variables look like ordinary variables but are kept in memory external to all tasks. Each task can access the common variable pool using the GET COMMON and PUT COMMON statements.

Theos' C language lets you create new tasks with the fork() function (which Unix programmers will recognize). You can also launch a program file from the disk as a subtask with the spawn() function. Once all these tasks are running, they can talk to one another through shared memory.

Shared memory works just like Wendin-DOS's global memory blocks: It's a region of memory to which a unique name is attached. Tasks running in the system can gain access to this memory by using the shared() function. And C supports semaphores as well, with the

continued

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Theos 86

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Walnut Creek, CA 94596
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Inquiry 1107.

Wendin-DOS

Wendin, Inc.
P.O. Box 3888
Spokane, WA 99220
(509) 326-1529
Inquiry 1105.

addition of *remote semaphores*, which allow subtasks spawned from one parent to access semaphores owned by tasks spawned by another parent. (Note that remote tasks would include tasks controlled by another user on the system.)

QNX

QNX looks a lot like Unix. Many system commands look so much like commands you've seen in Unix that it's easy to be fooled. Like Theos, QNX uses its own file system, so if you want to run both it and DOS, you'll have to buy a second hard disk drive, partition your disk, or banish your DOS files to floppy disks.

To alleviate the loss of DOS, QNX provides two remedies. RUNDOS lets you run a DOS application as a QNX task. RUNDOS captures incoming DOS and BIOS requests and refracts them into QNX calls. This works reasonably well, and the QNX people boast support of Lotus 1-2-3, WordPerfect, Windows/286, and others.

The other remedy is DFS, which attacks the problem from a different angle. This package deludes a QNX program into thinking that an MS-DOS disk is really a QNX disk. So, for example, I could write a C program under QNX that uses the standard I/O calls—`fseek()`, `fread()`, and so on—and when I run that program with DFS, I can direct it to do its work on my MS-DOS floppy disk.

For the programmer willing to divorce himself from DOS in the interest of multitasking, QNX teems with capabilities. Intertask communication in QNX is built on messages: memory buffers of arbitrary size that can be transmitted between tasks. Once you know a task's process ID, you send it a message via the `send()` command, and it uses the `receive()` function. Of course, this raises the question of how the sender determines the receiver's task ID.

QNX's answer to this is unique: A

task can attach a name to itself. Most other operating systems allow names to be assigned to the abstract communications objects (i.e., the message queues, the shared memory blocks, and so on), but under QNX you can actually name a task. Thereafter, any other task can post a query to the operating system to locate the named task and determine its associated process ID.

If you prefer the named message queue approach, however, QNX provides a queue utility that you launch as a background task. This task is built on the `send()` and `receive()` commands, but it allows tasks to reference queues, rather than tasks, by name. Also, queues are buffered and nonblocking; messages aren't. If you send a message to another task, your task waits until the other task receives the message. Best of all, queues can stretch across networked QNX machines so that tasks on your machine can communicate with tasks on remote machines as easily as if the remote tasks were executing locally.

When Money Is an Object

At least two multitasking operating systems are available that are less like commercial products and more like labors of love.

Minix, created by Andrew Tanenbaum, is a complete Unix-like operating system for the IBM XT and AT machines. Minix was created as an educational tool (its author teaches courses in operating systems), but this is no toy operating system. With only minor exceptions, Minix uses system calls identical to those of Unix version 7. (You get a complete multitasking operating system with utilities and a C compiler for under \$80. Not bad.) You create new processes using the `fork()` function. Process communication is supported by the `send()` and `receive()` calls; the only restriction is that (on the 8088) the maximum mes-

sage size is 24 bytes.

Since Minix is so closely tied to Unix, its file system is incompatible with that of MS-DOS. Nor have I seen any Minix programs for running DOS as a subtask (although it wouldn't surprise me if one is out there somewhere). This means you'll either have to partition your hard disk into DOS and Minix, or simply give up DOS altogether for a single large Minix partition.

In any case, if you are at all interested in multitasking in particular and operating systems in general, you should at least check out Tanenbaum's book (see the bibliography). It contains the complete source code to the Minix kernel, with meticulous comments by the author.

Xinu (a self-referencing acronym that stands for "Xinu is not Unix") is the opus of Douglas Comer and associates. In testimony to this operating system's adaptability, it has made its way onto PDP-11s, Sun minicomputers, VAX machines, IBM PCs, and Macintoshes.

On the PC, Xinu is something of an operating-system hybrid. You do all your development work under PC-DOS in Microsoft C and Macro Assembler (or Turbo C and Turbo Assembler) and link the result with a Xinu library to create an .EXE program. When you execute this program, Xinu takes over the computer and becomes the new operating system. The multitasking appears when you designate a function as a process using the `create()` function. The call looks something like this:

```
pid = create(myproc,STACK,  
            PRIORITY,"proc1",nargs,  
            arglist);
```

This creates a process out of function `myproc()` (which you've defined elsewhere in your program) and returns its process ID in `pid`.

The process's stack size is given by `STACK`, its priority defined by `PRIORITY`. Following the priority argument is a symbolic name to be associated with the process, and then comes the number and list of arguments to be passed into the process when it starts. Once you've created the process, it is suspended, so your program must jump-start it with

```
resume(pid);
```

which causes the process given by `pid` to execute concurrently with the caller.

Since you run Xinu as a single large C program, processes can communicate through shared memory. In this case, the

continued

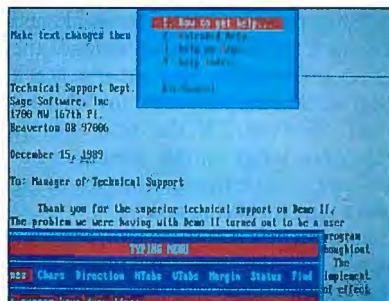
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shared memory is nothing more than global variables defined in the program's header. For process coordination, Xinu has semaphores.

Xinu provides two message-passing systems, one built atop the other. The first is simple process-to-process message passing; the sender must know the process ID of the receiver. The second is a more versatile scheme based on ports, where a port consists of a message queue controlled by two semaphores. The first semaphore regulates input to the queue, blocking any process that tries to write to a full queue. The second semaphore controls output, blocking processes that try to read from an empty queue. The system maintains an array of ports. Any process can access a port, given that the process knows the port number.

As with Minix, Xinu is available in association with a book (see the bibliography, and be aware that there are separate editions for the PC and the Mac) providing rigorous coverage of the source code. Even if you don't plan to use Xinu, there's a great deal to be gained from its associated text.

Multitasking Languages

F83 is a remarkably extensive public domain Forth package created by Henry Laxen and Michael Perry. F83 runs on several systems, including IBM PCs, and its authors have done a lot to integrate the package with the native operating system. However, what I'm most interested in here is F83's built-in multitasking capabilities.

Multitasking in F83 is cooperative, unlike the preemptive approach you've seen in the above operating-system replacements. When you create a task in

F83, a data structure that defines that task is linked into a circular list (see figure 2). This data structure consists of a header field, which holds the name of the task; an entry-point field, which holds executable code that I'll describe in a moment; a link field, which points to the next task in the list; and the task's local data storage area. This local data storage area holds the task's personal variable space (called *user variables*), return, and parameter stacks.

The currently running task passes control to the next task in the list by executing the PAUSE word. PAUSE saves the state of the current task by pushing the return stack pointer and the instruction pointer onto the parameter stack and then storing the parameter stack pointer into the local user area. Finally, PAUSE fetches the address in the LINK field and jumps to that address. If the next task is awake, then this jump sends execution off to the Int 80H routine that F83 has patched to hold its context-switching routine. This routine resets the awakened task's stack pointer and then unloads the instruction pointer and return stack pointer so that the task resumes where it left off. However, if the next task is asleep, this jump simply executes another jump instruction that moves along the list to the following task.

Creating a task's data structure is done by specifying the size of the task's local user area and stack and then giving the task a name. You create task FRANK with

```
400 TASK: FRANK
```

which allocates 400 bytes to the user area and stacks. Now, say you want FRANK

to watch a variable and then ring the bell and terminate when that variable becomes 0.

```
VARIABLE WATCHME
1 WATCHME !
```

```
: FRANK-DOES
```

```
FRANK ACTIVATE
  BEGIN PAUSE WATCHME
    @ 0= UNTIL
  BEEP STOP ;
```

Executing FRANK-DOES will assign to FRANK the code following the ACTIVATE word, which simply babysits the variable WATCHME. When WATCHME goes to 0, FRANK rings the bell and, using the STOP word, puts himself to sleep forever.

Of course, it's up to the programmer to sow PAUSE instructions in strategic places to keep one task from hogging the system (referred to as "starving" a task). Since there's the potential for indefinite delay in many I/O operations (e.g., as the computer waits for a human to enter something at the keyboard), the low-level I/O words of F83 have PAUSE instructions built in.

Regarding interprocess communications, there is nothing specific in F83. As with almost everything else in Forth, you've got to build it yourself. Since the only real scoping that controls variables is the order in which they are defined, all variables are more or less global and therefore provide all the intertask communications you need.

Mach 2

Mach 2, a Forth system for the Mac, takes a practically identical approach to multitasking. You create tasks by building a data structure that holds the task's user area and stacks. (Mach 2 has two more stacks than F83 has: a subroutine stack—used because Mach 2 is subroutine-threaded—and a floating-point stack used by floating-point words.) Task switching is accomplished using the PAUSE word. Also, as in F83, a task is either awakened or put to sleep by storing an instruction in the task's entry point—referred to in Mach 2 as the STATUS variable.

Tasks in Mach 2 come in two flavors: terminal and background. A terminal task has an associated window and is therefore able to communicate with the user. A background task, as you might guess, runs in the background and is not associated with a window. To create a

continued

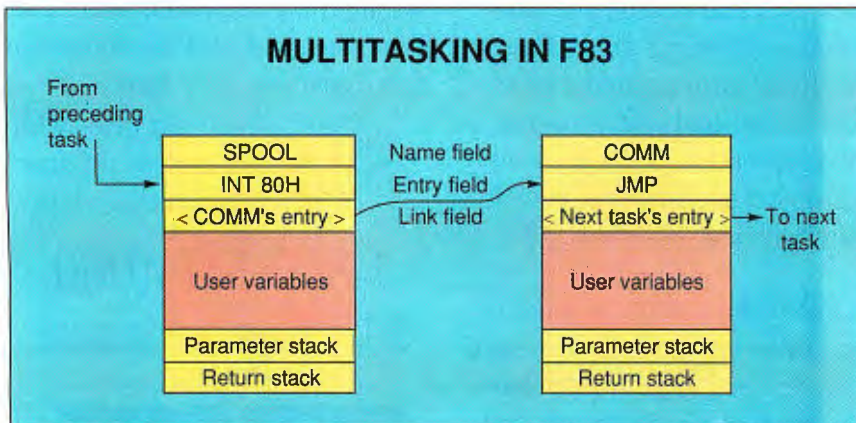


Figure 2: The task SPOOL is awake; its entry field holds an Int 80H, which, when executed, transfers control to F83's task-switching routine. The task COMM is asleep. Execution of the JMP instruction in COMM's entry field causes control to pass to the next task, skipping COMM.

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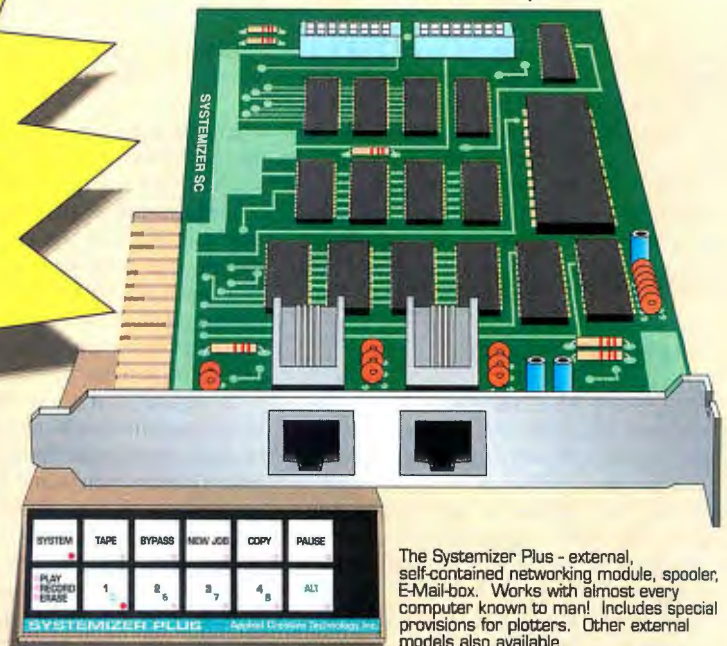
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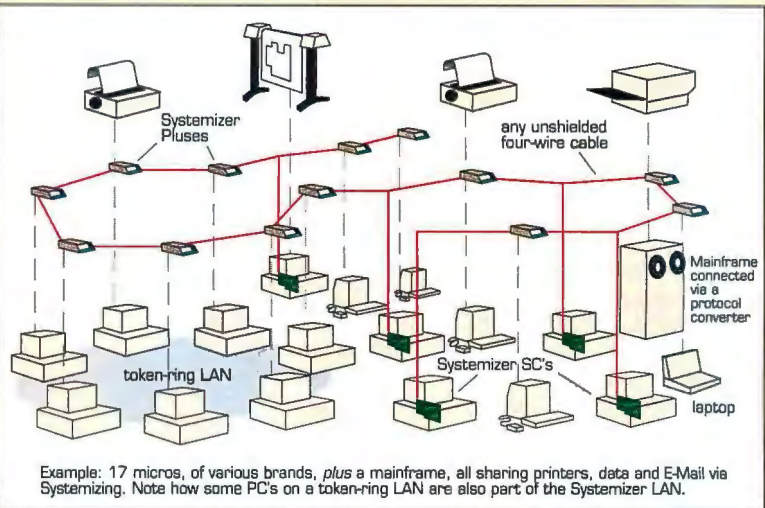
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terminal task, you use the word **TERMINAL**; to create a background task, you use the word **BACKGROUND**. Both **TERMINAL** and **BACKGROUND** expect two values on top of the stack: the number of bytes to be allocated to the new task's parameter stack and the number to be allocated to the subroutine stack. Therefore, to create terminal task **FRANK**, you use the following:

```
800 800 TERMINAL FRANK
```

Now, since **FRANK** needs a window, you have to define the window's details and connect it with the task **FRANK**. You can see how this is done in listing 1, where I've defined a bare-bones window. The **ADD** word actually makes the window visible, and **BUILD** connects the window with the task **FRANK**. Finally, to associate actual code with **FRANK**, use the **ACTIVATE** word.

As in **F83**, all the I/O words in **Mach 2** contain embedded **PAUSE** instructions. That's why the routine in listing 1 needs no explicit **PAUSE**; **?TERMINAL** causes task switching.

Coroutines and Modula-2

Modula-2 possesses a kind of multitasking mechanism called *coroutines*. The idea of a coroutine is similar to that of a subroutine, but, as the names suggest, a subroutine is subordinate to its caller while a coroutine operates at the same level as its caller. You can think of a coroutine mechanism as an explicit task switch. And if I may add a qualifier, it's a very explicit task switch. Recall the **PAUSE** word in the **F83** example. It performs a task switch, but, as you've seen, an internal scheduler determines which task is next awakened. **Modula-2**'s coroutine mechanism allows the task currently executing to request a switch to a specific location.

Before a program can begin executing coroutines, it must assign a workspace to each coroutine. This workspace is a memory block wherein the coroutine's local variables and stack are stored. You assign the workspace using the **NEWPROCESS()** procedure as follows:

```
NEWPROCESS(myproc,  
  ADR(workspace),  
  SIZE(workspace),  
  coroutineloc);
```

The **NEWPROCESS()** procedure doesn't cause the associated coroutine to begin executing; you have to transfer control to the routine using the **TRANSFER()** procedure. This looks like

```
TRANSFER(mylocation,  
  hislocation);
```

where **mylocation** and **hislocation** are the coroutine reference variables (**coroutineLoc** in the **NEWPROCESS()** procedure above); the first is for the current routine, and the second is for the routine that processing will transfer to. You can see how all this works by examining figure 3, where the main routine (**MainProcess**) launches two coroutines, **Routine1** and **Routine2**.

In figure 3, it's easy to see how the term *coroutine* got its name. All routines operate on an equal footing. There is no prioritization (you would have to add that explicitly). When **TRANSFER()** executes, the caller saves its current state (so it can be restarted where it left off) and gives control to the destination routine.

Note that coroutines are procedures that do not have arguments or return values. If you examine the format of the

continued on page 334

Listing 1: A Mach 2 Forth routine that builds a window and associates it with an existing task.

```
NEW.WINDOW FRANKWIND

(* Give FRANKWIND a title *)
" Franks Window" FRANKWIND TITLE

(* Identify its location and size *)
100 300 300 500 FRANKWIND BOUNDS

(* Add all the doo-dads *)
DOCUMENT VISIBLE CLOSEBOX
FRANKWIND ITEMS

(* Now make the window visible *)
FRANKWIND ADD

(* Associate the window with the task *)
FRANKWIND FRANK BUILD

(* Give FRANK some code to execute *)
: FRANK-DOES ACTIVATE
  BEGIN ." Frank here" CR ?TERMINAL
  UNTIL QUIT ;

(* Turn FRANK on *)
FRANK FRANK-DOES
```

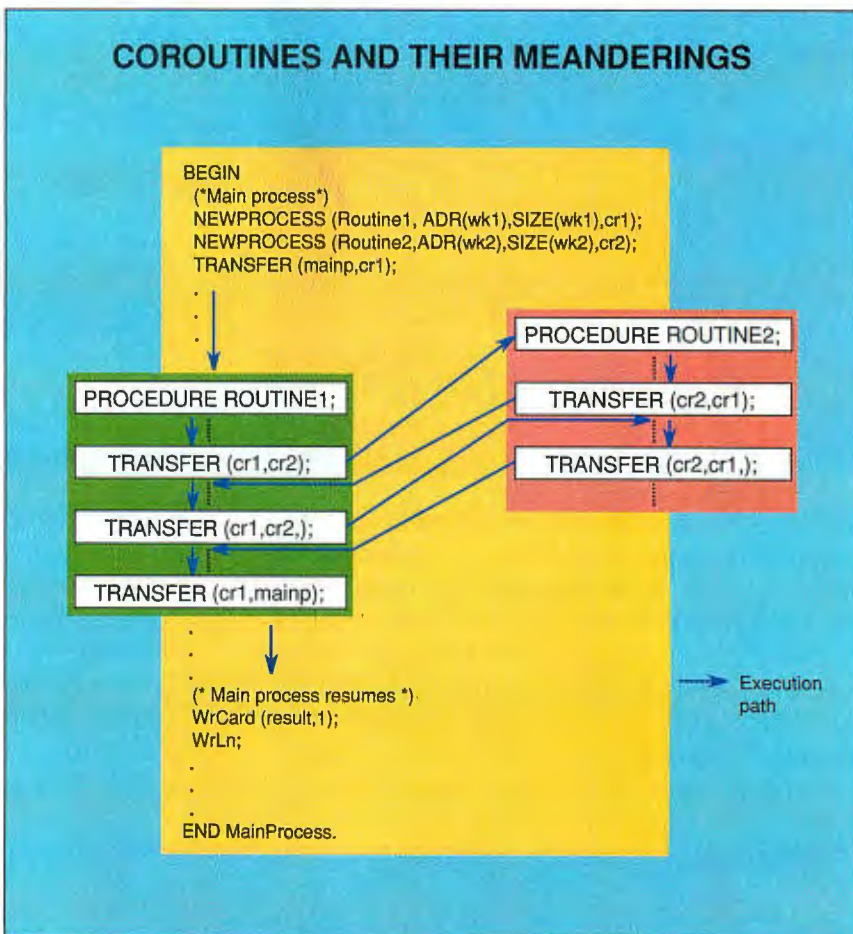


Figure 3: *MainProcess* executes two **NEWPROCESS()** calls to assign workspace to coroutines *Routine1* and *Routine2*. One routine passes control to another via the **TRANSFER()** procedure.

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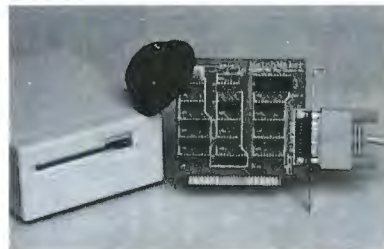
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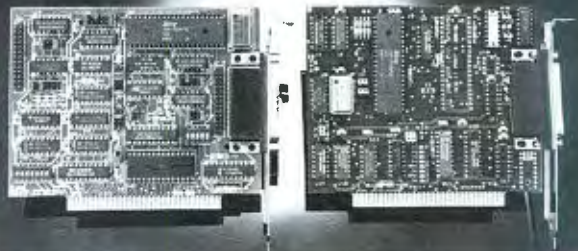
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7402	29	19	7475	49	39
7404	29	19	7476	45	35
7405	35	25	7483	59	49
7406	39	29	7485	65	55
7407	39	29	7486	45	35
7408	35	25	7489	225	215
7410	29	19	7490	49	39
7411	35	25	7493	45	35
7414	49	39	7495	59	49
7416	35	25	74107	29	19
7417	35	25	74121	39	29
7420	29	19	74133	49	39
7427	29	19	74125	49	39
7430	29	19	74147	199	189
7432	39	29	74150	135	125
7438	39	29	74151	39	29
7442	49	39	74154	135	125
7445	75	65	74161	69	59
7446	79	69	74174	59	49
7447	89	79	74175	59	49
7473	39	29	74193	79	69

74LS

Part No.	1-9	10+	Part No.	1-9	10+
74LS00	26	16	74LS139	49	39
74LS02	26	16	74LS151	49	39
74LS03	26	16	74LS153	49	39
74LS04	26	16	74LS154	129	119
74LS05	26	16	74LS157	45	35
74LS06	59	49	74LS161	49	39
74LS07	59	49	74LS164	49	39
74LS08	26	16	74LS164	59	49
74LS09	26	16	74LS165	75	65
74LS10	26	16	74LS166	89	79
74LS11	29	19	74LS173	45	35
74LS14	49	39	74LS174	39	29
74LS20	26	16	74LS175	39	29
74LS21	29	19	74LS184	59	49
74LS27	35	25	74LS192	69	59
74LS30	26	16	74LS193	69	59
74LS32	26	16	74LS194	69	59
74LS38	35	25	74LS221	69	59
74LS42	49	39	74LS240	59	49
74LS47	85	75	74LS241	59	49
74LS53	39	29	74LS244	59	49
74LS74	35	25	74LS245	79	69
74LS75	39	29	74LS257	49	39
74LS76	39	29	74LS259	99	89
74LS83	55	45	74LS273	89	79
74LS85	55	45	74LS279	49	39
74LS86	29	19	74LS307	49	39
74LS90	49	39	74LS314	79	69
74LS93	49	39	74LS374	79	69
74LS123	49	39	74LS393	89	79
74LS125	49	39	74LS451	129	119
74LS132	49	39	74LS590	595	585
74LS138	49	39	74LS688	239	229

74S/PROMS*

Part No.	1-9	10+	Part No.	1-9	10+
74S00	25	15	74S188	149	
74S04	25	15	74S189	149	
74S32	25	15	74S240	139	
74S74	25	15	74S374	149	
74S112	25	15	74S287	149	
74S124	125	115	74S288	149	
74S138	49	39	74S373	99	
74S153	49	39	74S374	99	
74S163	75	65	74S387	129	
74S174	29	19	74S472	295	
74S175	29	19	74S571	249	

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CD4002	19	14	CD4052	59	
CD4007	19	14	CD4053	59	
CD4011	19	14	CD4060	65	
CD4012	19	14	CD4066	25	
CD4013	29	24	CD4069	25	
CD4015	29	24	CD4070	25	
CD4016	29	24	CD4071	19	
CD4017	29	24	CD4072	19	
CD4018	29	24	CD4073	19	
CD4020	29	24	CD4081	19	
CD4021	29	24	CD4093	35	
CD4024	35	29	CD4094	35	
CD4027	35	29	CD4095	35	
CD4028	35	29	CD4511	75	
CD4029	35	29	CD4518	75	
CD4030	35	29	CD4520	69	
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CD4043	49	39	CD4528	69	
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		8035	1.25	80287-8 (8MHz)	23.95
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2114N	1024x4 450ns	2.49
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21C14	1024x4 200ns (CMOS)	.49
5101	256x4 450ns (CMOS)	1.95
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6116P-3	2048x8 150ns (16K) CMOS	2.79
6116LP-1	2048x8 100ns (16K) LP CMOS	3.59
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6264P-10	8192x8 100ns (64K) CMOS	6.75
6264P-15	8192x8 150ns (64K) CMOS	6.95
6264LP-10	8192x8 100ns (64K) LP CMOS	6.95
6264LP-12	8192x8 120ns (64K) LP CMOS	6.49
6264LP-15	8192x8 150ns (64K) LP CMOS	7.75
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4164-120	65,536x1 120ns	2.39
4164-150	65,536x1 150ns	2.15
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41256-120	262,144x1 120ns	2.95
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41464-80	65,536x4 80ns	5.95
41464-12	65,536x4 120ns	3.95
41464-15	65,536x4 150ns	3.95
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51100P-80	1,048,576x1 80ns (1 Meg)	12.95
51100P-10	1,048,576x1 100ns (1 Meg)	12.95
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TMS2532A	4096x8 450ns (12.5V)	5.25
TMS2564	8192x8 450ns (25V)	6.95
TMS2716	2048x16 450ns (-5V, -15V, +12V)	5.49
1702A	256x8 2K (1µs)	2.25
2708	1024x8 450ns	6.95
2716	2048x8 450ns (25V)	3.49
2716-1	2048x8 350ns (25V)	3.95
27C16	2048x8 450ns (25V) CMOS	4.25
2732	4096x8 450ns (25V)	3.95
2732A-20	4096x8 450ns (25V) CMOS	4.25
2732	4096x8 450ns (25V) CMOS	4.25
2764-25	8192x8 250ns (21V)	3.95
2764A-20	8192x8 200ns (12.5V)	4.19
2764A-25	8192x8 250ns (12.5V)	3.49
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27128-15	16,384x8 150ns (12.5V)	5.25
27128A-15	16,384x8 150ns (12.5V)	4.75
27128A-20	16,384x8 200ns (12.5V)	5.95
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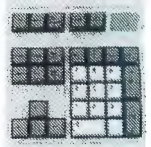
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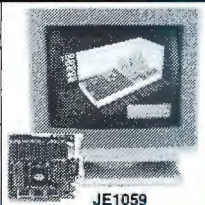
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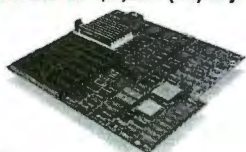
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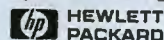
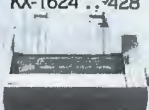
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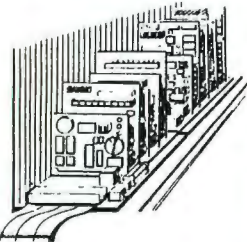
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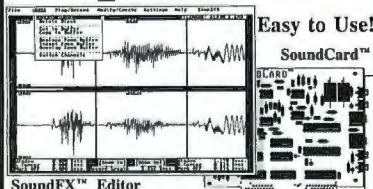
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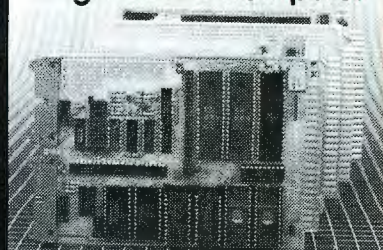
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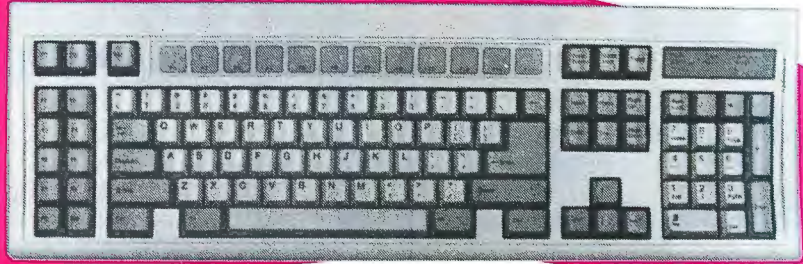
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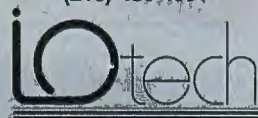
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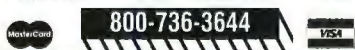
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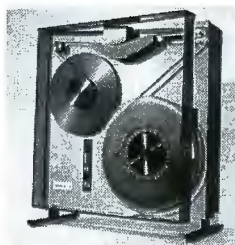
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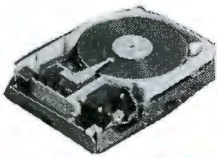
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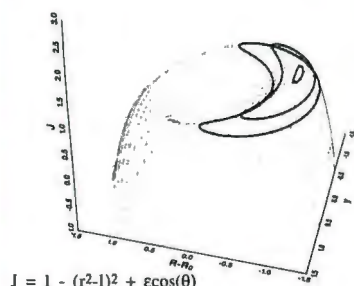
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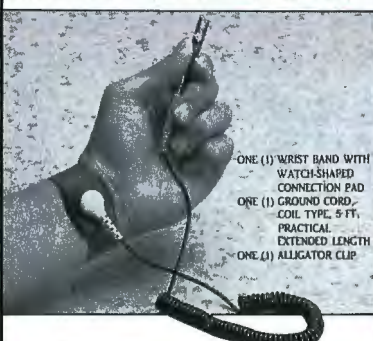
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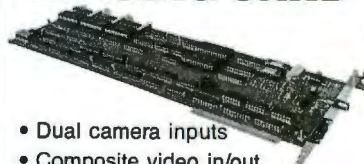
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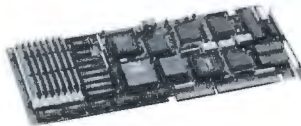

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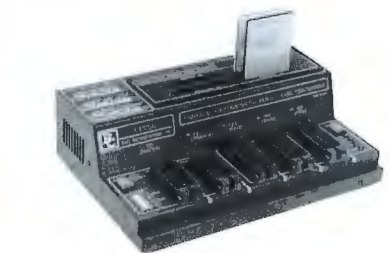
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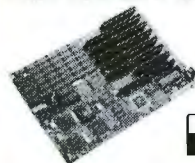
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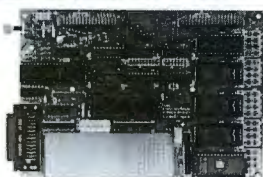
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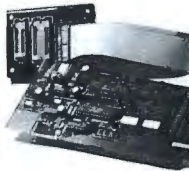
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Circle 99 on Reader Service Card



68HC05 In-Circuit Emulator

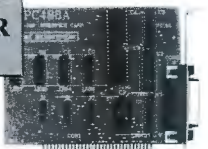
The TECICE-HC05 is a low cost real time emulator for the Motorola 68HC05 family of single chip microcomputers. Any host computer with serial port and terminal emulation software can be used with TECICE-HC05. Base price is \$1195.00. Complete development system software is available for MS-DOS computers including the Byte Craft Limited C6805 Code Development System which includes a 6805 C compiler with Integrated Development Environment.



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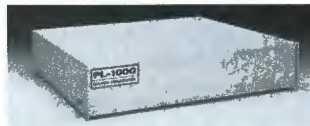
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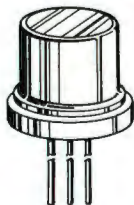
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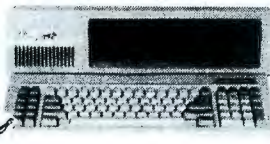
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256 x 1	2 ⁷⁵	2 ⁵⁵	3 ⁴⁵	3 ⁹⁵
256 x 4	12 ²⁵	12 ⁴⁵	12 ²⁵	13 ⁴⁵
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1Meg x 8 For Apple Products	94 ⁰⁰	99 ⁰⁰	114 ⁰⁰	124 ⁰⁰
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25MHz CPU, 32MB 40MS SEAGATE HD	2021	2307	2398
25MHz CPU, 32K CACHE 32MB 40MS SEAGATE HD	2580	2866	2957
33MHz CPU, 32K CACHE 32MB 40MS SEAGATE HD	3205	3491	3582

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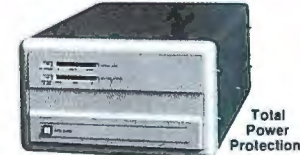
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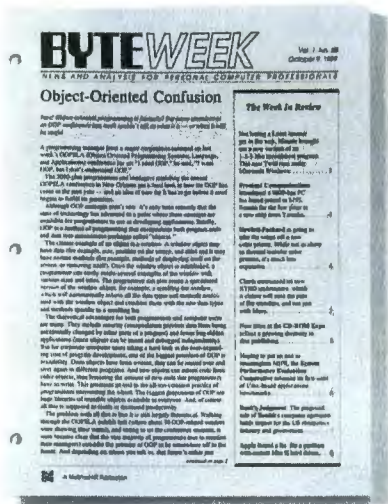
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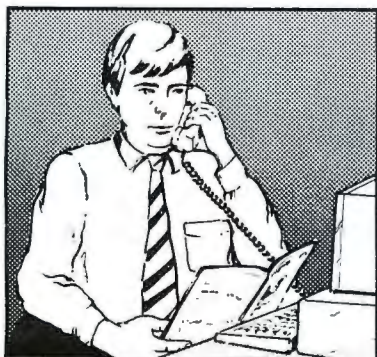
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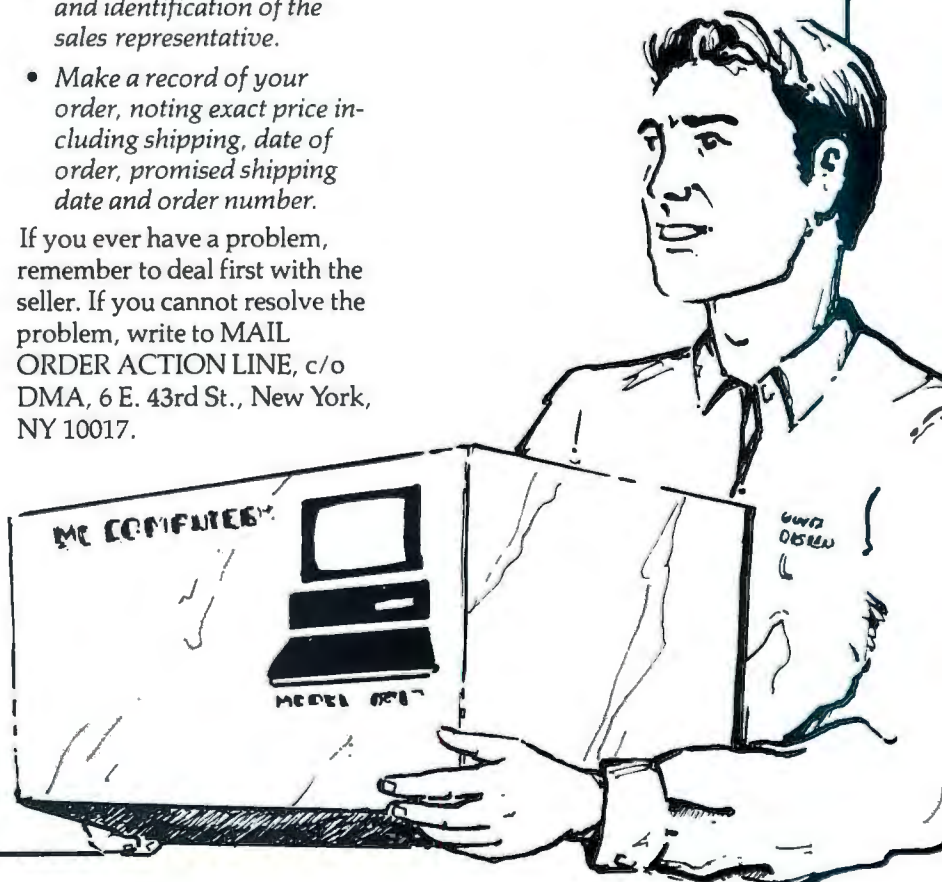
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This list of Intel based processors contains information that should determine which memory speed you require. It is not exhaustive, and may differ from the specifications which came with your computer. Please use the manufacturers recommendations when in doubt.

CPU	Speed	Standard	0 wait	1 wait	Interleaved
8088	5MHz	200ns	-	-	-
8088	8MHz	150ns	-	-	-
8088	10MHz	120ns	-	-	-
80286	6MHz	-	200ns	200ns	-
80286	8MHz	-	120ns	200ns	-
80286	10MHz	-	100ns	150ns	-
80286	12MHz	-	80ns	120ns	-
80286	16MHz	-	60ns	100ns	120ns
80286	20MHz	-	< 50ns	80ns	80ns
80386	16MHz	-	60ns	100ns	120ns
80386	20MHz	-	< 50ns	80ns	100ns
80386	25MHz	-	< 40ns	80ns	80ns

Some very high speed computers require memory even faster than is currently available and rely on interleaving and/or a memory cache to achieve the higher speed. Memory caches use static RAM as opposed to the dynamic RAM used for most processor memory.

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4164-150	65536x1	150ns	16	2.49
4164-120	65536x1	120ns	16	2.89
4164-100	65536x1	100ns	16	3.39
TMS4464-12	65536x4	120ns	16	3.95
41256-150	262144x1	150ns	16	2.59
41256-120	262144x1	120ns	16	2.95
41256-100	262144x1	100ns	16	3.15
41256-80	262144x1	80ns	16	3.75
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42100A8B-10	1MB x 8	100ns	SIMM/MAC	109.95
42100A8B-10	1MB x 9	100ns	SIMM/PC	113.95
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256K9SIP-80	256K x 9	80ns	SIP/PC	54.95
256K9SIP-60	256K x 9	60ns	SIP/PC	64.95
1MB9SIP-80	1MB x 9	80ns	SIP/PC	124.95

STATIC RAMS

PART#	SIZE	SPEED	PINS	PRICE
HM5116LP-2	2048x8	120ns	24	5.49
HM5264LP-15	8192x8	150ns	28	4.95
HM5264LP-12	8192x8	120ns	28	6.49
HM43256LP-15	32768x8	150ns	28	13.95
HM43256LP-12	32768x8	120ns	28	14.95
HM43256LP-10	32768x8	100ns	28	15.95

EPROMS

PART#	SIZE	SPEED	Vpp	PINS	PRICE
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2732A	4096x8	250ns	21V	24	3.95
2764	8192x8	450ns	12.5V	28	3.49
2764-250	8192x8	250ns	12.5V	28	3.59
2764-200	8192x8	200ns	12.5V	28	4.25
27128	16384x8	250ns	12.5V	28	4.25
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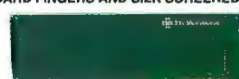
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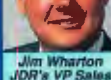
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City _____ State _____ Zip _____

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.)

- 4 ☐ Administration
5 ☐ Accounting/Finance
6 ☐ MIS/DP/Information Center
7 ☐ Product Design and Development
8 ☐ Research and Development
9 ☐ Manufacturing
10 ☐ Sales/Marketing
11 ☐ Purchasing
12 ☐ Personnel
13 ☐ Education/Training
14 ☐ Other: _____

C. Please indicate your organization's primary business activity: (Check one.)

- 15 ☐ Manufacturer (Hardware, Software)

- 16 ☐ Computer Retail Stores
17 ☐ Consultants
18 ☐ Service Bureau/Planning
19 ☐ Distributor/Wholesaler
20 ☐ Systems House/Integrator/VAR

Non-Computer-Related Businesses:

- 21 ☐ Other: _____
22 ☐ Manufacturing
23 ☐ Finance, Insurance, Real Estate
24 ☐ Retail/Wholesale
25 ☐ Education
26 ☐ Government
27 ☐ Military
28 ☐ Professions (Law, Medicine, Engineering, Architecture)
29 ☐ Consulting
30 ☐ Other Business Services
31 ☐ Transportation, Communications, Utilities
32 ☐ Other: _____

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☐ 2 Other Management
☐ 3 Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)

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☐ 11 Purchasing
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☐ 19 Distributor/Wholesaler
☐ 20 Systems House/Integrator/VAR

☐ 21 Other: _____

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☐ 23 Finance, Insurance, Real Estate
☐ 24 Retail/Wholesale
☐ 25 Education
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Technology of Object-Oriented Languages and Systems

SECOND INTERNATIONAL CONFERENCE & EXHIBITION CNIT Paris (La Défense), June 26-29, 1990

FIRST ANNOUNCEMENT AND CALL FOR PAPERS

Program Chairman: Jean Bézivin, Conference Chairman: Bertrand Meyer

TOOLS '89 was the first large-scale event ever to be devoted to the practical applications of object-oriented technology. The conference drew together more than 500 participants from all over the world.

TOOLS '90 will continue the tradition of excellence and practicality established by TOOLS '89. To be held in the last week of June, TOOLS '90 will include tutorials (on June 26 and 27), workshops, invited presentations, submitted papers, and an exhibition of industrial and research object-oriented tools.

The conference format will include:

- ☐ Tutorials (on June 26-27) addressing major object-oriented languages (such as Smalltalk, Eiffel, Objective-C, C++, CLOS), Object-Oriented Databases, Object-Oriented Design methods and other key topics.
- ☐ Invited presentations by international object-oriented experts.
- ☐ Submitted papers on important practical aspects of object-oriented techniques.
- ☐ Demonstrations of object-oriented tools, languages, environments, databases and their applications.

TOOLS '90 will again be held in the exciting new CNIT center in Paris (La Défense), a business and conference center devoted entirely to technologies of the future. The new CNIT is the home of the

Paris Infomart, an ongoing exhibition of advanced computer tools and applications.

TOOLS '90 is now soliciting papers on all aspects of object-oriented technology. All submitted papers should have a strong practical bend and emphasize applications. Suggested topics include:

- ☐ Reports of actual experiences with object-oriented tools and methods.
- ☐ New developments in the technology.
- ☐ Development and use of reusable component libraries.
- ☐ Management and educational issues.

Beyond this list, any paper dealing with object-oriented topics is potentially acceptable if it is of interest to industry practitioners.

Submissions may be made in the form of either full papers (8 to 15 single-spaced pages) or extended abstracts (5 or more pages including basic bibliography). Submissions will be evaluated by the International Program Committee, chaired by Professor Jean Bézivin of the University of Nantes. Six copies of each submission should be sent to:

TOOLS '90
Attn: Jean Bézivin
Laboratoire d'Informatique
Faculté des Sciences et Techniques
Université de Nantes
2, rue de la Houssinière
44072 Nantes Cedex - France

IMPORTANT DATES:

All submissions must be received by March 1 to be considered for inclusion in the conference. Submissions should be in English. Notification of acceptance will be mailed by April 1st; final manuscripts will be due May 1st.

THE INTERNATIONAL OBJECT-ORIENTED PROGRAMMING WEEK

It is anticipated that other meetings related to the topic of the conference, such as User Group meetings or standardization committees, will be organized in the same venue during the week of TOOLS '90, especially on Monday, June 25. The organizers of TOOLS '90 will help coordinate and publicize such events if they fall within the scope of the conference. Prospective meeting organizers should contact the TOOLS organizer.

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TRANSFER() procedure, you will see why. Since TRANSFER() has no way of knowing whether it is transferring to the start or the middle of the coroutine, it can't tell whether to load the routine's input arguments. So any communication between the main routine and coroutines (or between coroutines and each other) must take place in global variables (as in the examples I gave for F83 and Mach 2).

The Task Is Done

There's quite a variety out there; enough to satisfy everyone's needs. Of course, if you want full-blown development systems, you'll probably have to pay a bit more. But it's good to know that if you decide to replace money spent with some old-fashioned time and sweat to get your multitasking, you can do that, too.

Certainly, there are problems. Any multitasking operating system running on the 8088/8086 is going to be flying without any task protection. There's no keeping an insane process from loading up its segment registers with whatever it pleases and laying waste to the operating system's kernel. (Interesting aside: The Wendin people are up-front about this to the degree that their manual provides a road map of the Wendin-DOS kernel's data structures. I guess they figure that if you're going to get yourself into trouble, you might as well be informed about it.)

Still, I've gotten plenty of good work done thanks to DESQview, and I intend to continue my development work with multitasking systems. These will certainly include more than one of the selections I've presented this month. The bottom line, I suppose, is that a Mac Plus with a 20-megabyte hard disk drive or an XT with a hard disk drive and 640K bytes isn't such a has-been after all. ■

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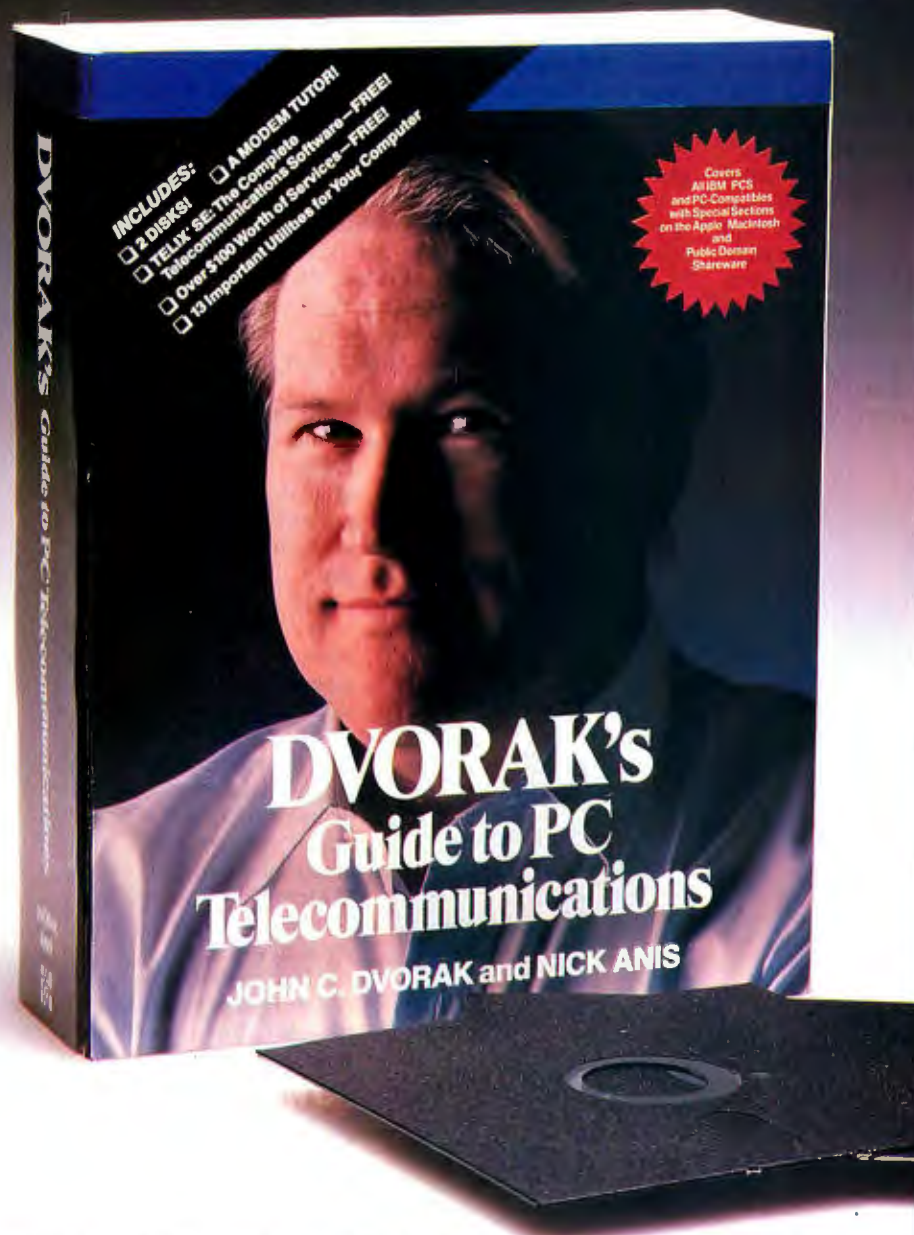
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PRINT QUEUE

Hugh Kenner

Matter at the End of Its Tether

In technology, small is beautiful, not to mention cooler and cheaper

Publishing is a ballet of delays. When I wrote about Fred Warshofsky's *The Chip War* (June 1989), George Gilder's *Microcosm: The Quantum Revolution in Economics and Technology* (Simon & Schuster, New York) was still undergoing the peristaltic rhythms of what is grandly called "production." About the time my Warshofsky review appeared, a "proof copy" of Gilder's book turned up in the mail. (Reviewers, you should understand, seldom see actual books. They are sent error-ridden paperbound page proofs, which lack such essentials as the index whereby they might find something a second time. The page numbers, even, are written in by hand and not to be relied on.) The Gilder proof copy seemed especially error-prone, and I put it to one side. And now that I have a hardbound copy fit to appraise, I must write this four months before you'll see it, which will be eight months after you saw my Warshofsky piece, if you did.

All of which helps explain why one optimal scenario, a Warshofsky-Gilder confrontation, couldn't be arranged. So I'll summarize it en route to trying another scenario. *The Chip War*, briefly, deplored a series of fumbles whereby production of components like video RAMs became a Far Eastern monopoly. But *Microcosm* says, pooh, that needn't matter, if we can stop fussing about our Asian brethren and stop lobbying Washington and just resume confidence in our normal strength, which is design. For what Japan mass-produces is merely replacement parts, which design routinely obsolesces.

And that claim is a detail of a larger historical vision. What Gilder sees as the prime theme of at least the past century is the steady obsolescence of *matter* as a key to importance, to wealth. That rhymes with a lifelong theme of Buckminster Fuller's, who preached a long-term trend "from tracked to trackless, from wired to wireless, from

visible to invisible." It pleased Fuller that the year he was born—1895—was the very year W. C. Roentgen sent his famous rays clear through what had always seemed "solid"; the same year, too, that Marconi did without wires, Charles Duryea without tracks. (Duryea? He patented the first American gasoline-engine car.)

It's noteworthy how fast and how frequently Roentgen's work got replicated. Within months they were pumping out x-rays in places as remote from Wuerzburg as Colorado, shouting "Lo!" as the rays streamed through boxes and hands to limn shadowy coins and bones. That matter might be transparent, perhaps as a first step toward being nonexistent, must have seemed a theme to rejoice in. For how matter did load nineteenth-century shoulders!

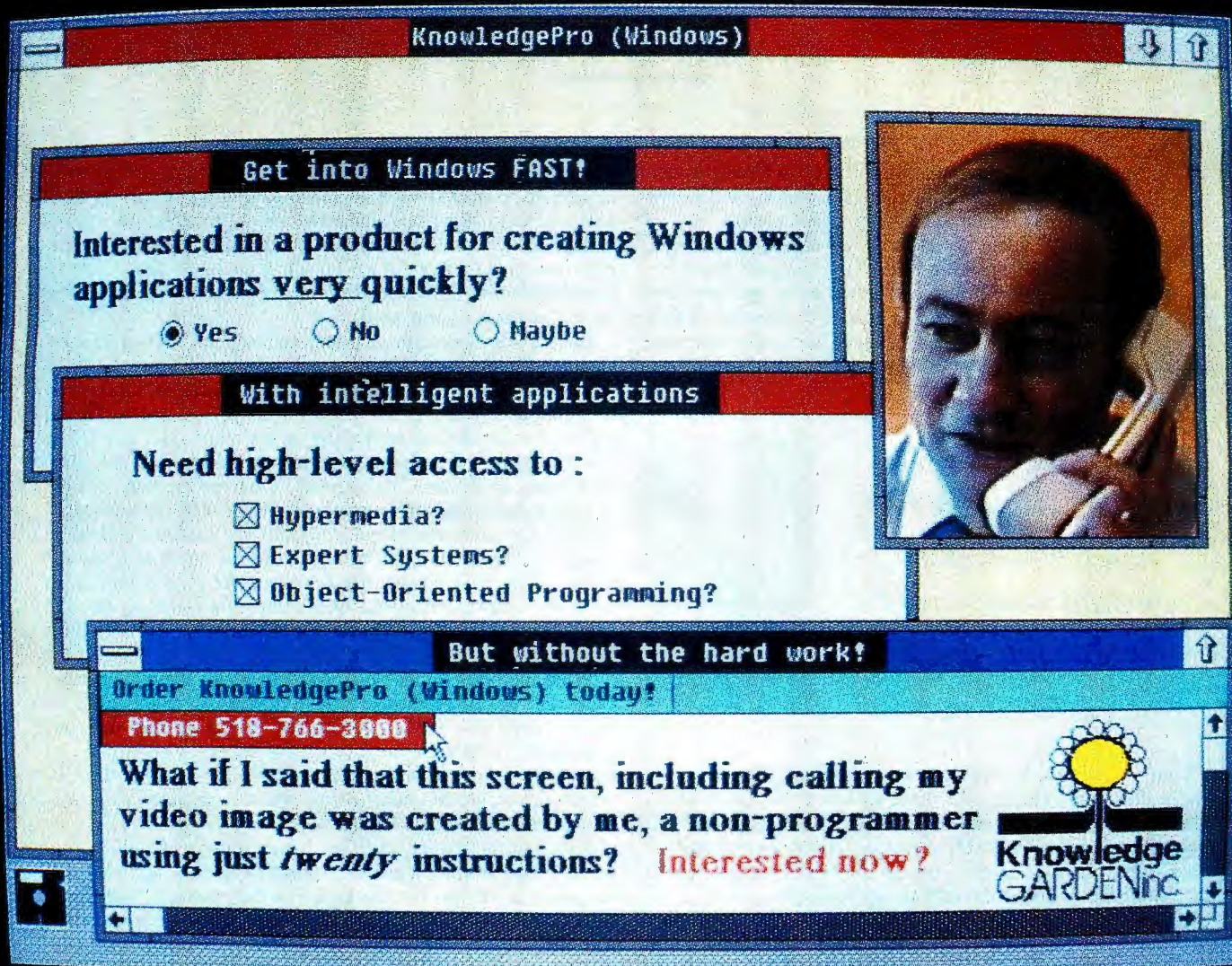
"Wealth"—that was once land and treasure, slaves and armies; later, wealth was ore and oil and regimented labor. But today, "The global network of telecommunications carries more valuable goods than all the world's supertankers," says Gilder. What it carries is literally weightless.

Still, for most people, Newton's world remains definitive. Solids bang against solids; reaction accompanies action. In the Freudian psyche, pressures build up like steam. In even the theologians' world, effect follows cause. So (says MIT mathematician Gian Carlo Rota), "Our logic is patterned exclusively on the structure of physical objects."

Thus, most people are out of date (and even think wealth is gold). For according to their logic, quantum theory makes no sense. Meanwhile, millions of appliances—TVs, radios, microwaves, computers—prove that transistors are doing something reliably. And since (to cut a long story short) our transistorized technology posits quantum theory, we'd best abandon such logic and plunge into the

continued





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microcosm, where whatever we can think of is forever invisible—don't even try to draw a picture of a quark—and events seem to work the way the mind does, by making leaps.

The focal figure of *Microcosm* is Carver Mead, 56 this year, who (among other feats) showed that "as you move down into the microcosm... everything gets better as it gets smaller, cooler as it gets faster, cheaper as it gets more valuable. As the traffic of electrons becomes denser, speedier, more complex, and more plentiful, the number of accidents drops, defects decline, and nothing ever wears out."

It was the replacement-part mentality that paved the way for Japan.



That's contrary to the Newton-based intuition that the smaller the more fragile, the more complex the less reliable. Mead foresaw a whole computer on a chip, salable at a few dollars, as long ago as 1968. He's waged lifelong war against all that seemed plausible in 1945 to John von Neumann: all that till very lately has dominated computer architecture.

Not that von Neumann was wrong in his time. Switches (vacuum tubes) were expensive, wire was cheap. So economize on the tubes, using miles of wire. That meant a CPU, which we wire to "memory" cells that are wired to one another, the whole then wired to input (cards, keyboard, ROM) and to output (printer, CRT). But today, says Mead, "It is wire that has become costly in every way, clogging the chip with complex metals hard to lay down, subject to deterioration from heat, and difficult and expensive to link to the world." Meanwhile, processor and memory "all can be made of the same sliver of silicon." And silicon (sand) is the cheapest stuff in the world.

That can all seem obvious in 1990. Unhappily, it became evident to the industry far less suddenly than it did to Mead. For a long time, the transistor was a substitute for the vacuum tube: a replacement part, with some interesting advantages. It ran cool, it used little power, it was small. Then the IC was a substitute for a board stuffed with transistors. Then RAM and DRAM chips were replacements for the ferrite-core memory components that had themselves replaced tube flip-flops. At every stage, the replacement-part metaphor prevailed: Do the von Neumann thing, which is the way to do it, only do it smaller and cooler (and, by golly, cheaper!).

It was the replacement-part mentality that paved the way for Japan. A computer being (1) a CPU plus some supporting stuff, which we wire to (2) some dozens or hundreds of interwired memory chips, and then equip with (3) a keyboard and (4) a *viewscreen*—well, whoever can best mass-produce these discrete standardized parts sits in the catbird seat. Warshofsky's book outlined the process whereby Far Eastern companies came to occupy that seat. Japan makes the CPU, memory, keyboard, and LED viewscreen for every laptop made today that I know of. In fact, Japan will even assemble the laptop, for Zenith or Tandy to rebrand.

But that all depends on the parts being standardized, which

in turn depends on the von Neumann architecture. Think back to ENIAC's 18,000 vacuum tubes (one-third of which were 6SN7 memory flip-flops) and ponder how the replacement-part metaphor locks in limitations half a century old—like the engine chugging up front of the horseless carriage, despite every complication of U-jointed drive shaft, because up front was where the horse once panted.

But the von Neumann architecture has been likened to some General Motors factory where one person does all the work while thousands more queue up to give instructions. Or think of dragging an evening gown through the eye of a needle: You'd reduce it to thread, for reweaving on the other side. One CPU, that's a needle's eye. So we come to parallel architecture; also, once more, to Gilder's main theme, the obsolescence not only of matter but of matter's analogies. For "CPU" says "logic," logic of the cause-and-effect kind that, as Rota has told us, is "patterned exclusively on the structure of physical objects." (That is why, says Gilder, the AI movement plays a game with mirrors, "scientists exalting the human brain as a computer and computers performing ever more dazzling logical feats for their masters.")

What the book nudges us toward is what "logic" some decades ago was discrediting: analog devices, deemed fuzzy by logic's either-or, which nonetheless function the way our senses do. We'll need them (e.g., for speech recognition and speech synthesis) if we're ever to force keyboard and viewscreen down into the microcosm, where what were once vacuum tubes have already vanished.

And, getting there, we'll need the "silicon compilers," to which Gilder devotes a whole fascinating section: software that designs microchips, not the logic but the physical chips themselves; and not "neater" chips than human designers can manage, just cheaper ones, faster ones. For by orthodox methods, whereby women cut lines in huge sheets of Mylar with Xacto knives, "a single 1990s design would take up much of the Bay Area and have most of its female population crawling across Mylar on knee pads."

That's not the way Chips & Technologies, an outfit you may have heard of, cloned the IBM AT. Using silicon compilation and concentrating on the support chips Intel's 80286 had obligated, they got the total chip count down from IBM's 130 to 47, the power consumption down by 60 percent. Fabricating the new chips? Sure, contract that out to Japan. Why not? And sell the output to Tandy, Dell, Olivetti, Siemens, NEC, Sony, Epson, Goldstar, Daewoo. . . . That list kept lengthening, while at IBM they struggled to comprehend what was going on.

Likewise at Weitek, two Chinese-American defectors from Hewlett-Packard achieved generic math coprocessors disentangled from Intel and Motorola CPUs. The market turned out to be twice as large as that for the "gotcha" devices: the ones that will work only with a specified microprocessor.

Not greatly publicized, silicon compilers are here. So are silicon analog units. Combine them, and, lo, design! And, lo, the end of the replacement-part philosophy. And (given no loss of nerve) the end of the Asian Peril. And special-purpose devices proliferating. And Gilder's utopia, our triumph over matter. For we didn't launch off from solidity. "In the beginning was . . . the idea." ■

Hugh Kenner is a professor of English at Johns Hopkins University. His reviews have appeared in publications like the New York Times and Harper's. His recent books include A Sinking Island and Mazes. He can be contacted on BIX as "hkenner."

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Inheritance and why it is essential. Multiple and repeated inheritance. Redefinition, polymorphism, dynamic binding, typing. Deferred classes and software reuse. Naming issues. High-level design techniques. The cluster model of software lifecycle. Practical issues: finding the classes, putting multiple inheritance to good use. Software reliability: producing correct, robust components. Assertions; preconditions, postconditions, invariants. Disciplined exception handling. Implementing the concepts in Eiffel.

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A detailed analysis of how to apply object-oriented design to a complete example, and a comparison with a classical, top-down functional solution.

PART 4: TOOLS

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ABOUT THE SPEAKER

Dr. Bertrand Meyer is President of Interactive Software Engineering Inc. (Santa Barbara). He was previously on the faculty at the University of California, Santa Barbara, and Division Head at Electricité de France. He holds an MS in Computer Science from Stanford and a doctorate from the University of Nancy. He has extensively published on many aspects of software engineering. One of his latest books, *Object-Oriented Software Construction* (Prentice-Hall, 1988), will be distributed to course participants.

He has been a member of numerous program committees and editorial boards and was program chairman of the 10th International Conference on Software Engineering.

Dr. Meyer has been a user and developer of object-oriented technology for more than 13 years. He was Chairman of the User Association for Simula, the first object-oriented language. More recently, he designed the object-oriented language Eiffel, combining object-oriented techniques with other advanced concepts of software engineering, and directed the implementation of the Eiffel CASE environment.

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Applications that are commonly performed by high-performance computers, such as graphics and networking, manipulate large volumes of data. If you have a fast processor, you need to have a fast bus that can handle the volume of data that goes along with these applications. However, many computer manufacturers are simply ignoring the key relationship between the bus and the CPU. They're churning out high-speed 80386, 80486, and even RISC machines that use the standard IBM AT bus. These aren't machines that end up on the secretary's desk for some high-speed word processing. These are machines intended to be used as file servers or graphics workstations.

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Sure, they're competitively priced, but, in the final analysis, you get what you pay for.

Consider the AT bus. It has a 16-bit-wide data path and a maximum bandwidth (data transfer rate) of about 6 megabytes per second. Now, suppose you want to perform some animation on your new 80486 "screamer" with its AT bus. Good-looking animation requires the display of about 30 frames per second. If you have a high-resolution monitor (e.g., 1 million pixels), that means you need to manipulate 30 megabytes per second. The AT bus is obviously not up to the task. Plus, if you want realistic color, you'll need a 32-bit-wide data bus to store all those pixel definitions. That means that you've got a blazing CPU without the bus architecture necessary to support it.

Nor is IBM's Micro Channel Architecture—which has a maximum bandwidth of about 20 megabytes per second—up to the task of animation. The Extended Industry Standard Architecture (EISA) maximum bandwidth is 33 megabytes per second. If you add the overhead for bus arbitration, interrupts, background tasks, and so forth, even the EISA bus would not cut the mustard in a high-resolution animation application.

The demand for high-performance graphics caused Hewlett-Packard to add a custom bus to its new EISA-bus Vectra 486. The special bus is dedicated to a "Super VGA" graphics controller and can handle as much as 40 megabytes per second. High-performance graphics is one of the reasons that Sun came up with its SBus, which can handle up to 80 megabytes per second.

The AT bus has equally serious limitations when used in network server systems. It simply doesn't have the data bandwidth necessary to ensure fast performance on a network. Here, the MCA and EISA buses perform much better. And new systems, like the NetFrame, that support additional I/O channels and

coprocessors are specifically designed to accommodate large networks and at the same time preserve compatibility with the IBM PC architecture.

The AT bus is also inadequate for multitasking operating systems like Unix and OS/2, particularly in 32-bit mode. When the 32-bit 80386 version of OS/2 comes out this year, machines with the AT bus will have a hard time keeping up. Unix users are already experiencing the frustrations of running Unix on an 80386 system with the AT bus. When you start performing multiple tasks, all of which are trying to access the bus, performance slows down to a crawl.

The gist of this argument is that the AT bus was not designed for 32-bit graphics, network I/O, or multitasking operating systems. It was designed for single-user, single-tasking PCs before the era of PC-based CAD and network applications. The 80386, 80486, and RISC processors like the SPARC or R3000 chips, on the other hand, are designed to take on the applications typically performed by minicomputers and mainframes. Just as it makes no sense to buy an 80386 if all you need to do is some word processing or a couple of mailing lists, it also makes no sense to build a machine with such a high-performance processor connected to the slow and limited AT bus.

Nevertheless, many clone vendors are doing exactly that. They're serving up cheap machines based on old technology, the only difference being that they have the latest CPU. These machines are deceptively fast when used in single-user mode and with simple graphics applications or standard PC business applications. And don't get me wrong—there's still a lot of life in the AT bus for those applications.

But you just might be in for a big disappointment. ■

Nick Baran is the West Coast Bureau Chief for BYTE. He can be reached on BIX as "nickbaran."

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