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BYTE

FEBRUARY 1991 A McGRAW-HILL PUBLICATION

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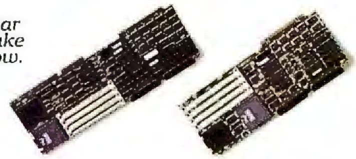

Just Upgrade the CPU!™

Strapping two traditional PCs together won't give you the dual processing power you need to keep pace with today's growing networks and multi-user environments, but the new ALR®POWERPRO will. It's the affordable, high-performance alternative to the COMPAQ® SYSTEMPRO™.

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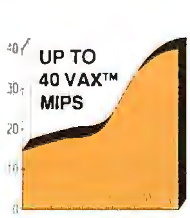

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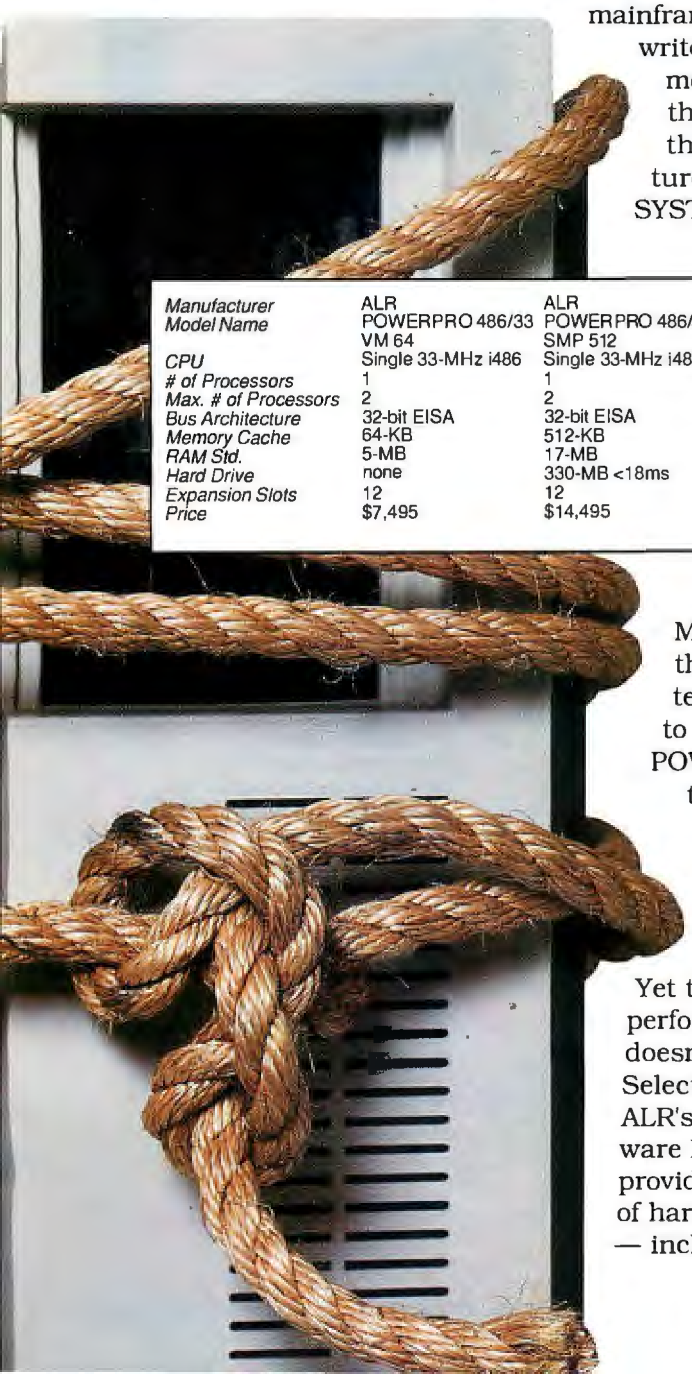

PROCACHE scalable cache memory architecture. This mainframe-like read-and-write-back design is more efficient than the standard write-through architecture found on the SYSTEMPRO.

Manufacturer	ALR	ALR	Compaq
Model Name	POWERPRO 486/33 VM 64	POWERPRO 486/33 SMP 512	SYSTEMPRO 486/33
CPU	Single 33-MHz i486	Single 33-MHz i486	Single 33-MHz i486
# of Processors	1	1	1
Max. # of Processors	2	2	2
Bus Architecture	32-bit EISA	32-bit EISA	32-bit EISA
Memory Cache	64-KB	512-KB	512-KB
RAM Std.	5-MB	17-MB	8-MB
Hard Drive	none	330-MB <18ms	240-MB <19ms
Expansion Slots	12	12	11
Price	$7,495	$14,495	$20,995

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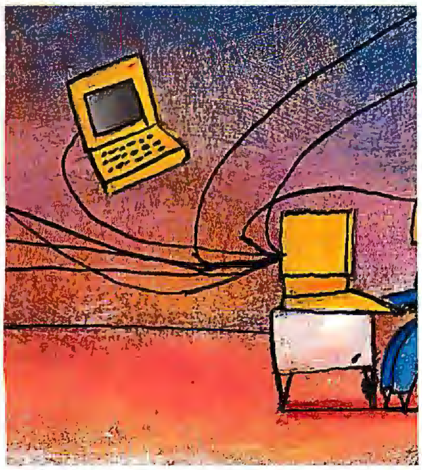

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WE PICK YOUR BRAIN TO MAKE OUR PICKS

Monthly surveys help the BYTE Lab fine-tune the Product Focus to suit your needs

The next piece of mail you get from BYTE might be a questionnaire seeking your thoughts on a product category. Starting this month, the BYTE Lab is surveying a random sampling of BYTE subscribers in an effort to better hone our Product Focus section to suit your needs.

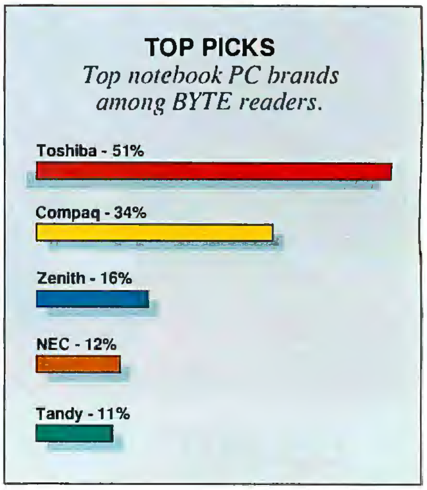
BYTE has always consulted its readers and other industry experts in preparation for product comparisons. The BIX (BYTE Information Exchange) conferencing system, in particular, has been invaluable to us in this regard. The survey allows us to get a timely, statistically accurate snapshot of both your interest and requirements for a given product type.

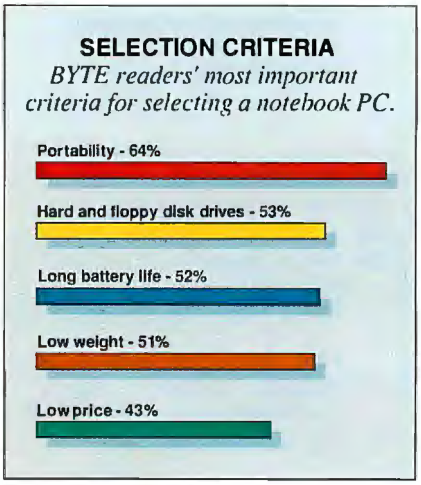
The survey for this month's Product Focus on notebook PCs, for instance, told us which brands of notebook PCs you use (see above right), which features are important to you (see below), and what applications you intend to use (see below right). The results were mostly in sync with our expectations, but there were surprises. For example, over half of you want *both* a hard disk drive and a floppy disk drive, rating this feature higher than either performance or price.

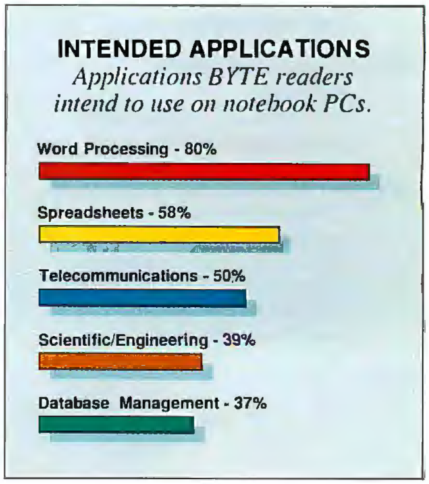
Your answers and comments helped shape our test procedures. Our new application benchmark suite for notebook and laptop PCs, premiering in this issue, owes much to your responses. When it came time to make recommendations to you about which notebook PC to buy, we knew what you were looking for.

These days, you need much more than benchmark scores to make intelligent purchasing decisions. You also need the perspective that comes from knowing both the market and its customers—the perspective that the BYTE Lab is committed to provide to you. ■

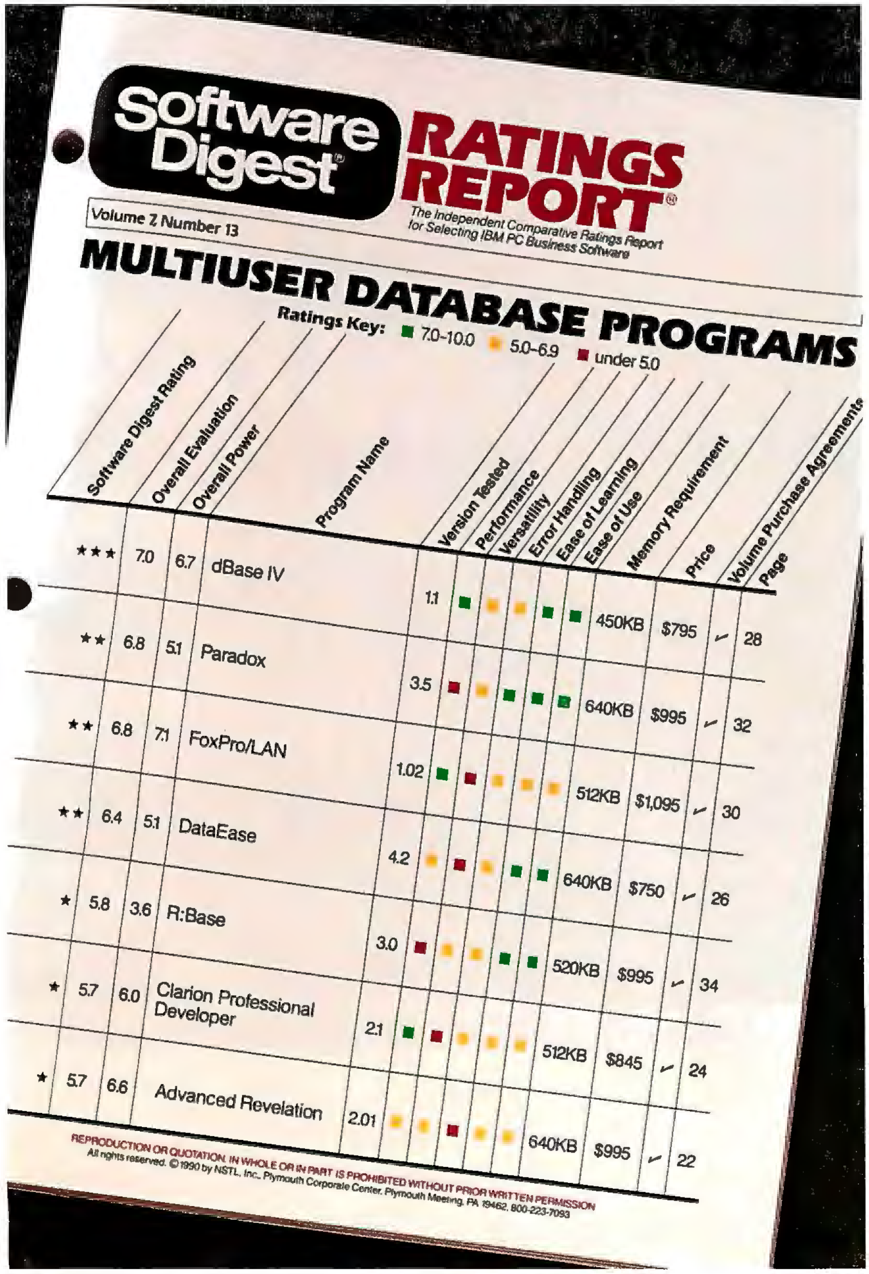
—Michael Nadeau







d Truth Comes Out.



Software Digest® RATINGS REPORT®

Volume 7 Number 13

The Independent Comparative Ratings Report for Selecting IBM PC Business Software

MULTIUSER DATABASE PROGRAMS

Ratings Key: ■ 7.0–10.0 ■ 5.0–6.9 ■ under 5.0

Software Digest Rating	Overall Evaluation	Overall Power	Program Name	Version Tested	Performance	Versatility	Error Handling	Ease of Learning	Ease of Use	Memory Requirement	Price	Volume Purchase Agreements	Page
★★★	7.0	6.7	dBase IV	1.1	■	■	■	■	■	450KB	$795	✓	28
★★	6.8	5.1	Paradox	3.5	■	■	■	■	■	640KB	$995	✓	32
★★	6.8	7.1	FoxPro/LAN	1.02	■	■	■	■	■	512KB	$1,095	✓	30
★★	6.4	5.1	DataEase	4.2	■	■	■	■	■	640KB	$750	✓	26
★	5.8	3.6	R:Base	3.0	■	■	■	■	■	520KB	$995	✓	34
★	5.7	6.0	Clarion Professional Developer	2.1	■	■	■	■	■	512KB	$845	✓	24
★	5.7	6.6	Advanced Revelation	2.01	■	■	■	■	■	640KB	$995	✓	22

The new dBASE IV® version 1.1 has been rated the #1 Multiuser Database by Software Digest Ratings Report (Volume 7 Number 3, October, 1990).

Because Software Digest accepts no advertising whatsoever, subscribers pay hundreds of dollars a year to receive their reviews—which are considered highly unbiased and objective.

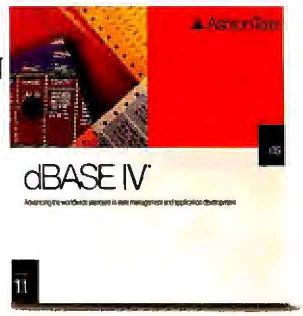
In summation, their 75-page report says: "Among the top ranking programs, dBASE IV (version 1.1) is the most well rounded, with solid performance, versatility, and usability." Commenting on speed, Software Digest points out that "dBASE IV produces all three test reports as fast as or faster than FoxPro/LAN." As for Ease of Use/Ease of Learning, dBASE IV scored as many times in the Excellent range as any other database product tested.

Of course, Software Digest is definitely not alone in its conclusions.

Because consumers have already made dBASE IV version 1.1 the #1 best-selling PC database in the world.

Call 1-800-437-4329 ext. 1407 for more information. Better yet, call 1-800-2ASHTON now to upgrade.

The truth is, no other database can do so much to improve productivity.



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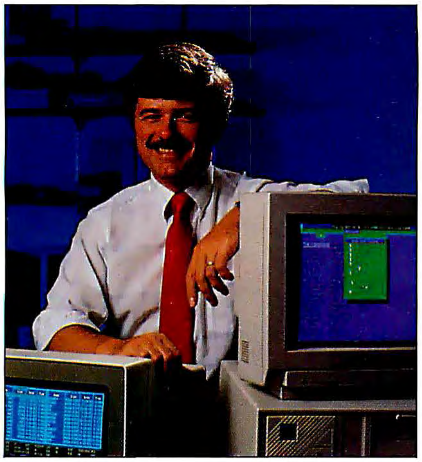

EDITORIAL ■ Fred Langa

FACING HARD TIMES?

Don't overlook some powerful tools to help you stretch your computing dollars

As I write this, the Bush administration keeps dancing around the "R" word—recession. It's not official yet because the politicians prefer silly euphemisms like "a meaningful downturn in the economy."

On top of the economic doubts, there's the whole mess in the Middle East. Perhaps the situation there will have resolved itself by the time you read these words, but it doesn't seem likely.

No one can predict what the overall effects will be, but at least in BYTE's topic areas, the reaction to these uncertainties is clear, consistent, and conservative: Through our reader mail, focus groups, and other means, you're telling us that this year you'll have to be more careful than ever in spending your (or your company's) computing dollars.

Word of mouth is one of the best ways to supplement product reviews. But there are obvious limitations to word of mouth.

The on-line variant—would you call it word of modem?—gets around the limitations. With one question, you can tap into the collective wisdom of people from around the world. The odds are good that you can find someone who has personal experience in solving almost exactly the same problem you're trying to solve, or who has very recently dealt with the company you're considering doing business with. It's an unmatchable resource when you're making every dollar count.

Almost any of the large on-line systems can serve, although some of the largest systems can cost a fortune to access and suffer from content dilution—large numbers of subscribers who cannot meaningfully answer your questions. Paying premium rates to get uninformed answers is hardly the way to stretch your computing dollars.

But if you pick your system carefully, there's a wealth of information to be had at low cost. Naturally, I'm BIX-biased, and you should decide which on-line system to use for yourself.

But, just by way of example, here's a small part of a thread of messages taken from the "compatibility" topic of the ibm.pc conference on BIX. See how one BIXen—concerned about spending money with a mail-order vendor—got a flood of excellent, firsthand advice:

ibm.pc/compatibility #227, from rmstutz, Title: CompuAdd clones
Who has had experience with CompuAdd clones? General opinions? Any likes or dislikes? Quality? Support? I'm in the market for a clone, and they are close by. Any good-quality mail-order clone manufacturers to recommend? Thanks all, Rich

ibm.pc/compatibility #228, from barryn
CompuAdd sells pretty good computers, I understand. I've bought a number of peripherals from them over the years (monitors, modems) and have been happy with the equipment. However, the computer I use most right now is from Gateway 2000.

ibm.pc/compatibility #229, from bkep
We buy all our computers from CompuAdd. I don't particularly like the monitors (GoldStar), the keyboards are pretty good, we haven't had any hardware problems that weren't our fault, and the technical support is first-rate. They even have on-site service. They were at our place the next day when we asked for help with a disk problem.

ibm.pc/compatibility #230, from jndunlap
I've read good things about CompuAdd's machines and support. I've had good luck with my Gateway 386—seems it was one of the last with a motherboard they discontinued, so they did a lot of phone diagnosis, real knowledgeable people, patient. I'd also look closely at Austin Computer Systems—I read a review of one of their machines that fairly glowed about its craftsmanship and fit.—arky

ibm.pc/compatibility #231, from bstrauss
CompuAdd's advantage is that they also run retail stores, so you can see the box. Most of the big mail-order names are also good, provided you use your head. This means: Ask questions about exactly what you are getting. Put it in writing when you place the order (fax it to them if you are in a hurry). Use a credit card—it gives you some protection.

ibm.pc/compatibility #234, from vic.sobranie
I can vouch for the quality of the Austin computers. I have a 286/16 that I bought from them going on two years ago. It's a great machine. I used to know several of the people there, since our offices were all but next door to each other in Austin, and they're all very nice. Hopefully, their technical staff has improved since I dealt with them last, but the machines are so good you should never need to talk to them. . . . Vic

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—Fred Langa
Editor in Chief
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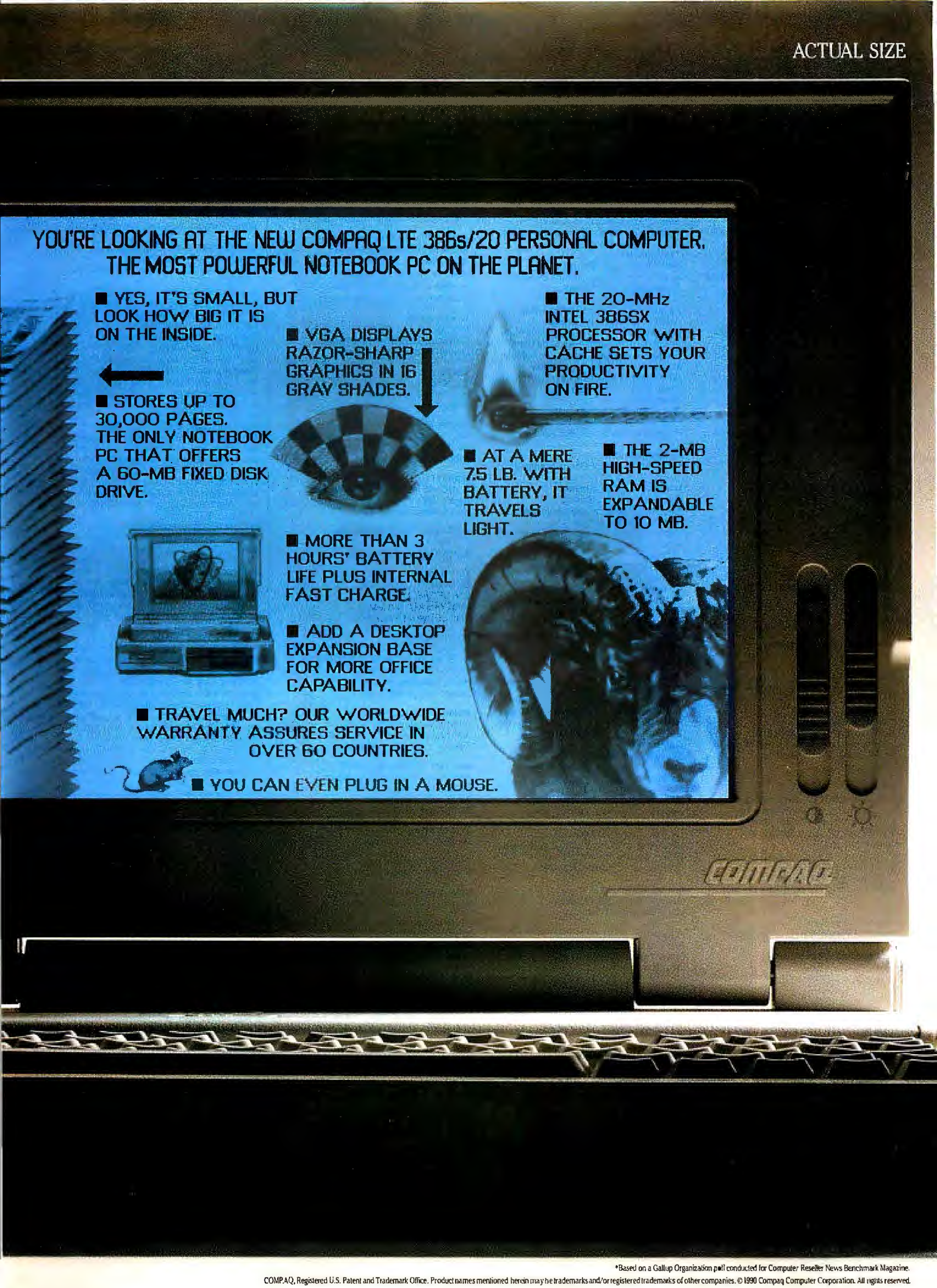
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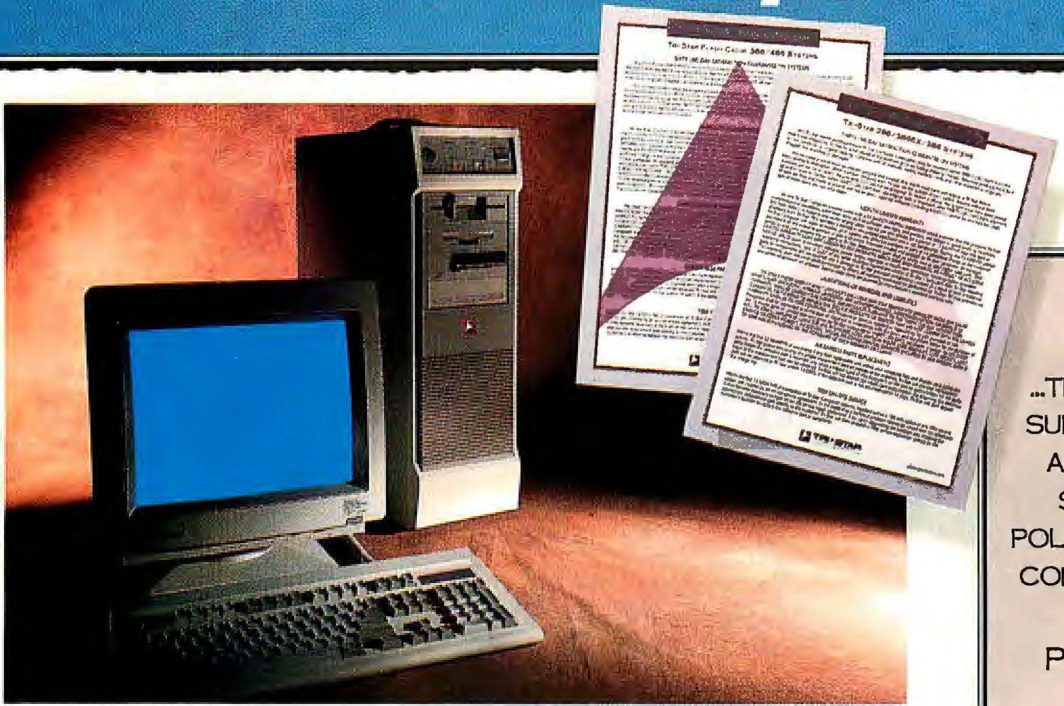

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PC MAGAZINE
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MICROBYTES

Research news and industry developments shaping the world of desktop computing
Edited by D. Barker

Users Will Have More Room for Applications Under New DOS; 5.0 Due Soon

The next version of MS-DOS will soon be in the hands of users, say sources involved in the beta-testing program. According to people who've gotten a look at preliminary versions of the new operating system, Microsoft has developed a DOS that's stouter in terms of capabilities but is leaner in size.

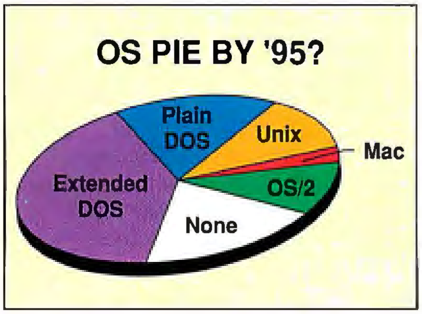
Some of the biggest changes to DOS will involve memory management, changes perhaps inspired by the innovative memory manager in Digital Research's DR DOS 5.0. MS-DOS 5.0 will come with a new utility that loads most of the operating system into the high-memory area of extended memory, yielding more room for running application programs. Current versions run in the low-memory zone, taking up RAM that could otherwise go to applications. But most of DOS 5.0 (which is about 60K bytes, beta testers say) can reside above that, in the first 64K-byte block above 1 MB. As a result, users of DOS 5.0 will have about 45K bytes of RAM that they don't have now. This improved efficiency will be possible with 286, 386, and 486 systems equipped with extended memory; due to processor design, it won't work with older PCs.

On 386 and 486 machines, DOS 5.0 can save even more memory by loading TSR programs, device drivers, and other programs into the upper-memory block (between 640K bytes and 1 MB), sources say. This is similar to what Quarterdeck's LOADHI utility does in QRAM and QEMM products.

Like DOS 4.0, the new edition has a graphical shell for file and directory operations, but it looks more like Windows 3.0 than DOS 4.0, said sources who've seen preliminary versions. Files and directories are presented as icons in a tree structure. As with a real graphical interface, you can navigate this shell, issue commands, and launch applications by pointing and clicking, sources say. The shell includes one of the most significant enhancements to MS-DOS: a task switcher for bouncing between programs without having to shut one down and start another up. Microsoft has confirmed that DOS 5.0 will support the Virtual Control Program Interface.

The new operating system will come with a sophisticated help system, which calls to the screen a brief summary of any DOS command (done by typing /? after a command) or explanation of certain features, such as task switching. DOS 5.0 will also come with several

BYTE's Comdex poll continues to reflect an expectation that Extended DOS — DOS enhanced with Windows or Desqview, for example — will be the dominant desktop operating system by 1995. Results at fall Comdex were essentially the same as in previous polls, except that Extended DOS picked up about 10 points, a significant shift in opinion. A record 41 percent said they believe Extended DOS will dominate the desktop by 1995. That increase in votes might have come from OS/2, which continues to slide in the poll. In 1988, more than one-third of those surveyed said OS/2 would be the dominant operating system by 1995; now,



about 12 percent say that. Eighteen percent said plain DOS will continue its current reign. Unix fell to its lowest vote since the poll's debut in 1988, coming in at 17 percent. The Mac OS continued to hold at about 3 percent, while 10 percent envision a democratic world in which no one system dominates.

NANOBYTES

At a Comdex breakfast for 1500 of its closest friends and dealers, **IBM** offered a glimpse of a 3½-inch magneto-optical floppy disk capable of holding about 120 MB. Or, as Personal Systems Division vice president James Cannavino calculated it, up to 85 disks' worth of data, 12,000 graphics displays, or a 5-minute multimedia presentation. Company officials pointed out that this was not a product announcement but one of those "technology demonstrations"— which IBM watchers know generally precede a product announcement by six months to a year.

Buying one of the new **Mac Classics** has been like trying to buy a Mazda Miata when they first arrived: good luck finding a dealer who has one. According to dealers and other sources speaking to Microbytes Daily, there were about 100,000 of the machines on back order as the end of 1990 approached. Corporate customers as well as individuals are buying the new "Cheap Mac." Stores in the New York City area — where the basic Classic ($999 list) is selling for as low as $699 — said that they couldn't fill the orders. Most dealers would not even hazard a guess as to when a machine that was paid for today would be delivered, but one store representative said that it could be between three and five weeks. Apple officials wouldn't comment on shipment numbers, but one spokesperson did confirm that sales have been higher than expected. The Classics "went out of warehouses like they had wheels on them," he said.

Advanced Logic Research (Irvine, CA) plans to come out with a competitor to Compaq Computer's 7½-pound LTE 386s/20 computer soon. It'll be comparable to Compaq's 20-MHz SX system but will cost less, said ALR vice president Dave Kirkey. The little Compaq lists for around $6000.

NANOBYTES

DVI coming to the Mac: **New Video Corp.** (Venice, CA) plans to bring Digital Video Interactive technology to the Macintosh, using Intel's upcoming i750 "multimedia" chips. New Video's DVI products will let users capture video and create productions on the Mac and also play them back on the PC under DOS and Windows, New Video officials say. The company is currently prototyping delivery boards for software developers and plans commercial products for this quarter. Among these products will be a NuBus board for the Mac II (probably around $2500) that will come with 2 MB of video RAM, built-in special effects, and other features yet to be determined; the board will offer real-time, full-motion video and audio capture and playback, New Video says. In a recent demonstration for BYTE, the DVI board was in fact two separate boards; company officials admit that they've got a lot of engineering work left to do when it comes to whittling the components down to fit on a single board.

Motorola's 68040 microprocessor, which will be the brain of several new computers expected this year, is **finally available** in a production version. Plagued by technical difficulties, particularly with the multiprocessor functions of the chip, the million-transistor 68040 has been delayed almost a year. (Motorola had initially expected to ship the 68040, which was announced right before Intel's i486, last January.) While the 68040's arrival is good news for Next and other vendors, such as Hewlett-Packard, who plan to release 68040-based machines, supplies will be limited for the first half of the year. According to a Motorola representative, the company will initially deliver the 68040 in "lots of several hundred per week" but has a backlog of "250,000 to 500,000" orders, which won't be filled until summer.

Matsushita Electric (of Japan) plans to build Unix systems around Sun's **SPARC** architecture. These RISC systems, expected in desktop and laptop models, will conform to SPARC Compliance Definition 1.0 and run Sun's version of Unix and the Open Look graphical interface.

utilities for restoring files accidentally deleted and for rebuilding disks. According to sources, Microsoft has licensed Central Point Software's Mirror program and incorporated it in DOS 5.0; Mirror captures an image of the file allocation table, which you can then use to restore a disk that's been damaged or mistakenly formatted.

Microsoft has replaced DOS's GWBASIC with an interpreter and debugger extracted from the company's QuickBASIC. However, GWBASIC programs will work with the new interpreter, one source said.

The minimalist EDLIN program has bowed out to a full-screen ASCII editor that is complete with pull-down menus, a change applauded by several beta testers. Some sources pointed out one addition that won't be appreciated until hardware designers implement the necessary device: support for 2.8-MB floppy disks. And as Digital Research does with DR DOS, Microsoft plans to offer OEMs a ROM version of DOS 5.0, according to a source inside the company.

When the new DOS will be ready was still up in the air at press time. A Microsoft staff member said that the company was putting DOS 5.0 through a rigorous testing program and would release it when "it's stable." March or April are likely, according to some reports. As for the cost, some sources said that the retail price could be as low as $99; one analyst said that it probably won't be more than $199, the price of DR DOS 5.0.

— *D. Barker*

New Blues Will Mean Better Color Displays

While color LCDs continue to appear in more and more portable PCs, full-color electroluminescent displays remain confined to the laboratory. The reason? The lack of a good blue phosphor to match the b ightness of the green and red phosphors, according to Jonathan Gilbert, marketing manager at Planar Systems (Beaverton, OR), the largest U.S. maker of EL displays.

But Planar, a leading researcher in color EL technology, has high hopes for a new blue phosphor that the company has been working with for the past year. "We've succeeded in increasing its brightness by a factor of about 15 in the last nine months," Gilbert says. "And we only have a factor of about 2 to go. Once we get to that stage, it'll be bright enough to match the existing green and red phosphors. Then we can begin putting together a full-color display."

EL displays account for less than 2 percent of the flat-panel displays sold today, according to Stanford Resources figures quoted by Planar Systems. Although EL displays offer better contrast and a broader viewing angle than LCD or plasma screens, their high-power consumption and lack of color have limited their use in portable PCs.

— *Jeffrey Bertolucci*

Object Links Coming to Windows Applications

As pa t of its plan to provide dynamic connections between different kinds of applications, Microsoft has released to developers a beta version of its Object Linking and Embedding technology for Windows. Applications that implement these links will be able to swap and update information easily, through a collective effort that will yield sort of a universal Clipboard on steroids. OLE objects are "opaque," Microsoft says, meaning the target application doesn't have to understand the format of the data in the object. OLE will initially show up in Windows programs, but it's designed to work across platforms. Microsoft says the developer tools for OS/2 and Macintosh will be ready soon.

Linking allows many applications to reference a single block of data, and it puts the mechanism in place to update all the referents when the original data changes. The downside: the fragility of the link. Embedding allows one application to store data from another application within a single document; the embedded data automatically moves if the document moves. The downside: Each copy of the data is private, and there is no mechanism for updating it automatically if the source data changes.

According to Microsoft's Viktor Grabner, the first OLE applications should ship in the first quarter of this year. "The current OLE libraries are stable enough for developing code, but we wouldn't want applications shipped with the current code—there will undoubtedly be bugs we'll want to fix in the libraries. However, the application

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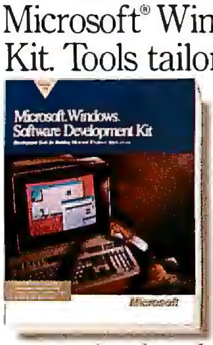

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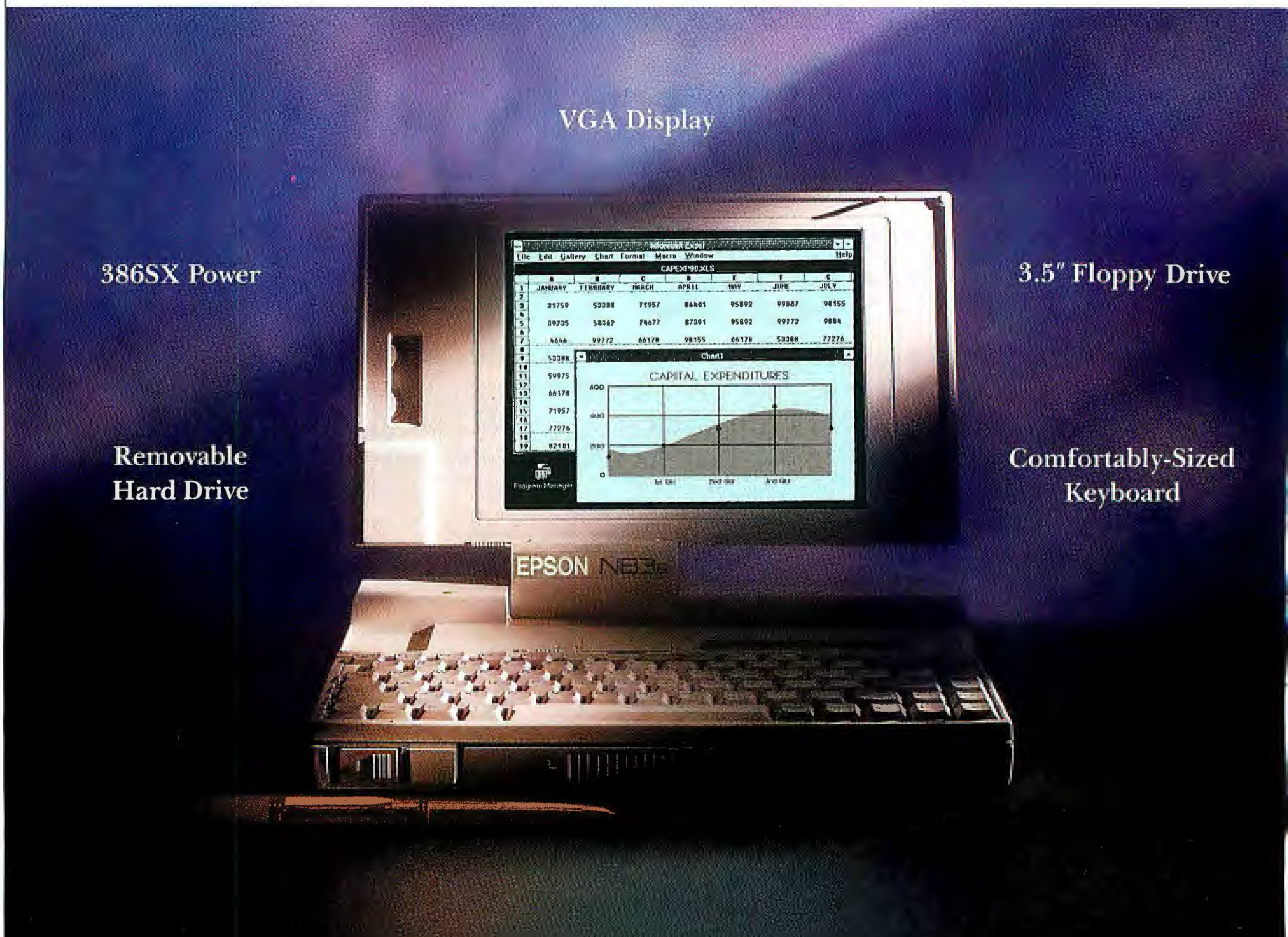

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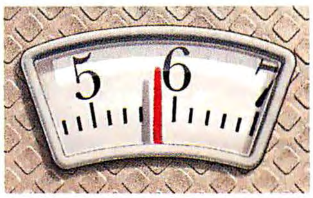

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NANOBYTES

Europe has become a **major market for American software,** according to a new report from the **Software Publisher's Association.** The trade group said that European sales of American software grew by nearly two-thirds in the third quarter of 1990 to $228 million. Combined software sales for DOS and Windows were up over half, the SPA reported, with Macintosh program sales in Europe up by a staggering 83 percent. The SPA report is based on figures provided by 32 software houses, including Lotus, WordPerfect, Microsoft, and Ashton-Tate. An SPA research assistant said the international market now accounts for nearly a third of total sales of the companies in the survey.

Apple Computer is now willing to license its **Apple Terminal Services** protocols to developers and corporate MIS departments. ATS protocols pass between a mainframe computer and a personal computer. Programs can thus retrieve information from a mainframe or minicomputer and display it on a graphical terminal—a Mac, an IBM PC running Windows, or a Unix workstation running X Window System. Before, ATS protocols could be used only to display the retrieved data on a Mac. Apple says that ATS differs from terminal screen protocols because it lets a mainframe programmer control the microcomputer's user interface and desktop.

If the **U.S. government** doesn't do something soon, its **computer records** will be inaccessible and unusable, a Congressional committee has warned. A new study by the House Committee on Government Operations warns of increased difficulty in preserving and accessing old computer records housed in the various federal archiving systems. Problems will be caused by changes in hardware and software, lack of documentation, nonstandard data-file formats, and deterioration of storage media, the report said. The committee advocates an overhaul of the way the government stores data files and information, recommending that standard record-keeping rules and procedures be built into federal electronic information systems.

programming interfaces have been frozen, so developers will not have to change their own code when the final libraries are released." Grabner estimates that a developer will need 8 to 10 weeks to add embedding and linking to an application.

OLE, which builds on Microsoft's Extensible Compound Document Architecture specification, provides developers with libraries and examples to help them implement Bill Gates's vision of "document-centric," as opposed to "application-centric," computing. The idea is to make it easy for users to construct seamless documents containing data and other elements (e.g., graphics and charts) from multiple and disparate sources.

Beta libraries for OS/2 and the Macintosh should be available early this year, he said. "The push is coming from the applications side: Microsoft is committed to adding OLE capabilities to all its Windows applications, and if you look at those programs, they're all supported on multiple platforms. We want the same capabilities to be available no matter what platform the program is running on."

Some of what Microsoft hopes to accomplish with OLE is similar to what Hewlett-Packard is doing with NewWave. "Microsoft is moving in the same direction we are, telling developers they should write applications that work with each other," said HP's Bill Crow, chief architect of NewWave.

OLE, however, "is a less ambitious approach than NewWave," he said. "By working within the limitations of the existing file system, it sacrifices some capabilities. In OLE, as in today's hot links, linking depends on one application remembering the location of a file. That link can be broken easily if the file moves: There is no mechanism for tracking the file location and updating the name. NewWave, by contrast, has an intelligent object manager that takes care of mapping objects to files."

Crow and Grabner agree that NewWave and OLE can coexist. "OLE and NewWave are philosophically similar," Crow said. "Once a developer has structured his application to support OLE, it shouldn't be that difficult to modify it to support NewWave. We'd like to see applications work in both environments, and we're thinking about ways to make that easy, or even automatic." According to Grabner, "There should be some way for NewWave to provide a wrapper to interface with OLE to make everything work together transparently."

— Martin Heller

Hitachi Neural Prototype Thinks, Learns Quickly

Hitachi Ltd. has developed a prototype neurocomputer that demonstrates the promise of this emerging technology. The device is built on a single semiconductor wafer and contains more than 1100 neural circuits. It can perform 2.3 billion learning operations per second, more than 10 times the speed of a Hitachi supercomputer running a neural-network simulation, company officials said during a recent demonstration of the machine.

Neurocomputers mimic the learning ability of the human brain, thus making them better suited than traditional computer architectures to tasks such as recognition, pattern matching, and optimization, proponents say.

Hitachi doesn't currently plan to distribute its general-purpose neurocomputer as a product, but the technology in it will surface in commercial systems. "It will be commercialized in about two years, first in Japan," a company official said. Because of the computation speeds and learning capabilities, this technology will probably find its first applications in financial and security systems.

The Hitachi neurocomputer is based on large-scale integration neural components originally made public in 1989. The components, built in 0.8-micron CMOS technology, each contain 576 interconnected neural circuits. Eight of these chips are connected on a single semiconductor, using wafer-scale integration, to form the neurocomputer.

The device shown was housed in a beige box (12 by 9 by 8⅓ inches) attached to a Hitachi Unix workstation. The workstation served as a windowing front end, while the neurocomputer ran sample software applications. One demonstration involved handwriting verification: The system "learned" the pattern of a signature based on the pressure and direction the user applied to the stylus and was later able to recognize the signature with near 90 percent certainty. In another example, the system made stock price predictions.

Hitachi says that it is "generally accepted" that a neurocomputer will need at least 1000 interconnections to be practical. The system that the

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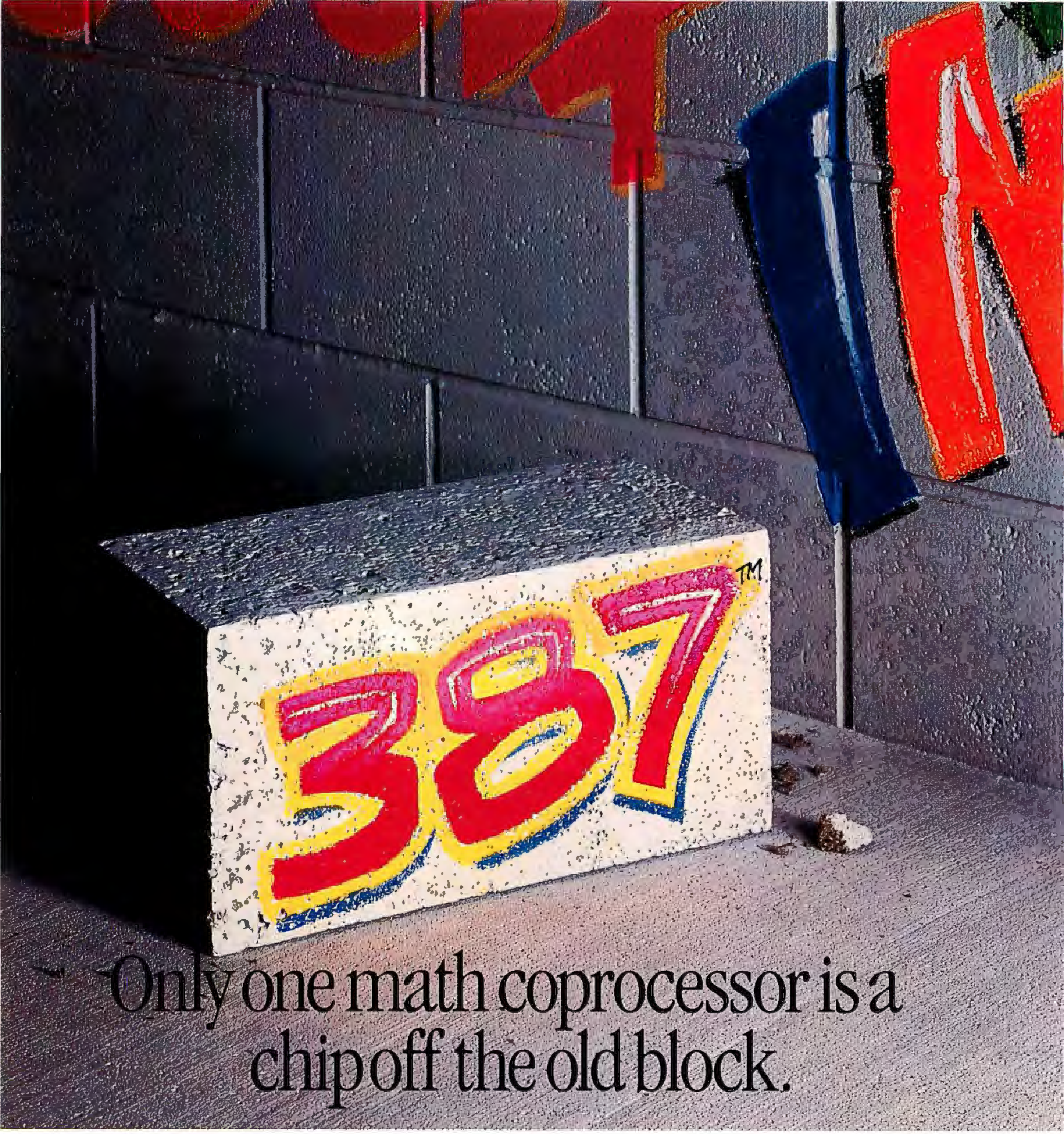

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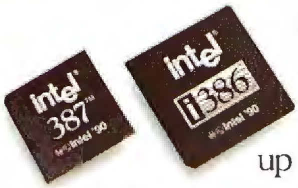

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company showed had 1152 connections, and more will likely be possible as the technology matures. Engineers were able to construct a network this large because they crammed the neural components onto a single wafer and used a bus-type interconnection scheme, which Hitachi calls time-sharing, to link the neurons. Multiplexing neural circuits by way of an address bus permits a high level of logical complexity while greatly reducing the number of physical circuits needed to connect the neurons.

While dismissed by some critics as far-out technology, major chip makers like Intel are now involved in neural processors.

—Andy Reinhardt

What Will Apple Do with New RISC Chip?

Apple Computer is investing about $3 million in a joint $10 million effort with VLSI Technology and Acorn Computer to develop a new RISC processor. The chip will be designed by a new Acorn spin-off called ARM Ltd. (Cambridge, England). It's not clear yet what Apple will do with ARM's RISC processor, but some observers speculate the chip could be the basis of a future Apple computer—most likely a notebook or hand-held. An Apple U.K. official would say only that it's part of the company's program of "strategic external investments in strongly differentiated technologies."

Apple is working on a RISC-based system, but the assumption around the industry has been that the machine would use Motorola's 88000 chip. It's possible that Apple will use ARM's low-power processor in either a workstation or, more likely, a portable system. Apple vice president Larry Tesler said that the company doesn't intend to replace any of the processors in existing products with the ARM chip.

"It's a strong technology for the coming years, and we think it will make a lot of money for us," Tesler said. "This is primarily an investment announcement at this point. We won't be replacing any Mac components with ARM technology."

Barbara Kalkis of VLSI, which will fabricate the chips, said that her company was attracted by certain aspects of ARM's processor design. "It's a very small-die chip that indicates a product trend for the nineties," she said. "We're looking toward battery operation and hand-held operation as being some of the factors that we like about ARM." The chip could show up in graphics boards (Radius has plans for one, she said), modems, and LAN adapters, as well as in digital signal processors, scanners, laser printers, and tape drives, according to Kalkis.

"The key thing for us is that the RISC die that we have can be used as an application specific integrated circuit or as a standard product," Kalkis said. "It will be perfect for a notebook computer or laptop where the size of the chip becomes important, as well as battery operation." Indeed, Active Book Co. of the U.K. has already announced that it will develop a notebook computer based on the ARM RISC chip.

Apple CEO John Sculley has often noted that Apple is interested in "miniaturization and mobility."

—Larry Loeb

System Uses Fractals to Compress Images

Research into fractals, mathematical descriptions of pictures, has yielded a new compression system that drastically reduces the amount of space that image files consume. Iterated Systems (Norcross, GA), founded by two Georgia Institute of Technology professors, has developed a hardware/software combo for compressing and playing full-motion images on a standard AT computer with a VGA screen. What's most unique about Iterated's system is that its compression scheme is based on fractal transforms. This process, put very simply, turns an image into a mathematical formula. These fractal formulas are much smaller, and thus occupy less space, than the images they represent. A straight line on a VGA screen, for example, requires about 38K bytes of data, said Iterated copresident Alan Sloan; but fractal code to depict that line requires only 4 bytes, he said. Iterated's approach focuses not on compression ratio but file size.

Sloan and partner Michael Barnsley have been working on fractal-based compression for several years (they wrote about it in the January 1988

NANOBYTES

Next is now focusing on the considerable networking and communications capabilities of its computers, judging by new things on the horizon and recent comments made by company chairman Steve Jobs. By next summer, **Next computers will support Novell NetWare clients** and **links to AppleTalk** via EtherTalk. The NetWare client support will let Next users access Novell files easily, and the AppleTalk connection will eliminate having to use a $4000 Cayman Gatorbox to hook Next machines to Macs, Jobs said. At a meeting of the Boston Computer Society, Jobs demonstrated a sample Next E-mail document that could contain elements such as sound, graphics, text, and data in one message just by cutting and pasting. By summer, the company hopes to add the capability of storing live, full-motion video in that E-mail message.

The **Association of PC Users Groups** will expand its Globalnet telecommunications network for users group officers this year. The organization plans to operate new BBSes in Australia, England, France, and Japan. The BBS in France will operate in English, French, German, and Spanish. The language the user operates in will be determined by the telephone number called. The individual user must provide translation services. Messages on the four overseas BBSes and the main APCUG BBS (in Scotts Valley, CA) will be exchanged every four days. Paul Curtis, system operator of Globalnet, said that the system serves the 155 member users groups of APCUG and other interested persons who call into the system.

The first company to market a word processor for OS/2 now plans to develop one for Windows 3.0. **DeScribe** (Sacramento, CA) hopes to ship its new program sometime during the second quarter, said marketing vice president Clif Whalen. "We'll port the entire technology set of our OS/2 program to Windows," Whalen said, but "we're still arguing about what part of the market we're going to enter." The company hopes to develop a Unix word processor "sometime down the road," he said.

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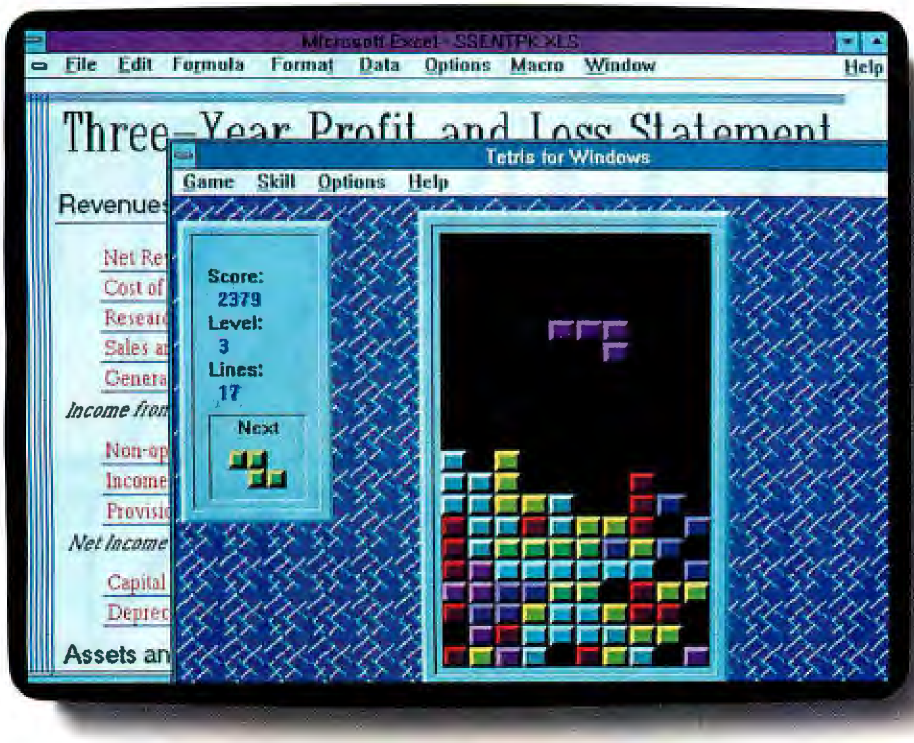

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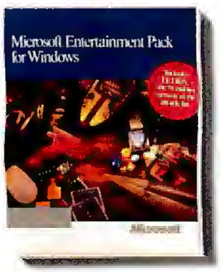

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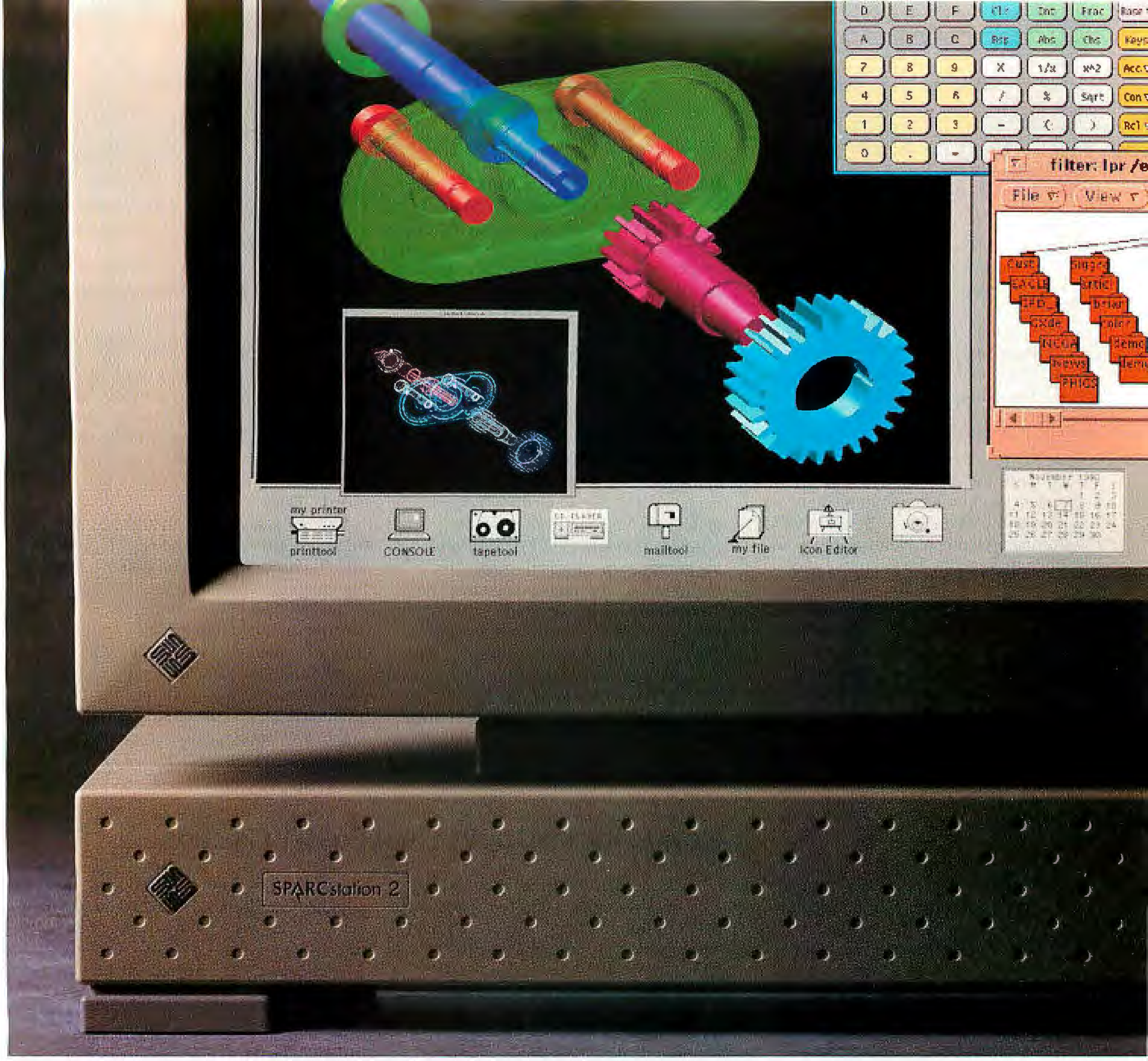

you create 3-D solid images in 24-bit true color. It's the kind of machine you hate to share. And from now on, you won't have to.

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BYTE). But now they're ready to commercialize their research. The company has developed a compressor board and decompressor software based on fractal-transform technology. The board uses eight fractal-transform ASICs and an Intel i960 RISC processor. Decoding and playback, however, can be done on any 286-based system running Iterated's decompression software module.

The compression hardware can squeeze 1.5 minutes of moving images on a regular 1.4-MB floppy disk, the company says. The compressed material is just a DOS file. On a 40-MB hard disk drive, you can store up to 40 minutes of video. On a compact disc, the compressor can fit 10 hours of motion video, or almost the entire *Rocky* epic. Using Iterated's system, you can store a video presentation on a floppy disk and send it to someone else, who can play it back, at 24 to 30 frames per second, without any special hardware; all they need is the decoding software.

Iterated's system can also be used for storing still images. On a 1.4-MB floppy disk, the compressor can fit about 70 photo-quality color pictures, said vice president Rick Darby. So far, the highest ratio the company has achieved is 500-to-1, with a still-frame image. Images to be compressed can come from any digitizing device.

Right now Iterated's P.OEM (as in "pictures for OEMs") system is a $25,000 investment. But eventually the technology should come down in size and price. "It's reasonable to say that future generations of our compressor could exist in a chip, and at that point, you could see this on a PC motherboard," Darby said.

Iterated officials say that fractal transformation offers the greatest compression for your computation dollars. The fractal approach is superior not only because it uses compact code to describe pictures but because, unlike JPEG, for instance, it doesn't throw away important data. "Fractal transformation throws away some information, because it's a lossy method, but it tends to throw away noise, rather than data you need," Darby said.

— D. Barker

New Material Could Yield Faster Circuits

A new silicon-on-insulator material has yielded CMOS transistors capable of running three times faster than comparable pure silicon transistors, IBM reports. IBM researchers hope their SOI material could eventually lead to computer circuits that run faster and have fewer errors, says Ghavam Shahidi, a research staff member at IBM's T. J. Watson Research Center (Yorktown Heights, NY).

Silicon grown on top of an insulator offers several advantages for computer circuit designers. The insulator can help cut down on current leakage from the semiconductor and make the chip run faster. And SOI can protect computer circuits from "soft errors" caused by external radiation sources.

The different properties of semiconductors and insulators have made it difficult to produce SOI. But IBM researchers say they have developed a new method to grow silicon on an insulator, resulting in an almost defect-free material with qualities not unlike pure silicon.

The researchers start with a silicon wafer as a base, heated to 1800°F, which produces a layer of silicon dioxide (the insulating material) on top of the wafer. They cut thin lines in the oxide, which exposes the silicon base and then pump a gas over the wafer that causes silicon to grow in blobs on top of the lines.

IBM researchers have used their SOI material to build experimental, high-speed transistors, Shahidi says. In tests, these CMOS transistors can conduct current through a ½-micron-thick channel. They have a switching speed of 33 picoseconds, making them three times faster than similar ½-micron CMOS transistors built of pure silicon.

— Jeffrey Bertolucci

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NANOBYTES

Echelon (Palo Alto, CA), started by Apple's Mike Markkula, has introduced a **new chip and protocols** for controlling a wide array of devices, from office lighting systems to factory machines to home appliances. The technology is based on a new chip called the **Neuron**, which contains three 8-bit processors connected in pipeline fashion, 10K bytes of ROM, 1K byte of RAM, and 512 bytes of EEPROM. The ROM contains the code for a complete seven-layer communications network protocol. According to Echelon CEO Kenneth Oshman, Neurons have been designed to be simple low-cost devices "that can find out if something is on, off, or in-between, and turn something on, off, or in-between." For example, a network of Neurons in your office connected to a motion detector and an ambient light sensor can ensure that the lights in your office are on only when you are there and it is dark outside. Neurons will be connected in what Echelon calls a Local Operating Network.

Poqet Computer (Sunnyvale, CA), maker of the 1-pound DOS-compatible Poqet PC, and **Infonet Services** (El Segundo, CA) plan to jointly develop products and services for a **worldwide messaging and communications network**. Their first product is called The Personal Communicator ($1995), which basically is a Poqet PC, WorldPort 2400 modem, and Infonet's Notice Notebook software for using the Infonet communications system. Infonet's services include E-mail, fax/telex features, and on-line news wires.

PC users **curious about the upcoming MS-DOS 5.0** can get a sneak preview from a new book published by **Bantam**. The new edition of *The PC Configuration Handbook*, by John Woram, has an appendix discussing some of the features of the upcoming DOS. The 729-page text, subtitled *A Complete Guide to Troubleshooting, Enhancing, and Maintaining Your PC*, spends 19 pages on DOS 5.0. "It's not meant as an extensive look at DOS 5.0 but covers what you need to know from a system-configuration standpoint," a Bantam editor said.

People the World Over

Everywhere you look these days you'll find Gateway 2000 computers. That's because people everywhere know a good value when they see one. In all 50 states and in over 70 foreign countries, thousands of people are comparing price, quality and service – and choosing Gateway 2000.

In Gothenburg, Sweden

Anders Bjernefors, a computer dealer and programmer, bought a Gateway 2000 25 MHz 486 system last April. "After many faxes and a lot of study, I selected Gateway 2000," said Anders. "I'm pleased with the machine. I received a very powerful, well-built computer for an astonishingly low price."

Anders Bjernefors, Computer Link AB, and his Gateway 2000 25 MHz 486™ system.

Anders was so impressed by his system and by the people at Gateway that he contacted the company about becoming a Gateway 2000 reseller. "I telephoned my salesman," Anders remembered, "and he told me I'd have to visit the factory to make the arrangements. I was on the next plane out of Goteborg on my way to North Sioux City, South Dakota."

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In Worland, Wyoming

Bob Borst, owner and operator of Cloud Peak Pest Control in Worland, spent two and a half months researching his computer purchase. He chose a Gateway 2000 386SX.

Bob Borst, owner and operator of Cloud Peak Pest Control, and his Gateway 2000 386SX.

"My final decision was based on people, not hardware," said Bob. "The Gateway people make you feel like you're the most important person in the world. I didn't buy a computer – I bought Gateway."

Bob was equally impressed by Gateway's service people. "One time I got into a file and couldn't get out of it," Bob related. "Even though it was a software problem, I called Gateway and they talked me through it."

In Socorro, New Mexico

Gordon Kane, Laboratory Associate at New Mexico Tech, runs a computer lab with 15 Gateway 2000 286 systems. "At first we bought Gateway's because of the good prices," said Gordon. "But now I buy them because of the technical support, which is very superior, and because the company is committed to improving its product line."

Gordon Kane, New Mexico Tech, with his Gateway 2000 286 lab computers.

NMT also uses Gateway computers in its research programs. "A Gateway 386 cache system will be used

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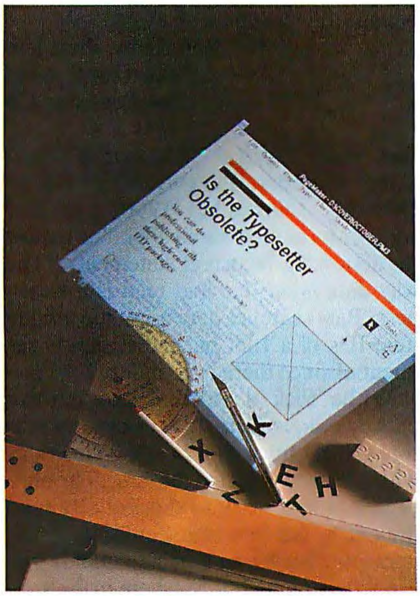

DTP Debate

As a professional desktop publisher, I read with great interest "Is the Typesetter Obsolete?" (October 1990), which compares DTP packages. While for the most part the review was informative, I must make a few comments, some relating specifically to Ventura Publisher.

First, the primary goal of desktop publishing is to communicate a message effectively, not just to "make your pages look pretty."

The authors wonder why anyone would use Ventura's headers/footers feature, since the repeating frames are so easy to use. That's true, but the headers/footers provide valuable text functions with many preset values that can be easily customized. For example, headers/footers have an option to insert the first and last match of a given tag, allowing automatic placement of page references such as those found in dictionaries and telephone books.

Ventura addresses tracking as either tighter or looser, but this does not limit it to "only two levels of tracking." You can numerically specify the amount of tightness or looseness in 100ths of ems. Moreover, tracking is not a feature designed for those "trying to do fancy things with type." It is a typographic element allowing precise control over letter and line spacing to improve readability.

Kerning is not "an adjustment made to specific characters to account for their shape." The adjustment is made to the amount of space between specific pairs of characters, not to the characters themselves.

Given that Ventura, like most DTP software, is complex and requires time to learn adequately, I understand the reviewers' misconceptions and omissions.

I was particularly interested in their comments on FrameMaker, since I am looking to upgrade my system to the Unix platform. I was disappointed that they covered only the Macintosh version, especially since the cover announced "DTP Packages for Macs, PCs, and Unix." In that light, it seems a considerable oversight and somewhat unfair not to address all available platforms, as you do with PageMaker.

Ginny Ruths
Imagigraphics
Colorado Springs, CO

If nothing else, we agree on one thing—desktop publishing software is complex and definitely takes some time to master. For that reason, we cut down our list of review candidates and spent our time learning each package, looking for tips and shortcuts. Except for a few specific goofs, we believe the article reads correctly as is.

For the review, we needed to reproduce pages from BYTE, laid out exactly as they appear in print. We chose to implement the page numbers as footers, and Ventura's inflexible placement of footers on the page made that difficult. Instead, we found that placing the page numbers as repeating frames made it much easier to get them exactly where we wanted them. Fortunately, Ventura offered us a way to get around one of its shortcomings.

Also, we found Ventura's tracking to be a bit lacking. Yes, you can individually set the tracking amount by tag or selection, but you get only one setting per selection. Having to change the setting throughout the document gets to be a bit tiresome. We greatly preferred Quark's full control or PageMaker's five preset levels (in version 4.0). PageMaker's controls should give most users all the control they need. Yes, Ventura can do it, but it's clunky at best.

Your point about kerning is well taken. Indeed, kerning involves adjusting the space between pairs of characters. We refer to that idea throughout the text, but somehow the phrase you quote slipped through. Thanks for pointing it out.

As for the Unix coverage, our covers are designed as articles are being edited. Two products in the review (Interleaf and FrameMaker) are members of families of products that include Unix versions. We had hoped to get the latest incarnations of both products. For FrameMaker, that was the Mac version we tested; for Interleaf, the latest version runs only under Unix. The Unix version didn't arrive in time, so at the last minute we reverted to the PC version. The Mac FrameMaker we reviewed is a later version than the current Unix product. When the Unix version of Interleaf dropped out, the cover lines should have been changed. We're sorry for any confusion this may have caused.

Finally, I've been installing and working with DTP software ever since the beta versions of both Ventura and PageMaker. In the wrong hands, DTP software simply makes it easier to design horrible-looking pages. I disagree that DTP was designed for professionals. While it is a powerful tool in the hands of professionals, it's equally at home in the hands of occasional users with a flair for good design. For these users, DTP software's ability to "make pretty pages" is the primary reason they buy it.—Howard Eglowstein

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the page and include your name and address. Letters two pages in length or under have a better chance of being published in their entirety. Address correspondence to Letters Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send letters via BIXmail c/o "editors."*

Your letter will be read, but because of the large volume of mail we receive, we cannot guarantee publication. We also reserve the right to edit letters. It takes about four months from the time we receive a letter until we publish it.

Your October 1990 story "Is the Typesetter Obsolete?" seems to have completely missed one of the premier DTP systems: the Commodore Amiga. I believe the Amiga supported color DTP first and has certainly been the price/performance leader since DTP was first available.

BYTE is a fine magazine, but its blindness to the Amiga is a blemish on its reputation. It makes the informed reader wonder: What else is getting short shrift?

Stan Sieler
Redwood City, CA

I can understand your frustration. The Amiga is a very nice platform that pioneered several key areas the rest of the microcomputing world is only now starting to address. That's why BYTE covers the Amiga more than any other non-Amiga-specific magazine. For example, a quick search of the BYTE archives through October showed that we covered the Amiga 57 times in 1990, in ways ranging from splashy cover stories to references inside other articles (e.g., our recent coverage of SCSI, in which we acknowledge the Amiga's lead). The Amiga is regularly a part of "What's New," it's been in our columns, and we reviewed the 3000 when it came out. It's been in the State of the Art section and Features. And it figured in the 15th Anniversary Summit (we even interviewed Jay Miner). This is not an Amiga-hostile magazine!

I'm proud that we already cover the Amiga as much as we do. The rest is up to Commodore and third-party developers. If these companies give the Amiga the push it probably deserves, then we'll increase our coverage even more. But that kind of push can ethically come only from Commodore—it's not the job of editors to promote a product. We report; the companies promote.

In any case, we'll do our best to give the Amiga its due whenever and wherever appropriate.—Fred Langa

Alternatives Explored

Your article "Alternative Operating Systems, Part 3, Theos: Serious Business" (October 1990) and its technical editor Tom Yager really did their duty by bringing good ideas from quiet companies like Theos Software to the public's attention. The Theos multiuser operating system, with its BASIC and C components and operating-system-supported data files, has built a following from professional doubters—programmers and developers who have taken the time, as your editor obviously did, to investigate the platform.

My company no longer has any doubts. Working in the Theos environment has allowed us to create software without having to concern ourselves with alien data structures. Theos helps us make products that are easier to use and that are developed from the ground up for multiuser environments.

I've read and reread the article. Each time, I felt a charge, a positive stroke that has been missing for the last five years—mainstream acknowledgment! It's the bane of the artist and a bone for the businessperson. Thanks for both bane and bone.

Ron Gibbs, President
Phase One Systems
San Leandro, CA

Ben Smith's article "Alternative Operating Systems, Part 4, Pick: OS or DBMS?" (November 1990) provides some information about Pick but makes the following incorrect statement: "The way data is written and read is a weakness. Pick searches data using the unique item-IDs of a file, but the search is sequential since there is no index."

While Pick does store and retrieve data by unique item-ID, it does so by putting the ID through a hashing function, which is used to locate the data. The only time it is necessary to sequentially read the entire file is when searching for an item (record) by an attribute (field) that is not the unique ID. Nowhere in the article is the word *hash* used. Hashing is fundamental to the Pick filing system. To omit hashing from a description of Pick is to reduce its elegant filing system to nothing more than a delimited flat file. You simply cannot describe Pick without discussing hashing.

Kevin M. Sproule
Shrewsbury, MA

You are quite right! Hashing is fundamental to Pick's organization of records based on their unique item-IDs. However, if you are searching on any field other than the item-ID, you must resort to a sequential search.—Ben Smith

From Inside the Beltway

It is my great pleasure to congratulate the management and employees of BYTE as you celebrate your 15th anniversary. This is a milestone in the life of any business enterprise. It is a measure of your commitment and your success. As a businessman myself for more than 40 years, I know how much work and effort have gone into making this event possible.

Take pride in your accomplishment and in the fact that, as you continue to work for the success of your organization, you are contributing to the prosperity and well-being of our entire country.

I wish you continued success.

Robert A. Mosbacher
Secretary of Commerce
U.S. Department of Commerce
Washington, DC

OS/2 Bashing?

In your 1990 *IBM Special Edition*, the article "Through a Window, Darkly" erroneously states that OS/2 doesn't recognize any printer other than an IBM Proprinter. Version 1.2 of OS/2 (surely available to the author, since it has been around for nearly a year) supports not only the IBM printer family, but many Epson and Hewlett-Packard models, for a start. In practice, this means a great number of printers, because most manufacturers choose to provide emulation for one of the above. A simple generic printer driver and a PostScript driver are also included. I accept that this is still a small selection, but it's a good deal more than just a Proprinter.

Another paragraph states that "a DOS application operating in the background with PM seems to run very slowly." This statement shows a worrying lack of research and familiarity with the system. For good technical reasons, the DOS emulator in OS/2 1.x actually suspends operation when a switch is made from DOS to a PM window.

In the same paragraph, it is stated that "you can't download from an on-line database in one session while doing word processing in another." Why on earth not? Run Kermit (or something similar) in one window and Microsoft Word in another—I do it frequently.

R. D. Eager
Kent, U.K.

Regarding multitasking under Presentation Manager, I wrote a little program that simply ran a loop that incremented a number and reported it. While I know that Microsoft says that the DOS box is in suspended animation, I rarely if ever believe claims that I don't test. In this case, I noticed that the program had incremented a few ticks of the counter between the time I switched out and when I came back to it. It may be that these were simply caused by delays in screen reporting or that the processing continues briefly after the application leaves the screen but before it's really packed away by PM. I don't know, and neither (at the time) did Microsoft. That is why I said that it "seems" to run slowly. I didn't know for sure, and I still don't.

The printer support for PM is a different issue, because when you install the software, it does clearly offer such printers as the HP LaserJet as options. Unfortunately, they don't all work as they should, and the LaserJet driver is one of those that seems to have problems. The one you can really count on is the Proprinter driver.

continued

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If you need DOS graphics in your applications, we also have the answer. Vermont Views™ GraphEx allows all Vermont Views' windows, menus, and forms to work in CGA, EGA, VGA, and Hercules graphics modes. So you can use your favorite graphics package to create charts, graphs, and other images to enhance text displays.

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Don't take *our* word for it. Put Vermont Views to the test by calling for your personal, free demonstration kit. Or fax us at (802) 848-3502.

Regarding your statement about running Kermit and Microsoft Word, what you say may be true if both applications are OS/2 versions (as I said at the beginning of the paragraph you're questioning), but if they are both DOS applications, then you cannot. OS/2 will support only one DOS program at a time, and while you can switch in and out of it, you can't multitask.—Wayne Rash Jr.

OOP Redux

I enthusiastically agree with Brad J. Cox ("There *Is* a Silver Bullet," October 1990) that the reusable, interchangeable component approach to software construction offers greater promise than any other of today's developments. Indeed, I argued that very point strongly in my 1986 paper "No Silver Bullet."

Although we agree on approach, I must protest Cox's treatment of the argument of my paper. First, the viewpoint is by no means pessimistic. I stated, and still believe, that an order-of-magnitude improvement in productivity can be achieved in 10 years by a variety of modern approaches pursued together. I also stated, and still believe, that no one approach will achieve a tenfold productivity gain by itself in 10 years.

Most of the many response papers I have seen take the form, "Oh yes, there is a silver bullet, and it is mine." I shall be most impressed by testimonials from users who are not technology developers and who say, "I have used this product/technique that somebody else supplied, and it gave me a tenfold improvement between 1986 and 1996." Observe that four of the 10 years have gone by since my November 1986 paper. I still see no single development that will by itself prove me wrong by 1996.

Second, I most emphatically did not argue, as Cox asserts, that software difficulties arise "from some deficiency in how programmers build software today." My argument was that the difficulties are inherent in the conceptual complexity of the software functions to be designed and built, at any time, by any method.

The only way to avoid some layers of these conceptual complexities is not to design, build, and debug those layers at all, but to buy them—that is, to design and build at a higher conceptual level altogether. This is exactly what Cox advocates so eloquently.

Frederick P. Brooks Jr.
Kenan Professor of Computer Science
Department of Computer Science
University of North Carolina
Chapel Hill, NC

Computer Comrade

When I wrote my letter to you two months ago, I did not suppose that you would answer me. Then our postman gave me four thick parcels from you. I jumped like a child.

My wife could not believe that BYTE would send me four magazines. "They are capitalists," she said. "They count each pound in a pocket." But later she looked at all the BYTEs, and she said that you were not capitalists, but people with good souls.

Most interesting for me in BYTE are the articles about the history of fonts and scripts, information from the BYTE Lab, news about peripherals, reports about new software for IBM-compatible computers, and, of course, prices of software and hardware.

Thank you very much for your present, and remember that BYTE has a reader and friend in the Soviet Union.

Ignatenko I. Artem
Moscow, U.S.S.R.

Mac Magic

I was heartened to see two articles that appeared back-to-back in the October 1990 issue: "Interface/Shplinterface" and "Spare Me the Details." They are complementary in their appeal for hardware/software systems that keep out of the way so that users can devote their attention and energy to doing the job at hand. Both writers recognize the Mac's progress in this direction and the potential for progress in Windows 3.0. Perhaps they deplore, as I do, the fact that PC users need to waste much intellectual (and emotional) energy learning and using many arcane commands and routines to address the job at hand.

The industry seems to be moving in the right direction, and these articles support that movement. I laud your printing them. I even think they deserve to be printed again, but next time in the front of the magazine, not on the last two pages.

E. H. Gautier
Pittsburgh, PA

ASK BYTE

Unix Student

I will begin my computer studies in Australia next year, and I am very interested in joining the Unix community. Can you provide me with more information on Unix-related magazines, newsletters, and organizations? Also, I would very much like to know how to obtain free Unix software.

Chow Keng Choon
Singapore

Although BYTE has a regular column devoted to the Unix user and regularly runs features and reviews that are specific to Unix, you may find additional information in our sister publication, UNIX World *(444 Castro St., Mountain View, CA 94041, (415) 940-1500).*

The two most valuable organizations for the Unix community are USENIX (22672 Lambert St., Suite 613, El Toro, CA 92630) and UniForum (2901 Tasman Dr., #201, Santa Clara, CA 95054, (408) 986-8840). Every nation seems to have its own Unix users group. Australia's is AUUG; contact Jim Roper, Labtam Melbourne, 10 Whitley Way, Seaford, Victoria 3198, Australia.—B. S.

Affordable COBOL

I need your help in finding a COBOL compiler. The only one I'm aware of is the very expensive Microsoft COBOL compiler that is out of my price range.

Charles Igie
Tallahassee, FL

Try BOS National, Inc. (2607 Walnut Hill Lane, Suite 200, Dallas, TX 75229, (214) 956-7722); it provides BOS MicroCOBOL. VisiCOBOL from Innovative Computers, Inc. (26400 Southfield, Suite F, Lathrup Village, MI 48076, (313) 569-7422) is an inexpensive ($100, last time we checked) COBOL interpreter that supports a subset of ANSI level 1 COBOL but might have what you need. Micro Focus, Inc. (2465 East Bayshore Rd., Suite 400, Palo Alto, CA 94303, (415) 856-4161) sells various COBOL compilers; call them for prices.—R. G.

They're Coming

As a biochemical research scientist, one of my traditional duties is to keep a notebook or daily log of my lab activities—a record of meetings, correspondence, measurements, experimental results, observations, and so on. Your article "The Spoken Word" (July 1990) about voice interfaces and dictation devices gave me the idea that speech-to-text devices could greatly reduce the burden and improve the quality of laboratory record-keeping. What I envision as being useful (and feasible) is the following scenario:

The scientist records on a small, voice-activated pocket cassette recorder (e.g., those commonly available at Radio Shack stores) the events of the day as they happen. At the close of the working day,

On the left, the best-selling VGA monitor. On

The MultiSync® 2A is one monitor that performs like two. On one hand, it's an uncompromised VGA monitor that works so well, VGA users have made it the best-selling 14″ VGA color monitor in America.

On the other hand, the MultiSync 2A is also an equally uncompromised SuperVGA monitor, providing the perfect upgrade path to a standard that, at 800 x 600, gives you 56% more resolution than VGA.

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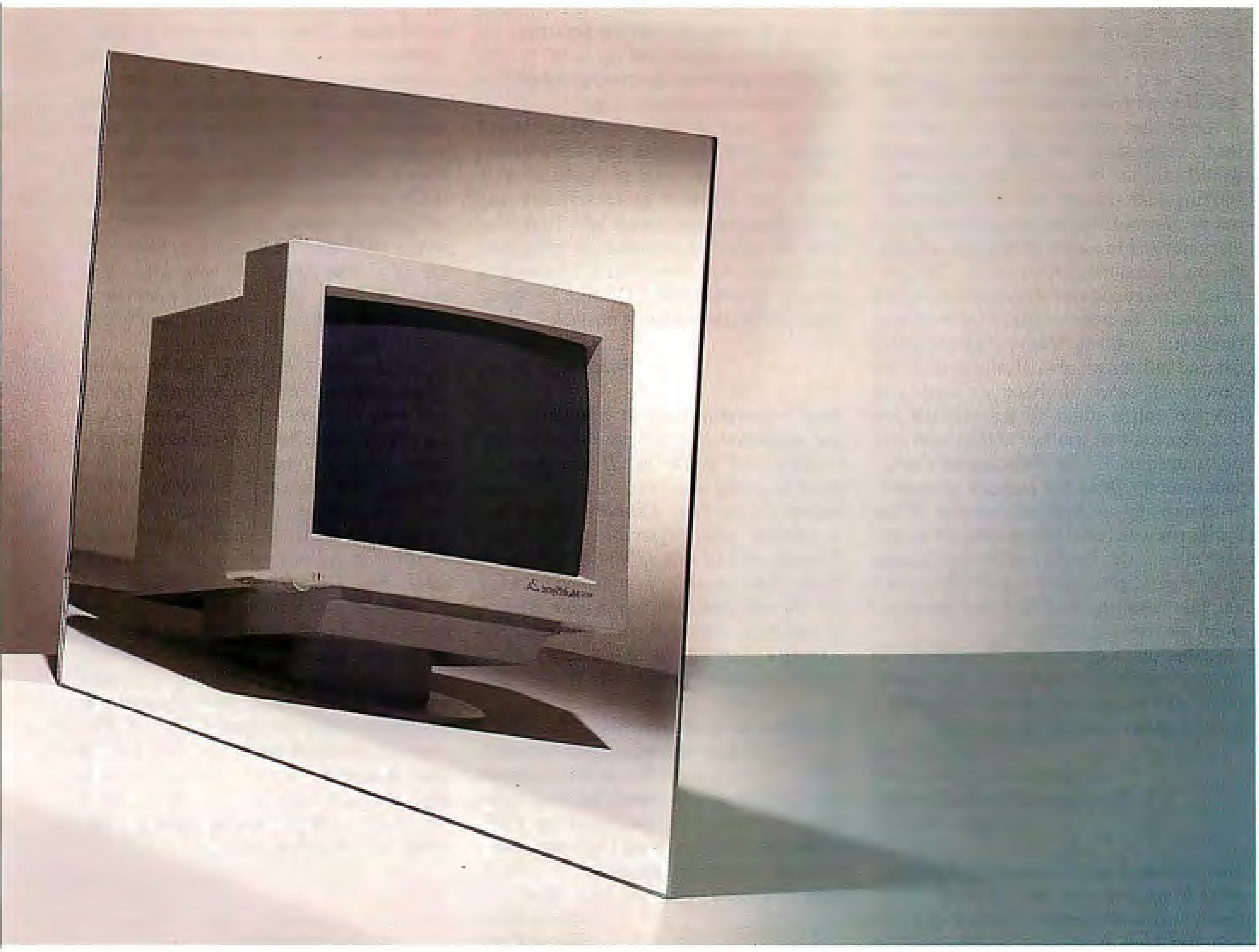
the right, the best-selling SuperVGA monitor.



It's even available in a gray-scale version—the MultiSync GS2A—which delivers everything the 2A does, in glorious shades of gray.

The MultiSync 2A. It's two of the best monitors you've ever seen.

For technical information or for the location of the dealer nearest you, call 1-800-FONE-NEC. For product literature, call 1-800-826-2255. In Canada, call 1-800-268-3997.

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the cassette recorder is connected via an interface board or stand-alone box to a lab PC. Software controls the cassette recorder and translates voice data into ASCII text in an unattended batch mode.

Given that science requires a specialized vocabulary, memory requirements would inhibit the size of the program's starting lexicon and active vocabulary, but words could be added to the program dictionary or to a user dictionary accessible on an external hard disk. The program need recognize only one voice and work with discrete words. Fast response times are not necessary. The program has the ability to rewind and replay the cassette in order to check its work and has the entire night to accomplish the task. Words that are not understood can be "played back" for the scientist's audition directly from the cassette recorder. Alternatively, a digitized version of the unknown word could be played while the user checks the fidelity of the translation with a word processor's spelling checker. The resulting ASCII file is incorporated into the lab notebook.

Is this just a dream, or does this technology currently exist at a reasonable price? If not, could available technology be adapted to accomplish this task?

Paul Wilson
Department of Chemistry
University of North Carolina
Chapel Hill, NC

Your scenario of a computerized amanuensis is not a dream, but you have to define "reasonable cost." The list of products included in the article you mention shows that systems that have a large vocabulary are very expensive, while more reasonable systems just can't cope with extensive vocabularies, let alone everyday speech. Currently available systems for translating real-time speech to text are prohibitively expensive and won't soon be found on the average desktop. But be patient, they're coming.—S. W.

Computerized Graphic Equalizer

I have a 386SX with 4 megabytes of RAM, a 70-MB hard disk drive, and a VGA multisync monitor with a 512K-byte video card. I use the system mainly for technical applications and am very satisfied with it. I am also involved in hi-fi and am very disappointed with ordinary graphic equalizers because of the inadequate displays they incorporate.

I think that I could convert my computer into an efficient real-time analyzer if only I knew the right interface and software. What I'd like is a pink-noise analyzer to handle the range of from 25 Hz to somewhere around 16 kHz, with ⅓ octave resolution and an accuracy of from 0.5 to 1.0 decibel up to 90 to 100 dB. I already have the pink-noise source and a good electrostatic mike.

What kind of data acquisition board should I buy? Is there any commercial software for this kind of application? I know that all hi-fi manufacturers and many independent sound labs have this kind of software running on 386s and maybe even ATs, but as far as I know it is usually custom-made. I'd like to spend about $2000 on this. Is it possible?

J. M. Salietti
Barcelona, Spain

Most commercial audio manufacturers use dedicated instruments that are specialized and expensive. If you want to build a sound analyzer system, a good source for parts is Keithley Metrabyte/Asyst/DAC (440 Myles Standish Blvd., Taunton, MA 02780, (508) 880-3000). In Spain, you can order products via Pacisa SA (01-402-7060); it has a wide variety of analog-to-digital boards and analysis software. You may be able to assemble a system for under $2000.—S. W.

The Best of Both Worlds

I am a DOS user and would like to install OS/2 1.2 on my hard disk as well. I recall that a BYTE article stated that there is an undocumented trick for installing OS/2 at the end of the existing DOS partitions without having to reformat the entire hard disk, but I can't find the article.

Antonio Lam
Hong Kong

You're probably referring to Mark J. Minasi's column, "A First Look at HPFS" (January 1990). The question was, "Will I have to reformat my hard disk to use HPFS (the High Performance File System)?" The answer was "Yes, if you've only got a single file allocation table (FAT) partition, otherwise no."

But you're really asking a more basic question: "Can DOS and OS/2 coexist?" Yes, they can. All versions of OS/2 1.2 I've seen recently offer a dual-boot facility. You install OS/2 (using FAT, not HPFS) on top of DOS. Then, when you boot, you can pick the operating system you want to use. This works because OS/2 can read and write FAT partitions just like DOS—specifically, the C partition, from which both systems boot. So, if you've got enough space on C for OS/2 and DOS, you're all set. If not, OS/2's installation program will tell you so, and you can trim accordingly.

Of course, OS/2's new file system, HPFS, is pretty nifty, and you may want to try it out. If you've got several FAT partitions to work with—a primary C and an extended partition with logical drive D—you might want to convert the extended partition to HPFS. Note that you'll have to back up D's data, and when you restore it, only OS/2 will be able to read it. (DOS programs can get at the data but only when running in OS/2's DOS session.) OS/2 and DOS will now share the use of C (the FAT partition), and OS/2 alone will use D (the HPFS partition). The command to do the trick is `format D: /fs:hpfs`.

On the other hand, if you're asking "Can I install OS/2 on logical drive D and boot from there?" the answer is no. Like DOS, OS/2 has to boot from the primary partition. And you can't have two of those. Or can you? According to BIX user Jim Gilliland ("jgilliland"), a dual-primary-partition machine can be created as follows: Wipe the partition table, boot DOS from a floppy disk, use FDISK to define a primary partition, and install OS/2 with HPFS (which uses that partition), and then install DOS, which won't recognize the HPFS partition and so will create its own. Now you can use FDISK to toggle between OS/2's HPFS-based C partition and DOS's FAT-based one. Whew! I haven't tried this myself, and of course you have to start with a fresh disk to implement the scheme. My advice: Stick with dual-boot.—J. U.

FIXES

• The correct price for Carpenter's Dream 3.0 from Workhorses, Inc. (January, page 88) is $74.50.

• The correct phone number for Advanced Matrix Technology (December 1990 Product Focus, page 168B) is (800) 992-2264.

• The current address and phone number for Future Domain (November 1990 Product Focus, page 188) are 2801 McGaw Ave., Irvine, CA 92714, (714) 253-0400.

• The correct processor for the IBM XT included in the chart on page 76 of the 1990 *IBM Special Edition* is the 8088.

• In "FPU Face-Off" (November 1990), we inadvertently referred to an 80387-class chip manufactured by Cyrix as the FastMath 83D87. The correct name of this chip is FasMath. Winkel Engineering manufactures software that performs arithmetic calculations under the registered trademark FastMath. ■


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A Forward-Looking 486-25 Machine

The Dasher/486-25 is an AT compatible with Novell and Unix flexibility in its expansion slots. Running at 25 MHz, the Dasher/486-25 accommodates up to five half-height 5¼-inch drives for fault-redundant Novell networking.

The system's 32-bit memory expansion lets you work in such environments as SCO/Xenix, Interactive 386/ix, and DOS. It comes with 4 MB of memory on a 32-bit 25-MHz controller. For more than 16 MB of memory, you add a second memory controller for a total of 32 MB of system RAM. The unit incorporates 8K bytes of cache and a floating-point processor.

In addition to eight expansion slots, the Dasher/486-25 includes a 16-bit VGA controller card, two RS-232C serial ports, and mouse and printer ports. It supports Windows 3.0.

Price: $7995 and up.
Contact: Data General Corp., 3400 Computer Dr., Westborough, MA 01580, (508) 898-4051.
Inquiry 1289.

The Dasher/486-25's expandability lets you configure it to meet your computing needs.

Modular in design, the Dauphin 1000 offers a customized approach to portable computing.

A Laptop of Options

Dauphin Technology has introduced the 1000 series modular laptop. Weighing from 4 to 7½ pounds, depending on your combination of modules, the 1000 is easily customized.

The laptop's modularity lies in its detachable screen, network-ready architecture, diskless design, and upgradable CPU. You can configure it at 12 MHz with a 286 chip, at 20 MHz with a 386SX chip, or at 25 MHz with a 386 chip and built-in RAM cache.

Price: $3295 to $5795.
Contact: Dauphin Technology, Inc., 1125 East St. Charles Rd., Lombard, IL 60148, (708) 627-4004; fax (708) 627-7618.
Inquiry 1290.

Expansion Is the Game

The Super-386SE from Hyundai is expandable from its clock speed to its functionality. An 8-MHz unit (switchable to 16 MHz), the system comes with 2 MB of RAM (expandable to 16 MB).

You can mix 256K-byte and 1-MB single in-line memory module chips, which lets you add memory without removing any installed 256K-byte chips. Built-in ROM is 64K bytes (expandable to 128K bytes).

The Super-386SE supports EMS 4.0 and has one 8-bit and four 16-bit expansion slots. It includes one parallel and two serial ports, a system diagnostic floppy disk, a 135-W power supply, and a socket for an 80387SX math coprocessor. Options include 40-MB, 100-MB, and 200-MB hard disk drives.

Price: $1595 to $3295.
Contact: Hyundai Electronics America, 166 Baypointe Pkwy., San Jose, CA 95134, (408) 473-9200.
Inquiry 1291.

A Workstation 386SX

New in the PC market, Cumulus has introduced its GLC/SBS 386SX all-in-one workstation. Running at 16 or 20 MHz, the GLC/SBS is geared toward small and medium-size businesses.

Each model of the GLC/SBS includes a fax/modem, telephone answering system, a 3½-inch floppy disk drive, 1 MB of RAM, a 16-bit VGA graphics adapter and VGA monitor, and a mouse. The top-of-the-line model also has a color monitor and a 3½-inch hard disk drive.

Price: $1395 to $2095.
Contact: Cumulus Corp., 23500 Mercantile Rd., Cleveland, OH 44122, (216) 464-2211; fax (216) 464-2483.
Inquiry 1292.

Puma Plus

A digitizer with a 16-button cursor option, 100 percent compatibility with AutoCAD, a Windows 3.0 driver, and a mouse emulator is available from Hitachi America. The Puma Plus runs on PCs, the Sparcstation, and the DECstation.

Puma Plus features a 12- by 12-inch tablet with a resolution of 1016 lines per inch that works with a stylus or a 4-, 12-, or 16-button cursor. According to Hitachi, Puma Plus supports more than 250 CAD/CAM/CAE and graphics packages.

You install and operate Puma Plus by placing the color-coded menu on the tablet, pointing to the operating mode you need, and clicking a cursor button. After you configure it, Puma Plus stores all setup parameters in nonvolatile memory.

Puma Plus is available in three models. Each includes a template from Promontory Systems that is compatible with AutoCAD, VersaCAD, CADKey, and Windows 3.0. The tablet carries a 10-year warranty; the cursors and stylus have five-year warranties.
Price: $549.
Contact: Hitachi America, Ltd., 950 Benicia Ave., Sunnyvale, CA 94086, (408) 773-8833; fax (408) 773-9806.
Inquiry 1293.

The Puma Plus digitizer gives you a choice of four pointing devices and a wide range of applications.

Monitors for Different Tastes

Three monitors that address different spheres of compatibility are the MultiVision 795, the M24LMAX, and the Viking 31/72 C24.

Taxan's MultiVision 795 Trinitron color monitor is the latest in its Trinitron series. The 14-inch auto-scanning monitor is PC or Macintosh compatible. Its 70-Hz refresh rate has a resolution of 1024 by 768 pixels in noninterlaced mode and a 0.26-mm pitch-black Trinitron tube.

Ergonomically designed with all controls up front, the MultiVision 795 uses an aperture grille screen and a one-gun, three-beam system. It has a tilt-and-swivel base.
Price: $1095.
Contact: Taxan Corp., 161 Nortech Pkwy., San Jose, CA 95134, (408) 946-3400.
Inquiry 1294.

The M24LMAX 24-inch monochrome/gray-scale monitor from Image Systems works with the Apollo 2500 workstation and other terminals with 1024- by 768-pixel and higher resolutions. You can view two complete facing pages, a full B-size drawing, or multiple applications.

The monitor automatically adjusts to horizontal scanning frequencies of from 48 to 96 kHz and frame rates of from 60 to 80 Hz. It is ergonomically designed, with paper-white phosphor, a tilt-and-swivel base, and front-panel brightness and contrast controls.
Price: $1995.
Contact: Image Systems Corp., 11543 K-Tel Dr., Hopkins, MN 55343, (612) 935-1171; fax (612) 935-1386.
Inquiry 1295.

The Viking 31/72 C24 is a 20-inch Trinitron color monitor. It has a resolution of 1024 by 768 pixels at 72 dpi, 16.8 million colors, a 75-Hz refresh rate, an antiglare OCLI filter, and a controller for Mac II computers. In addition, it has pan and zoom capabilities and rests on a tilt-and-swivel base.
Price: $7890.
Contact: Moniterm Corp., 5740 Green Circle Dr., Minnetonka, MN 55343, (800) 933-5740 or (612) 935-4151; fax (612) 933-5701.
Inquiry 1296.

A Color Printer with Pizzazz

The Kodak Diconix color 4 printer runs at speeds as high as 150 cps in draft mode in DOS and Macintosh versions. It prints color text and graphics at resolutions of up to 192 by 192 dpi.

Able to print on plain paper or ink-jet transparency material, the color printer automatically feeds as many as 60 cut-sheet pages from a built-in tray. It also handles continuous-form tractor-feed paper.

The four print heads use nonsmearing non-water-based inks. Each cartridge holds an ink supply for printing up to 500 pages.

Featuring draft, near-letter-quality, and letter-quality printing modes, the Kodak Diconix color 4 printer has three built-in fonts—Prestige 10 and 12 and Gothic 18. The printer measures 4 by 13⁷⁄₁₀ by 20 inches and weighs 13 pounds.
Price: $1495.
Contact: Eastman Kodak Co., 901 Elmgrove Rd., Rochester, NY 14653, (800) 344-0006.
Inquiry 1297.

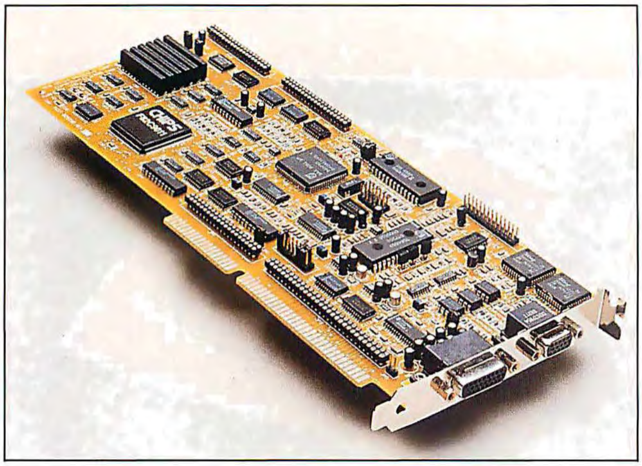
Kodak's Diconix color 4 printer uses plain paper or ink-jet transparency material.

Multimedia at Home

Super VideoWindows, a digital video/audio board for PC and Micro Channel systems, may be the answer to your wish for multimedia capability at home. Enabling you to play full-motion video and stereo audio from a TV camera, VCR, videodisk player, or cable TV in any size window, Super VideoWindows stores individual frames on disk or ports them to other applications.

Super VideoWindows runs under Windows 3.0 or NewWave 3.0. An optional software developer's toolkit provides a library of C function calls.

Price: $695; developer's toolkit, $295.
Contact: New Media Graphics Corp., 780 Boston Rd., Billerica, MA 01821, (508) 663-0666; fax (508) 663-6678.
Inquiry 1298.



Super VideoWindows lets you store individual video frames or port them to other applications, such as DTP or CAD/CAM.

A One-Slot Deal

The DTC6290E EISA bus-master disk drive controller from Data Technology fits into a single PC slot. It uses a custom 32-bit RISC microprocessor that supports as many as four 15-Mbps ESDI drives and up to three floppy disk drives. According to the manufacturer, the controller accesses most disks in less than 0.5 ms.

Using its on-board bus-master interface processor, the DTC6290E transfers data directly at a rate of 33 MBps. A special feature of the board is a proprietary cache memory controller that can handle up to 4 MB of cache memory. The custom circuitry on the board anticipates the most likely area of the disk drive you would access; it then preloads the files in that area into cache memory.

Price: ½ MB, $845; 1 MB, $895; 2 MB, $995; 4 MB, $1195; OEM prices on request.
Contact: Data Technology, a division of Qume Corp., 500 Yosemite Dr., Milpitas, CA 95035, (408) 262-7700; fax (408) 942-4052.
Inquiry 1299.

Double-Duty Amiga Card

The AdSCSI 2080, an expansion card with 8 MB of RAM combined with a hard disk drive controller, is available for all Amiga 2000, 2500, and 3000 computers. With a flexible configuration, the AdSCSI 2080 adds Fast RAM in 2-MB increments and controls as many as seven internal, external, and removable hard disk drives.

Price: $279.95.
Contact: ICD, Inc., 1220 Rock St., Rockford, IL 61101, (815) 968-2228; fax (815) 968-6888.
Inquiry 1300.

VGA Boards by Boca

An entry-level 16-bit VGA board that supports a resolution of 640 by 480 pixels with 16 simultaneous colors has been introduced by Boca Research. The Basic VGA by Boca board also supports EGA, CGA, MDA, and Hercules standards and comes configured with 256K bytes of video RAM.

The Basic VGA by Boca board's 15-pin analog connector attaches to VGA or multiple-frequency monitors. The board includes automatic recognition of monitor type and a diagnostic test program.

The 16-bit Super VGA by Boca board supports a resolution of 1024 by 768 pixels with a display of 256 colors. It uses the Tseng Laboratories single graphics chip and is available with 512K bytes or 1 MB of video RAM.

Price: Basic VGA by Boca, $98; Super VGA by Boca: 512K, $195; 1 MB, $245.
Contact: Boca Research, Inc., 6401 Congress Ave., Boca Raton, FL 33487, (407) 997-6227; fax (407) 997-0918.
Inquiry 1301.

Book a Date with a ThinCard

The Databook ThinCard Drive Model TMB-200-03 lets you transfer IC memory cards from your palmtop computer to a desktop DOS system. The drive emulates a floppy disk drive and includes a half-length PC board, a 3½-inch disk-drive-size unit for the memory card, and an interconnect cable. The software supports the Poqet file format and Microsoft Flash file system.

Price: $489.
Contact: Databook, 10 Alder Bush, Rochester, NY 14624, (716) 889-4204; fax (716) 889-2593.
Inquiry 1302.

A Bus on a Different Route

BusTek's EISA 32-bit Bus Master SCSI host adapter works with Unix, Xenix, NetWare, and OS/2 systems. Called the BT-742A and based on a proprietary Bus Master application-specific IC, the product works at transfer rates of 33 MBps with direct access to more than 4 gigabytes of host-system main memory.

The BT-742A can handle asynchronous and synchronous SCSI data transfers at rates of up to 5 MBps. Its on-board ROM BIOS lets you work as a single user in DOS and Windows and provides more than 1 gigabyte of storage capacity per drive. It incorporates an independent floppy disk drive controller chip for on-board control of one or two 3½- or 5¼-inch floppy disk drives.

Price: $499.
Contact: BusTek Corp., 2255G Martin Ave., Santa Clara, CA 95050, (408) 492-9090; fax (408) 492-1542.
Inquiry 1303.

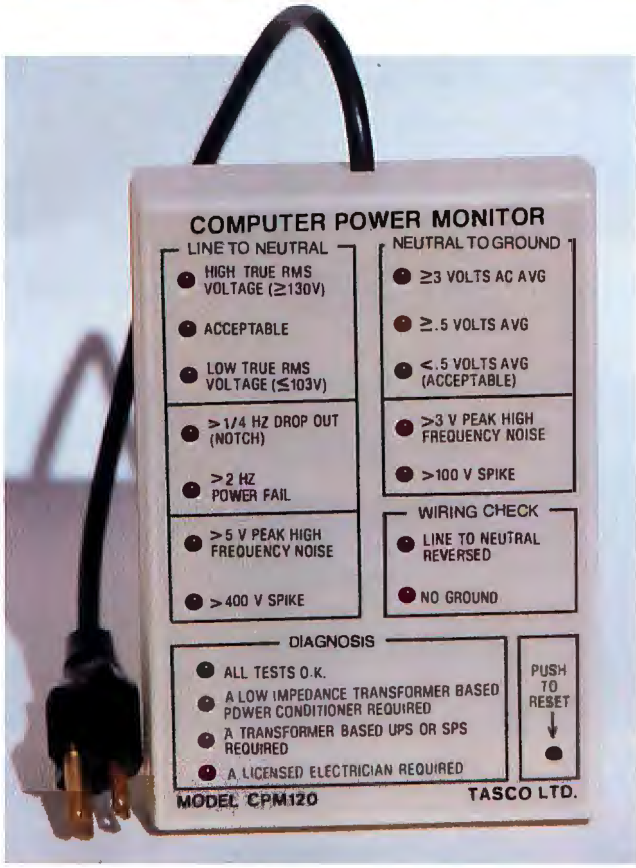
Power-Line Tester

By using Tasco's Computer Power Monitor to test the power line supplying your computer, you can avoid damage to your system. The unit monitors line voltage and indicates power-line fluctuations.

The monitor measures true RMS voltage going into your computer. On detecting a power variation, it recommends typical solutions for the indicated problem and checks wiring polarity.

If a power failure occurs, the unit stores prior alarms that were not manually reset for up to 48 hours without power. The solid-state monitor doesn't require batteries or maintenance.

Price: $538.
Contact: Tasco, Ltd., 2875 West Oxford Ave., Suite 5, Englewood, CO 80110, (800) 999-9952 or (303) 762-9952; fax (303) 762-1205.
Inquiry 1304.



Tasco's Computer Power Monitor measures power, warns of problems, tests the power line, and offers solutions.

Three Cubs in the Den

Square D Company has expanded its line of Topaz uninterruptible power supply products. Available in three configurations, the Cub provides as much as 10 minutes of backup power for your PC, Macintosh, file server, or workstation.

The Cub 250 is designed to protect 286, 386, and Macintosh systems; the Cub 350 works with high-end workstations and low-end file servers; and the Cub 550 is compatible with LANs, high-end file servers, and multiuser workstations. Each model uses a sealed, maintenance-free internal lead-acid battery, is fully automatic, has an audible and visual alarm, and recharges in 2 to 3 hours.

Other features include surge suppression, noise filtering, and overload protection. The Cubs work with Novell, Banyan, Santa Cruz Operation, Apple, and Xenix networks.

Price: Cub 250, $249; Cub 350, $349; Cub 550, $589.
Contact: Square D Company, Power Protection Systems, 9192 Topaz Way, San Diego, CA 92123, (800) 344-0570 or (619) 279-0111; fax (619) 549-8427.
Inquiry 1305.

Keep One Eye on the Camera

Proxima Cyclops, an interactive presentation pointer system that acts as a remote-control mouse, consists of a camera and a pointer with an LED. It is used in conjunction with any Proxima Data Display that has the Cyclops connector. An optional laser pointer works at up to 20 feet from the screen.

Cyclops is PC and Macintosh compatible. It attaches to the serial port of your PC; with an optional Mouse Trap, it can share the port with a mouse. Used with a Mac, it operates as a second mouse.

Price: $1195 to $4795.
Contact: Computer Accessories Corp., 6610 Nancy Ridge Dr., San Diego, CA 92121, (800) 582-2580 or (800) 582-0852 in California; fax (619) 457-9647.
Inquiry 1306.

Mac Connections for the Disabled

If you're physically disabled, you can now access a Mac by using Ke:nx (pronounced *connects*). A keyboard and mouse emulator with input setups that you customize according to your physical, cognitive, or visual-perceptual needs, Ke:nx is a 3- by 5-inch box that plugs into the ADB port. To use Ke:nx, you point and click with a mouse or your own specialized input device.

Ke:nx requires a Macintosh with 1 MB of RAM, a hard disk drive, System software 6.0 or higher, and an ADB keyboard.

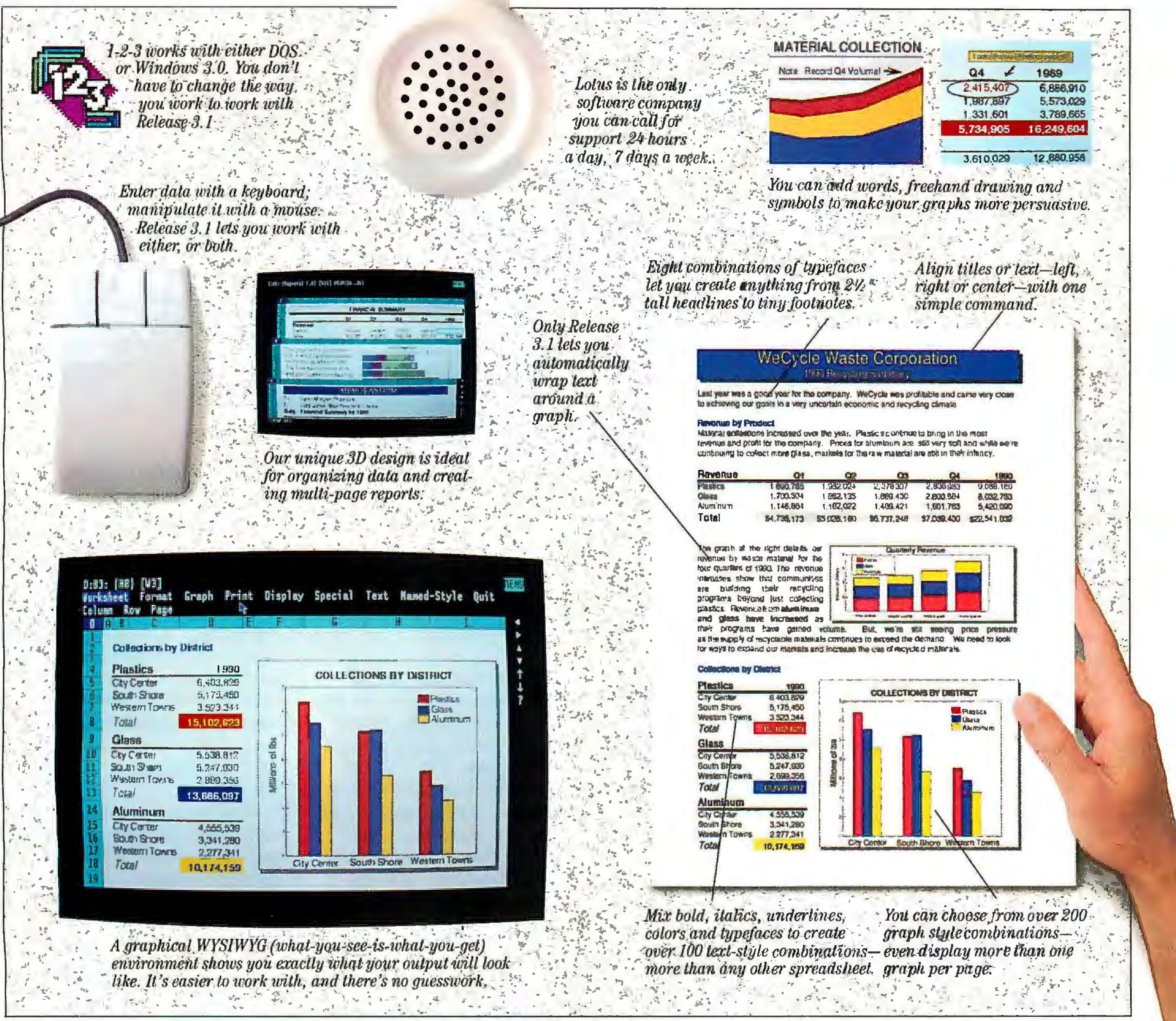
Price: $780.
Contact: Don Johnston Developmental Equipment, Inc., P.O. Box 639, 1000 North Rand Rd., Building 115, Wauconda, IL 60084, (800) 999-4660 or (708) 526-2682; fax (708) 526-4177.
Inquiry 1307.

Parallel Printing at a Distance

Connect your printer to your parallel port and still position it 200 feet from your computer. With HyperCable, such a setup is not just wishful thinking.

Designed to work with PCs, minis, mainframes, print buffers, printer switch boxes, and LANs, HyperCable installs like an ordinary parallel cable. Using its own patented circuitry, it does not require an external power source, yet runs as fast as 200,000 bps.

Price: $74 to $249.
Contact: Autotime Corp., 8950 Southwest Burnham, Tigard, OR 97223, (503) 639-2584.
Inquiry 1308.



Since 1983, 7 out of 10 spreadsheet buyers have chosen 1-2-3.* Now we're going after the other 3.

Over 10 *million* business people are more productive and more insightful because of Lotus 1-2-3.

Now Lotus introduces 1-2-3 Release 3.1.

And if you're currently using 1-2-3, you'll find it offers the features you've been wishing for. Like the ability to see, on screen, exactly what your printed output will look like. Our unique 3D approach to organizing and consolidating spreadsheet data. And the most professional and persuasive printed reports you've ever created on your computer.

Or if you're one of the holdouts not using 1-2-3, you'll find it offers an interactive, graphical environment. Plus it works with Windows 3.0. And supports both a keyboard and a mouse.

We've prepared a free demo disk to show you what 1-2-3 can do for you. **First time buyers should visit their local Lotus Reseller. Or to request a Release 3.1 Auto Demo, call 1-800-TRADEUP, ext. 673.**

And see why 7 out of 10 spreadsheet buyers chose 1-2-3. And the other 3 may not be far behind.

Introducing Lotus 1-2-3 **3.1**

*As reported by Audits & Surveys, Inc., measuring IBM-Compatible spreadsheet sales among computer and software dealers nationwide.

Circle 130 on Reader Service Card

Drive Across Your System . . .

CorelDriver, an interface based on a RAM-resident device driver, comes as a kit designed to provide compatibility between optical disk drives and DOS, OS/2, Macintosh, or NetWare systems. Said by its manufacturer to be compatible with most WORM (write once, read many times) and erasable optical disk drives on the market, CorelDriver supports the ISO erasable optical cartridge format. This lets users of ISO-compatible drives exchange cartridges across their operating systems.

Running with EMS memory installed, CorelDriver can use as little as 3K bytes of RAM. Without EMS memory, the driver will use up to 50K bytes of RAM.

All kits include the software device driver; utilities, including diagnostics and formatting; and cabling. DOS, OS/2, and NetWare kits also include a SCSI connection.

Price: $495 to $1795.

Contact: Corel Systems Corp., 1600 Carling Ave., Ottawa, Ontario, Canada K1Z 8R7, (613) 728-8200; fax (613) 728-9790.

Inquiry 1309.

The CorelDriver interface kit is fully compatible with most optical drives.

. . . or Talk Across It

Crosstalk Communicator, asynchronous communications software for the PC, is a terminal emulator designed for easy installation and use. Accessing dial-up information services is as easy as dialing the telephone, according to the company. Its interface is based on Crosstalk Mk.4 and Remote2.

During installation of Crosstalk Communicator, the program queries your PC to determine the number of serial ports available. It then asks which port your modem is connected to, after which it gives you a list of modem types from which you select the kind you are using.

To access a system or service, you supply information such as your telephone number, account number, and password. Crosstalk Communicator retains this information, letting you subsequently access the system with one keystroke.

You use the program's point-and-shoot dialing directory to access information systems and BBSes. File transfer protocols include XMODEM, YMODEM, ZMODEM, Kermit, and CompuServe B+.

Price: $99.

Contact: Digital Communications Associates, Inc., 1000 Alderman Dr., Alpharetta, GA 30202, (404) 442-3210.

Inquiry 1310.

Asanté Supports New Macs

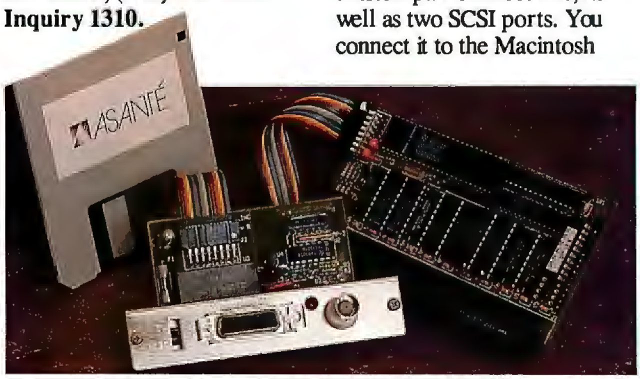
The MacCon+30i, an Ethernet card for the Mac IIsi, is described by Asanté as the smallest Ethernet card for any Mac. The card fits in the machine's Direct Slot 030 bus, eliminating the need for an extender card. You have a choice of two versions of the MacCon+30i: one with thick and thin ports, the other with thick and twisted-pair ports. The MacCon+30i is register-level compatible with Apple's EtherTalk card and uses a 32-bit data bus. An optional 64K-byte buffer is available.

The EN/SC external SCSI box provides Ethernet support for the Macintosh Classic. Its standard configuration includes thick, thin, and twisted-pair connections, as well as two SCSI ports. You connect it to the Macintosh Classic's SCSI port.

Price: MacCon+30i, $495; 64K-byte buffer, $50; EN/SC, $595.

Contact: Asanté Technologies, Inc., 405 Tasman Dr., Sunnyvale, CA 94089, (408) 734-4844; fax (408) 734-4864.

Inquiry 1311.



Asanté's MacCon+30i Ethernet card is small but reliable and easy to install.

Automated Group Editing

You can now use ForComment Document Review Groupware on VAX/VMS computers and on PCs connected to a Novell LAN. Access Technology's solution to workgroup documentation disarray, ForComment speeds up document review by automating inherent procedures previously managed by the author.

ForComment automatically routes your document to selected reviewers. After the reviewers comment on-line, ForComment collates the comments and enters them into the document, letting everyone with access immediately see what other reviewers have said. The program maintains a record of the development of the document for an audit trail of the decisions that led to the finished product.

In addition to working with such applications as WordPerfect, Microsoft Word, and WPS-Plus, ForComment is compatible with leading E-mail systems, according to the manufacturer.

Price: VAX/VMS and All-in-1 versions, $375 to $9900; basic PC LAN version for 10 users, $1295 ($100 for each user above that).

Contact: Access Technology, Inc., 2 Natick Executive Park, Natick, MA 01760, (508) 655-9191; fax (508) 651-3788.

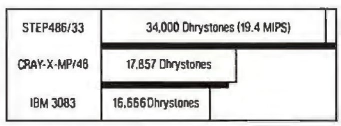
Inquiry 1312.

The Joneses.

EVEREX STEP

Check out the benchmarks. When it comes to speed, pure and simple, mainframes are no longer the main attraction.

Introducing the Everex STEP 486/33 and STEP 486/25. Along with the STEP 486*is*, they give you desktop performance that was previously unheard of.



There are two reasons. The first, of course, is the 486™ chip. The other is AMMA™, Everex's proprietary Advanced Memory Management Architecture.

AMMA uses "write-back" cache technology instead of the "write-through" technologies used in most PC's. The write-back cache was developed for mainframes. Everex was the pioneer in developing it for the PC. And in doing so, opened a whole new dimension in desktop performance.

With AMMA, you can write directly to the STEP 486's cache in nearly all cases. With write-through techniques, on the other hand, you lose most of the performance benefit of the cache.

And how to keep up with them.

That's because write-through forces you to write to main memory much more often. And main memory is slower than the cache.

This is especially important in 486 computing, where the CPU performs as many as four times the write operations as in 386. Which makes AMMA's write-back architecture, combined with the 486's embedded cache, a powerful combination indeed.

But the STEP 486 machines give you more than just speed. They come with Programmable Drive Select. If your drive isn't listed on the set-up table, PDS™ lets you custom-configure the BIOS. It's good for virtually any hard drive.

What's more, all STEP systems come with a one-year extendable warranty and a one year renewable on-site service contract that also covers all Everex peripherals in the system.

To find out more, call 1-800-368-STEP* for the name of your nearest Authorized Everex Reseller–every one a high performance expert

Then you can let the Joneses try keeping up for a change.

EVEREX
EVER for EXcellence

Circle 80 on Reader Service Card

A Miniature Modem

Available for PC or Macintosh use, the Practical Peripherals Pocket Modem operates at 2400 bps in a credit-card-size box. It is compatible with the Hayes 2400 Smartmodem and includes an automatic answer mode and pulse or Touch-Tone dialing.

The PC version, which doesn't require batteries or a power supply, plugs into your PC's serial port. It weighs 4 ounces and measures 2¼ by 3 by ¾ inches.

The Macintosh version requires a 9-V battery adapter. It includes cables and a communications software package.
Price: PC version, $159; Mac version, $199.
Contact: Practical Peripherals, 31245 La Baya Dr., Westlake Vilage, CA 91362, (818) 706-0333; fax (818) 706-2474.
Inquiry 1313.

The credit-card-size, 2400-bps Practical Peripherals Pocket Modem accepts pulse or Touch-Tone dialing.

Next, DoveFax

DoveFax Next lets you transmit and receive fax text and graphics using your Next computer. With the optional OCR Servant Software from HSD Microcomputer U.S., you can also edit received faxes on-screen. Compatible with all Next machines, DoveFax Next runs at 9600-bps fax speed and 2400 bps for the data modem.

Once the DoveFax Next modem is connected to your Next system, you can fax any document that you can print. Since PostScript is used in imaging the pages, the faxes you send are clearer than ordinary fax transmissions, according to Dove. Features include automatic answering and redialing capabilities.
Price: Basic unit, $499; with OCR Servant Software, $899.
Contact: Dove Computer Corp., 1200 North 23rd St., Wilmington, NC 28405, (800) 622-7627 or (919) 763-7918; fax (919) 251-9441.
Inquiry 1314.

The Lazer Link II lets you place your SCSI-linked peripherals up to 3000 feet from your controller.

SCSI Bus Extender

A fiber-optic modem that connects directly to standard SCSI-1 and SCSI-2 interface adapters and peripherals has been introduced by Applied Concepts. The Lazer Link II SCSI Bus Extender lets you increase the working distance of your SCSI bus interface from the present maximum of 19 feet to 3000 feet. It supports 5-MBps data transfer rates in asynchronous and synchronous modes.
Price: $950.
Contact: Applied Concepts, Inc., 5350-H Eastgate Mall, San Diego, CA 92121, (619) 453-0090; fax (619) 453-6715.
Inquiry 1315.

A Plug-in Line Sharer

The Easy-Connect Line Sharer from VSI lets you connect a fax, a phone, and answering machine to an ordinary phone line without any prewiring. An electronic circuit detects when other phones on the same line go off-hook and responds to their remote Touch-Tone or dial commands. A microprocessor controller provides such features as voice alert, hold, line request, and international ring count.
Price: $159.95.
Contact: VSI Telecommunications, Inc., 9329 Douglas Dr., Riverside, CA 92503, (800) 999-8232 or (714) 687-2492; fax (800) 444-8232 or (714) 687-2513.
Inquiry 1316.

A Small but Mighty UPS

An off-line power system compatible with Novell, 3Com, Banyan, SCO Xenix, Apple, Convergent, and Prime networks has been introduced by Upsonic. The PC Might 35 provides up to 20 minutes of battery backup power during a power surge, spike, line noise, or blackout.

With a rating of 350 V, the PC Might 35 has a maintenance-free battery, overcurrent protector, overload and short-circuit protector, and line filtering. It weighs 13⁷⁄₁₀ pounds and measures 5⁹⁄₁₀ by 3³⁄₁₀ by 12 inches.
Price: $275.
Contact: Upsonic, 1 Park Plaza, Suite 600, Irvine, CA 92714, (800) 877-6642 or (714) 833-7161; fax (714) 833-7164.
Inquiry 1317.

If You Want In A 386 System, Do

Selecting a new computer system can be a real challenge. That's where we come in. We have the knowledge, experience and the best value packed computer systems available. So, pick up the phone and check us out. Ask us about our quality. Our service. And especially our prices. You'll like what you hear.

Let's Talk Features.

Then ask us about our new 386/25 and 386/33 systems. The list of standard features includes the latest that high technology has to offer. Like a 128 KB memory cache for the 386/25 and the 386/33, both expandable to 256 KB. Then there's the integrated VGA controller supporting 1024 x 768 resolution, with 256 vibrant colors and a 50% performance increase all made possible by 1 MB of 32-bit video memory. Plus support for interlaced and non-interlaced monitors. When it comes to features, we set the standard.

Compare Our New High Performance 386 Cache Systems.

- ☐ 128K cache memory expandable to 256K
- ☐ 4MB of 32-bit high speed memory (Expandable to 16MB on-board)
- ☐ High performance 1024 x 768 VGA with 256 colors including 1MB of 32-bit video memory
- ☐ 14" Super Hi-Res .28mm dot pitch VGA color monitor with tilt/swivel base
- ☐ 100MB 17ms IDE hard drive with 64K "look-ahead" cache buffer
- ☐ 1.2MB 5.25" and 1.44MB 3.5" floppy drives
- ☐ 1 parallel and 2 serial ports
- ☐ 101-key enhanced keyboard
- ☐ MS DOS 4.01
- ☐ Microsoft Windows 3.0
- ☐ Hi-Resolution mouse

Free one year on-site service

386▼33 With Cache **$2895**

386▼25 With Cache **$2595**

How About Flexibility?

No one can beat our flexibility either. An integrated floppy controller and hard disk interface that support up to three floppy drives and two hard drives. Up to 16 MB of RAM on board using the new industry standard 32-bit memory modules leave all six expansion slots available.

Our small footprint chassis includes both 5.25" and 3.5" floppy drives and 1 parallel and 2 serial ports. And consider this feature, our new 386/25 and 386/33 systems come standard with 5 drive bays to hold up to one additional floppy drive or tape backup and 2 hard drives. So, we can help you add on and update to your heart's content.

Look At Our Other Value-Packed Systems.

All of these fully-loaded systems include:

- ☐ 2MB of 32-bit high speed memory (Expandable to 8MB on-board)
- ☐ High performance 1024 x 768 VGA with 256 colors including 1MB of 32-bit video memory
- ☐ 14" Super Hi-Res .28mm dot pitch VGA color monitor with tilt/swivel base
- ☐ 40MB IDE Hard Disk Drive
- ☐ 1.2MB 5.25" & 1.44MB 3.5" floppy drives
- ☐ 1 parallel and 2 serial ports
- ☐ 101-key enhanced keyboard
- ☐ MS DOS 4.01
- ☐ Microsoft Windows 3.0 & Hi-Res mouse
- ☐ Free one year on-site service

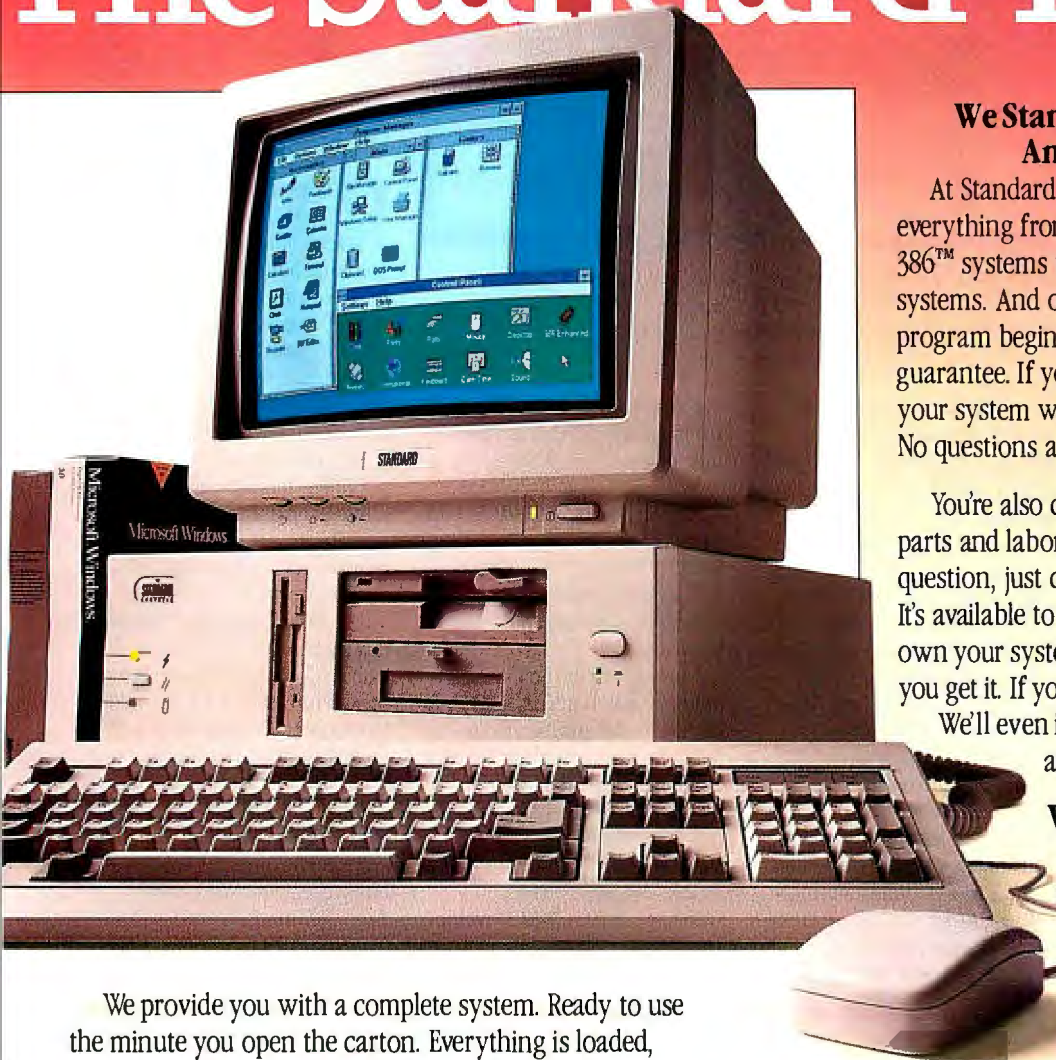
386▼SX-16 Only $1795.00 **386▼SX-20 Only $1895.00**

Shown with optional tape drive. 386 is a trademark of Intel Corporation.

We're Made In The U.S.A.

Since 1984 our R&D center has been designing our products, and all system boards are manufactured right here in the U.S. The latest surface mount and VLSI technology is utilized for the ultimate in product reliability and space saving design. If it's performance and quality you seek, we're the standard to beat.

The Best Value The Standard Thing.



We Stand Behind Our Systems And Our Customers.

At Standard Computer, we manufacture everything from high performance 486™ and 386™ systems to low cost 386/SX and 286 systems. And our total customer satisfaction program begins with a 30 day money-back guarantee. If you're dissatisfied, simply return your system within 30 days for a full refund. No questions asked.

You're also covered by our complete one-year parts and labor warranty. And when you have a question, just call our customer service hotline. It's available to you toll-free for as long as you own your system. If you need help, we'll see that you get it. If you need a part, we'll express ship it. We'll even include one year of on-site service at no extra charge.

Value That's Easy To Afford.

We make it easy to own and use our products. Our Standard purchasing programs are designed to fit your needs. Qualified company purchase orders, personal checks and most major credit cards are accepted.

We provide you with a complete system. Ready to use the minute you open the carton. Everything is loaded, tested, burned in, and ready to go. And, to help you easily handle the new multi-tasking, multi-screen programs, we preload MS DOS 4.01 and Microsoft Windows 3.0, and then throw in a high resolution mouse to boot. How's that for commitment!

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So, go ahead. Call us. Right now. Find out why we take so much pride in our exceptional products and services. Why our repeat customer rate is one of the highest in our industry. And why our product reliability is so good. For us, it's just the Standard thing.

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12803 Schabarum Avenue, Irwindale, CA 91706,
phone: 818/337-7711, FAX 818/337-2626.

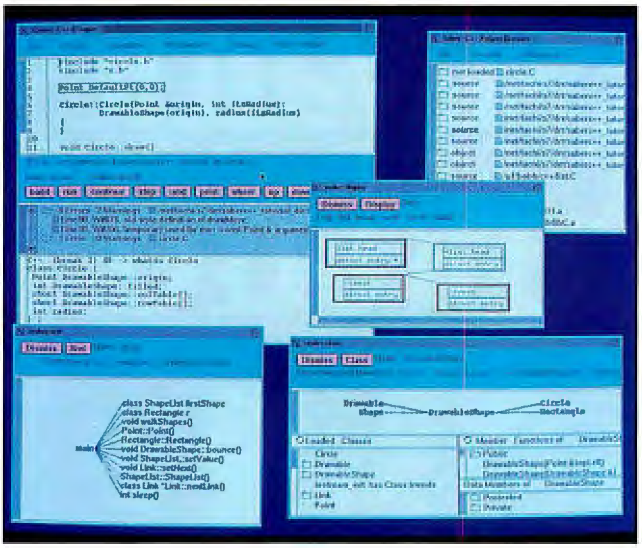
Circle 215 on Reader Service Card

C++ and C on Unix

Saber's dual C++ and C language development system is designed for programmers looking to make an incremental transition to object programming. Saber-C++ supports both languages in one integrated environment. It includes a C++ interpreter for prototyping and run-time error checking, plus class, cross-reference, and data browsers.

An interactive workspace lets you enter C++ and C code, evaluating and testing functions as you code them. Saber-C++ works with standard Unix programming tools such as `make`, `vi`, and `emacs`, letting you develop C++ programs without leaving the Saber-C++ environment.

Saber-C++ runs on Sun, DEC, and Hewlett-Packard Unix workstations.
Price: $3995.
Contact: Saber Software, Inc., 185 Alewife Brook Pkwy., Cambridge, MA 02138, (617) 876-7636; fax (617) 547-9011.
Inquiry 1271.



Saber's C++ environment lets you use standard Unix tools for development in one integrated environment. The Source Panel at top right provides interactive debugging of C++ and C code.

Four Tools from WallSoft

WallSoft Systems, known for its line of automated development tools, has new products for C, dBASE, Clipper, and BASIC programmers.

The company has updated its UI2 Developer's Release and UI2 Touch & Go template-driven application generator. The program can now generate code that's optimized for Clipper 5.0, including arrays, code blocks, nested GETs, and static and local variables. UI2 supports dBASE IV 1.1 and the windowing and mouse capabilities of FoxPro.

UI2 for C lets you build scrolling browse boxes, reports, memo fields, relational data handling, scrolling lookup windows, and other features into your C application without writing any code, the company says. UI2 for C is bundled with AllC, Village Software's C template system. By turning on UI2's multiuser switch, AllC generates multiuser code automatically. UI2 for C runs on DOS-based platforms. It also includes Sequiter's CodeBase 4.2, a multiuser C library, for handling dBASE data and index files.

With BasicAge (developed by Omicron for WallSoft), you can generate Microsoft BASIC 7.0 and 7.1 code for pull-down menus, stackable windows, reports, and other functions.

Version 1.5 of the Documentor, which makes sense of dBASE code, produces output detailing system structure and logic flow. It supports all the commands and functions found in dBASE IV and FoxPro.
Price: UI2 for C, $695; BasicAge, $595; UI2 Developer's Edition, $595; Documentor, $295. If you already have UI2, two C templates are $299.
Contact: WallSoft Systems, 233 Broadway, Suite 869, New York, NY 10279, (800) 233-3569 or (212) 406-7026; fax (212) 693-0979.
Inquiry 1272.

C++ for Unix/386

Computer Innovations' C++ for Unix System V-based 386/486 systems contains both Super-C and object features of the C++ language. Super-C extensions include default function arguments, in-line methods and functions, type-safe linkage, and call by reference or value, the company reports.

Object features of C++ include class/method organization, overloaded operators, inheritance, polymorphism, constructors and destructors, and virtual functions. It also has standard C++ class libraries for streams and complex arithmetic. The program works with the company's Debug-2000 full-screen, multiwindow, source-level debugger.
Price: $495.
Contact: Computer Innovations, Inc., 980 Shrewsbury Ave., Tinton Falls, NJ 07724, (201) 542-5920.
Inquiry 1273.

Smalltalk for Windows

Digitalk's new Windows version of its Smalltalk/V programming language combines a prototype-to-delivery development style while integrating with the host Windows 3.0 environment. The environment simplifies the complex maze of subsystems in graphical environments such as the Macintosh, OS/2 Presentation Manager, and Windows, Digitalk says. You can use browsers, inspectors, and push-button debuggers to navigate Smalltalk/V code and the Windows environment. The interface to Dynamic Data Exchange lets you share information between Smalltalk/V and other programs, while dynamic link libraries provide a way to call applications outside Smalltalk/V. The Smalltalk/V Windows source code is compatible with the Smalltalk/V PM environment, allowing you to choose either system as a development platform and deliver applications for both.
Price: $499.95.
Contact: Digitalk, Inc., 9841 Airport Blvd., Los Angeles, CA 90045, (213) 645-1082; fax (213) 645-1306.
Inquiry 1274.

show your true colors.

No longer does your world have to be black and white.

With millions of different color shades produced by high-quality inkjet technology, the HP PaintJet printer family makes it easy for you to look brilliant.

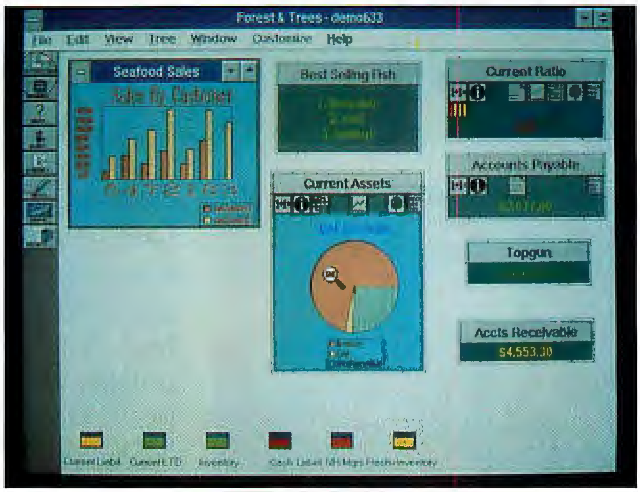
Better yet, it doesn't take much green to get this kind of color. Only $1,395* for the PaintJet. Or for even faster printing, larger formats, and more font capabilities, only $2,495* for the PaintJet XL.

Of course, HP PaintJets are DOS and Macintosh compatible. Work with all your favorite graphics software. And print on transparencies as well as paper.

So call **1-800-752-0900, Ext. 1632** for your nearest authorized HP dealer. And get a firsthand demonstration of what the PaintJet family can do for your business communications.

You'll be surprised how high you can fly with color.

HEWLETT PACKARD



With Forest & Trees, you can monitor the vital signs of your business without relying on MIS involvement.

Drive Your Business by the Dashboard

In the business world, you need up-to-the-minute reports. However, with so many incompatible systems and programs, getting this instant information can be difficult. Channel Computing's Windows and NewWave versions of its executive information system Forest & Trees lets you monitor the vital signs of your business or departments. Forest & Trees, also available in a DOS version, resides on an IBM PC and collects data from spreadsheets, local and LAN databases, minicomputers, and mainframes, combining data into useful information, the company says. The program presents information and monitors vital signs as frequently as you wish—minute by minute, hourly, quarterly, or longer—and provides an electronic dashboard that visually alerts you when a defined condition is met.

Forest & Trees presents 12 main views, each of which can have more information underneath. You can build database queries in Structured Query Language commands and display information in graphs, reports, or a history of past query results.

The standard version includes interfaces to dBASE, R:base, Lotus 1-2-3, Excel, Paradox, and DataEase. Optional interfaces for SQL Server and SQLBase, Oracle, DB2, and ASCII flat files are also available. It runs over Novell, 3Com, Banyan Vines, and other LANs.

Price: Windows versions, $495; NewWave version, $595; SQL Server and SQLBase interfaces, $1250 each; Oracle and IBM AS/400 interfaces, $2995.

Contact: Channel Computing, Inc., 53 Main St., Newmarket, NH 03857, (800) 289-0053 or (603) 659-2832; fax (603) 659-7590.

Inquiry 1275.

Spreadsheet Optimizer Evolves to Excel

Evolver, the program that does what-if analysis to the max, is now available for Microsoft Excel on the Macintosh and Windows, in addition to the original version for Informix's WingZ. Instead of you doing all the work in trying different what-if scenarios, Evolver does it for you, working in the background on your spreadsheets to optimize a value in a given cell.

You enter the cells Evolver is allowed to adjust, as well as the cell Evolver should minimize or maximize, and identify constraints. Evolver does the rest. You can add any number of constraints and give them different priorities. Evolver can optimize spreadsheets with linear, nonlinear, and stochastic (random) functions, Axcélis says.

Price: $145.

Contact: Axcélis, Inc., 1406 Western Ave., Seattle, WA 98101, (800) 292-3547 or (206) 624-2446.

Inquiry 1276.

Three Business Analysis Programs

Business Resource Software designed its expert system to help you assess the potential risks and rewards of your business ideas. The knowledge base and rules in Business Insight, which runs on the IBM PC, are based on the years of experience of the company's founders, as well as research on launching new businesses and product lines, the company says.

Business Insight starts by asking a series of questions about the proposed business. Using the responses to these questions, the program begins to build a financial model of the business and reports on how likely the business is to succeed or fail. A spreadsheet lets you build business projections. The program will also let you do what-if analysis, comparing results of different pricing and marketing schemes. Hundreds of questions deal with such issues as the current state of the proposed market, pricing and marketing strategies, market life cycle, and competitors.

The program offers direct criticism, which can be an advantage because you expose plans to the program in private and needn't fear brutal public comment about any failings they might have.

Price: $495.

Contact: Business Resource Software, 2013 Wells Branch Pkwy., Suite 305, Austin, TX 78728, (800) 423-1228 or (512) 251-7541.

Inquiry 1277.

Business Profiles 1.4, a program for financial and insurance professionals who need to analyze business strategies and financial goals for their business-owning clients, can now export data from any of its 10 modules to Harvard Graphics. Each module is designed to maximize business performance in a particular area such as key financial ratios, valuation, continuation, owner's retirement income, key employee valuation, or business priorities and concerns.

Price: $1495.

Contact: Financial Profiles, Inc., 5964 La Place Court, Suite 100, Carlsbad, CA 92008, (800) 237-6335, (800) 822-8302 in CA, or (619) 431-9400; fax (619) 431-9497.

Inquiry 1278.

Automate Your Business Plan, for the IBM PC, takes the approach developed in the book *Anatomy of a Business Plan* and combines it with a text editor and spreadsheet program with predefined planning outlines, spreadsheets, templates, and instructions. Its developer says the program automates many of the steps necessary for developing a business plan. With the spreadsheet, you can perform budgeting and financial analysis.

Price: $79; book and software, $95.

Contact: Out of Your Mind . . . and Into the Marketplace, 13381 White Sand Dr., Tustin, CA 92680, (714) 544-0248.

Inquiry 1279.

Buy BORLAND's Best at Programmer's Paradise

TURBO PASCAL

Turbo Pascal® takes you easily from inspiration to application.

Turbo Pascal 6.0 with Turbo Vision represents a breakthrough in Pascal programming, in object-oriented programming, and in programming for DOS. Turbo Vision is the first object-oriented application framework for DOS, bringing home the power of OOP, and allowing programmers to easily develop sophisticated applications with advanced user interfaces.

Turbo Pascal 6.0 is just as significant today as Turbo Pascal 1.0 was in 1983. And just as version 1.0 helped spearhead the popularity of structured programming, Turbo Pascal 6.0 with Turbo Vision will lead the way in OOP.

Turbo Pascal 6.0	**$ 99**
Turbo Pascal Pro 6.0	**$199**

TURBO C++

Borland's new Turbo C++ supports the de facto industry standard for object-oriented programming (OOP) in C; AT&T's C++ 2.0 specification. Turbo C++ is the first Turbo-charged native code compiler and also compiles your existing ANSI C code. The new Programmer's Platform allows you to integrate the tools of your choice. Its user interface has multiple overlapping windows and mouse support. You can also take advantage of VROOMM, Virtual Runtime Object-Oriented Memory Manager, to write programs that break the 640K barrier.

Turbo C++	**$139**
Turbo C++ Professional	**$205**

PARADOX

Paradox® 3.5 brings new levels of power, performance and connectivity to Paradox–the #1 rated PC relational database.

Paradox,® provides immediate database power. VROOMM™ with Turbo Drive™ makes Paradox faster, more powerful and easier to use than any other PC database. And Paradox is the ideal front end in SQL client/server applications. It allows you to ask complex, ad hoc questions about your data without the need for programming. Contains PAL, a full-featured development language. Excellent network capabilities.

Paradox 3.5	**$549**

TRY IT!

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Quattro Professional 2.0	495	329
Turbo C	99	69
Turbo C++	200	139
Turbo C++ Professional	300	205
Turbo Debugger & Tools 2.0	150	105
Turbo Pascal 6.0	150	99
Turbo Pascal Professional 6.0	300	199

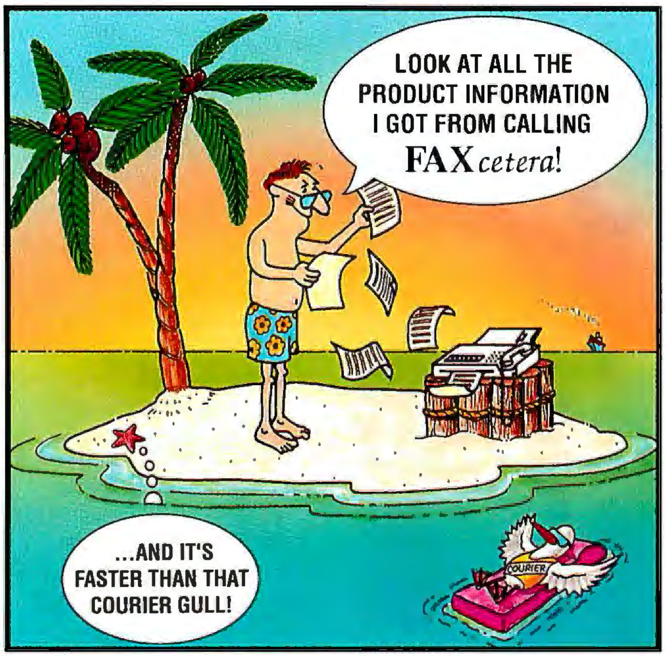
COMPETITIVE UPGRADES

	SPECIAL
Paradox 3.5	162
Quattro Pro 2.0	95
Turbo C++ Professional	139

• Prices are subject to change without notice.

- All brand/product names are trademarks or registered trademarks of their respective holders.
- UPGRADES: Proof-of-ownership required: original disk or manual page; while supplies last.

Programmer's Paradise®...



We'll *Beat* The Competition's Advertised Prices!

386 CONTROL PROGRAMS

	LIST	OURS
DESQview 386 w/QEMM	220	169
Microsoft Windows 3.0	150	99
VM/386	245	209
VM/386 MultiUser	895	839
VM/386 MultiUser Starter	395	339

386 DEVELOPMENT TOOLS

	LIST	OURS
386 ASM/LinkLoc	1295	1159
386/DOS Extender	495	439
C Windows Toolkit/386	200	179
C-Terp 386	398	315
Lahey F77L-EM/32 (w/OS/386)	1290	1035
MetaWare High C 386	895	849
Novell C Network Compiler/386	995	799
PC-lint 386	239	179
WATCOM C 8.0/386 Prof.	1295	1099
w/386/DOS Extender	1790	1399
WATCOM C 8.0/386 Standard	895	719
WATCOM FORTRAN 77/386	1095	CALL
Zortech C++ 386	995	849

ADA

	LIST	OURS
Academic IntegrAda	249	225
Ada Scope Debugger	495	445
Ada Training Environment	895	805
Adagraphics	695	629
IntegrAda	795	719
Meridian Ada Developer's Kit	1195	1095

ASSEMBLY LANGUAGE

	LIST	OURS
Advantage Disassembler	295	279
ASMFlow Professional	200	179
MS Macro Assembler	150	105
OPTASM	150	129
Re:Source	150	129
Sourcer w/Pre-Processor	170	149
SpontaneousAssembly	395	189
Turbo Debugger & Tools	150	105
Visible Computer: 80286	100	89

BASIC COMPILERS

	LIST	OURS
MS BASIC Prof. Devel. System	495	349
Power Basic	129	89
QuickBASIC	99	69

BASIC LIBS/UTILITIES

	LIST	OURS
GraphPak Professional	149	129
P.D.Q.	129	115
ProBas	159	149
ProBas Toolkit	99	94
QBase	149	125
QuickComm	149	119
QuickPak Professional	169	149
QuickWindows Advanced	149	119

C COMPILERS

	LIST	OURS
Lattice C 6.0	250	155
Microsoft C 6.0	495	339
w/Objective-C	699	539
MS QuickC 2.5	99	69
MS QuickC w/QuickAssembler	199	139
Turbo C 2.0	99	69
WATCOM C 8.0 Professional	495	419
WATCOM C 8.0 Standard	395	335

C++

	LIST	OURS
C++/Views	495	419
Data++Windows	189	169
NDP C++	495	479
Rogue Wave Math.h++	200	179
Rogue Wave Tools.h++	200	179
Turbo C++	200	139
Turbo C++ Professional	300	205
Competitive Upgrade	150	139
Zinc Library	200	179
Zortech C++	200	165
Zortech C++ Database	300	255
Zortech C++ Developer's Edition	450	399
Zortech C++ Video Course	500	449

C-COMMUNICATIONS

	LIST	OURS
Breakout II	249	189
C Asynch Manager 3.0	189	139
C Communications Toolkit	150	129
Essential Communications	329	259
Greenleaf CommLib	359	287
Greenleaf ViewComm	399	319
SilverComm "C" Async Library	249	209
View-232	189	149

C-FILE MANAGEMENT

	LIST	OURS
AccSys for dBASE or Paradox	395	349
Btrieve Devel. System	595	449
Codebase IV	295	219
c-tree Plus	595	475
dBC III Plus	500	439
db_FILE Bundle	295	249
Essential B-Tree w/source	198	149
Paradox Engine	495	349
The Toolbox - Prof. Edition	1295	1035
The Toolbox - Special	795	635

C-GENERAL LIBRARIES

	LIST	OURS
C Function Library	99	79
C TOOLS PLUS/6.0	149	109
C Utility Library	249	199
Greenleaf Functions	229	179
Greenleaf SuperFunctions	299	239
Turbo C TOOLS/2.0	149	109

C SCREENS

	LIST	OURS
C-Worthy	399	CALL
Greenleaf DataWindows	395	315
Vermont Views	495	395
Vitamin C	395	289
VC Screen	149	125

C-UTILITIES/OTHER

	LIST	OURS
Bar Code Library	389	319
"C" EMM Library	149	119
Clear for C	200	169
C Shroud	198	149
GrafPrint Plus	150	119
Developer's License	300	239
Heap Expander	80	70
MKS LEX & YACC	249	197
Objective-C	249	225
PC-lint	139	105
PCYACC Professional	495	459
TimeSlicer	295	279

CASE TOOLS

	LIST	OURS
EasyCASE Plus	295	265
Professional Pack	395	355
Personal CASE	199	179

COBOL LANGUAGE

	LIST	OURS
Micro Focus:		
COBOL/2 w/Toolset	1800	1499
Personal COBOL	149	129
MS COBOL	900	629
Realia COBOL	995	849

DATABASE DEVELOPMENT

	LIST	OURS
Clarion 2.1	895	539
Clipper 5.0	795	521
Data Junction Advanced	299	269
dBASE IV	795	495
dBFast/PLUS	345	295
dGE	295	249
Dr. Switch-ASE	180	149
Facelt	99	90
FlashTools!	89	79
Flipper	195	169
Force 2.1	695	589
FoxPro	795	489
FUNCKy Library	195	179
R&R Code Generator	150	129
R&R Report Writer	150	129
Say What?!	50	39
SilverComm "C" Interface	99	89
SilverComm Library 2.0	249	209
The Documentor	295	245
Tom Rettig's Library	100	80
UI2 Version 2	595	479

DEBUGGERS (DOS)

	LIST	OURS
MultiScope	179	139
Periscope Debuggers	CALL	CALL
Trapper	200	179
w/optional cable	240	219
Turbo Debugger & Tools	150	105

DOCUMENTING/ FLOWCHARTING

	LIST	OURS
allCLEAR	300	229
Clear for C or dBASE	200	169
C-Clearly	130	115
Flow Charting 3	250	199
Interactive Easyflow	150	125
Source Print	99	74
Tree Diagrammer	99	74

EDITORS

	LIST	OURS
BRIEF 3.0	249	CALL
EDT+	295	269
EMACS	395	315
Epsilon	195	159
KEDIT 4.0	150	125
MKSVi	149	129
PI Editor	195	175
Sage Professional Editor	295	249
SLICK Editor	195	154
Speed Edit	295	275
SPF/PC	245	199
SYNDIE	495	399
VEDIT PLUS	185	CALL

EMBEDDED SYSTEMS

	LIST	OURS
C6toPROM	149	119
Link & Locate ++	395	349
Link & Locate ++ Extended	479	395

FORTRAN LANGUAGE

	LIST	OURS
Grafmatic	135	119
Lahey F77L	595	535
Lahey Personal FORTRAN 77	99	89
MS FORTRAN	450	299
Plotmatic	135	119

GRAPHICS LIBRARIES

	LIST	OURS
Baby Driver	250	199
Essential Graphics	399	319
Font-Tools	150	119
Graf/Drive Plus Developer's	299	269
GraphiC 5.0	395	319
GSS Graphics Devel. Toolkit	795	685
GX Graphics	149	135
HALO	395	279
HALO Professional	595	419
HALO Window Toolkit	595	419
Icon-Tools/Plus	150	119
Menuet	325	279
MetaWindow	295	209
MetaWindow Plus	395	289
PCX Effects	99	89
PCX Programmer's Toolkit	195	175
PCX Text	149	135
SilverPaint	129	109
Slate w/graphics	448	399
Turbo Geometry Library	200	179

LINKERS/LIBRARIANS

	LIST	OURS
Overlay Toolkit	395	369
Plink86+	395	335
Plink/LTO	495	419
PolyLibrarian	249	209
.RTLink	295	265
.RTLink/Plus	495	359

OBJECT-ORIENTED TOOLS

	LIST	OURS
Objective-C	249	225
Smalltalk/V	100	85
Smalltalk/V 286	200	169

OS/2 TOOLS

	LIST	OURS
Brief	249	CALL
CASE:PM for C or C++	1995	1799
Epsilon	195	159
MKS LEX & YACC	349	279
MS OS/2 Pres. Manager Toolkit	500	349
MultiScope for OS/2	449	345
PCYACC	695	625
PI Editor	249	225
Smalltalk/V PM	495	369
Vitamin C (OS/2)	345	279
Zortech C++ OS/2 Devel. Ed.	600	509

PASCAL LANGUAGE

	LIST	OURS
Asynch PLUS	149	115
B-tree Filer	125	109
MS QuickPASCAL	99	69
Object Professional	189	109
ObejctVision	400	CALL
PowerTools PLUS/5.0	149	109
Topaz	99	89
Topaz Multi-user	149	135
Turbo Analyst	129	99
TurboMAGIC	199	179
Turbo Pascal 6.0	150	105
Turbo Pascal 6.0 Professional	300	205
Turbo-Plus 5.5	199	159
Turbo Professional 5.0	125	109

SOURCE MAINTENANCE

	LIST	OURS
Codan	395	345
CodeCheck	495	469
MKS Make	149	119
MKS RCS	249	199
MKS Software Mgmt. Team	299	239
PolyMake	179	149
PVCS Professional	495	419
SMS	495	399
Sourcerer's Apprentice:		
Personal	199	159
Professional	499	399
TLIB	139	109
5 Station LAN	419	339

WINDOWS (MS) TOOLS

	LIST	OURS
Actor 3.0	895	719
Asymetrix Toolbook	395	CALL
Bridge Toolkit	695	659
Case:W	995	CALL
C-Talk/Views	450	375
DialogCoder	499	435
Drover's Toolbox for Windows	295	269
w/source	885	799
MS Windows Development Kit	500	349
MultiScope for Windows	379	289
ObjectGraphics	445	365
ProtoView	695	625
Resource Workshop	300	269
Smalltalk V/Windows	500	395
Spinnaker Plus	495	349
WindowsMAKER	795	635
WinTrieve	395	339
WNDX GUI Toolbox	499	449

NEW RELEASES

Smalltalk/V Windows by Digitalk

Provides complete access to all Windows objects, including windows, menus, dialog boxes and scroll bars. Source code is portable to DOS, OS/2 and Mac versions of Smalltalk/V. Ability to call any DLL. Supports DDE. More than 150 classes and 3500 methods.

List: $500 **Ours: $395**

ESIX System V by ESIX Systems

UNIX System 3.2 operating system with 100% SVVS and SVID conformance and XENIX binary compatibility. Includes TCP/IP, Sendmail, RFS, TLI, STREAMS, and kernal support for DOS under UNIX applications.

2-user List: $399 **Ours: $349**
Unlimited List: $665 **Ours: $589**

DERIVE, A Mathematical Assistant Version 2

Productivity tool for scientists, engineers, educators, and students. Intelligently uses the rules of algebra, trig., calculus, vector and matrices to solve a wide range of math problems. Over 200 functions and variables.

List: $250 **Ours: $219**

3-D Wire-Frame, NURBS, Solids Under DOS

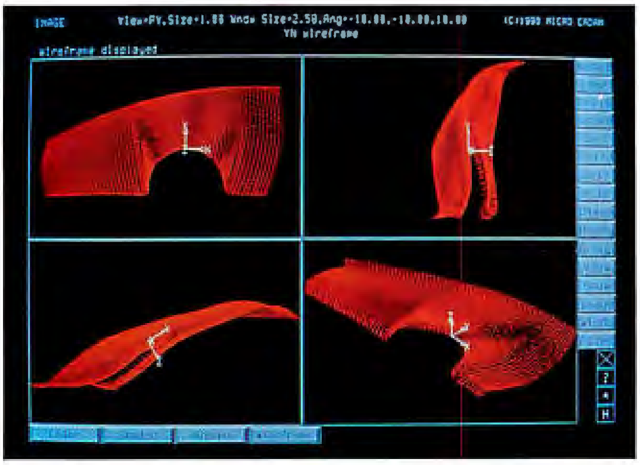
Micro Cadam 3D provides 3-D wire-frame, NURBS (nonuniform relational B-spline) surfaces, solids, and parametric design in a single module on a 386- or i486-based machine running DOS. Multiple viewports let you see an object in top, front, isometric, or true view.

By using the integrated 3-D display technology of Ithaca Software's HOOPS, Micro Cadam 3D can display shaded, high-definition images of surfaces and solids without requiring a separate rendering application, Cadam says. The program can organize individual design components into an assembly so that you can separate the items. You can also create, use, and save 3-D details of a drawing. You can associate copies of the details and text with a master file. With these associations, changes to the master are reflected in the detail drawings.

Price: Micro Cadam Plus (required), $3900; Micro Cadam 3D, $1200.

Contact: Cadam, 1935 North Buena Vista St., Burbank, CA 91504, (818) 841-9470; fax (818) 840-8428.

Inquiry 1280.



Micro Cadam 3D lets you view this automobile fender comprising several 3-D splines in four different views, each of which is a shaded rendering of the object.

Integrated Site Planning for AutoCAD 11

The latest version of Landcadd's modules for Site Planning & Landscape Design, Irrigation Design, Quadrangle, and Plant Specifier run on AutoCAD release 11, providing a way to integrate all your third-party applications on a network, the company says. New features to the modules include network compatibility, over 800 symbols, new Lisp routines, unlimited control points for creating a grid terrain model, and automatic elevation adjustments of blocks onto the terrain. The modules offer complete compatibility with any other AutoCAD applications from companies such as ASG and DCA.

Landcadd can act as a link between products from other vendors. Features of release 11 include automatic layering without forcing a layering convention on you, open ACAD.LSP files, the ability to run the program from any drive or directory regardless of what the ACAD variable is set to, and the ability to use any type of unit.

Price: Modules range from $295 to $995; complete set, $3695.

Contact: Landcadd, Inc., 7519 East Highway 86, Franktown, CO 80116, (303) 688-8160; fax (303) 688-8178.

Inquiry 1281.

A perspective view created in Landcadd's Site Planning & Landscape Design module.

3-D Conceptual Modeling on the Mac

Alias developed Upfront for architects, interior designers, and facility planners who need a natural way to create 3-D drawings during the concept phase of design. The program can export drawings to the Clipboard or in DXF, PICT II, bit-map, EPS, or Excel format.

The program supports interactive 3-D perspective sketching and drawing. It includes automatic shading in full color with hidden-surface removal. You can also use Upfront to view shadows as they would fall on a building. You can program the sun to appear as it would in real life.

Upfront runs on any Macintosh with 1 MB of RAM.

Price: $895.

Contact: Alias Research, Inc., 110 Richmond St. E, Toronto, Canada M5C 1P1, (416) 362-9181; fax (416) 362-0630.

Inquiry 1282.

Take a Walk in Your Computer

Bechtel has ported its Walkthru design animation program to Silicon Graphics' IrisVision board, bringing real-time animation technology from high-end Unix workstations to the IBM PC.

With Walkthru, you can view 3-D computer models as if you were inside them, viewing shaded images and moving through the model. The program can simulate head and body movement and the operation of objects in the model, and, when used with equipment from StereoGraphics, can produce images with full-depth perception.

The program requires an IrisVision 24-bit graphics board on the IBM PC. Walkthru is also available for the IBM RISC System/6000 and Silicon Graphics' Iris 4D.

Price: $3995.

Contact: Bechtel Software, Inc., 289 Great Rd., Acton, MA 01720, (508) 635-0580.

Inquiry 1283.

CompuAdd 333T

"Power User's Dream Machine"
— *PC Magazine*, December 25, 1990

$2775 *(66656)*

CompuAdd's Hot Slots Boost 333T Performance

PC Magazine picked the CompuAdd 333T as Editors' Choice in a December 25, 1990 review of 45 leading 33MHz 386 computers!

"CompuAdd wins Editors' Choice for its superb combination of performance, expandability, and service. ... For the best value in an intelligently designed PC, CompuAdd is worth the investment."

—*PC Magazine*, December 25, 1990

CompuAdd's innovative engineering design team produced the *fastest 33MHz 386 computer you can buy* — as measured by top scores on *seven of nine* PC Labs benchmarks, including the 386 Instruction Mix test. *PC Magazine* calls the CompuAdd 333T "a speed demon" and "a power user's dream machine."

Our engineers designed two of the system's 16-bit expansion slots to maximize performance of the CompuAdd HardCache/ESDI controller card and CompuAdd Hi-Rez VGA card. We call them "hot slots." Each slot still works perfectly with a standard 16-bit expansion card, should you choose that option. Plus CompuAdd designed the motherboard to take maximum advantage of the optional SRAM board.

333 Monitor and Hard Drive Options

		MGA	CVGA*
333T	80MB	66658 - $3575	66659 - $4175
333T	200MB	66661 - $3975	66662- $4575
333FP	80MB	66667 - $3395	66668 - $3995
333FP	200MB	66670 - $3795	66671 - $4395

* Super VGA 1024x768 monitor with CompuAdd Hi-Rez VGA controller.

With the CompuAdd 333T or desktop 333 at the heart of your network, you'll have all the power, speed and expandability you need. Speed to keep your work flowing.

Power to run today's — and tomorrow's — 32-bit software. Expandability to grow with your business. And the CompuAdd commitment to quality and service.

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Circle 52 on Reader Service Card

Get Ahead with 386 Power.
Stay Ahead with CompuAdd Value!

Call 800-999-7103

Key Code 815

CompuAdd®

Customer driven, by design.™

Award-Winning Notebook! CompuAdd Companion™ $2895

Byte Award of Excellence, January 1991

CompuAdd Companion™ Exceeds Expectations

"The critical test for any notebook computer is in the balance between size and processing power."
— *PC Computing*, December 1989

CompuAdd has what the editor expects in a portable computer. At 4.4 pounds and 1.4" thin, the new CompuAdd Companion notebook computer is what portables ought to be—light, slim and fully featured.

"Storage media may be the biggest challenge for notebook computers."

The CompuAdd Companion sports a fast, built-in 20MB (23ms) hard disk drive. You'll never have to buy volatile, expensive, hard to find RAM disk memory cards. You'll have all the reliable storage you need for applications and data files.

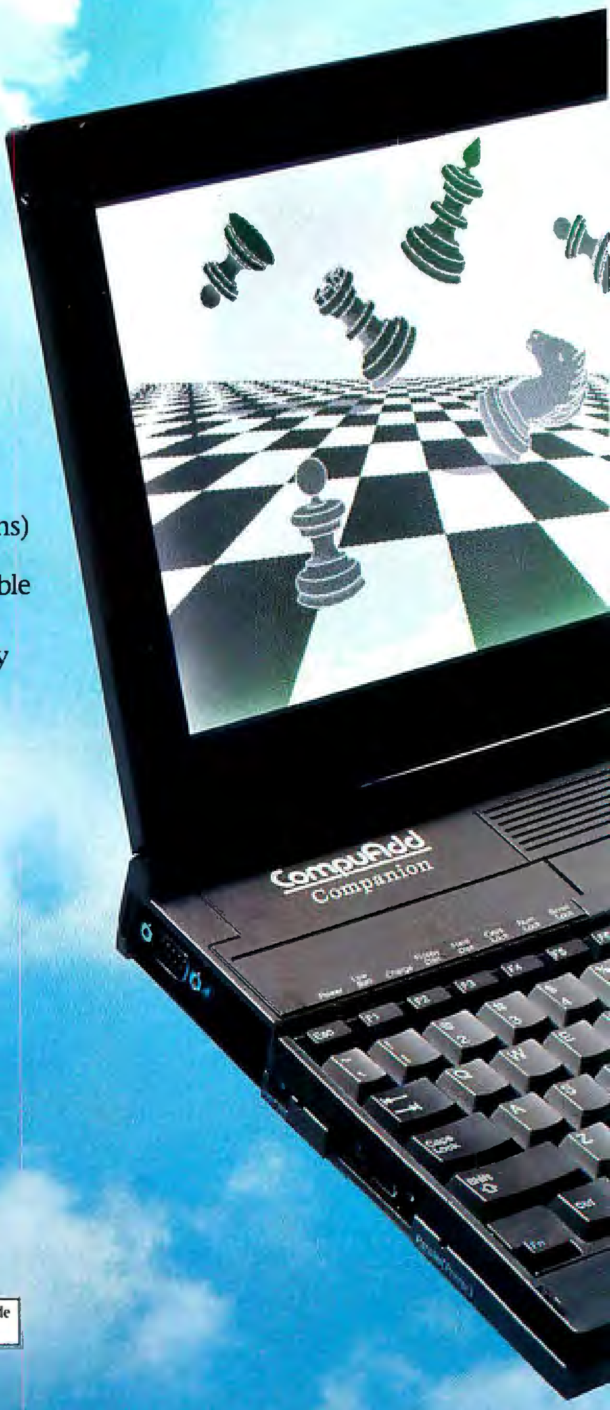
And using the pre-loaded LapLink II software, you can quickly and easily exchange files with your desktop system.

"...today's notebook screens all offer CGA resolution or better and enough contrast to allow you to work on them for hours..."

Why settle for less than a **VGA display** with the highest resolution and best contrast? The CompuAdd Companion has a bright, 640 by 480 pixel, 10-inch, sidelit LCD screen.

"The PC must be large and powerful enough to do useful work but small enough to fit into a briefcase."

The CompuAdd Companion uses the Intel™ 80C286 microprocessor running at 12MHz, and can handle sophisticated software applications, like Windows 3.0, Lotus 1-2-3™ and WordPerfect™ 5.1. It's compatible with MS-DOS and OS/2. The standard 1MB DRAM is expandable to 3MB.



Call TODAY or visit your CompuAdd Superstore for these sa ings!

Key Code 814

800-456-6008

Hours: Monday - Friday 7:00am to 9:00pm CST; Saturday 9:00am to 5:00pm CST

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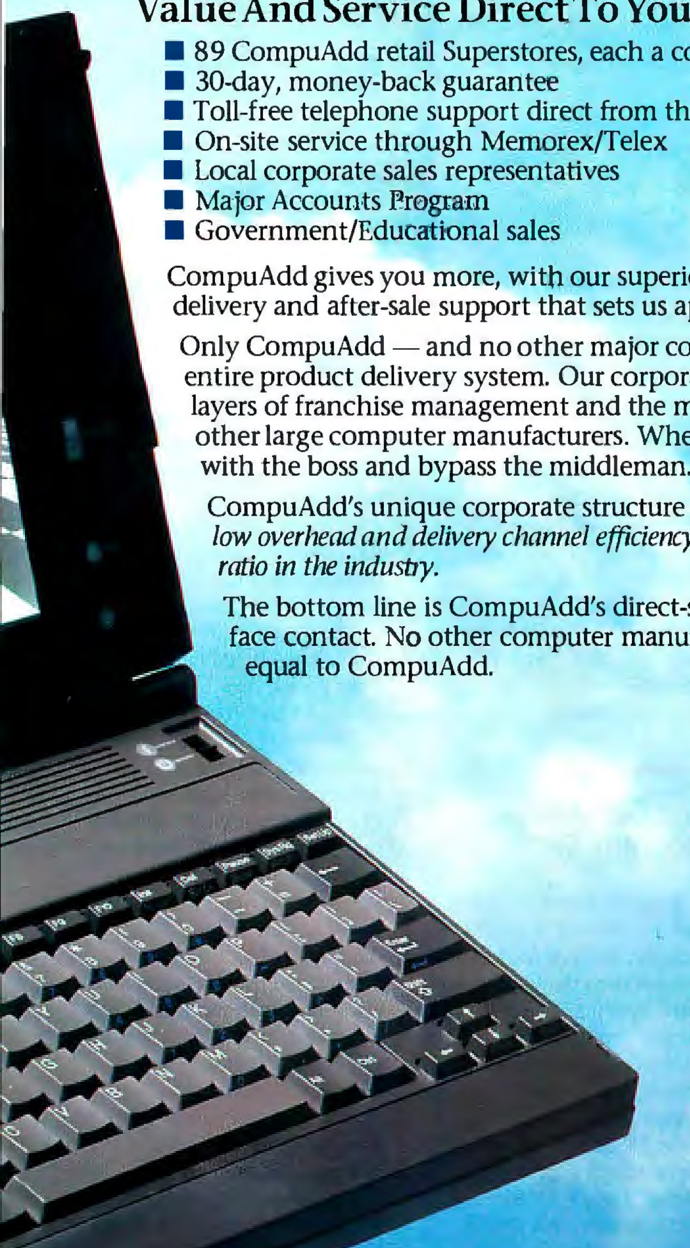

Value And Service Direct To You!

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- Toll-free telephone support direct from the manufacturer
- On-site service through Memorex/Telex
- Local corporate sales representatives
- Major Accounts Program
- Government/Educational sales

CompuAdd gives you more, with our superior, exclusive method of product delivery and after-sale support that sets us apart from other manufacturers.

Only CompuAdd — and no other major competitor in the industry — owns the entire product delivery system. Our corporate structure eliminates the multiple layers of franchise management and the middleman overhead you encounter at other large computer manufacturers. When you deal with CompuAdd, you deal with the boss and bypass the middleman.

CompuAdd's unique corporate structure and delivery system means we maintain *low overhead and delivery channel efficiency to bring you the best price/performance ratio in the industry.*

The bottom line is CompuAdd's direct-supplier relationship and local, face-to-face contact. No other computer manufacturer has made a service commitment equal to CompuAdd.

CompuAdd Companion Features:

- 80C286 microprocessor running at 6,7.16, or 12MHz
- Standard 1MB high speed dynamic RAM expandable to 3MB
- 1 wait-state page-mode memory
- Dedicated 80C287 math coprocessor socket
- Built-in serial, parallel printer, numeric keypad, and modular expansion ports can be used for external CVGA monitor or modem/fax interface modules
- High-resolution 640×480 VGA display
- 20MB hard disk drive with 23ms access time
- 79-key keyboard with 101-key emulation
- MS-DOS 4.01 and LapLink II in ROM
- Rechargeable/removeable internal battery pack
- Modular AC adapter
- Dimensions: 8.5"×11"×1.4"
- **System Price: $2895** *(62280)*

CompuAdd®

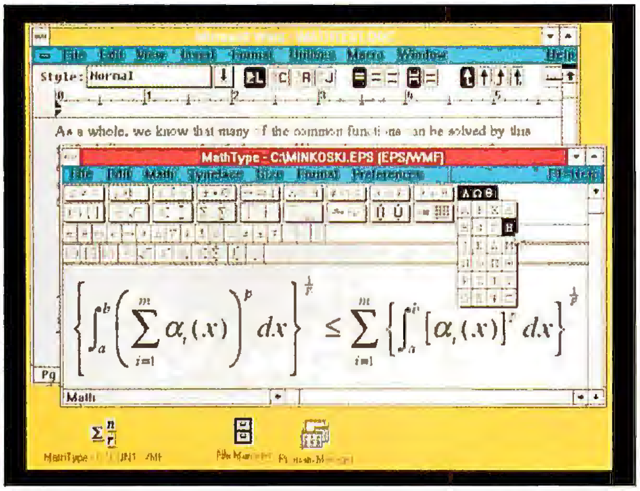
Customer driven, by design.™

12303 Technology Boulevard, Austin, TX 78727

We accept MasterCard, VISA, money orders, certified checks and personal checks (please allow 10 days for processing); CODs ($50 minimum order), company and institutional purchase orders (minimum initial purchase $500, thereafter $50), and wire transfers.

Please add 2% to all purchases for shipping and handling (minimum $3, shipping outside the continental United States will increase cost). Add 8% for shipping and handling to APO/FPO addresses (minimum $10). AZ, CO, CT, DC, FL, GA, IL, IN, KS, LA, MA, MD, MI, MN, MO, NC, NE, NJ, NM, NY, OH, OK, PA, RI, SC, TN, TX, UT, VA, and WI residents, please add appropriate local sales tax. Thirty-day money-back guarantee does not include return freight or shipping and handling. Opened software, videotapes and other consumables are nonrefundable. All return items must be accompanied by a return merchandise authorization (RMA) number. Prices and product descriptions are subject to change without notice. CompuAdd is not liable for damage due to omissions or typographical errors. Call 800-666-1872 for a copy of CompuAdd's complete warranty.

Circle 53 on Reader Service Card



Programs such as MathType let you do mathematical and scientific word processing without resorting to special key combinations and codes.

Three Science Word Processors

Design Science's MathType is an intelligent mathematical equation editor for Windows or the Mac that lets you construct equations by clicking on symbols and templates from menus and typing in details. The program is designed to work with another word processor.

MathType automatically sizes, spaces, and positions symbols and uses the correct typeface for standard function abbreviations such as log and sin. Once you create an equation in the Windows version, you can save it in EPS, TIFF, WMF, or Aldus Placeable Metafile format and place it in the document. MathType for Windows also supports Dynamic Data Exchange for Microsoft Word for Windows and Ami Professional.
Price: MathType for Windows, $249; Macintosh version, $149.
Contact: Design Science, Inc., 6475-B East Pacific Coast Hwy., Suite 392, Long Beach, CA 90803, (213) 433-0685; fax (213) 433-6969.
Inquiry 1284.

MathWriter 2.0, the Scientific Word Processing Program for the Macintosh, includes features standard to a general word processing program such as a spelling checker, thesaurus, and automatic hyphenation, Brooks/Cole reports. With MathWriter, you can create documents in WYSIWYG mode, editing text and mathematical expressions in the same document without leaving the program.

The program automatically sizes and centers math symbols, italicizes variables, formats tables and matrices, and shows on-screen renumbering of both equations and references to equations. A revision feature lets you track insertions and deletions while you retain the original version. You accept or reject changes individually or globally.
Price: $395; student version, $99.
Contact: Brooks/Cole Publishing Co., 511 Forest Lodge Rd., Pacific Grove, CA 93950, (408) 373-0728; fax (408) 375-6414.
Inquiry 1285.

ChiWriter combines a word processor and WYSIWYG equation editor running on the IBM PC under DOS. Version 4.0 lets you select symbols from a menu and place them in your document without requiring special modes or encoding. The program lets you undo and redo up to 100 keystrokes.

With ChiWriter you can edit up to 10 documents at once and cut and paste among them. Documents can be as long as you like; if the document exceeds available memory, the excess is swapped to disk. ChiWriter supports split footnotes, variable headers and footers, and automatic paragraph formatting.
Price: $349.95.
Contact: Horstmann Software Design Corp., Four North Second St., Suite 500, P.O. Box 1807, San Jose, CA 95109, (800) 736-8886 or (408) 298-0828; fax (408) 298-6157.
Inquiry 1286.

Unit Conversion Program

Units on Hand, available as a TSR or Windows application, lets you convert units between the English and metric systems. The program also performs unit consistency checks to prevent you from converting a volume to an area or other unit.
Price: $49.95.
Contact: NovaComp Engineering, Inc., P.O. Box 95137, Seattle, WA 98145, (206) 634-9016; fax (206) 634-9017.
Inquiry 1287.

SPREAD THE WORD

Your new product is important to us. Please address information to New Products Editors, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Better yet, use your modem and mail new product information to the microbytes.hw or microbytes.sw conferences on BIX. Please send the product description, price, ship date, and an address and telephone number where readers can get more information.

Numerical Methods, Engineering Packs for MathCAD

MathSoft's Numerical Methods and Civil Engineering Applications Packs for the IBM PC, Macintosh, and Unix platforms contain a number of applications for frequently performed tasks in each area, the company reports. The packs work with MathCAD, the company's program for equation editing, calculating, and plotting.

The 26 applications in the Numerical Methods Pack cover such topics as partial differential equations, polynomials, applications of contour integration, ordinary differential equations, integral equations, iterated mappings, and testing for primes.

The Civil Engineering Packs are divided into two separate packs, one for structures and materials and the other for soil mechanics and hydraulics. Key topics in the first pack include area of tension steel required for symmetrical T-beams, determination of settlement of foundations, structural design for footings (working stress design), and the design of retaining walls. The second pack includes applications for flow classification and critical depth for open rectangular channel flow, design of flocculators, determination of soil permeability from pumping test results, and soil consolidation ratio.

The application packs use MathCAD's complex arithmetic, matrix operators, equation-solving power, and plotting capabilities.
Price: $99 each.
Contact: MathSoft, Inc., 201 Broadway, Cambridge, MA 02139, (617) 577-1017; fax (617) 577-8829.
Inquiry 1288.

TAX PREPARATION

Softview's Tax Family

Softview's Taxview Professional Series, previously available for the Mac, is now available for Windows 3.0. Also new from the company are Client Organizer, Client Write-Up, new federal forms, and six new state supplements.

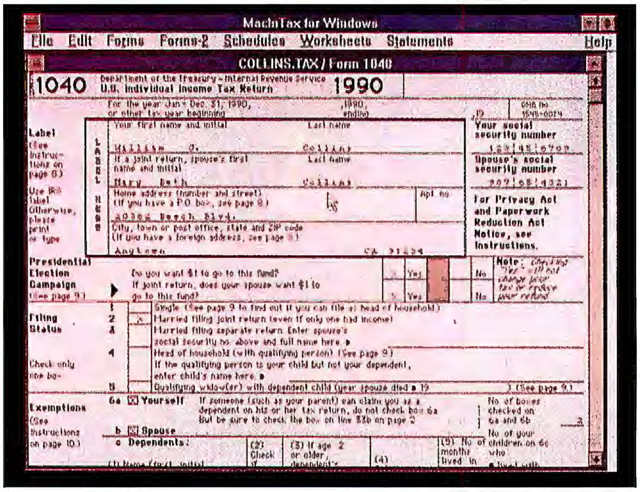
The Client Organizer module, included with Taxview 1040, helps clients gather and summarize tax data. New forms included with Taxview 1040 are 2210F Farmers Underpayment of Estimated Tax, 3903F Foreign Moving Expenses, 8822 Change of Address, and TD F90-22.1 Report of Foreign Bank Accounts.

Taxview 1120, 1120-S, and 1065 include more depreciable assets and support for short year and fiscal year returns. Taxview 1065 and 1120-S automatically calculate sharing percentages and include many new forms. Forms, schedules, statements, and worksheets are available for 14 states.

Client Write-Up, also for the Mac or Windows, an accounting package for automated bookkeeping that provides unlimited customized reports through access to Microsoft Excel, is integrated with Taxview and available for $495 for Taxview users.

The if:X Personal Tax Analyst, included free with Taxview 1065, 1120, and 1120-S, lets you compare the five-year cumulative results of as many as five different tax scenarios within a single study. It also calculates W-4 and 1040ES forms.

MacInTax for Windows and the Mac include a Forms Guide, a question-and-answer interview that helps you determine which forms to complete. The program includes many forms, including 1040EZ, 1040X, 1040ES, and 4868, and built-in electronic filing.



MacInTax for Windows displays and prints exact replicas of IRS forms, complete with data, without requiring additional fonts.

Price: Taxview 1040, $495; Taxview 1065, 1120, and 1120-S, $395 each; state supplements, $69 each; Taxview/Speed>S module, $199; if:X Personal Tax Analyst, $79; MacInTax, $99.
Contact: Softview, Inc., 1721 Pacific Ave., Suite 100, Oxnard, CA 93033, (800) 622-6829 or (805) 385-5000, fax (805) 385-5001.
Inquiry 1172.

TaxCut for the IBM PC

Meca Software says that its TaxCut program includes 55 forms and schedules, 10 worksheets, and its Expert Advisor for walking you through the tax-preparation process step by step. TaxCut calculates and prints any IRS-acceptable 1040 on any type of printer, the company says.

The program is also available in versions for 10 states.

Meca says the personal version of TaxCut is certified by a Big Six accounting firm with guaranteed accurate calculations, or Meca pays the penalty.
Price: $89.95; state versions, $39.95 each.
Contact: Meca Software, Inc., 327 Riverside Ave., Westport, CT 06880, (203) 222-9150 or (203) 226-2400, fax (203) 226-2480.
Inquiry 1174.

RapidTax for the IBM PC

Sylvia Porter's RapidTax includes built-in electronic filing software and an IRS Audit Detector that alerts you any time a deduction exceeds IRS limits (based on historical data from the IRS), which could prompt an audit. If you're married, RapidTax can determine if filing separately is your best option. The program includes a tutor, Form Help, and an interview/input mode for collecting your financial information. A professional version, which has client write-up, billing, and other modules, is available for 1040 preparation.

DacEasy, publisher of the program, is offering 38 state versions in five regional packages. When you buy a Regional State Tax Filer, which interfaces with RapidTax, you get up to nine individual states. RapidTax also includes Light Checkbook Accounting, a checkbook and financial management program.
Price: $79.95; Regional State Tax Filer, $49.95 each; professional version, $399.
Contact: DacEasy, Inc., 17950 Preston Rd., Suite 800, Dallas, TX 75252, (800) 877-8088 or (214) 248-0205, fax (214) 250-3752.
Inquiry 1175.

TurboTax for the PC and Mac

The Logical Next Step feature of TurboTax walks you through each step as you prepare your tax return, ChipSoft says. In addition to an interview for getting a handle on what to do, the program includes a "file cabinet" for entering data by subject, and a forms finder.

TurboTax offers more than 60 forms, schedules, and worksheets, and it can print all forms in a graphical format on dot-matrix and laser printers without requiring special font cartridges. TurboTax for the IBM PC has 44 state versions; the Mac version supports 11 state returns. Both versions support tax planning, for tracking your 1991 finances after you file the return.

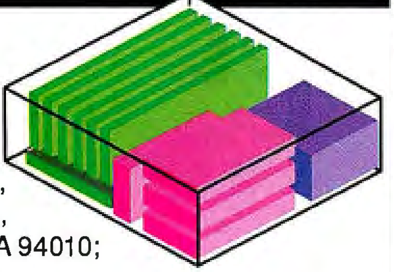
ChipSoft also offers a ProSeries of programs for 1040, 1041, 1065, and 1120-1120S returns.
Price: Personal 1040 for the IBM PC, $75; Personal States, $40 each. Personal 1040 for the Mac, $89; Personal States, $49 each. ProSeries: 1040, $395; 1041, $395; 1065, $295; 1120-1120S, $395; state versions, $250 each.
Contact: ChipSoft, Inc., P.O. Box 85709, San Diego, CA 92186, (619) 453-4446, fax (800) 755-1040 or (800) 366-5538.
Inquiry 1173.

A Winner.

We didn't say it. PC Magazine did.

PC MAGAZINE FACT FILE

EDITORS' CHOICE



Tangent 386SX/20
Tangent Computer, Inc., 303 Beach Rd., Burlingame, CA 94010; (800)223-6677, (415) 342-9388.

List Price: With 1MB RAM, 1.2MB 5.25-inch or 1.44MB 3.5-inch floppy disk drive, one parallel and two serial ports, VGA monitor, $1,644; with 2MB RAM, 60MB hard disk, DOS 4.01, $2,278; with 105MB hard disk, $2,384.
In Short: An excellent contender with above-average electronics and hard-working peripherals, the Tangent 386SX/20 adds an FCC Class B certification to the pile to make it an extremely attractive computer for either home or office.

"The 20 MHz 80386SX is the new entry-level business system of choice, starting right now."
PC Magazine

Best choice of the best choices.
Here's how PC Magazine summed up the Tangent 386™SX/20 (Tangent's Model 320s):

"The Tangent 386SX packs outstanding video, expandability to 8 MB, and plenty of free slots into a nicely reduced-size case. The price is right too. This PC offers a 105 MB hard disk and Orchid's ProDesigner II Super VGA card for a mere $2295. Add in clear documentation and on-site service (with Tangent's one-year warranty) and you have a solid winner."

"The Tangent 386SX/20 is the best of the show; it garnered top scores in all of our video tests."

A system with a future. The Tangent 386SX/20 runs all of yesterday's programs. All of today's. And most important, tomorrow's. Because it implements the full Intel 80386 feature set.

Circle 623 on Reader Service Card

Standard Configuration:
- Intel 20 MHz 80386SX CPU **$2295**
- 2 MB of Memory (to 8 MB)
- 105MB 17ms Quantum Hard Disk
- Orchid ProDesigner IIe SuperVGA Card
- 14" SuperVGA Color Monitor
- Small Footprint Case w/200W Power Supply
- 5.25" or 3.5" High Density Floppy Drive
- Coprocessor Socket
- One Parallel, Two Serial, One Game Port
- 101-key Enhanced Keytronics Keyboard
- One-year Warranty with On-site Service

PC MAGAZINE
EDITORS' CHOICE
November 27, 1990
Tangent 320S

Why buy their computer, when we'll build yours?
High performance. Low price, Tangent offers you a complete line of high performance systems: 20 MHz 80386, 25 and 33 MHz 80386SD, and award winning 25 and 33 MHz 80486. All, at what some people think is the best price-to-performance ratio in the business.

Built your way. Dealing with Tangent is like owning your own computer factory. Tell us exactly how you want your system configured, we'll build it, test it, and ship it. Your way. And even though it's your configuration, it carries our one-year warranty.

PC Magazine's windup: *"Add an FCC Class B rating and a one-year warranty on parts and labor that includes on-site service into the bargain, and you begin to suspect that the Tangent 386SX/20 is a winner. Consider the price/performance ratio of the computer and that suspicion starts to look like a certainty."* Bill O'Brien, PC Magazine, 11/27/90

Thanks Bill. We couldn't have said it better.

Order now, Toll Free:
1-800-223-6677

TANGENT
COMPUTER

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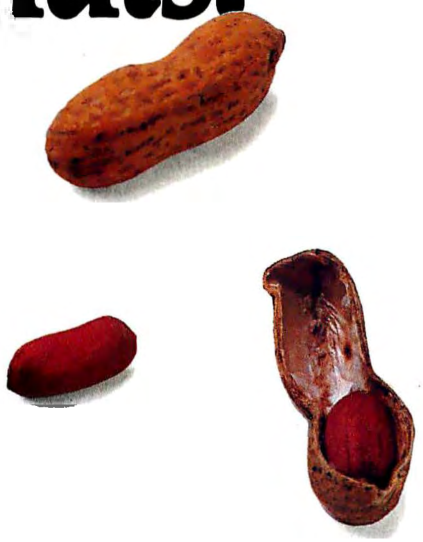
PostScript for peanuts.



At last, low-cost, high performance PostScript® printing! This complete solution for PC publishers is yours for peanuts — from The Printer Works.

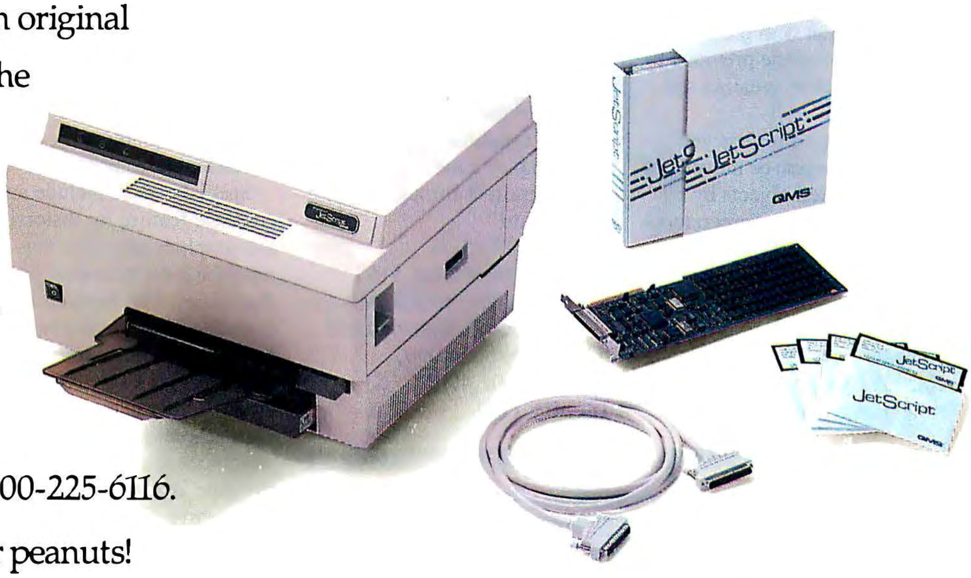
For as little as $995.*

That's all it takes to command this powerful system consisting of a Canon CX™ printer for superb print quality. Plus a QMS JetScript™ controller which adds true Adobe PostScript, in 35 different fonts, for trouble-free compatibility with all your favorite applications.

Now, for only $995, you can easily produce stunning type and graphics that will make you look like a desktop wizard. And you can do it faster than with PostScript cartridges because JetScript has its own high speed processor and 3 megabytes of RAM.

JetScript was developed jointly by Adobe Systems, QMS and Hewlett-Packard to bring the power of PostScript to the HP LaserJet™ Series II. If you already have an HP LaserJet II, or an original LaserJet, you can get the JetScript controller separately for as low as $495. That's a whopping 80% below the list price!

Don't delay, call The Printer Works. 1-800-225-6116. And get PostScript for peanuts!



* JetScript with refurbished Canon CX printer, $995
JetScript with NEW Canon CX printer, $1295
JetScript for original HP LaserJet or LaserJet Plus, $695
JetScript for OEM CX (Cordata Etc.), $595
JetScript for HP LaserJet II, $495

Prices subject to change, quantities limited. Dealer Inquiries Welcome

THE PRINTER WORKS

3481 Arden Road, Hayward, CA 94545

Circle 624 on Reader Service Card (RESELLERS: 625)

Making Movies on the Mac

Animation Works is a 1- to 8-bit color program for combining graphics, text, and sound into animations without making a giant commitment to training or hardware, Gold Disk says. You can use the program to create animated storyboards, simulations, sales presentations, and low-end video productions.

With the program's cel editor, you create and edit animated characters (i.e., cels). The movie editor lets you combine the animation with static or scrolling backgrounds that you've made with the background editor.

The cel editor includes tools for creating the different cels that make up the animation. An onion skin feature enables you to see the previous or next cel while creating the current cel.

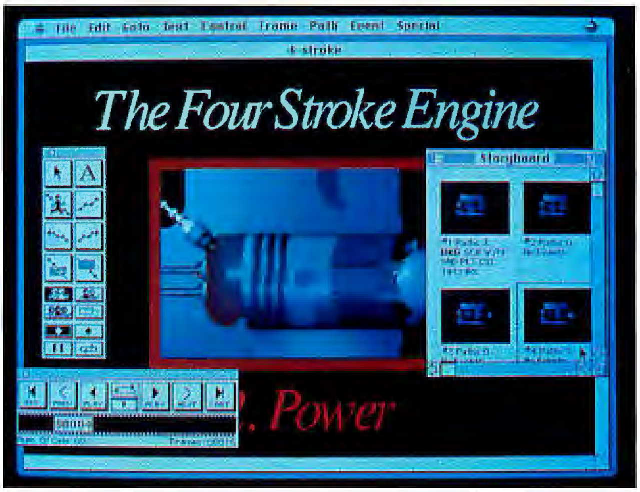
The movie editor lets you define the motion or movement of the animated objects by creating paths. On-screen tools like line and elliptical paths with horizontal or vertical accelerations help you create smooth, realistic motion, the company says. You can define the path one frame at a time or register the motion selectively, as on a hand or foot. Within the movie editor, you can add sound, add coloring effects, and use a variety of wipes.

Animation Works imports standard audio files (e.g., MacRecorder, PICS, and PICT). Also included is a runtime player and external commands and functions for use from within HyperCard. Length of the movie is limited only by available memory. You can play a movie from the program or through HyperCard.

Price: $199.95.

Contact: Gold Disk, 5155 Spectrum Way, Unit 5, Mississauga, Ontario, Canada L4W 5A1, (416) 602-4000, fax (416) 602-4001.

Inquiry 1177.



Gold Disk's Animation Works lets you put color, sound, text, and graphics in motion on the Mac.

In addition to its perspective, extrude, and blend features, CorelDraw 2.0 lets you design your own typefaces.

Corel Steps Out with CorelDraw 2.0

CorelDraw 2.0 adds a suite of special effects and the ability to convert its 153 typefaces to Adobe's Type 1 format. By using CorelDraw as a font editor and the WFNBOSS conversion utility, you can create new display fonts and print them on any PostScript laser printer.

Special effects include an envelope feature for distorting any graphics object by manipulating the bounding box of that image. The perspective feature gives objects a sense of depth by moving some of the edges farther away than the others. Other new effects create three-dimensional appearances and blend objects to create an effect similar to tweening.

CorelDraw 2.0's new visual file manager, Mosaic, supports batch printing and exporting.

The CorelTrace auto-tracing utility can now trace color and gray-scale bit maps.

Price: $695.

Contact: Corel Systems Corp., Corel Building, 1600 Carling Ave., Ottawa, Ontario, Canada K1Z 8R7, (613) 728-8200, fax (613) 728-9790.

Inquiry 1179.

ZSoft Puts Pixel Editing on the PC

Publisher's Paintbrush 2.0 includes new paint tools, editing and enhancement features, and multiple open windows. With the multiple windows, you can zoom in for precise pixel editing and see how the changes look in normal view in another window. You can also zoom out to edit larger-than-screen-size images.

New paint tools include an adjustable airbrush, gradient fills, and tiling for creating three-dimensional effects and other textures. An eyedropper feature lets you lift color from a single pixel and place it in the program's color palette. New editing features let you sharpen, blend, tint, smudge, or adjust brightness and contrast of any image portion.

Price: $495.

Contact: ZSoft Corp., 450 Franklin Rd., Suite 100, Marietta, GA 30067, (404) 428-0008.

Inquiry 1178.

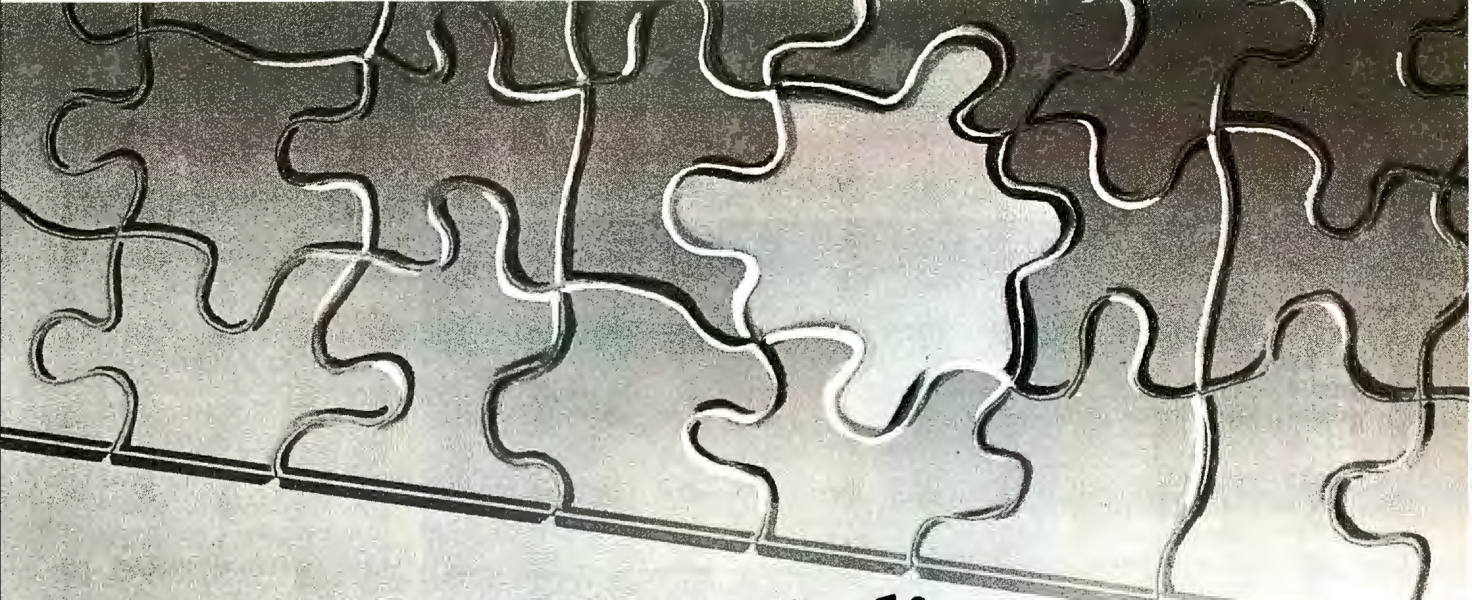
Portfolio for the Bubble-Jet

Portfolio, the integrated software package for creating presentation graphics, video, and electronic prepress, is now available for the Canon Bubble-Jet printer. Portfolio offers raster- and vector-based capabilities in the same package, along with graphing, fonts, drafting, and image editing on a 386-based machine.

Price: $3000.

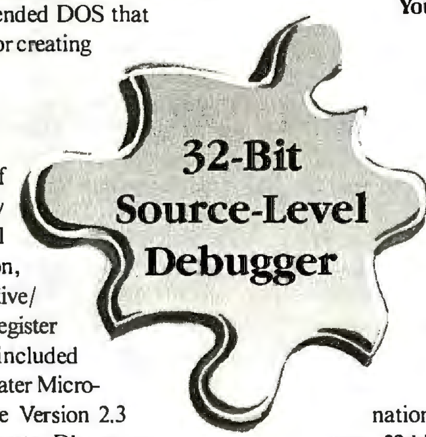
Contact: Wasatch Computer Technology, 123 East 200 South, Salt Lake City, UT 84111, (801) 575-8043, fax (801) 575-8075.

Inquiry 1180.



MetaWare Delivers The Essential Tool For C

Way back in 1986, MetaWare delivered the first 32-bit protected-mode DOS compiler for the 386. Our High C compiler set the standard for professional software developers. High C DOS 386/486, **Version 2.3**, brings important features to extended DOS that our UNIX C customers have come to rely on for creating lightning-fast executable code:



True Globally Optimizing Technology

Global Optimizations that increase speed of code execution include: constant and copy propagation, constant expression folding, local *and* global common subexpression elimination, removal of invariant expressions from loops, live/dead analysis, dead code elimination, global register allocation, and tail merging. We've also included faster libraries with ANSI conformance and greater Microsoft compatibility. These optimizations make Version 2.3 generate 46% better Whetstone code and 15% better Dhrystone code than our previous version. But one piece was still missing:

True 32-Bit Source-Level Debugging

Our customers really needed a MetaWare-quality 32-bit, source-level debugger. It had to offer a friendly user interface with color or monochrome windows, featuring pull-down and pop-up menus. They needed to watch or edit data, registers, and breakpoints through windows that displayed: flags, memory in any format, variables, stack data, 387 registers, locals, globals, structs, pointers, modules, and more! **We've delivered!** MetaWare's 386 protected-mode debugger features source-level symbolic debug capabilities. High C users can tackle even the largest DOS C programs and debug code on the host or a remote DOS machine, via a standard serial port.

In an ever-changing, puzzling, multi-platform world, it's reassuring to know that:

Your Code is Portable to Other Platforms

Many professional programmers are delighted to discover that their existing High C programs may be easily ported to many other popular platforms, including MS-DOS, FlexOS, OS/2, UNIX System V 386/486, Sun 386*i*, Sun-3, Sun-4, SPARC, and IBM AIX on PS/2, RT, i860, and 370, IBM AOS 4.3 on RT and 370, Am29K, Motorola 680x0, and Intel i860. And we're already talking with several of our OEMs about porting the debugger to these and other new platforms.

Our customers who are already using the combination of High C and the new debugger all agree that the new, 32-bit source-level debugger is *the essential tool* for the only compiler you need.

MetaWare®
INCORPORATED

Compiler Products for
Professional Software Developers
High C® • Professional Pascal®

2161 Delaware Ave. • Santa Cruz, CA • 95060-5706 • 408/429-6382 • Fax 408/429-9273

Circle 619 on Reader Service Card

New Systat Integrates Graphics and Analysis

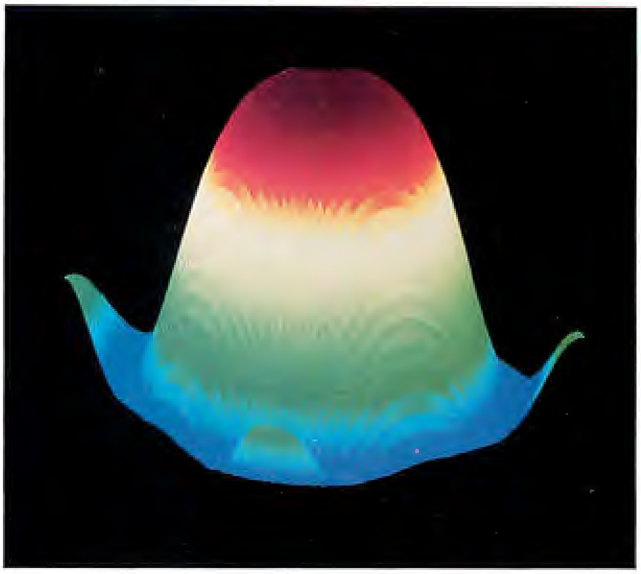
Systat 5.0 integrates graphics and analysis procedures. New graphing capabilities include spherical mapping, dot plots for displaying densities, arrow or vector plots for fluid flow and other problems, and weather-vane plots. A new spinning procedure lets you view data in three dimensions.

Enhancements to model estimation and the Multivariate General Linear Hypothesis testing capabilities include support for the means model for designs that have missing cells or cells with unequal *n* values that reflect population differences. Additional hypothesis tests include new post hoc methods (e.g., Scheffé, Dunnett one- and two-sided, and Bonferroni). The program also has a variety of other statistical procedures.

Price: $895.

Contact: Systat, Inc., 1800 Sherman Ave., Suite 801, Evanston, IL 60201, (708) 864-5670.

Inquiry 1182.



Systat 5.0 for DOS lets you analyze data and graph it in color.

Exact Testing Goes Small

With StatXact, you can compute exact p-values and exact confidence intervals for small sample sizes, discrete categorical data, and imbalanced data. Cytel Software says that the program eliminates the uncertainty associated with using the asymptotic approach for these kinds of data sets.

The program runs on the IBM PC with 640K bytes of RAM and a math coprocessor.

Price: $495.

Contact: Cytel Software Corp., 137 Erie St., Cambridge, MA 02139, (617) 661-2011, fax (617) 661-4405.

Inquiry 1184.

Economic Analysis on OS/2, Mac

Economists who need to do econometric analysis on Mac, DOS, OS/2, or Presentation Manager can use Shazam 6.2, which supports Heteroskedastic and ARCH (Autoregressive Conditional Heteroskedastic) models. In addition to those functions normally found in statistical packages, Shazam 6.2 calculates auto-correlation consistent covariance matrices and hypergeometric distributions, and it solves nonlinear simultaneous equations.

Price: OS/2 version, $395; other versions, $295.

Contact: Shazam, University of British Columbia, Department of Economics, #997-1873 East Mall, Vancouver, BC, Canada V6T 1W5, (604) 228-2876, fax (604) 228-5915.

Inquiry 1185.

AI Stats Program Forecasts Thousands of Items

Forecast Pro, the program that uses AI to help you choose the correct methodology for historical-data forecasting, can now forecast hundreds or thousands of items automatically. The Forecast Pro Batch Version uses a variety of univariate methods and can interface with databases and production planning systems, according to Business Forecast Systems.

You can choose from techniques like simple moving average, exponential smoothing, and Box-Jenkins, or let the program choose them for you. For tracking forecast accuracy, the program provides exception reports, monitoring for forecast bias, and a built-in forecast evaluation system. Both DOS and OS/2 versions are available.

Price: $3995.

Contact: Business Forecast Systems, 68 Leonard St., Belmont, MA 02178, (617) 484-5050.

Inquiry 1183.

Two Stat Packages from SPSS

SPSS restructured its pricing policy and added features to version 4.0 of its statistical analysis package for DOS systems. Another package, SPSS for OS/2 4.1, takes advantage of the High Performance File System and Dynamic Data Exchange and has direct links to Microsoft Excel and Structured Query Language databases.

The base module of the IBM PC version contains data and file management facilities, several basic statistical procedures, a report writer, and network support. Graph-in-the-Box, New England Software's TSR graphing program, is included. From the base SPSS/PC+ 4.0 module, you can add other modules for your purposes, including a new mapping option from MapInfo for creating thematic maps. Other modules are available for additional statistical procedures, forecasting, and graphics.

The OS/2 version is a full port of SPSS 4.0 for mainframes and runs under Presentation Manager. It includes a logistic regression command and support for matrix commands. The OS/2 base system lets you extract data directly from Oracle, SQL Server, and IBM Database Manager and read it directly into SPSS for OS/2.

Price: SPSS/PC+ 4.0, $195; add-on modules start at $295 when purchased with the base, $395 if purchased later. SPSS for OS/2 4.1, $995.

Contact: SPSS, Inc., 444 North Michigan Ave., Chicago, IL 60611, (312) 329-2400.

Inquiry 1181.

CACHE SAVINGS

LT 5200 Series Laptops

TWO FULL 16 BIT EXPANSION SLOTS
"Flexibility of a Laptop, Power of a Desktop"

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- 2 Serial/1 parallel/ 2 Game port
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Design Tool for Motif Interfaces

Integrated Computer Solutions developed Builder Xcessory to help reduce the development time needed for creating OSF/Motif-based user interfaces for the X Window System. You can use Builder Xcessory, a paint-like tool for building, prototyping, and testing interfaces, by clicking icons and moving them within the interface. Builder Xcessory lets you test and modify the interface without compiling, according to the company.

Because you're manipulating Motif objects, output code exactly matches what you see, the company says. Builder Xcessory outputs C, Motif/User Interface Language, make files, and X Resource files. Because the Builder can read in UIL files, you can use it to modify existing programs.

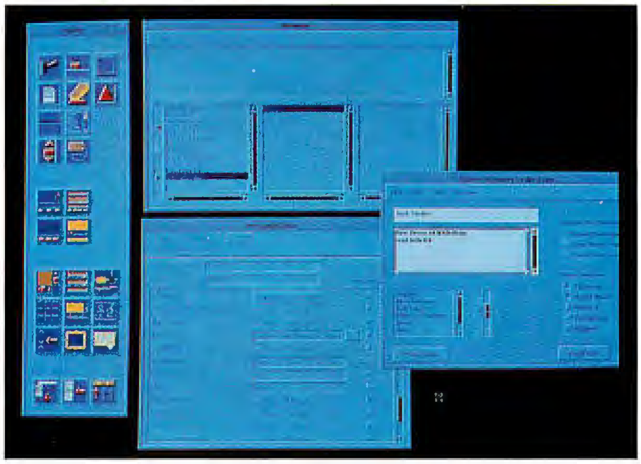
Price: $2500.
Contact: Integrated Computer Solutions, Inc., 201 Broadway, Cambridge, MA 02139, (617) 547-0510, fax (617) 547-0758.
Inquiry 1189.

Programmer's Editor for Windows

CView 1.0 lets you write your Windows application in the Microsoft Windows 3.0 environment and includes the entire C source code.

Eastern Language Systems says that CView features automatic reformatting of files to standard C style, search and replace, and access to Windows SDK help.

Price: $99.
Contact: Eastern Language Systems, 39 West 300 North, Provo, UT 84601, (801) 377-4558, fax (801) 377-2200.
Inquiry 1188.



The Builder Xcessory resource editor lets you view and modify the resources of any Motif widget. The browser lets you navigate the interface hierarchy.

Build GUIs for Windows, Mac, Sun

With the Tigre Programming Environment, you can develop color graphical user interfaces that run without modification on Windows 3.0, the Mac II family, and a host of Unix workstations. Written in and based on Objectworks\Smalltalk, the object system comprises the Tigre Interface Designer and the Tigris multiuser object database system.

With the environment, you can develop applications with full-motion video and sound running over a mixed network. Supported workstations include the Sun-3, Sparcstation, IBM RISC System/6000, Digital DECstation, Hewlett-Packard 9000 series, and Apollo Series 2500, 3500, and 4500.

Once you select an interface object that you need and place it on the screen, you can visually control characteristics like position, border weight, and shape. You can graphically set and change the connections between the interface and logic, the company reports. The interface designer includes a library of user interface object classes.

Price: $3495.
Contact: Tigre Object Systems, Inc., 3641C Soquel Dr., Soquel, CA 95073, (408) 476-1854, fax (408) 479-4196.
Inquiry 1187.

One-Step Mixed Make in Brief

Turbo Brief enhances Solution Systems' Brief programming editor by letting you choose from two key maps: Turbo Brief's key assignments that are consistent with Borland's Turbo Debugger and Power Brief, a key set that enhances the original Brief key assignments. Turbo Brief's integrated make utility for mixed languages combines warnings from several assemble/compiles into one error window, OurSoft says.

Turbo Brief can jump from one error to the next in different source files and languages like Pascal, C, and assembly without exiting the environment. By a single step with a hot key, you can go right to the offending line.

The program lets you edit, make, debug, compile, and run from within Brief using your favorite debugger.

Price: $199.50.
Contact: OurSoft, P.O. Box 6396, Bellevue, WA 98008, (206) 643-0204.
Inquiry 1190.

Object Programming in C

For those wanting to add object functionality to a C program without taking the deep plunge into C++, Bogie Hardware says that its OOC Libraries add message passing, methods, and classes to C programs without special preprocessors. The OOC Libraries do this in several ways.

According to Bogie Hardware, you describe data structures in a program as objects and the functionality of the program in terms of routines, or methods, that operate on those objects. Messages to methods replace subroutine calls. In this case, the libraries replace the use of a compiled object language like C++. You can also use the libraries to create a standalone TR prototyping development environment.

TR is an interpreted object language that is accessible through OOC Library function calls. It supports a full compiler and byte-code interpreter and interoperability between C and TR.

You can use the libraries to create a hybrid application program consisting of object C and TR components, creating an application that's partially compiled and partially interpreted, the company says.

The OOC Libraries are the first step in the development of a portable, persistent object storage system, the company says. Programs that use the libraries are portable to the Mac, IBM PC, DEC VAX, and Sun Unix.

Price: Single-user license, $150; network platform starts at $450.
Contact: Bogie Hardware, Inc., 502 Berlin Rd., Pittsburgh, PA 15221, (412) 371-9449, fax (412) 371-0737.
Inquiry 1186.

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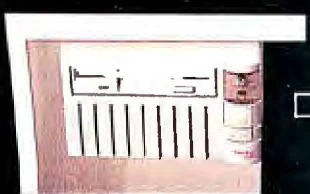

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Windows Word Processing for the World

World View 1.0 is the latest in a series of multilingual word processing programs from Eastern Language Systems. It runs under Windows 3.0 and comes with a customization utility that lets you place any character in any font at any location on the keyboard. The program comes standard with support for the Latin alphabet. You can add layouts for Greek, Russian, Hebrew, and other languages.
Price: $249; each additional language, $100 each.
Contact: Eastern Language Systems, 39 West 300 North, Provo, UT 84601, (801) 377-4558, fax (801) 377-2200.
Inquiry 1195.

World View 1.0 displays Greek, Hebrew, Russian, and Latin fonts in WYSIWYG mode.

Up and Down the Volkswriter Line

Volkswriter's new word processors share a common user interface and identical keystroke commands. Each version is targeted for a different level of use, letting you jump up and down the line without having to learn a new command set.

Volkswriter 2 is designed for entry-level users. Volkswriter 4 version 2.0, for executives, includes page preview, macros, a 310,000-word thesaurus, and integrated Grammatik IV, Reference Software's grammar checker. Volkswriter 6 has all the features of Volkswriter 4 version 2.0, plus Inset Graphics' technology, for importing, processing, and printing desktop publishing graphics; integrated HP AutoFont support and AGFA; and Compugraphics' Intellifont scaling technology.

Volkswriter 4 version 2.0 is available now. Volkswriter 2 should ship by the end of March, and Volkswriter 6 should ship in the second quarter of this year.
Price: Volkswriter 2, $149; Volkswriter 4 version 2.0, $249; Volkswriter 6, $499.
Contact: Volkswriter, Inc., One Lower Ragsdale Dr., Building 2, Suite 100, Monterey, CA 93940, (408) 648-3000, fax (408) 648-3016.
Inquiry 1193.

Dictionary/ Thesaurus for Windows

The Windows version of Language Master, an electronic dictionary/ thesaurus/speller, is now available for site licensing. Franklin's Language Master provides complete dictionary definitions for 80,000 words and 40,000 entries from *Merriam-Webster's Collegiate Thesaurus*. The program is also available for DOS and the Macintosh.
Price: $79.95.
Contact: Franklin Electronic Publishers, Inc., 122 Burrs Rd., Mt. Holly, NJ 08060, (609) 261-4800, fax (609) 261-1631.
Inquiry 1191.

Shared Word Processing in OS/2

The new version of DeScribe Word Publisher for OS/2 is available in a floating-license network version. It can act as a server or client in Dynamic Data Exchange (DDE) conversations, the company says.

You can assign any text or graphics a tag name for DDE conversations. Through the DDE tags, you can link numbers in DeScribe text to a spreadsheet template with a defined formula that calculates a solution from the numbers, which DeScribe retrieves and positions in text. If you change a tagged number, it will automatically be updated to the correct value.

Version 2.0 lets an administrator define system dictionaries, layouts, and macros for shared use by all users on the network. Twenty-three dictionary options (e.g., medical, legal, and scientific) are available.
Price: Server, $595; client, $250; dictionaries, $149.95 each.
Contact: DeScribe, Inc., 4047 North Freeway Blvd., Sacramento, CA 95834, (916) 646-1111, fax (916) 923-3447.
Inquiry 1194.

Word Processor for Laptops

Laptop display technology has come a long way since the days of the barely readable screen, but when you're working in murky light on the road, you may still find yourself straining to see your screen. SkiSoft, publisher of Eye Relief: The Large Type Word Processor for the visually impaired, has developed a program for laptops that lets you work with normal-size text or magnify that text by two, three, or four times on the screen.

Eye Relief for Laptops offers automatic word wrap, margins, headers, footers, and page numbers. Although text appears larger on-screen, it will print normally. Eye Relief for Laptops occupies just 80K bytes of RAM and runs on a single floppy disk drive.

And for those exasperating moments when the only way you can find an invisible cursor is by hitting the Home key, SkiSoft has No-Squint II, which gives your cursor a big and bold appearance on the screen. You can use it to adjust the blink rate of the cursor from very fast to no blink at all, important for epileptics who've found that a blinking cursor can spark a seizure.

No-Squint II supports any laptop PC or desktop PC and any character-based program except for Microsoft Word, SkiSoft says. Supported word processors include XyWrite, WordPerfect, and Microsoft Works.
Price: Eye Relief for Laptops, $129.95; No-Squint II, $49.95.
Contact: SkiSoft Publishing Corp., 1644 Massachusetts Ave., Suite 79, Lexington, MA 02173, (800) 622-3622 or (617) 863-1876, fax (617) 861-0086.
Inquiry 1192.

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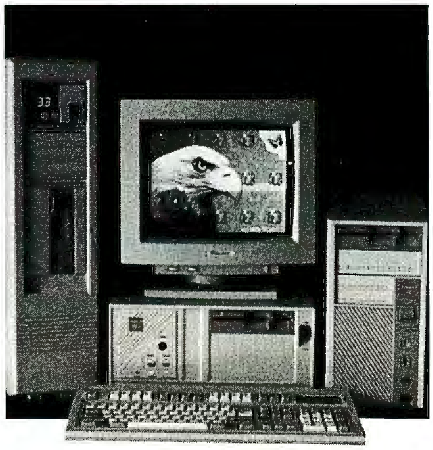

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- ♦ Shadow RAM Enable
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- ♦ 80386-25 ΣΣ C.P.U.
- ♦ 1MB expandable to 8 MB on board
- ♦ 80387 coprocessor socket
- ♦ Shadow RAM Enable

25 MHz* 286 $549

- ♦ 80286-20 C.P.U.
- ♦ 1MB expandable to 5 MB on board
- ♦ 80287 coprocessor socket
- ♦ Shadow RAM Enable
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CONTACT MANAGEMENT

Security, New Budgets in Timeslips

Version 4.0 of the Timeslips III time tracking, billing, and productivity reporting program includes system security. A systems administrator can define up to eight user groups, each with its own password and rights to 27 secured operations, the company says.

The program has four new reports: User-Defined Client reports, Client Budget Worksheet, Client Hold report, and User History report. User-Defined Client reports can contain any of the data on the Client Information or History screens. Through a mail-merge file, you can export data to a spreadsheet for further analysis.

The Client Budget Worksheet lets you compare historical amount billed and amount of work in progress versus budgeted amount. The Client Hold report lets you delay client billing or bill only a portion of an account. The User History report automatically accumulates billable and unbillable hours and fees.

The program runs on DOS systems. The network version requires DOS 3.1 or higher.

Timeslips' TSTimer feature lets you search user, client, and activity name lists, detailing activities such as phone calls.

Price: $299.95; network version, $699.95.
Contact: Timeslips Corp., 239 Western Ave., Essex, MA 01929, (508) 768-6100, fax (508) 768-7660.
Inquiry 1197.

LAN Contact Management at Low Cost

Diamond Data Management's Prospector program for lead tracking and prospect qualification offers full network compatibility for under $200.

Prospector is designed to manage sales prospects or any other kind of list. It supports up to eight prospect lists, with up to 20 form letters per list. You can use the program for mass mailings as a reminder of follow-up calls and mailings. You can define up to five user categories and 10 items per prospect.

Prospector is NetBIOS-compatible and requires DOS 3.1 or higher.
Price: $195.
Contact: Diamond Data Management, Inc., 740 Pilgrim Pkwy., Elm Grove, WI 53122, (414) 786-9000.
Inquiry 1199.

Unix Contact Management

The Prospect Management System is a sales, telemarketing, prospect tracking, and analysis program that integrates with other Unix applications.

The program features sales forecasting, on-line prospect history, automatic form-letter generation, and support for multiple sales campaigns and contacts and addresses. You can use the program to track a prospect's interests, demographics, and advertising, the company says.

The program uses Structured Query Language for its information access, but these commands are transparent to the end user.
Price: Starts at $3800.
Contact: Data Code, Inc., 7208 Sand Lake Rd., Suite 202, Orlando, FL 32819, (407) 351-3441, fax (407) 351-5019.
Inquiry 1200.

Data Code's Prospect Management System for sales, prospect tracking, and telemarketing is written in Informix-4GL.

Stay in Touch with Ease

The new version of Contact Ease, a direct mail and telemarketing program for the Mac, has been optimized to run twice as fast as the previous version and supports multiline searching, WestWare says.

As you set up a marketing plan in Contact Ease 1.2, you can add any number of clients, prospects, or associates to the plan, and the program automatically generates mailing pieces and schedules phone calls according to the time frames you specify. You can test several marketing plans for a target group of contacts and compare the results for each campaign.

The program includes a word processor, Postnet printing capabilities, a telephone dialer, and a call timer. With multiline searching, you can narrow a search for prospects by area code, ZIP code, state, or any other criteria.

The program runs on TOPS, Novell, and AppleShare networks.
Price: $395 for a five-user license.
Contact: WestWare, Inc., 10148 Diamond Head Court, Spring Valley, CA 92077, (800) 869-0871 or (619) 660-0356.
Inquiry 1198.

USERS GROUPS AND OTHER NOTES

Paradox 3.5: SQL Without the Syntax

At the September general meeting of the Triangle Computer Society (NC), a representative of Borland International (Scotts Valley, CA) discussed the latest version of Paradox (3.5) and the company's aim for a database that insulates you from the complexities of Structured Query Language (SQL).

Speaking to a crowd of about 50, David Luvinson demonstrated how the program lets you use the Paradox interface to work with data on a SQL server and the program's Query by Example (QBE) method of forming relations between data. Paradox 3.5's SQL Link automatically translates Paradox commands into SQL and sends them to the server, doing all the syntax work so you don't have to.

During the presentation, Luvinson stressed Paradox's ability to manipulate tabular views of data, multi-table forms, and table bands in tabular reports. He also provided examples of QBE methods of obtaining and summarizing data from various tables. For the finale, he showed the graphing capabilities of Paradox.

Future meeting topics of the Triangle Computer Society (contact Robert Bean at (919) 932-9635) include printers in February, Unix in March, faxes in April, networking in May, and the Amiga and Arexx in June.

—Robert Bean

GeoWorks Unveils Less-Filling GUI

Microsoft has been riding the crest of the Windows 3.0 wave for the past few months, but with the public unveiling of GeoWorks Ensemble, GeoWorks brings a new surfboard to the graphical-user-interface party.

At the October meeting of the Boston Computer Society's IBM PC Users Group, four GeoWorks representatives (Berkeley, CA) traveled to Wellesley, Massachusetts, for the first public showing of the environment that offers most of OS/2's benefits and all the windowing management of Windows and Presentation Manager, while still running on an 8088-based PC.

To prove this point, the company set up a table that showed the program running a Hercules-equipped 640K-byte IBM XT on the low end, and a 386 on the high end. For the actual demonstration of the product, the company used a 286. Lee Llevano, vice president of marketing, said, "Most people were pretty amazed that you could get that kind of performance on an XT."

The demonstration focused on GeoWorks Ensemble's ability to run on all levels of hardware, GeoManager (the graphical file manager), its preemptive multitasking capability, and the WYSIWYG word processor.

GeoWorks Ensemble is small, requiring only 100K bytes of RAM.

—Dave Andrews

OTHER

Nutrition Analysis for Windows

Dine Windows II, a nutritional-analysis and diet-improvement program that runs under Microsoft Windows, includes a database of more than 5600 foods and 24 food components, as well as a database of almost 200 activities and exercises. The new version lets you expand the database.

An optional statistics/graphics program analyzes data using line and bar charts, scatter plots, and statistical analyses. As you enter your meals, the program can provide a rating on a scale of from 1 to 10 that compares the actual diet with dietary guidelines.

The statistics module for Dine Windows II lets you analyze data using a variety of charts.

Price: $295; statistics module, $50.
Contact: Dine Systems, Inc., 586 North French Rd., Suite 2, Amherst, NY 14228, (716) 688-2492, fax (716) 688-2505.
Inquiry 1201.

Make Your Windows Display Big

Aristocad's new Windows 3.0 utility, More Windows, increases the application area of VGA and EGA screens, providing a virtual screen that lets you pan past the normal borders of your application. The company says that the program is an alternative to buying larger and more expensive display systems when you need to view several applications.
Price: $99.
Contact: Aristocad, Inc., 6920 Koll Center Pkwy., Suite 211, Pleasanton, CA 94566, (800) 338-2629, (800) 426-8288, or (415) 426-5355, fax (415) 426-6703.
Inquiry 1202.

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VGA-Mono	$899	$1,099	$1,149	$1,499	$2,299
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* 16-bit Hires 1024 x 768 VGA Graphics Card
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Microcom 386SX/16 Systems (1 MB RAM)
Standard System, Hard Drive, Monitor & Video Card

Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/16	105/16	205/16	340/16
Mono	$1,049	$1,249	$1,299	$1,649	$2,449
VGA-Mono	$1,199	$1,399	$1,449	$1,799	$2,599
VGA Hires	$1,449	$1,649	$1,699	$2,049	$2,849

386SX/16 Hires Package (w/4 MB RAM) $1,799
* 386SX/16 System w/42 MB 25 ms IDE Hard Disk
* 5.25" 1.2 MB Drive & 3.5" 1.44 MB Drive
* 14" Color Hires Monitor (1024 x 768)
* 16-bit Hires 1024 x 768 VGA Graphics Card
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Microcom 386/25 Systems (1 MB RAM)
for 64 KB Cache (in Tower Case), add $200

Standard System, Hard Drive, Monitor & Video Card

Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/16	105/16	205/16	340/16
Mono	$1,299	$1,499	$1,549	$1,899	$2,699
VGA-Mono	$1,449	$1,649	$1,699	$2,049	$2,849
VGA Hires	$1,699	$1,899	$1,949	$2,299	$3,099

386/25 Hires Package (w/4 MB RAM) $2,299
386/25C Hires Package (w/4 MB RAM) $2,499
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Microcom 386/33C Tower Systems (1 MB RAM/64 KB Cache)
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Hard Drives:	IDE	IDE	IDE	IDE	ESDI
MB/Ms	42/25	80/16	105/16	205/16	340/16
VGA-Mono	$1,749	$1,949	$1,999	$2,349	$3,149
VGA Hires	$1,999	$2,199	$2,249	$2,599	$3,399

386/33C Hires Tower Package (w/4 MB RAM) $2,999
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* 5.25" 1.2 MB Drive & 3.5" 1.44 MB Drive
* 14" Color Hires Monitor (1024 x 768)
* 16-bit Hires 1024 x 768 VGA Graphics Card
* **Microsoft Windows 3.0 & DOS 3.30 or 4.01**

Microcom 486/25C Tower Systems (4 MB RAM/128 KB Cache
Standard System, Tower Case, Hard Drive, Monitor & Video Card

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Borland Reveals Turbo Pascal for Windows

The listing in the Boston Computer Society's *Update* newsmagazine said that Borland International would introduce a "new programming language," but company representatives ended up disclosing much more.

At a special event held at the Copley Westin Hotel, a company official revealed Borland is at work on a version of Turbo Pascal that will run under Microsoft Windows and produce true Windows applications.

Borland official Gene Wang came to the Boston Computer Society meeting to introduce Turbo Pascal 6.0, but in the course of answering questions about the new program, he confirmed work on the Windows version.

"I'm glad you asked that question," Wang said to the BCS member who asked about Turbo Pascal's compatibility with Windows and Quarterdeck's Desqview. "We were going to wait until Comdex, next week, to show some of our early work on this," Wang said, "but we decided to give the Boston Computer Society members the first glimpse at Turbo Pascal for Windows."

Wang's colleagues then started an obviously scripted demonstration of the new product. "As you can see on the screen, Turbo Pascal for Windows is a hosted graphical interface for Windows [in other words, Windows provides the user interface]; it uses the MDI, or Multiple Document Interface, for handling multiple files," Wang said.

"Notice that the dialog box for compiler options has the usual check boxes, radio buttons, and input fields . . . but it also has these awesome-looking three-dimensional push buttons."

Wang demonstrated compiling and running a simple demonstration program; while the first program was still running, Wang compiled and ran a Pascal adaptation of Charles Petzold's Hex Calculator application.

"Turbo Pascal for Windows is the beginning of a whole new product line for Windows applications development. What you saw here was a look at some research-and-development efforts at Borland."

The company will deliver Turbo Pascal for Windows sometime in the first half of this year, Wang said. [Editor's note: *For more information on Turbo Pascal 6.0 for Windows, see the January BYTE, page 126.*]

Wang stressed that Borland's DOS program line will continue, and that Turbo Pascal's Turbo Vision application is a good introduction to object-oriented, message-passing architectures like Windows and Presentation Manager. Wang declined to answer further questions on Borland's Windows product line; however, developers attending the meeting said they are working with alpha-test versions of Turbo C++ for Windows.

—*Martin Heller*

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A PACK OF LAPTOPS

Getting away from it all to write takes more computers than you might think

One amusing way to spend an afternoon: try setting up a Desqview system without manuals. Of course, a story goes with it.

We have recently acquired use of a beach house. Even I don't know the phone number here. The idea of having a place to write is working, too; I've done two chapters of the sequel to *The Mote in God's Eye* and caught up on a bunch of other stuff. I can even work on this column down here.

This is possible because computers are now small enough that I can travel and still keep my computing environment. The basic idea is sound: carry not only your work, but your favorite environment: Desqview, Windows, Tornado, Norton Commander, your word processor, MathCAD—whatever you like, as well as what you can't do without.

In my case, I brought the Zenith SupersPort SX, a smaller Zenith MinisPort HD with a hard disk drive (for taking around to the beach and in my bicycle backpack), the TravelMate 2000 notebook computer from Texas Instruments, and the Ergo Brick, which is a 386SX that's smaller and lighter than the MinisPort HD. (The Brick doesn't have batteries, the power supply is external, and there's no screen.)

I also brought down a Northgate Computer Systems OmniKey Plus keyboard in the "Pournelle" layout (the oversize Backspace key is to the right of the *P*, where God intended it to be) and an Ultra-14 monitor from Princeton Graphic Systems, which, in the words of a colleague, is "some kind of monitor." Both work with either the Brick or the SupersPort SX; that is, the SupersPort SX has both keyboard and VGA ports as well as the built-in keyboard and supertwist screen. The keyboard and the monitor work just fine with the SupersPort SX. You do have to remove the computer's battery before you can plug in the external monitor, which means that you're not able to use the battery as an uninterruptible power supply, but that's only annoying, not fatal.

The neat part about this setup is that when I'm done, I simply unplug the external keyboard and monitor and leave them behind; all my work has been saved onto the SupersPort SX (and on a floppy disk for backup), so I am carrying it with me wherever I go next.

The SupersPort SX is plenty powerful enough for anything I'm likely to do here. It runs Desqview just fine, and even though it doesn't have as much extended/expanded memory as the Brick, it has enough to keep my word processor, Norton Commander, and a communications program going simultaneously. It runs Microsoft QuickBASIC, so I can work on Mrs. Pournelle's Reading Program if I'm inclined to. It will run Windows 3.0 if you attach a mouse. Anticipating that, I brought a Logitech TrackMan trackball, but any serial mouse would do. All told, the SupersPort SX is a lot more machine than I had at Chaos Manor three years ago.

The only problem with the SupersPort SX/Ultra-14/OmniKey Plus combination is that many programs have to be told whether they're being used by a color or monochrome setup, generally through command-line switches; thus, switching from monochrome to color can be a bit tedious if you're using Desqview. You can use batch files for programs that use a command-line switch. An example is Q&A Write, which uses various documented switches to change over to monochrome—and an *undocumented* switch, `QW -a`, to restore it to full VGA color.

I can, therefore, recommend the SupersPort SX not only as a portable, but as one's only machine. My fellow science fiction writer Norman Spinrad has for several years used a previous Zenith portable as his only machine. He's worked in locations from Hollywood to Moscow and done several books with it, and he has no complaints. The SupersPort SX is blooming heavy to lug around—but I like it enough that I do lug it. It is, in a word, good enough.

Again the Brick

My other alternative is the Ergo Brick, which I wrote about last month; this is a machine with a footprint the size of a sheet of paper. It stands 4 inches high and is as powerful as any 386SX. Mine has a 220-megabyte hard disk drive, two serial ports, and a bunch of features, including a built-in 2400-bps modem.

You can't have everything: if the modem is active, you can have only one serial port; if you use the modem and a mouse, you don't have any. I discovered all this while using LapLink to transfer files from the SupersPort SX to the Brick: I could disable the modem and use the COM2 port, disconnect the mouse and use the COM1 port, or use the printer ports. I finally did the latter.

I found one serious problem with the Brick: the cursor control keys were almost useless because the key repeat rate was set preposterously fast. If I used the Backspace key, I could either tap it one space at a time or risk losing half a page of text when the auto-repeat took over. Similarly, auto-repeat on the cursor keys would take you down a whole page before you could let go.

Now if Ergo Computing had used DOS 4.01, that wouldn't be a problem, because in DOS 4.0 and above the MODE command will let you set the key repeat rate. That feature will also be in DOS 5.0. However, Ergo has—wisely in my judgment, because I do not recommend DOS 4.x—used DOS 3.3+ for the Brick, and the too-rapid key repeat was not merely an annoyance, but a major difficulty.

A call to Ergo technical support got me the information that they'd work on the problem. Next day I got another message: they had a fix. I could dial into their BBS, or they'd mail me a disk to do the job.

I opted for the disk. What came was a bootable disk with files and control software in the AUTOEXEC.BAT; when I booted up, it offered the opportunity to revise my BIOS, also warning me to be sure that the process went to completion once it started, since any interruption would render my machine useless.

There weren't any lightning storms going on, so I told it to go ahead: with the result that my BIOS electrically erasable programmable ROMs were rewritten. Ergo has thoughtfully put EEPROMs in the Brick for just this purpose. The process took about 10 minutes; when it was done, the key repeat rate wasn't too fast any longer. In fact, it's a tad slow, and I am going to suggest they do it again, this time making it about twice as fast as it is now. This ability to change the BIOS on the fly is a neat feature of the Brick.

Setting Up Desqview

The Brick comes bundled with quite a bit of Desqview software, and Ergo has set things up so that many programs load on start-up. Ergo furnishes all the documentation with any programs bundled in with their machine, but I didn't bring all that stuff to the beach house.

I've always known that there is some way to make Desqview open windows on start-up, but I never knew how it was done. I'm sure it's somewhere in the Desqview manual, but a reasonably diligent search of the index and table of contents didn't find it the last time I looked. It didn't seem important. My normal practice is to open Norton Commander in window one, Q&A Write in a batch file that also loads Word Finder in window two, and leave everything else to be done as I need it. It doesn't take me 20 seconds to load those two programs, so I never really cared much.

To start up the Brick, though, I had to wait for six programs to load, close each one's window, and go to the Desqview Rearrange command and set the screen back to 25 rows and 80 columns, since the Brick has Desqview shift it to 50 rows, and I don't want tiny letters when I'm writing. It took an hour to figure out what was going on, but by diligent use of Norton Commander's View File feature, I found it.

The secret is in the script name. When you first start up Desqview, you begin building a macro—they call it a script—by doing whatever you want the system to do on start-up. When you're asked for the script name, begin it with an exclamation point: !STARTUP will do, but in fact it could be `!foo` for all the system cares. The result will be a script named `desqview.dvs`, and it will run when you first invoke Desqview.

You want to be careful about doing that, though: the usual way to change that script is to start over again. If you get at all confused redoing that macro (script), you can build a script that locks the machine; at least I did. The simple remedy is to delete `desqview.dvs` and open your windows manually until you are completely sure what you want Desqview to do on start-up.

However, there's a better way: Notepad, the mini editor utility that comes with Desqview, knows how to edit the

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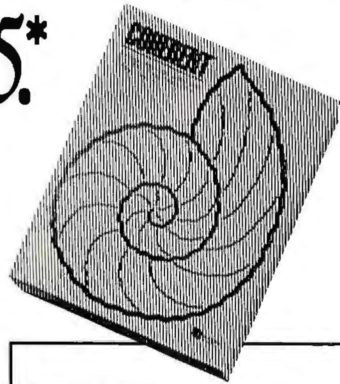

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Desqview script files. Nothing else will do it, because the script files contain control characters and such; but Notepad translates those characters into something you can read and lets you edit them as you like. The result is very powerful: you can make a highly complex Desqview script.

Anyway, it took me a while, but I got the Brick reconfigured to what I want; and it will now travel with me to the beach house and back.

The Ergo Brick will now travel with me to the beach house and back.

Notebooks and Laptops

I brought several laptops with me in addition to the SupersPort SX, which is in theory usable as a laptop—I've often used it in business class on airplanes—but is pretty heavy for that work.

Actually, I brought four: that beach house had more computing power than the U.S. government did when I was an undergraduate. There was Toshiba-San, the faithful Toshiba T1000 that Roberta relies on; the Texas Instruments TravelMate (TM) 2000; the MinisPort HD; and the Poqet PC. The notion was to test which machines were up to being stuffed into my backpack and taken out for walks, or bicycle rides, along the boardwalk, with stops for note taking and general writing as the mood seized me—clearly not a task for the SupersPort SX, much as I like it.

Each of the four has strengths and weaknesses.

The Poqet is a DOS machine, with lots of extra features. My problem is that I can't write with it: the keyboard is just too small for me. It is *not* too small for someone who does two-finger typing; indeed, the Poqet's keyboard is somewhat better than the Atari Portfolio's, with large square keys that have a good feel. Alas, they're just too close together for me to get my fingers on the home keys. I have noticed, though, that touch-typists with very small hands are able to use it.

The Poqet is a full computer, and you can get peripheral equipment like floppy disk drives. I'm not fond of it: I find the screen small and hard to read, the keyboard small and hard to use, and the computer a bit underpowered for what I want to do. On the other hand, it really will fit in your pocket; it weighs about as much as the Z88 but is smaller. Some people like the Poqet a lot.

The TM 2000 is about the size of the Z88, but it's a clamshell: it opens to reveal a screen that is much larger than the Z88's. Indeed, it's nearly as large as the SupersPort SX's screen and much larger than the MinisPort HD's screen. Unlike with the Poqet, screen brightness and contrast are adjusted manually, rather than by tapping keys. I find manual contrast adjustment much easier, and so has everyone else I have discussed it with.

The MinisPort HD, like the TM 2000, has a small (20 or 40 MB) hard disk drive and no internal floppy disk drive. Each has an optional external 3½-inch floppy disk drive. The TM 2000's floppy disk drive attaches directly to the machine, while the MinisPort HD's drive uses a cable.

The TM 2000's screen is larger, and better, than that on the MinisPort HD. After working with the TM 2000, the other screen looks small and dull; indeed, compared to the TM 2000's monochromatic VGA screen, the MinisPort HD's screen *is* small and dull.

The TM 2000 has one exceedingly annoying "feature": all its external connectors are equipped with small plastic covers. These are unattached to the machine, so it's dreadfully easy to lose them; indeed, I got sick of keeping track of them and used duct tape to cover the openings. This isn't pretty, but it does keep the dust out. The MinisPort HD's port covers are hinged to the case, so the problem doesn't arise.

The MinisPort HD has a handle; the TM 2000 does not. The TM 2000's screen is nicer, but the MinisPort HD's screen folds back more conveniently. And so forth.

The acid test for these two machines was to take them out to the beach on a bright sunny day and try to write notes with them; and that produced a definitive result. Under those conditions, it was almost impossible to see the TM 2000's screen. The MinisPort HD's screen, although smaller, was visible enough that I could write several pages of GrandView notes; I wasn't able to do anything very useful with the TM 2000.

Mind you, as soon as we got inside, I preferred the TM 2000's screen to that of the MinisPort HD; but so long as we were out in the bright sunlight, the MinisPort HD was clearly better. Incidentally, both of these screens are visible in light that is dim enough to make the Z88 completely useless, and both are preferable to the Z88's screen no matter what the light conditions.

My One and Only

I certainly won't be bringing a half dozen computers with me every trip, so I'm going to have to make a decision. That will probably be the Brick for inside work and the MinisPort HD as my carry-around notebook. Note, however, that Roberta will hang onto the TM 2000, preferring that to the T1000.

If I were setting up an office and had to settle for one and only one computer, and that computer had to be portable, I'm pretty sure I'd still choose the Brick. The reason is simple: while the SupersPort SX will do everything the Brick will and can be a laptop to boot, it does not have slots; and in these days of universal fax, that may make all the difference. The Brick has three half-card slots, meaning that I can, if I like, stuff one of the small fax boards in there.

On the gripping hand, you can send both fax and teletypes through MCI Mail. Spinrad has used a Zenith laptop as his only machine for years, and he's plenty happy; and I have very good reason to know that Zenith makes these machines rugged.

Info Select

Last time, I mentioned Tornado, the free-form notepad and database that some people can't live without. Info Select is Micro Logic's update to Tornado.

Real improvements include the ability to insert blank spaces at the beginnings of lines, a whole bunch of housekeeping improvements and minor bug fixes, and the capability to use EMS memory. There is a decided improvement to the manual: it's larger, and everything is explained in more detail. Alas, sometimes the details can get tedious, but stick with it; an hour spent browsing through the manual may save you a hundred hours a year. Tornado certainly had the capability for saving a lot of time, and this is an improved Tornado.

It takes two dense pages to explain how to convert from Tornado to Info Select format, and when you've finished reading that, you don't know a lot more than when you started. However, the conversion itself isn't hard. One warning: if you're one of those who can't live without any notes you've made, be sure that you copy your old piles (now called *stacks*) before trying the conversion.

One improvement is the ability to dial your phone (assuming you have a modem): this means that Info Select can take your Tornado phone file and use that to call numbers. I confess I don't myself use this; I find it's about as easy to punch in the numbers myself. Some people swear by it, though.

Dubious improvements over Tornado include a hard-to-use HyperCard generator, and something I don't think is an improvement at all: the notes now tile rather than stack, so that notes never overlap. This has the effect of making things marginally neater while giving less information per screen. I liked the old system a lot better.

I also liked the older name. "Info Select" sounds like a bad TV quiz show. "Tornado" had class.

Like Tornado, Info Select is capable of changing your life; it really is easy to use, it works fine with Desqview and

Windows (or as a TSR program under your word processor), and it will, once you're in the habit of using it, take care of much of the stuff that's now kept on Post-it Notes and the backs of old envelopes. Recommended, even with the wimpy new name.

Trilogy

I don't know if a new language can make a place for itself in the microcomputer world, but if one can, it might be Trilogy. There are now two implementations. One is from the original group headed by Dr. Voda; the other is from another of the language's designers and published by Vertical Software (VS), a division of AI Software—which, in fact, turns out to be a set of pretentious names for a company whose only product is Trilogy. They have, however, done a pretty good job of packaging, and the Trilogy environment they have developed is neat.

Trilogy is interesting: it combines features of Prolog, a logic interpreter language in which you make statements and ask questions and let the language solve the problem for you, and Pascal, a procedural language in which you have to tell the computer what to do in tedious detail. Prolog has no variable typing. Trilogy isn't as strongly typed as Pascal, but it does have type declarations and type checking during compilation.

Trilogy has graphics capabilities; I haven't yet decided whether they're good enough to use for games, but I think they are: and if so, Trilogy would be an excellent language for game designers.

VS Trilogy produces stand-alone compiled code, although that's not obvious from the manual. The marketing manager tells me there's no attempt at obtaining licensing fees or royalties on programs written in VS Trilogy, although the "licensing agreement" on the disk envelope implies the opposite; they say they will change that immediately and are notifying everyone that they never intended to require anyone to get their permission to sell compiled products.

I've written just enough code in Trilogy to become intrigued by it. I do not know the language's future; Vertical Software is putting considerable effort into marketing it, but it's very hard for new languages to break in. I certainly would not recommend that major companies use Trilogy for writing a new spreadsheet or database, although it might produce a better one than the more customary languages do.

On the other hand, I can recommend Trilogy to those who like to experiment with computer languages and programmers who are looking for an edge in writing programs with complex logic, such as strategy games. It would also be my language of choice for experimenting with programs to build expert systems.

The XyWrite Experience

It all started when my collaborator Steve Stirling sent me eight or nine chapters of our new Falkenberg novel, *Tell the Spartans*: he'd saved them into one big WordPerfect file. Jim Baen, our publisher, is anxious to get this book, so he undertook to convert from WordPerfect to ASCII so that I could read and comment on what Steve had done. Alas, he merely ran the file through Word for Word, and the result was a 330K-byte file. Q&A Write, my word processor, couldn't handle that large a file on its best day; so I was stuck with finding a word processor/text editor that I could live with.

For several years, Baen has been telling me that I ought to try XyWrite III

ITEMS DISCUSSED

American Heritage Dictionary $89.95
Houghton Mifflin Software
One Memorial Dr.
Cambridge, MA 02142
(800) 633-4514
Inquiry 1150.

Desqview 2.3 .... $129.95
Desqview/386 2.3 .... $219.95
Quarterdeck Office Systems
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(213) 392-9851
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Dr. Solomon's Anti-Virus Toolkit £99
S&S International
Berkley Court
Mill St.
Berkhamsted
Hertfordshire HP4 2HB,
U.K.
44-442-877877
fax: 44-442-877882
Inquiry 1152.

Ergo Brick $2495
Ergo Computing, Inc.
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Peabody, MA 01960
(800) 633-1925
(508) 535-7510
Inquiry 1153.

Info Select $99.95
Tornado $79.95
Micro Logic Corp.
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Hackensack, NJ 07602
(800) 342-5930
(201) 342-6518
Inquiry 1154.

Keynotes for the PC ... $79.95–$99.95
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Knowledge Acquisition Series .... $49.95–$79.95
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MicroMath Data Analysis and Graphics Software .... $149–$349
MicroMath Scientific Software
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MinisPort HD $2399
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Sunnyvale, CA 94086
(800) 624-8999
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Inquiry 1159.

Quotemaster $89
Penncomp
4660 Beechnut St., Suite 214
Houston, TX 77096
(713) 669-0965
Inquiry 1160.

Random House Encyclopedia $119
Microlytics, Inc.
2 Tobey Village Office Park
Pittsford, NY 14534
(716) 248-9150
Inquiry 1161.

TravelMate 2000 LT286 .... $3999
Texas Instruments, Inc.
P.O. Box 2022230
Austin, TX 78720
(800) 527-3500
(512) 250-7984
Inquiry 1162.

Trilogy $395
Vertical Software, Ltd.
636 Clyde Ave. W, Suite 14
West Vancouver, BC,
Canada V7T 1E1
(604) 925-0321
Inquiry 1163.

XyWrite III Plus 3.56 .... $445
XyQuest, Inc.
44 Manning Rd.
Billerica, MA 01821
(508) 671-0888
fax: (508) 671-0858
Inquiry 1164.

Plus; indeed, he has become something of a religious fanatic on the subject. "It's the One True Word Processor," he says. Others have told me the same thing: it's tough to learn, but once learned you will, they say, never change to anything else.

So, I figured, I'm reasonably experienced with computers. I've got to use *something* to break up this file. I could get out Brief, but I haven't used that in a couple of years, because while Brief is a good candidate for the world's best programming editor, it's far too complex and touchy for creative writers; and, I thought, it would take me about as long to relearn Brief as it would to learn XyWrite. I mean, thought I, how hard can it be to learn a word processor? So I tried it.

I very nearly went out of my mind.

Clearly it is possible to learn XyWrite, for many have done it; but I guarantee you that while you are learning it, you will get very little else done. In particular, don't even think of learning XyWrite while trying to work under a deadline. XyWrite just out of the box has a completely arcane command scheme, an actively user-hostile interface, and help files that are part of the problem.

Item: although Electric Pencil, which I used for many years, had no on-screen margins, Q&A Write does, and I have become accustomed to 60-column (on average) lines with a left margin. XyWrite out of the box fills the screen; it even automatically hyphenates words, so if you work on a paragraph inserting and deleting text, the lines jump around as XyWrite inserts and deletes hyphens. I have always been taught that you *never* put a hyphen into a manuscript unless you want that hyphen set in type; thus, the first thing to do was to turn off the hyphenation.

XyWrite has on-line help, of course,

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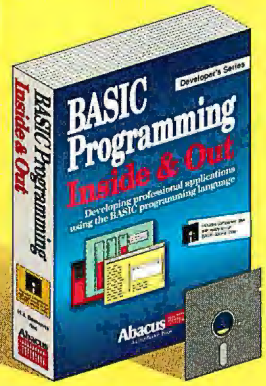

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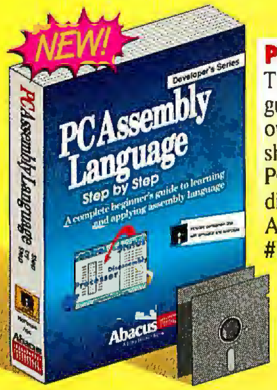

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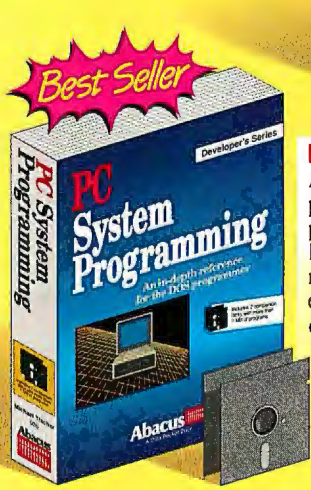

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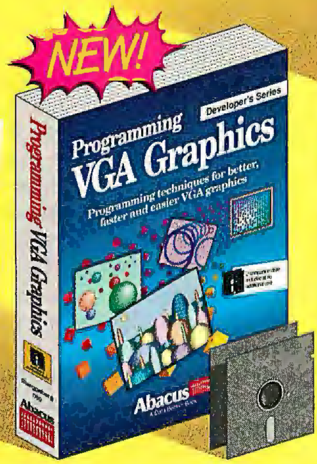

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and one help feature is that you can look up topics and words. Wonderful. Look up "hyphenation." "This key word is not in the help vocabulary. Is there some other way to phrase what you need to know?" "Hyphen." "This key word is not in the help vocabulary. . . . "

All right, what about setting the margins? Ask about "margin." "This key word. . . . " Indeed, I have yet to find a key word that does me any good. However, the help file will also give you a list of commands. Well, not really: it's a list of about 100 abbreviations of commands. One of them was LM, which, I thought, just might stand for left margin, and indeed did so. To set the left margin, go to the top of the text, go to the command line, and do "CMLM 8" to set the margin to 8. This seemed simple enough. Of course, you *don't* type "CMLM 8," although that's what help tells you to do. You type in "LM 8"; the "CM" is there largely to confuse you.

And on. It's also inconsistent. Sometimes the Escape key will undo what you last did; but when in the command mode, it takes you successively back until XyWrite is ready to accept a command—and then it starts putting escape characters into the command string. Since XyWrite can't execute any command that begins with an escape character, this has the result of confusing the hell out of you, since even if you type a legal command after the escape character, you get an "illegal command" error message.

XyWrite's error messages are arrogant and unhelpful.

The result was that after an hour or so, I was so upset I had lost all interest in editing *Tell the Spartans* and just wanted to get away from this hateful program.

The next day there arrived a reconfiguration of XyWrite as done by Baen. It is, I have to say, enormously preferable to XyWrite out of the box; indeed, it's almost usable. XyWrite really is reconfigurable, with a flexibility not found in any other editor except Borland's Sprint. On the other hand, while it's easy to reconfigure XyWrite, unless you have one whack of a better memory than I have, you must either write down what you have done or edit the XyWrite help file to reflect your changes.

The bottom line is this: XyWrite doesn't so much have a steep learning curve as an initial high cliff you must climb almost unaided. Once over that cliff, you have a very powerful editor, one that will do, albeit often with difficulties, things that no other text editor will do at all. XyWrite will handle enormous files and do global searches on them with amazing speed. Unlike with WordStar, the output from XyWrite is straight ASCII, so you can send XyWrite files through BIX or MCI Mail and still preserve all the formatting and typographical information.

It has weird idiosyncrasies—the way to change the screen colors is to put statements in the *printer* file!—and often insists on doing things its own way despite your wishes. But for people who must deal with lots of text and are more concerned with copyediting and typesetting than with creative writing, XyWrite may well be the best thing around.

Whether it's all that hot for creative writers is something else again. In my case, no.

A Minor Retraction

Last December, I said that AHED was an electronic version of the *American Heritage Dictionary* in all its glory. That wasn't quite true. AHED is the desktop version, which is considerably abridged. I found this out in an embarrassing way: someone in a BIX conversation used the word *burke* as a verb, and someone else asked what it meant. In an effort to show off, I used Desqview to load the AHED program into a window and told it to look up *burke*.

It didn't find it, and I reported that the word (which is British) hadn't made it over here; whereupon someone looked it up in a paper copy of the *American Heritage Dictionary* and found it. (*Burke* means to suppress something quietly; the origin is the name of a Scottish murderer who suffocated his victims so that they appeared to have died of natural causes.)

I'd sure like the *complete American Heritage Dictionary* on-line. Maybe someone will make a CD-ROM of it.

Random House Encyclopedia

Hard disk drives are getting larger and cheaper. Most of mine are now multiple hundred megabytes, and even small ones are 40 MB and more. Controllers are getting faster: the big race, in my judgment, is between a new company, Perceptive Solutions, and the older and larger Distributed Processing Technology, but there are plenty of other contenders, and several make hard disk drives about as fast as *memory access* was in the early PC days.

As a result, there's a lot of software being written to take advantage of the new disk capacity and access speed. I've written about much of it.

Some of the early efforts were plain useless. Others, like Inductel's Knowledge Acquisition Series, have wonderful databases—theirs has all the McGraw-Hill science dictionaries, as well as ways to translate words into *31* languages—but an awkward user interface. (I sure wish they'd fix that, since the programs are nearly indispensable.) Some, like Mike Wiener's Microlytics Word Finder, were both easy to use and had great databases.

Thus, when I got the new Random House Encyclopedia using a Microlytics engine, I was prepared to love it. Alas, it didn't quite work out that way.

First, installation: the program comes on *16* floppy disks. Apparently, Microlytics has never heard of data-compression programs: many programs, including the Norton Utilities and Norton Commander, come packed with ARC, PKZIP, or some such, and the installation program unpacks and explodes them. I'd have thought that system ideal for this encyclopedia, and it would save money as well. Anyway, there's nothing like swapping disks 16 times to sour you on a program.

Second, program transfer: I put the Random House Encyclopedia up on the Arche Legacy 386/33, which has an experimental copy of DOS 5.0 and one logical drive of 300+ MB. (DOS 5.0 so far runs fine; you'll love it.) I decided that I'd like to have it over on another machine, the Cheetah 486, which is still using Compaq clone DOS and thus has its hard disk partitioned into 20 33-MB logical drives. I keep word-related stuff in the D drive, so I used LapLink to transfer the INFODESK subdirectory from the Arche's C:\INFODESK drive to the Cheetah's D:\INFODESK drive. Even with LapLink in parallel mode it took a while, but it got done.

I couldn't access the file. It claimed there was something wrong with the configuration. Well, OK, so I tried to run the Setup program. It won't let you change the configuration file. OK, I got out the original floppy disks and tried to run Setup. That won't do it either. Eventually I said, what the hell, and started the installation procedure; but since I sure didn't want to swap 16 disks, I stopped it after the first disk in the hopes that this would let me run Setup.

Not only didn't it run Setup after that, but the machine began making "fire engine" noises, and a big red message appeared on the screen demanding that I reboot my computer, which indeed I had to do with the hardware switch since it was all locked up. At that point, I concluded that any company that paranoid about copies was capable of *anything* and got out Dr. Solomon's Anti-Virus Toolkit (which I highly recommend; if you have any suspicions about viruses, this kit tells you a great deal about them and can detect and eliminate most).

Now, I suppose at one level I knew that Mike Wiener, whom I have known for years, isn't going to do something awful to my machine; but at the same time, I am *not* accustomed to software that not only locks up my system to hardware reset level, but makes noises guaranteed to scare you into cardiac arrest.

This got me angry enough that I began looking at the installation on the Arche (which works). I found that the installation had, without saying anything about it, put a file called INFODESK.CFG into the root directory. I copied that over to the root directory on the Cheetah, but of course it told INFODESK that its files are on the C drive, so that didn't work.

Attempts to edit the INFODESK.CFG file with an ASCII editor were not successful, because the file contains an end-of-file mark at the beginning. However, the editor in Norton Commander 3.0 will edit it. It's tedious, because the file is one long file with no linefeeds, but it can be done, so I went through and changed every instance of C:\ to D:\; and lo!, it works. And no, I don't feel at all bad about having copies on two different machines: nobody is going to use them both at the same time.

The retrieval software, as with everything Microlytics does, works wonderfully: it's fast and reasonably intuitive, although you do have to poke about a bit since there are features you won't suspect without playing with it. The engine they use would work for *any* book a couple of inches thick, and the compression/retrieval/sort software is really marvelous. Wiener's index and search algorithms, which he developed from work done at the Xerox Palo Alto Research Center, are the best in the business.

The Random House Encyclopedia itself is better described as an expanded dictionary than an encyclopedia: despite the 16 disks, there's far less information here than on the Grolier Encyclopedia Americana CD-ROM—but of course that shouldn't surprise you. I find it woefully inadequate. For instance, the short mythology section on Achilles tells you he was the son of Peleus and Thetis, but neither of his parents is mentioned anywhere else; while the section on Frederick Barbarossa tells almost nothing of real interest about him.

Quotemaster and Keynotes

These are two more programs making use of big databases on fast hard disk drives. I haven't space to do justice to either: they're both very useful. Quotemaster has about 3000 quotations; the retrieval software is good, although the default mode is not. You have to poke about to see how to use it right, but then, you can find quotes on fools, courage, or any subject you like; these can be displayed on-screen, printed, or squirted directly into your word processor. If you write much, this isn't *Bartlett's Familiar Quotations* on-line—you need a CD-ROM drive and Microsoft Bookshelf for that—but it can sparkle up your letters. Recommended.

Keynotes for the PC is just that: a system of notes that can be accessed quickly and easily, either as a stand-alone program or as a TSR pop-up. If you use Desqview or Windows, it will work fine in its own window. I have the following Keynotes: Writer's Handbook, which I don't use, but beginners and editors will like it; the Complete Secretary's Handbook, which I do use; the Financial Mathematics Handbook; and the Associated Press Stylebook. The latter two are very good. The retrieval software is fast and efficient, and everything works as it should. Recommended.

MicroMath

This one makes me feel guilty: I have had some of this company's plotting and numerical calculation programs around here for a year, and I haven't written about them. They're quite good: the cost is reasonable, they do about what you think they will, and they're simple enough to use provided you know what you're doing in the first place; that is, I wouldn't try to learn LaPlace transforms from the MicroMath LaPlace program.

I used to be reluctant to write about MicroMath, despite the quality and usefulness of the software, because they wouldn't guarantee the software once the package was opened. They have now changed that to "Try it, you'll like it, or your money back." I doubt they've had to refund anyone's money. If you do much mathematical work, you should be aware of MicroMath. Recommended.

Winding Down

I'm off on another trip tomorrow. The game of the month is Origin's Wing Commander: I liked this so much that I went out and bought—*bought*—a Thunderstick joystick to play it with. I never believed I'd get hooked on an arcade shoot-'em-up, but this one did it to me. The best thing I can say is that it almost weaned me from Railroad Tycoon.

The computer books of the month are the Que Quick Reference Series: they have them on the Norton Utilities, PC Tools, Q&A, and a lot of other subjects, and I've found them uniformly good.

The book of the month is *Convictions* (Prometheus Books, 1989), the posthumous collection of essays by Sidney Hook. He was one of the important people of our century. I am proud to have debated him several times; debating Hook, like debating Norman Thomas, was an experience one did not soon forget.

Now to pay the bills, then I'm off to the Hackers' Conference, which I'll tell you about next month. ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

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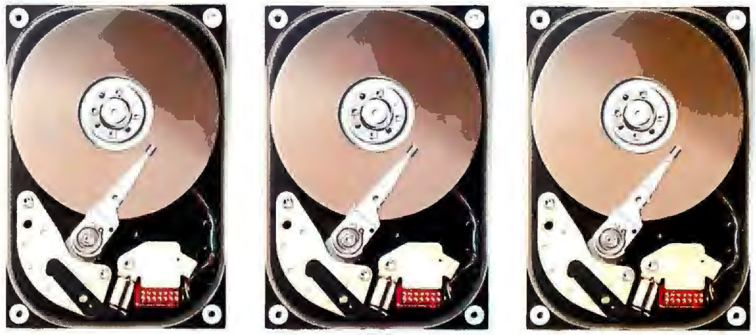

Some people can't imagine squeezing a 40,100 or even a 200MB hard disk into a portable PC. But when they take advantage of all that storage capacity, they find it hard to imagine life without it.

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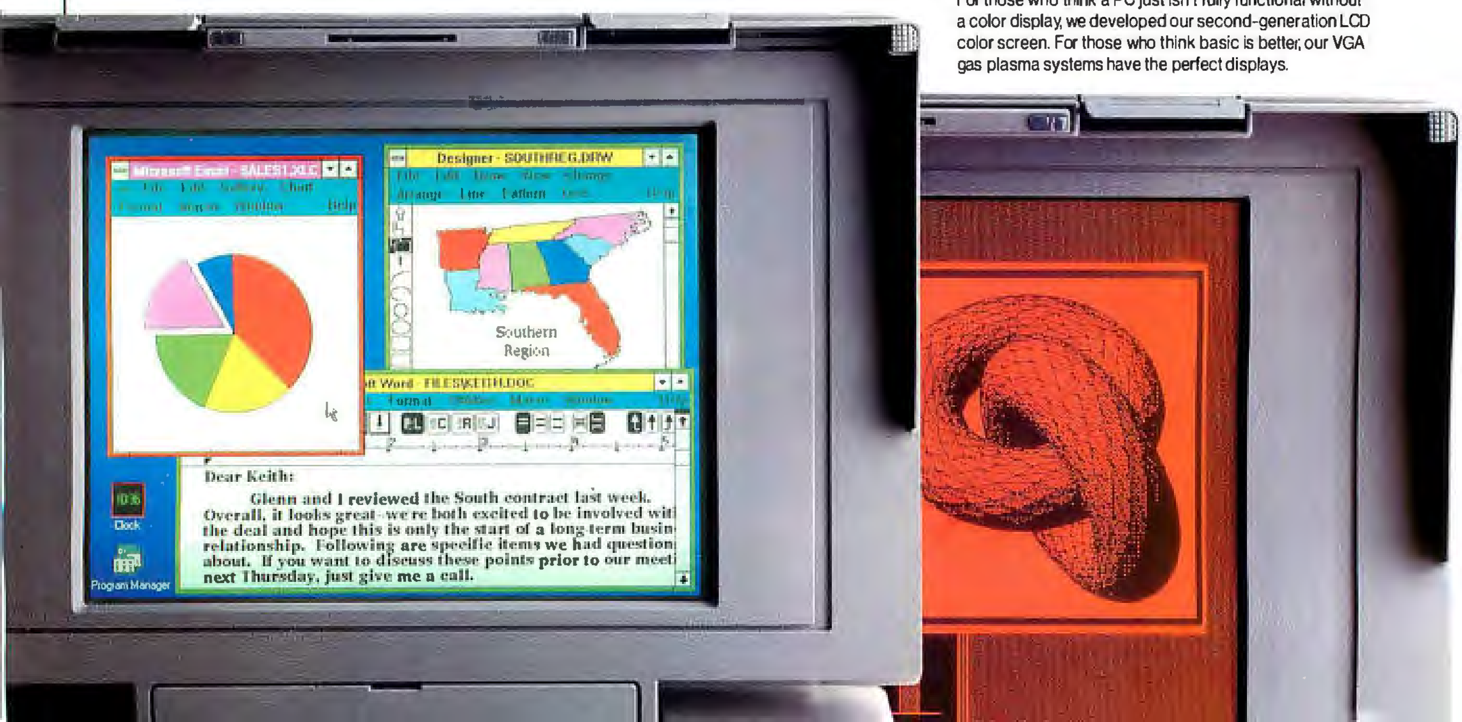

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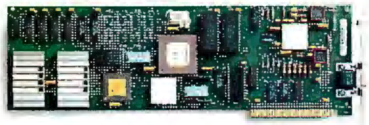

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tops run all of the same applications as your company's conventional PCs.

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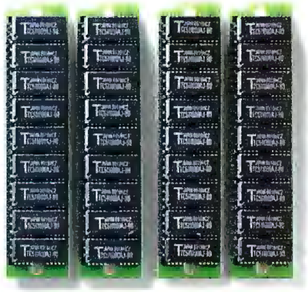
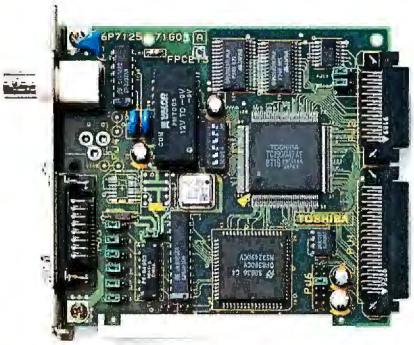


They say you can't squeeze much memory into a portable PC. But considering that our dedicated memory expansion slots let you add up to 12MB of RAM as your need for power grows, it looks like "they" were wrong again.



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T5200C
18.9 pounds, 20MHz, 80386 with 80387-20 coprocessor socket, 2 internal IBM-compatible expansion slots, 200MB hard disk with 16msec access, 2MB RAM expandable to 14MB, passive matrix VGA full-colorscreen, 1.44MB 3½" diskette drive.

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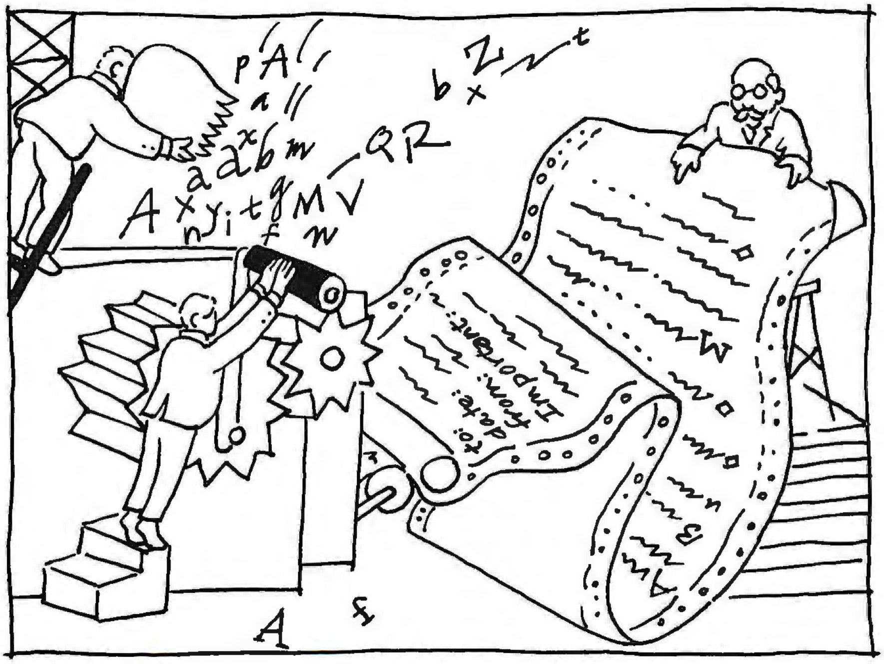
CORPORATE STYLE

In business communication, it's important for everyone to speak the same language



As I write this, I'm also preparing for a few days in a federal courtroom as an expert witness, explaining how the small computer industry actually works. I can't discuss any details of the case, but at least part of the problem stems from differences in the way companies interpreted a statement in a federal contracting document. Part of the reason for the trouble is that people can read the same words and ascribe different meanings to them.

This trouble that can come from varying understandings of written material can be confusing enough when the only problem is the differing usage that can exist among companies. When a company has no standard way of expressing itself, the result can be chaos. To prevent this, most companies end up developing their own corporate style. They do this by having managers edit the documents of the more junior people until those people learn to write in the company style.

While managers will probably always check the documents of those who work for them, spending more time than is necessary on this task is a significant waste of management time and talent. This is especially the case when automated tools exist to check documents that companies and organizations create to ensure that they meet standards. That way, while managers will still have to check to make sure that people don't say anything that is wrong, at least they won't have to spend hours correcting word usage, grammar, and style.

Targeted Approach

As you probably know, grammar- and style-checking programs have been with us for some time. Two of them, Grammatik IV and RightWriter, have been hot sellers since they were introduced. The problem with these packages is that while they do an excellent job of checking generic English, they don't really help you when it comes to developing a corporate writing style or usage guide. Most companies use either their own style or the style of a particular customer, especially if that customer is the government.

Governments in general, and the U.S. government in particular, have unique characteristics in their writing. In government writing, for example, you will often see the word *inclosure* where the rest of us would write *enclosure*. There are also special usage requirements, such as the proper use of the words *shall* and *will*, in writing proposals to the government. In some cases, even a small misuse can be very costly, so companies expend great effort making sure that the documents they send out are correct.

One way that companies can expend less effort, while retaining or even improving their accuracy in checking documents, is to use a specialized grammar or style checker. Two of these, Grammatik IV Government Edition from Reference Software and Corporate Voice from Scandinavian PC Systems, are designed specifically for use in specialized environments. Corporate Voice allows you to match your company's standard writing style to a specified ideal. Grammatik IV Government Edition, on the other hand, is designed to be used by the government and companies that deal with the government.

These products take fundamentally different approaches to the problems of providing consistency in writing. Corporate Voice compares your writing with a specific document or group of

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ITEMS DISCUSSED

Corporate Voice.................$119
Scandinavian PC Systems, Inc.
51 Monroe St., Suite 1101
Rockville, MD 20850
(800) 288-7226
(301) 294-7450
fax: (301) 251-1053
Inquiry 1223.

Grammatik IV
Government Edition $99
(GSA pricing is available
from qualified vendors)
Reference Software International
330 Townsend St., Suite 123
San Francisco, CA 94107
(800) 872-9933
(415) 541-0222
fax: (415) 541-0509
Inquiry 1222.

documents and shows you how you fit the style. Grammatik IV Government Edition, meanwhile, incorporates style and usage guidelines that the government already uses, and compares your document against them, suggesting changes where appropriate. Neither package requires you to abandon your creativity in writing, although they both encourage you to modify the style of a specific document to meet the standard.

A Voice for Change

Corporate Voice looks at documents as a whole and analyzes them in their entirety. This makes it easy to see how your document compares with whatever is considered the standard. Because it lets you select the standard, you don't have to worry about being forced to fit a standard that really doesn't meet your needs. In addition, it includes some standards, such as generic technical, news, and magazine writing, as well as fiction from Ian Fleming, John Gardner, and Tom Clancy. If you want to create your own standard, you can tell Corporate Voice to read documents that you consider representative of the style you want to use for a particular purpose.

Once Corporate Voice has read the material you select, you can then call that a new style, and from then on, you can have Corporate Voice compare other documents to that style. It makes heavy use of graphics in the comparison, creating a teardrop shape on the screen that represents the standard text. The text being checked appears as colored areas superimposed on the same screen. If the text being checked falls within the standard text's teardrop shape, and if other parameters such as sentence length and word usage check out as being close to the same, the document is consistent in style.

This does not mean, of course, that it's factually correct or that it's necessarily well written. For a more detailed analysis, the document being analyzed still needs to be read or checked by a program that handles proofreading. Finally, there is still no substitute for reading to confirm that the document reflects the company's position and that it's factual.

Government Certified

While it's nice to be able to run your company's documents through a style checker such as Corporate Voice, it isn't always possible. Sometimes the amount of written material is far too great, and sometimes the rules are far too diverse to

make creating your own rules practicable. This is especially the case with an organization as immense as the U.S. government.

To further complicate matters, thousands of private companies must use the government's style when they deal with the government, regardless of what they might want. This isn't an area in which a company has a great deal of choice. If your proposal doesn't have the proper word usage, for example, it may never have a chance. Likewise, other documents written for government customers must reflect government usage or the government may require that they be rewritten.

To cover all bases, Grammatik IV Government Edition incorporates rules from the Government Printing Office's style manual, the National Labor Relations Board's style manual, and writing guides from the Air Force and other agencies. It also uses the Internal Revenue Service instructions for the 1040EZ form as a comparison document. So that the Government Edition can be used by companies that work outside the government, it keeps all the comparison information and the rules from the regular edition of Grammatik IV.

Working with Style

How do they work? Both are easy to use, both support files from all major word processing packages, and both will print out more information than most writers will want to see, although it's valuable information for many.

I ran early versions of Down to Business through both packages. I also had them analyze the texts from two books: *The Novell Connection*—which Peter Stephenson and I wrote earlier this year and which has since been published by Brady Books—and a novel that I'm writing. I agreed with the analysis in both cases, and was pleased to see positive comments. The packages made appropriate suggestions about the use of passive voice, gender specificity, and other common problems. I was particularly pleased when I compared my novel with the work of Tom Clancy and Ian Fleming.

Of course, neither package will turn a bad writer into a Pulitzer winner, but they can help inexperienced writers get better, and they can help develop a consistent style, which can be extremely important in businesses that generate written material for external consumption. What's important is that when used correctly, both packages give managers another tool to escape the drudgery of editing words, allowing them to work with the ideas that the words contain. It is, after all, the ideas that they are really trying to communicate. ■

Editor's note: *This is the final installment of Down to Business. Next month marks the beginning of Wayne's new column, The Business Connection.*

Wayne Rash Jr. is a contributing editor for BYTE and technical director of the Network Integration Group 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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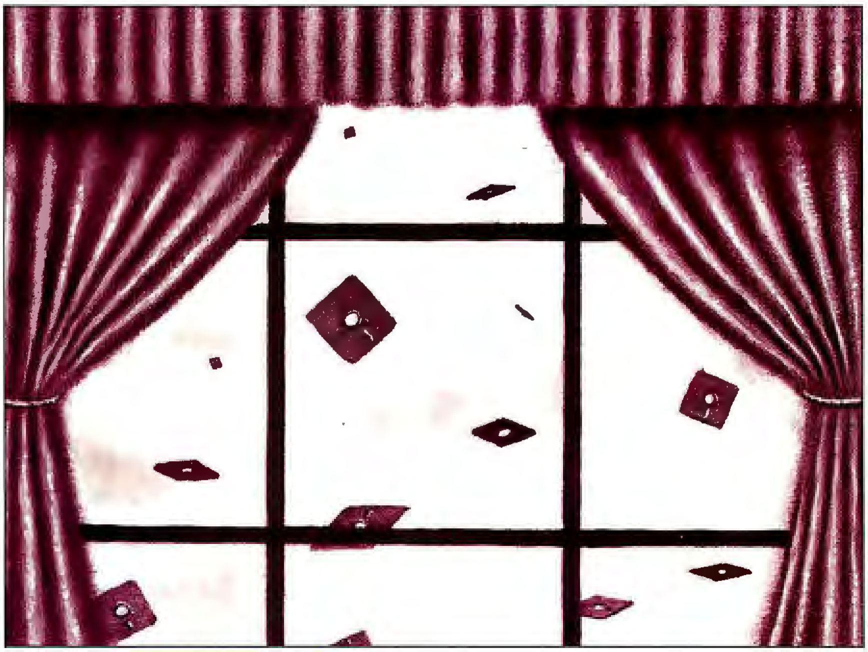
WHITHER WINDOWS?

1990's glamorous graphical user interface still needs a solid foundation



If you think Windows 3.0 is just another pretty face, think again. No other software product so radically expands the horizons of DOS-based computing. One day recently while editing an article, I stopped and marveled at the amount of work Windows lets me do with my 4-megabyte 386 PC. I don't usually do article layouts, but sometimes I find it helpful to drop rough text and artwork into a desktop publishing package for a quick thumbnail sketch of the final result. If you've done some DTP, you know that its software works best when surrounded by many supporting tools. Windows can make that synergy happen.

In this case, Ventura Publisher was the layout tool. I kept Corel Draw running in another window and used it to sketch a few figures. With Windows Paintbrush, which ran in yet another window, I resized, cleaned up, and added captions to other figures that the article's author had shipped to me as .PCX files.

Word for Windows occupied a fourth window. I don't write and edit much with Word, but the article required a complicated table, and I'm a big fan of Word's table editor. Meanwhile, Terminal, Windows' modest but useful telecommunications utility, was running as an icon, receiving revised text from the author. Clock, Calendar, Print Manager, and a few Notepads rounded out the collection of Windows applications helping me get through the day.

Of course, you can't get by without some good old DOS programs, too—at least I can't, not yet. So I had a few virtual DOS sessions going at the same time: Epsilon, the DOS text editor I use for all my writing and programming, and FoxPro, my data management ally.

My thumbnail layout took shape quickly. Interruptions weren't the annoyance they used to be. When a copy editor wandered in with a question about a previous month's article, I located the file, brought it up, and found the answer—without breaking stride or losing context.

With four major Windows applications, as many minor ones, and a pair of DOS programs all running at once, my machine showed only moderate signs of strain. That's Windows computing at its best: a pretty face, to be sure, but also a multitasking engine that pulls more useful work out of a 4-MB PC than you ever thought possible.

A Walk on the Wild Side

A few days later I had my worst Windows catastrophe. I received a beta copy of a networking utility for which I thought (erroneously, it turned out) that I'd need to load Novell's NetBIOS emulator. Normally, I boot DOS, run the NetWare IPX/NET4 substrate without the optional NetBIOS, and start Windows. That makes network services available to Windows itself, and to any virtual DOS sessions I launch from Windows.

Now, you don't have to load TSR programs from the original DOS session, and in the case of an optional utility like Novell's NetBIOS, you don't want to. I figured I'd just load it into the virtual DOS session in which I'd be running the program that required the NetBIOS interface. Wrong move.

When the dust settled, I surveyed the damage: My machine was still bootable, but CHKDSK reported hundreds of cross-linked clusters. Recovery was painless, since I had a fresh backup tape at hand. And I have never reproduced that particular crash; it may have been the fault of the beta NetWare shell I was

ILLUSTRATION: PAUL COZZOLINO © 1991

running at the time. Nevertheless, it was a rude reminder that Windows rests on a shaky foundation.

Windows 3.0 has two different modes of failure: There are Windows crashes, and then there are DOS crashes. Windows announces a failure of the first type with the message "Unrecoverable Application Error." Despite the ominous tone, UAEs are frequently benign. When a Windows program runs in protected mode (i.e., when Windows itself runs in either standard or 386-enhanced mode) and tries to write outside its authorized area in memory, Windows simply shuts the program down. It's just like a general protection fault under OS/2: The rogue task gets clobbered, but the rest of the system stays healthy.

UAE messages were common months ago when I ran lots of beta Windows 3.0 software. Now I rarely see such errors—unless I'm writing Windows programs myself, in which case they're a boon. Programmers like OS/2 because it takes the sting out of wild pointers; Windows 3.0 does much the same.

It's not the UAE that I dread, but rather the second sort of failure: errors that crash DOS and require the "three-fingered salute" (Ctrl-Alt-Del) or a hard reset. These are even more rare than UAEs, fortunately, but they can be very destructive. Windows usually gets the blame, but it's not really Windows' fault. DOS is the weak link in the chain.

Windows 3.0 has two modes of failure: Windows and DOS crashes.

Windows, like other DOS multitaskers, merely raises your expectations and encourages you to try to squeeze more work out of DOS. Because the 386/486 architecture enshrines a virtual 8086 processor in silicon, Windows' DOS multitasking usually works well. But V86 DOS sessions under Windows 3.0's 386-enhanced mode aren't isolated 1-MB partitions, as they are under, say, IGC's VM/386. Instead, the original real-mode DOS session supports all V86 sessions spawned under Windows.

The shared-DOS approach saves a lot of memory. It's the reason I can comfortably run two or three DOS sessions along with four or five beefy Windows applications, all in 4 MB.

But it's also a source of fragility. You don't have to crash and burn to see what I mean. Go to the Settings dialog box in a windowed DOS session and choose Terminate. (While I'm happy to have the option to end a hung DOS session, it's a far cry from Unix's `kill` command.) Before you pull the trigger, Windows warns you to "close all applications, exit Windows, and reboot." And you had better take its advice, because Terminate will almost certainly hose the original DOS session on which the whole show depends.

The Once and Future DOS

How can you patch up the DOS/Windows relationship? One way might be to offer an optional "VM/386" mode. If you're willing to trade memory (cheap) for stability (precious), you might, in some future version of Windows, allocate a full

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megabyte for each DOS task and keep them all separate from one another.

Or, you can simply avoid DOS applications. That's not as farfetched as it sounds. To the extent that Windows applications meet your needs, Windows works like a charm. You can bet that every vendor of big-name DOS applications is contemplating, if not developing, Windows 3.0 versions of its products. Never mind the graphical user interface: Windows is a potent DOS extender that makes the 640K-byte barrier seem like a bad dream.

If 1991 brings me Windows 3.0 versions of all my bread-and-butter applications, will I be satisfied? Nope. I have said that Windows expands the horizons of DOS-based computing. But strapping multiple copies of DOS into a preemptive-multitasking harness, and then yoking that ungainly contraption to the cooperative-multitasking Windows environment, can't be more than a stopgap solution. Windows deserves better than the archaic real-mode single-tasking disk operating system that now supports it.

Will Microsoft improve DOS or supersede it? Both, apparently. A new DOS, version 5.0, should be available soon—a kinder, gentler DOS that will manage memory more intelligently than current versions. That will be a big help to DOS users, and to users of Windows, Desqview, and other DOS multitaskers. (But it won't bear much resemblance to the first DOS 5.0—an operating system now known as OS/2.)

There's plenty of speculation about DOS 5.0's successor, too. Perhaps it will be a SuperDOS featuring the High Performance File System, dynamic link libraries, improved video and communication application programming interfaces, and the DOS protected-mode interface. I'm sure all these things can, and probably should, be added to DOS.

But wait, there's already a system that does all this and more: OS/2 2.0. It has great DOS support, it will run Windows applications by way of a mapping layer (or, depending on who you talk to, directly), and, most of all, it's an industrial-strength multitasker with a future.

Unfortunately, it's a political football right now. IBM and Microsoft are making lateral passes but not advancing toward the goal line. That's a shame. With version 2.0, the two companies finally have a product that offers useful backward compatibility with the all-important DOS (and increasingly important Windows) software base, puts a solid foundation under those programs, and rolls out the red carpet for a new generation of software.

OS/2 2.0 isn't for everyone. Many, and perhaps most, of today's DOS/Windows users don't need more in the way of multitasking than the ability to do a background 2400-bps download. Windows handles that just fine (but don't count on 9600 bps). On the other hand, there's a reason why the phrase "mission-critical applications" always crops up in discussions of OS/2. It's rock solid. Why should network operating systems and server-based applications be the sole beneficiaries of that stability? I could use a healthy dose of it myself. My mission is critical, too. ■

Jon Udell is a senior editor at large for BYTE. He can be reached on BIX as "judell."

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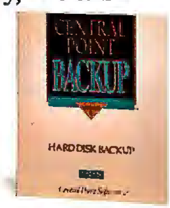

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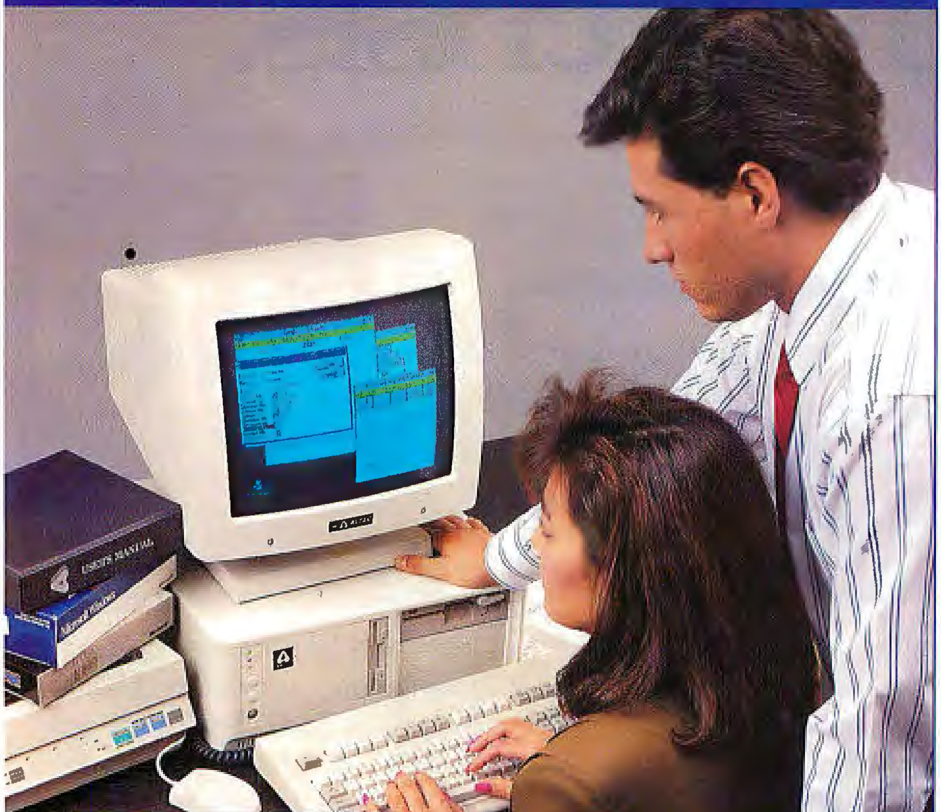

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MACINTOSH: THE NEXT GENERATION

Newer Macs need revolutionary designs to jump ahead of the PC pack

Congratulations, Apple. You've got your new Macs out the door and they're winners. Amazingly enough, they're winners we can afford. The Mac LC and IIsi pack more punch (if a little less expandability) than the SE and IIcx they replace, and the monetary hit you take when buying them is also way down. Let's not forget the Mac Classic. I know I won't. Especially since I begged you to build this machine (and even named it the Macintosh Classic) way back in the August 1989 BYTE. A real Mac for less than $1100 (discounted, of course), with 2 megabytes of RAM and a 40-MB hard disk drive. Nice job. With the new machines, Apple stands to regain market share. But is the job done? No way.

While the situation might be true regarding market share, Apple couldn't be further from the truth in thinking the job is done. The most important thing about the Classic, LC, and IIsi isn't what they cost or what they do. It's the philosophy they represent. These machines prove to us that Apple can respond positively to its customers once it makes a decision. And they prove that the engineering realization of a new Mac doesn't have to take forever.

Unfortunately, they also prove that Apple still takes too bloody long to make those realizations. The Classic, LC, and IIsi should have been agreed on long before they were finally being designed in 1990. Apple has to fix its marketing soon, or it won't make any difference how many versions of the future its engineers can invent. These fixes have got to start at the top. Apple needs a new, stable management that cuts the bull and hammers home its strengths. In short, Apple needs Bill Campbell, the president of Claris, to run its show.

That's not just my view. It's the view of the MacFolk I've been polling informally over the last two months. They see Campbell as the only Apple executive with the intelligence and moxie to make Apple invent the future we need. Here's what the MacFolk and I see as Apple's short-term agenda, should Campbell get the job:

- Apple should introduce a 40- to 50-MHz 68040 machine this year, priced to compete against the newest Sun Sparcstations. While the Mac IIfx is plenty powerful, Apple must regain the price/performance high ground from Sun.
- Apple must get System 7.0 out the door before this summer, with all its announced parts intact. We've all waited too long for this.
- Apple must put together a realistic vision of System 8.0 that includes preemptive multitasking and a dynamic memory map. System 8.0 must debut no later than the fourth quarter of 1992. Windows 3.0 isn't sitting still.
- Apple should make whatever alliances are necessary with Sony or Toshiba or Sharp to get a line of sub-7-pound Mac laptops on the market before the end of this year. The 16-pound Mac Portable is something of a joke.

In the long term, the MacFolk want Apple to invent, by 1994, a new Macintosh that's still software-compatible with the current generation, yet oriented around the three-dimensional universe, not just a two-dimensional screen. This new Mac should have built-in high-resolution sound input and output (no less than the reproduction capabilities of the new 16-bit A/D converters found in the top-of-the-line compact disc players). It must

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ITEMS DISCUSSED

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have a very high resolution 19-inch color screen with 16.8 million colors standard and the ability to show multiple levels of color depth.

In other words, the screen should offer resolution no less than what the new high-definition TV standards specify, a first step toward a 3-D Mac. This new Mac must have prodigious real memory (at least 32 MB), with growth into the hundreds of megabytes easily possible. It must include a standard thin-film hard disk drive of at least 1 gigabyte. It also needs a built-in optical read/write archival disk drive that can back up the hard disk drive several times over (3 to 5 gigabytes).

This new Mac must have an operating system and Finder that fully incorporates sound input and output and the use of detailed visuals to communicate. Given the proper voice-recognition algorithms, a mouse might not even be necessary, or it might be replaced by a more accurate cursor positioner, like an *x,y* digitizing wand or infrared drawing stylus.

What 1994 should hold, say the MacFolk, is not just more of the same with the Mac. They all agree that the tenth anniversary of the Mac must again show that Apple can invent the future. Finder twiddling, new font architectures, and improved virtual memory are fine, but they just don't go far enough. I hope Apple can take on the future Mac with the same dedication that it took on the 1984 version, which we're still using today.

Software of the Month

I get a lot of software sent to me each month. To many people, that would be nirvana, and it used to be for me, too. But having just celebrated my twelfth anniversary as a published computer writer, my attitude has changed a bit. I just can't take an in-depth look at all the

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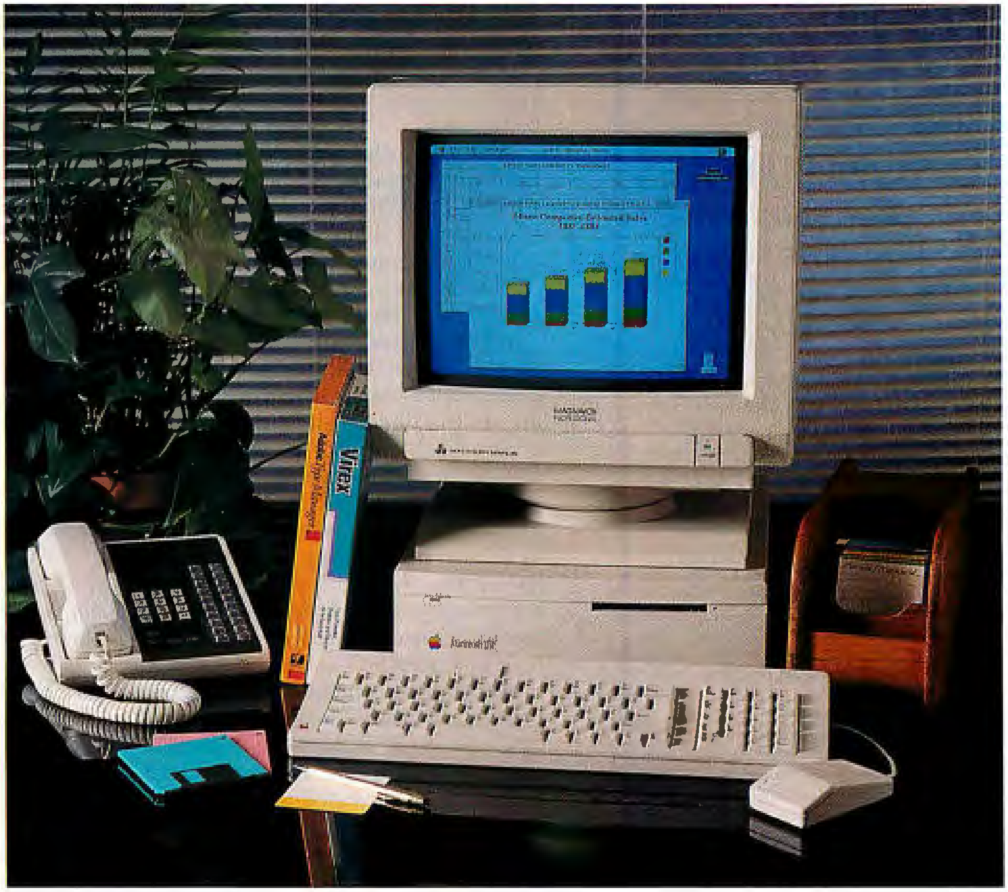

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dozens of packages sent to me each week, even though I really want to. Therefore, with the help of some of my colleagues and grad students, I've worked up a triage system to make sure every piece of software I receive each week gets looked at by a knowledgeable person who will report impressions back to me. Having this first cut will let me pick more carefully the stuff I want to emphasize in these pages.

With this new system in mind, I'm fashioning a new section in Macinations, which I'll call the Software of the Month. Each month, I'll look at one outstanding new Mac program.

This month, I give kudos to Lotus Marketplace: Business. Marketplace is a CD-ROM filled with information on over 7 million U.S. businesses. It includes the basic stuff, like names and addresses (for direct mail campaigns), and a slew of criteria that let you pick and choose the businesses you want to retrieve from the disk. You can search by business Standard Industry Code (SIC), by number of employees, and even by annual sales. With this information retrieved, you can create mailing lists, market research reports, or telemarketing call reports.

Marketplace combines huge prospect lists with target marketing software, all on the same CD-ROM. With this combination, you can find new customers without having to subscribe to more expensive on-line services that cater to this kind of direct marketing information niche. Marketplace is not cheap, of course, but the data you receive (it's updated with a new CD-ROM each quarter at a yearly subscription price of $150) is accurate and detailed. The basic package, which lets you retrieve the information of every company on the disk (all 7 million), costs $695. But the license limits your use to 5000 businesses. Each additional 5000 costs another $400. Volume discounts start to kick in after you buy over 25,000 names.

Marketplace includes all the software needed to do all this fancy market research and analysis (mostly HyperCard stacks and copies of HyperCard to work with any System from 6.0.2 to the current release). You'll also need a Mac with at least 4 MB of RAM (8 MB is better), a hard disk drive, and an AppleCD SC CD-ROM drive (or 100 percent compatible) to make it happen.

The only real problem with Marketplace is speed. Accessing a mountain of data from a CD-ROM disk is slow, slow, slow, even with the fastest IIfx as your search engine. However, compared to pulling similar data from a 2400-bps modem data link, Marketplace seems like a speed demon. And it's so much easier to use.

Tip of the Month: BIX

It's easy to forget the most obvious stuff. I guess I do it all the time. But it's time for me to redress a glaring omission in this column: my failure to discuss the BIX Macintosh Exchange. Whether you are a Mac fan or not, you should be on BIX. I suppose that sounds self-serving, coming as it does here in BYTE. But the point is, of all the on-line services out there in on-line-services land, BIX consistently offers the most high-quality information, especially for MacFolk.

The real strength of BIX is its membership. The people who contribute their expertise and souls to the on-line conferences are among the luminaries of the computing business. If you had to pay the consulting tabs these folks charge for their services while *not* on BIX, you'd be broke in a New York second.

If you're a Mac person, you are simply missing out if you aren't on BIX hanging out regularly in all the Macintosh Exchange conferences. In addition to getting tough technical questions answered (often by many experts), you can get to Apple's press releases and follow various threads that cover technology trends and specific implementation issues. And if you like to flame on every once in a while (hey, it's good for you!), the Macintosh Exchange on BIX offers just the forum for you.

BIX isn't as flashy as America Online or AppleLink, and, at least for the time being, it lacks CompuServe's automated front-end graphical-user-interface software (Navigator). Fortunately, though, its signal-to-noise ratio is much higher than that of any of these competitors. Of course, if you can afford it, you should live on as many services as possible. But if you're looking for a lot of Mac-specific information from *real* Mac experts, you should check out the BIX Macintosh Exchange. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is the author of a new book, Using Filemaker Pro *(Simon & Schuster/Brady Books). He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."*

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

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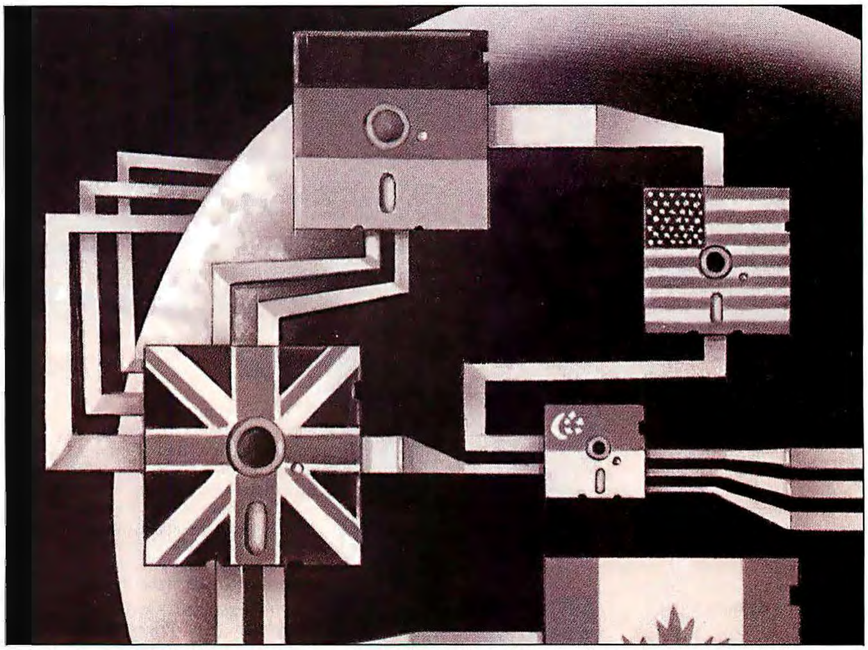
HEED THE STANDARDS

Love them or hate them, standards are something you have to deal with



Serving on a standards committee can be excruciatingly dull, yet it can turn into high drama when a controversial detail is debated. But the standards most people have to deal with are the ones that govern the software or hardware they're intending to buy. At such a point of decision, standards become very interesting, because failure to heed them may affect your job in a negative way. Less dramatically, there's always the problem of a standard that's not quite standard yet, which makes you scratch your head for days before finally making that big decision.

Unlike a stand-alone PC in an isolated office, Unix installations generally are designed with regard to company policies, history, and network connections. That's why it's a good idea to be aware of standards that may affect you. Perhaps more important, every new system installed that complies to a de facto standard means less work in the future to get that standard accepted.

Going Worldwide

The most important thing about the next few years will be the realization that computers exist as part of a worldwide market. I'm not talking about whether Asian companies control the U.S. computer market, but about computer users who are much the same everywhere. That is, it's not just Americans who like to see good software and hardware design and who insist on prompts and currency representation that correspond to their local language and customs.

In some ways, the computer industry is more fortunate than other industries. Power supplies that work on any worldwide voltage are commonplace, and many standards that started in one country (e.g., RS-232, Ethernet, and the myriad sizes of floppy disks) have been accepted in other lands as well.

Some Real Characters

Some languages (such as kanji and Arabic) need more than ASCII to represent them, and any new international standards must address this problem (see "Around the World in Text Displays," May 1990 BYTE). That's why newer releases of Unix (starting with System V release 3.2) support so-called 8-bit ASCII, which allows extensions to larger character sets as well as to distinctly non-ASCII representations. Only 7 bits are needed for all the characters in the U.S. The eighth bit is used in two ways internationally: to expand the 128-character ASCII set to a full 255 different characters (useful for European and other languages, such as Greek and Cyrillic) or to signal that another byte of character data will follow. Future releases of Unix will support character widths of up to 32 bits, which presumably will be enough until the Alpha Centaurians land.

The problem has been that Unix was not originally designed to be the international commercial operating system it has now become. The standard Unix shell, before Unix System V.3, used the eighth bit to mark literal strings internally. The basic Unix text editor, ed, wouldn't even accept a file that contained 8-bit characters, while vi would simply strip off the eighth bit silently.

Numerous internal changes, invisible to the average user or programmer, have been made in Unix to allow the full internationalization that is complete in Unix System V.4. The result will be an environment that can be easily customized for local variations in date, time, currency, and numeric formats, as well

ILLUSTRATION: TOM CENTOLA © 1991

as language and collating sequence. All this has been made possible by the `setlocale` function defined in the standard C language by ANSI X3J11.

Interestingly enough, much of the movement to internationalize and standardize Unix has come from the U.S. Apart from the X3J11 standard for C (which was defined by ANSI), we have the NIST's FIPS standard and AT&T's SVID standard. The POSIX standard has been issued by IEEE, an international organization based in New York, and the X/Open standard comes from San Francisco. Americans are not as insular as some people like to believe.

Of course, the most important move toward standardization is that of AT&T's Unix System V.4, which brings together previous versions of AT&T Unix, SCO/Microsoft Xenix, BSD Unix, and SunOS. This gives users one admittedly large Unix that can deal with programs from any of these once-separate environments. Open Software Foundation's release of its OSF/1 operating system will provide a second alternative for manufacturers and users alike. If both these competing systems prevail, at least there will be two main Unix standards to deal with, rather than four or five.

Hoisting Those Standards

People should look toward standards as rules that transcend traditional views of "where things belong." For instance, the traditional view is that IBM PCs and clones use LaserJet-compatible printers, and Macintosh computers use LaserWriters and other PostScript printers. My view is that PostScript is too important a standard to be relegated merely to Apple computers, because using PostScript also lets you access other devices such as typesetting machines and even windowing systems (e.g., the Next computers and the News system) that rely on Display PostScript. So I applaud makers of IBM PC software that support PostScript, and I doubly applaud recent developments, such as The Santa Cruz Operation's direct support of PostScript printers in its SCO Unix. The more PostScript is used as a mainstream Unix standard, the more you will see new hardware and software that support it.

Even saying things like "IBM PCs and clones" is now nonstandard. There's a new, Politically Correct way of saying the same thing: Industry Standard Architecture. That brings to mind the Extended ISA bus, which many manufacturers are attempting to make a de facto standard while flying in the face of IBM's own Micro Channel architecture bus. This is a perfect example of how unsettling standards wars can become. At this writing, there is no clear winner, so investors in either bus must lay down their money and take their chances.

In workstations, as I've discussed in previous columns, SPARC technology is becoming more popular. Now that Sun has relinquished licensing control of SPARC, it may become an industry-standard architecture of its own. Unlike PC-based computers, many workstations are becoming single-board computers, with expansion capabilities limited to the 64 or so megabytes of RAM that you can add to the system board or to what peripherals you can hook up to the SCSI port. In practice, that's not too limiting, since the server will have its own litany of expansion board capabilities.

What about Unix windows? The X Window System is about the closest thing to a standard you can find in this area. Once you've decided on that, you can

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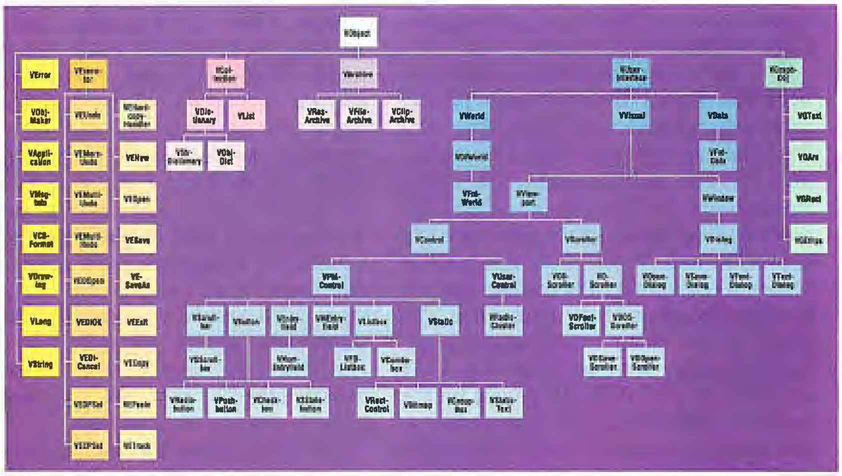

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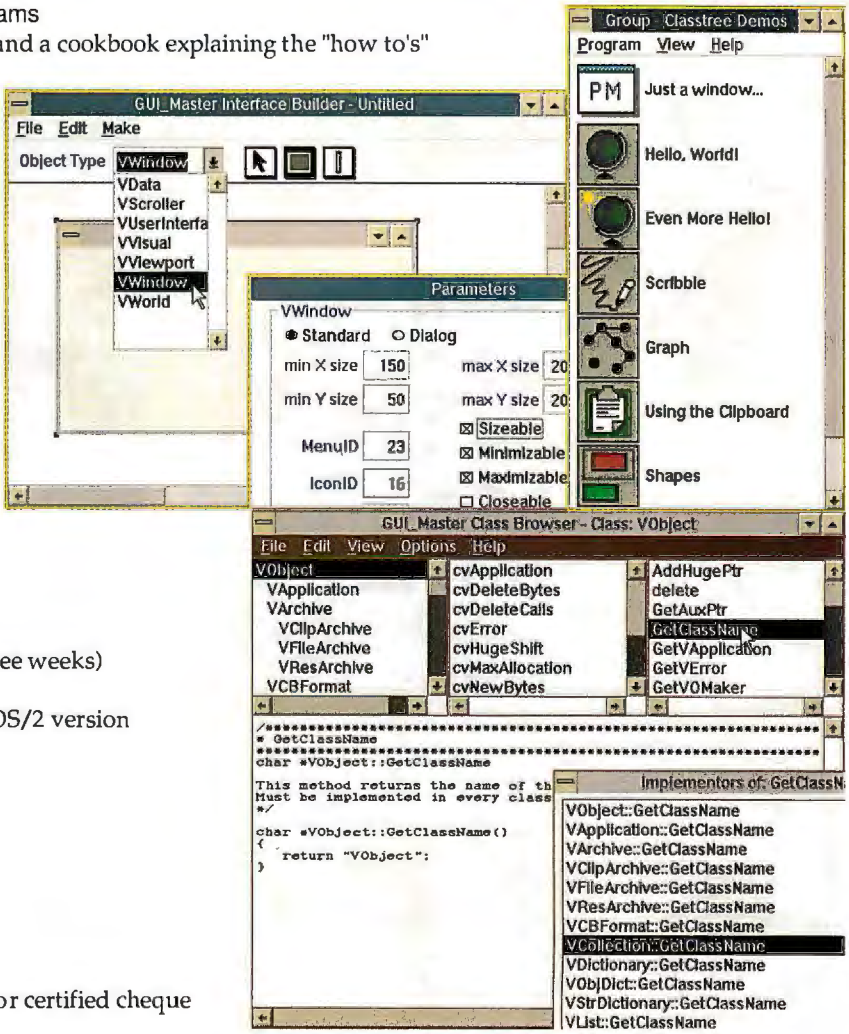

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Of course, the standard for LAN connections is still Ethernet and TCP/IP protocols, whether you're dealing with workstations, PCs, or Macs. In the future, you can look forward to even more connectivity as Open Systems Interconnection, fiber-optic and wide-area cable networks, and X.400 mail systems become more popular. People *like* talking to other people, and the easier it is, the better. Right now, I can send ASCII-based E-mail messages from my Unix machine on UUCP-Net to people on the Internet, MCI Mail, and CompuServe, but faxes, binaries, or image files wouldn't work. I expect that these kinds of problems will be solved in the next few years when machine brand and operating system are too petty to stand in the way of simple interpersonal communications.

Getting the Message Across

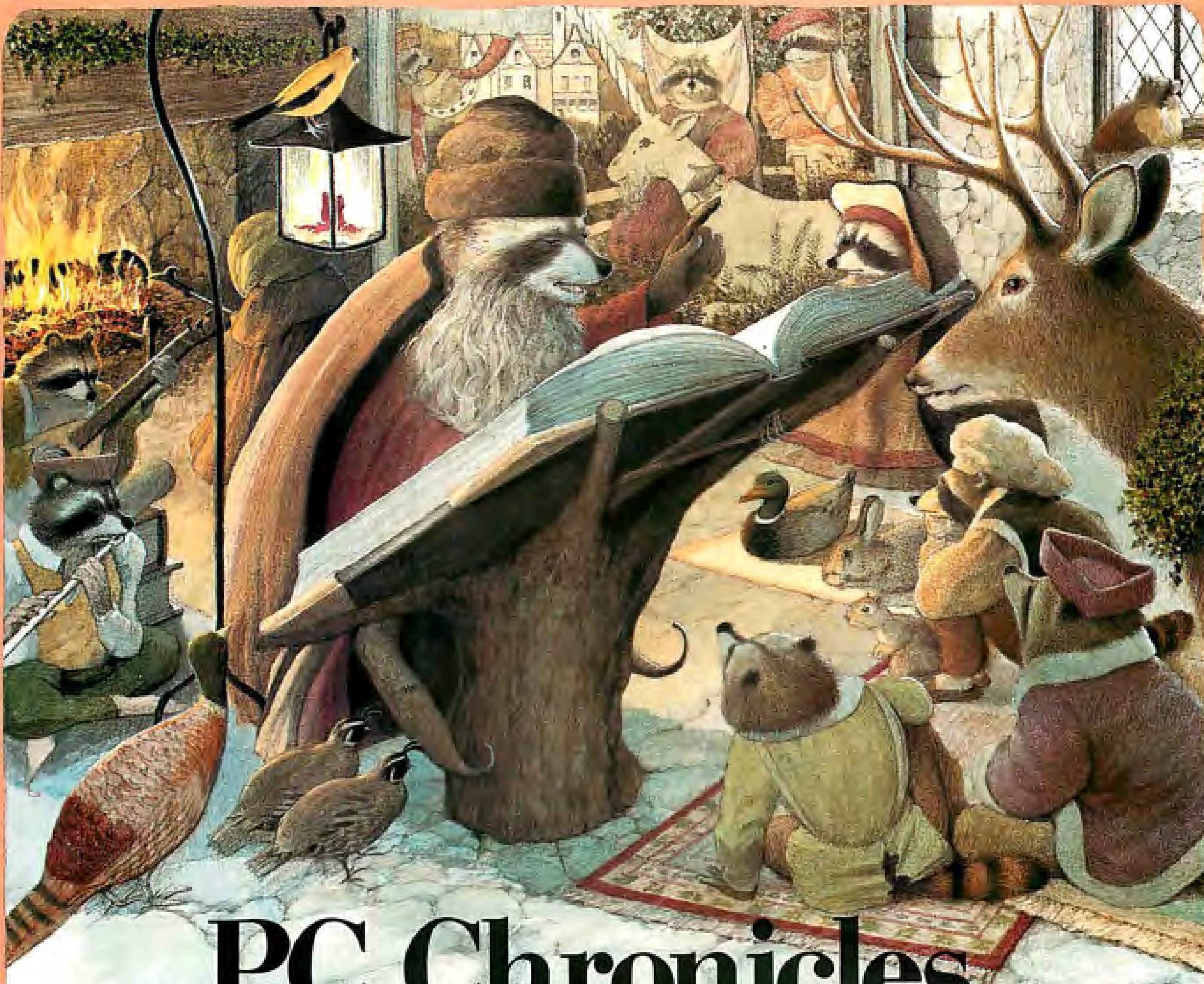
Here's an example of how standards have helped information exchange. Floppy disks, as mentioned above, have undergone many changes since the early days, but there are still enough standards that Apples, IBMs, Unix systems, and even Ataris can generally exchange disks using suitable software. Manufacturers learned from this, so hard disks and tapes now generally use one of a few standard interfaces and formats (e.g., SCSI, MFM, RLL, IDE, and QIC-24). This lets you buy a disk now for one system and use it later on a different architecture, or bring data from a Sun to a 386-based Unix system via cartridge tape. SCSI deserves special mention; it transcends a device type and allows great flexibility, although there are some potential security concerns with certain SCSI devices on Unix systems.

The most important standards you'll see will be developing now for the next decade. As with communications, the growth of true universal multimedia data and applications will only come when standards that cross operating systems and machine architectures arrive. This will allow all participating machines to exchange image, text, sound, and video data, using whatever hardware exists on the target machine to speed things up. This is especially important for video data compression and decompression, which itself will be standardized in the next few months.

At this writing, a standard called Macromedia has been proposed, and there will be others, perhaps based on the work already done by Next, in the same vein. I can only hope that a consensus is reached soon, so we can all benefit from this. Imagine getting E-mail with a verbal annotation that you can listen to and a 15-second video message that automatically pops up in a window on your screen. That's available now on several Unix platforms. But when you won't know or care what kind of machine the original message was created on, then standards will have finally done their job. ■

David Fiedler is executive producer of Unix Video Quarterly *and coauthor of the book* Unix System Administration. *He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

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



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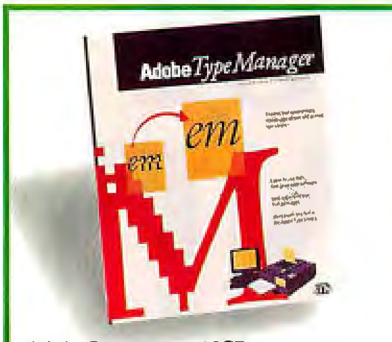

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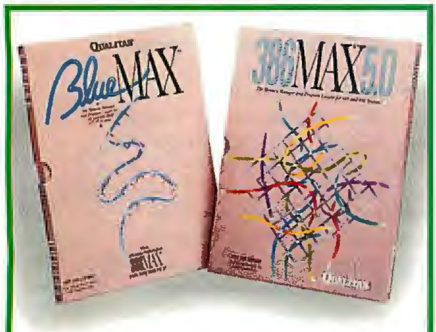

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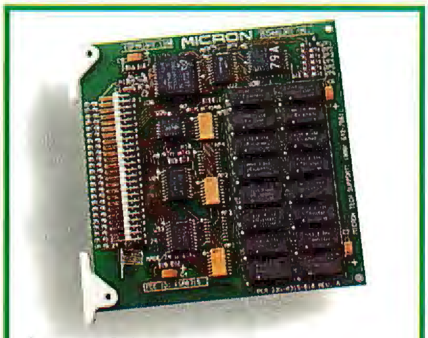

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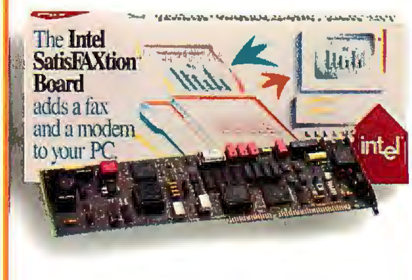

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6153 DC2120 Tape Cartridge *(5 pack)* .. 149.
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6602 1.44 Meg External *(for PC/XT/AT)* . 239.
Plus Development ... 2 years
6424 Hardcard II 80 Meg *(19 ms)* ..... 599.
8304 Hardcard II XL 50 Meg *(9 ms)* .... 399.
8287 Hardcard II XL 105 Meg *(9 ms)* ... 689.
Seagate ... 1 year
2285 20 Meg Int. Hard Drive ST225 *(w/controller and cables, 65 ms)* .. 255.
2286 30 Meg Int. Hard Drive ST238R *(w/controller and cables, 65 ms)* .. 269.
4554 40 Meg Int. HD ST251-1 (28 ms) .. 329.

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4326 1.44 Meg Drive for AT .... 109.

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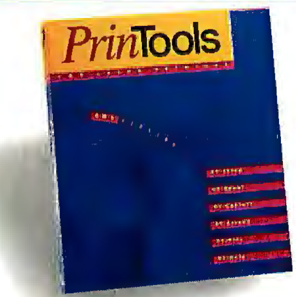
2789 5¼" MD2-D 360k Disks *(Qty. 10)* .... 12.
2792 3½" DS/DD 720k Diskettes *(Qty. 10)*.. 14.
2793 3½" DS/HD 1.44Mb Diskettes *(Qty. 10)* 27.

Hayes ... 2 years
8049 *JTFax 9600B*–Good, solid fax board from the company who wrote the book on communications. TSR fax software, print capture and one-step convert and send are just a few of the features .... $499.



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8320 ▣ *PrinTools 1.0*–Utilities for the HP LaserJet, DeskJet & compatibiles. Includes Spooler, Screen Dump, Screen Capture, SetUp, Plot with HPGL/2 support, and Help utilities .... $85.

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8185 QD 2040 Tape Cartridge .... 19.

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- For monitors, printers, Bernoulli Boxes, computers, hard drives, and power backups, actual UPS Blue charge will be added. For all other items, add $3 per order.

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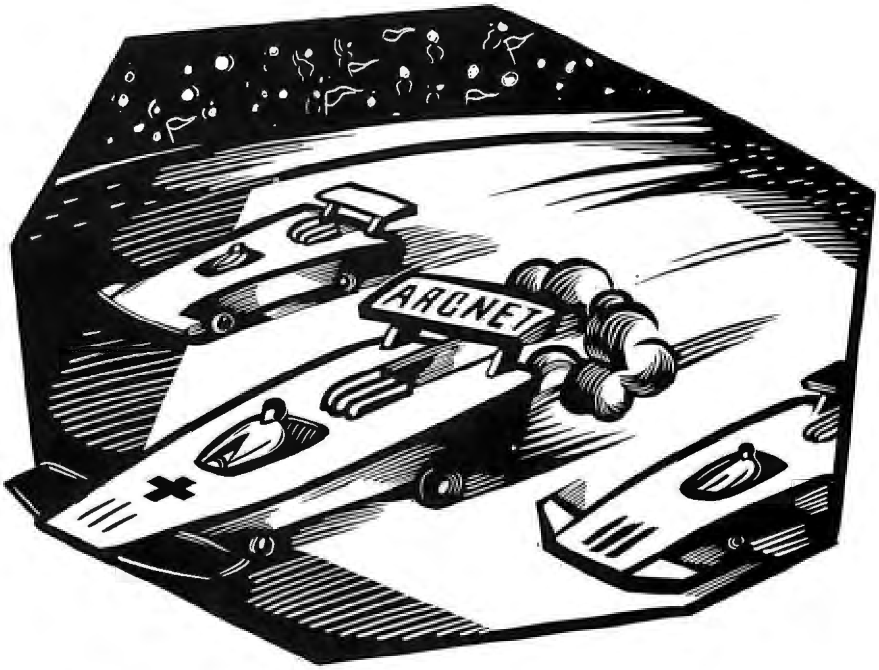


ARCnet, one of the oldest and most robust LAN architectures, is about to be turbocharged. While ARCnet transfers data at 2.5 megabits per second—significantly slower than Ethernet or Token Ring—the soon-to-be-released ARCnet Plus will leapfrog both, turning in transfer rates of 20 Mbps. What's more, unlike any other LAN standard that's undergone a speedup, ARCnet Plus will be downward-compatible with older ARCnet equipment.

Most people think of Ethernet as the first commercial LAN standard, but that's not the case. Introduced by Datapoint in 1977, ARCnet (which stands for Attached Resource Computing Network) was doing an excellent job integrating clusters of business workstations and intelligent terminals when Ethernet was still an experiment at Xerox's Palo Alto Research Center.

ARCnet's Slow Start

Although it was first to market, ARCnet fell behind Ethernet for several reasons. First, Datapoint kept the technology proprietary for several years, implementing it only on its own business computing systems. The first publicly available ARCnet chips were not sold until 1982, by which time Ethernet had already become popular. In addition, Datapoint—unlike Xerox, DEC, and Intel—didn't participate in the IEEE 802 committee meetings, which made Ethernet and Token Ring international standards. Finally, the fact that Datapoint was not an industry giant with the clout of these other companies may have kept the word from getting out.

Nonetheless, ARCnet is still an attractive standard, and many LAN managers have embraced it. One of ARCnet's main draws is that it uses 92-ohm coaxial cable, which is the same kind used with IBM 3270 terminals and which typically costs half as much per foot as the 50-ohm coaxial cable used with Ethernet. This means that many existing structures, such as airports and older office buildings, may not need to be rewired for ARCnet, since it can run over the web of existing cable that was installed (often at great expense) for mainframe terminals. Other implementations run over twisted-pair and fiber-optic cable, and you can use ARCnet on the IBM Cabling System with 92-ohm baluns.

Another ARCnet advantage is its robustness. ARCnet was so heavily over-designed that it works amazingly well even when connectors are loose, cable runs are too long or out of spec, or grounds are faulty or absent. An ARCnet that's built around "active" hubs—which is the recommended configuration—won't go down if you disconnect a node or forget to terminate a cable. And ARCnet's "modified token-passing" protocol, which requires that the hardware acknowledge every transaction, including passage of the token, provides a high degree of confidence that a message has been delivered.

Token passing in an ARCnet makes the network *deterministic*. That is, there is a fixed upper bound on the amount of time a station must wait before transmitting, so no one station can hog all the bandwidth.

ARCnet has a small minimum packet size, which makes it especially good at dealing with applications, such as data entry and terminal emulation, that involve the exchange of many small packets. Finally, there's price. ARCnet remains the low-cost leader. PC adapters

ITEMS DISCUSSED

ARCnet
ARCnet Plus
Datapoint Corp.
9725 Datapoint Dr.
San Antonio, TX 78229
(800) 334-9968
(512) 699-7000
fax: (512) 699-7920
Inquiry 1227.

can be had for as little as $75; typical low-end Ethernet cards cost twice as much.

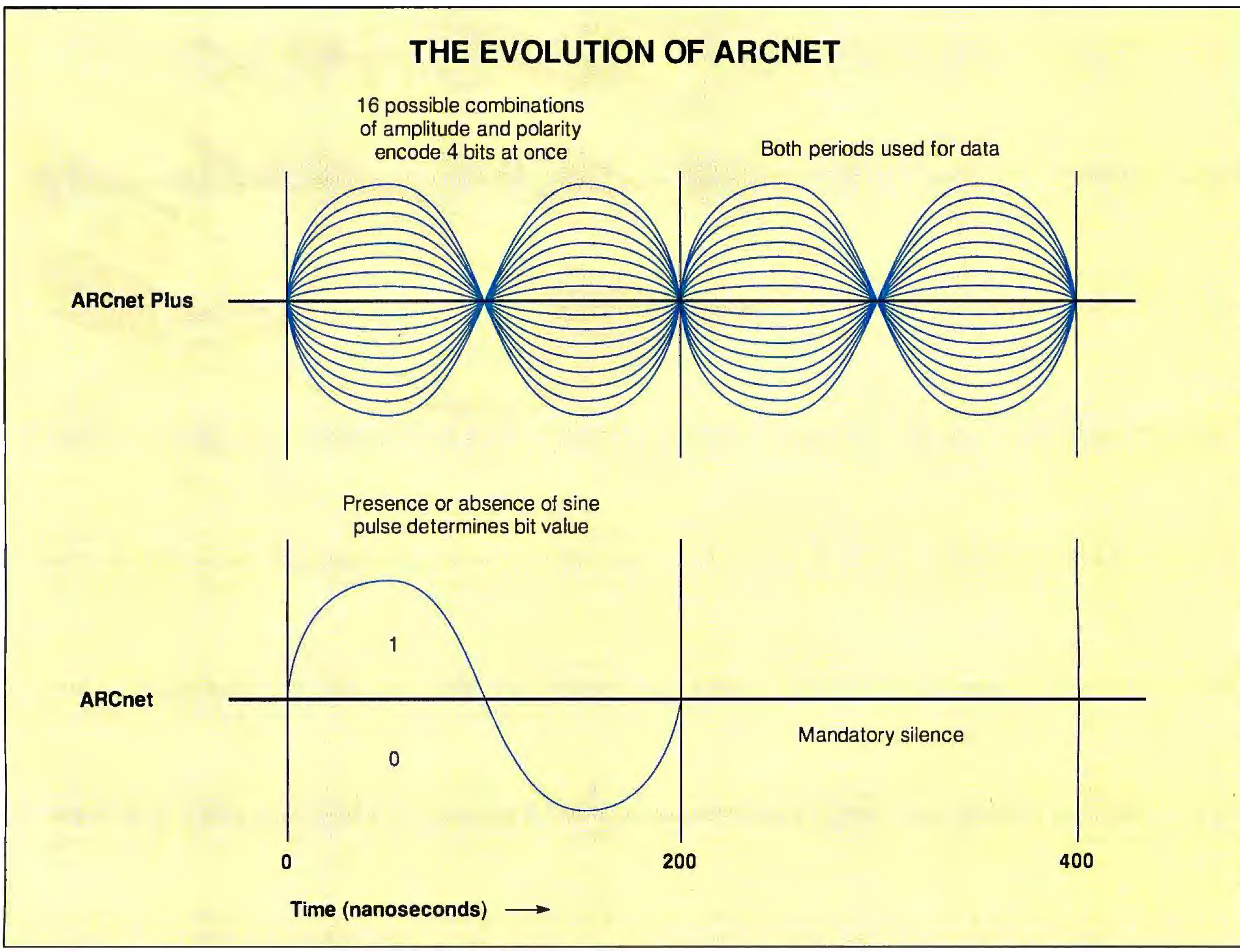
Revving Up the Standard

Despite ARCnet's many advantages, published benchmarks show it lagging far behind other standards in overall throughput. ARCnet proponents realized that they faced the spectre of dwindling market share unless bit rates also kept up with the competition. They also realized that not allowing the new, faster equipment to interoperate with existing units—as was the case when Ethernet and Token Ring moved to higher speeds—might cause users to switch to another standard. Finally, they sought to overcome some other ARCnet limitations, including the 255-node maximum per network and the low 508-byte ceiling on the amount of data per packet.

Datapoint's engineers set a challenging technical task for themselves when they decided to increase ARCnet's speed by a factor of eight *and* retain downward compatibility with 2.5-Mbps ARCnet. How they achieved this goal is extremely clever.

The figure shows how ARCnet Plus works. Nodes on a standard ARCnet signal a "1" bit by sending a 200-nanosecond pulse (consisting of a single cycle of a 5-MHz sine wave) followed by a silence of equal length. Two intervals of silence represent a "0" bit. (To make sure the receiver keeps pace with the transmitter, ARCnet precedes each byte with a 3-bit calibration pattern that consists of two 1s and a 0. This makes the actual data rate $^{8}/_{11}$ of 2.5 Mbps, or 1.82 Mbps.) As you can see, a lot of slack time can be eliminated from this scheme: The periods of silence are wasteful, and the calibration pulses take up 27 percent of the available bandwidth.

ARCnet Plus, like ARCnet, assumes that the base bandwidth of the cable is 5 MHz, but it uses that bandwidth more efficiently. It cuts out the silent period between bits, packing them back-to-back instead. It sends a calibration pattern only once for every 8 bytes, reducing the



The original 2.5-Mbps ARCnet signals bit values by determining the presense or absence of a sine pulse. Here, ARCnet signals a "1" bit by sending a 200-ns pulse, followed by a silence of equal length. The 20-Mbps ARCnet Plus specification makes more efficient use of the bandwidth by using both periods for data and by using amplitude modulation to encode 4 bits into every pulse. ARCnet Plus also sends a calibration pattern once for every 8 bytes, further reducing overhead.

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Users with an investment in ARCnet can upgrade their networks on an as-needed basis, without having to throw out valuable equipment or run new cable.

overhead to about 16 percent. Finally—and most novel—it uses amplitude modulation to squeeze 4 bits of data into every pulse. A pulse can be either a positive- or negative-going sine wave and can have one of eight possible amplitudes from 0 to 12 volts. This yields a total of 16 combinations, enough to represent a nibble of information. That adds up to 4 bits per pulse × 5 million pulses per second, to yield a 20-Mbps data rate, excluding overhead.

When you subtract the time spent sending calibration pulses, the result is an effective data rate of 16.84 Mbps—significantly faster than Ethernet and a shade faster than 16-Mbps Token Ring. However, since an ARCnet Plus adapter is much simpler than a Token Ring board, and the per-packet overhead is much lower than for either Ethernet or Token Ring, ARCnet Plus should have a big edge in benchmark tests.

Downward Compatibility

Every ARCnet Plus adapter will be capable of communicating with regular ARCnet nodes. This, plus the token-passing scheme, is the key to downward compatibility. When the network starts up, each node "sounds off" in turn and lets the others know if it's capable of handling high-speed transmissions. Thereafter, whenever an ARCnet Plus node passes the token, it signals its capabilities again. Therefore, communications between two ARCnet Plus nodes can occur at 20 Mbps, but the network steps down gracefully to 2.5 Mbps whenever a slower node is involved.

In many cases, no old equipment need be removed from an ARCnet network to run ARCnet Plus. But even in the worst case, you must replace only the hubs if you're looking to mix old and new nodes. ARCnet's star topology uses active hubs that amplify and distribute the signals to all nodes—in much the same way that a cable TV system uses amplified signal splitters. However, since the old hubs don't expect the new, high-speed signals, they will filter them out instead of amplifying them.

There are two solutions to this problem. You can simply buy new hubs, or you can make sure that you don't put two high-speed nodes on opposite sides of an old hub. There's one other restriction: ARCnet Plus interfaces can't attach directly to a "high-impedance" (i.e., bus-based) ARCnet. However, they can communicate with such a network through a hub.

Bigger Packets

ARCnet Plus offers other advantages to users with large networks or with high throughput needs. The new standard allows packet lengths of up to 4096 bytes instead of the current 508 bytes. This means that certain file-server and database transactions will get a boost under the new standard. There's also a provision for more nodes: up to 2047, compared to ARCnet's 255. And 802.2 or IP addressing can be added to make it easy to connect ARCnet Plus networks to Ethernet, Token Ring, or TCP/IP networks using a bridge, router, or gateway.

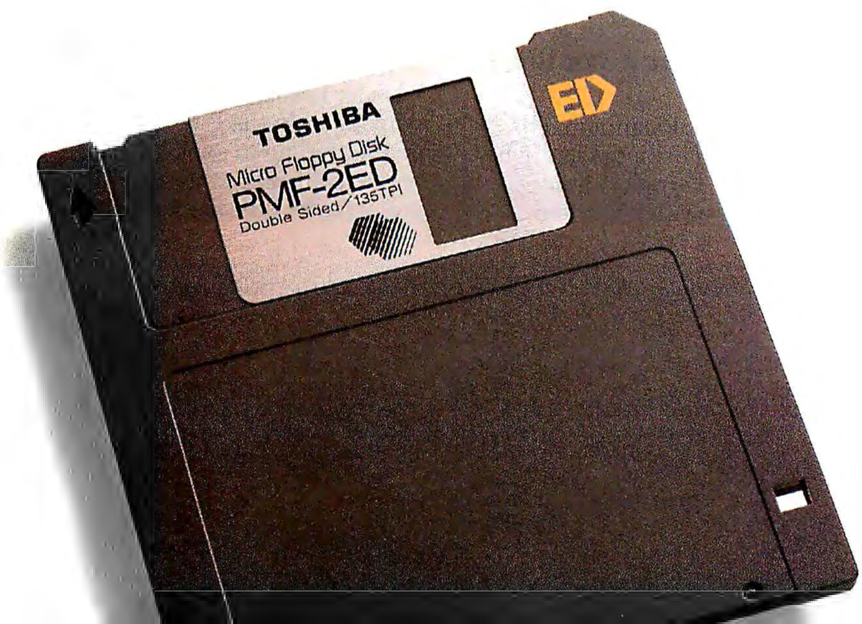
All in all, ARCnet Plus offers an opportunity for users with an investment in ARCnet to upgrade their networks on an as-needed basis, without having to throw out valuable equipment or run new cable. It may also attract a lot of first-time buyers looking for a fast, reliable, efficient LAN standard.

When will ARCnet Plus be ready for prime time? Datapoint and other manufacturers will not say for sure, but industry observers estimate that commercial products will begin shipping in the second quarter of this year. In any case, users should cheer Datapoint's ARCnet Plus as a first in the world of LANs: a new standard that doesn't require that users throw away perfectly good equipment to achieve a higher level of performance. ■

Brett Glass, a frequent contributor to BYTE, is a programmer, hardware designer, author, and consultant in Palo Alto, California. You can reach him on BIX as "glass."

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

Toshiba's New Disk Medium Is No Small Accomplishment.



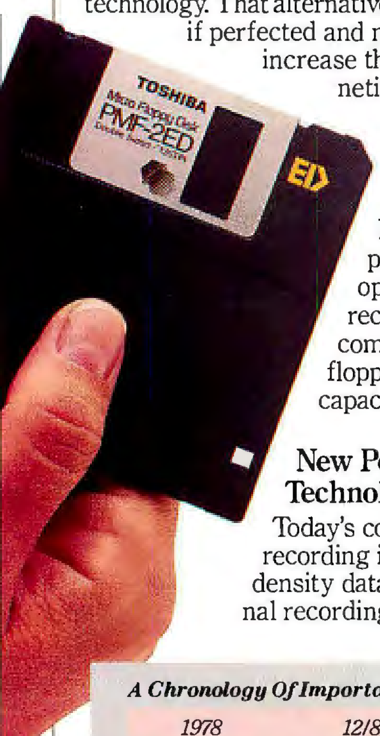
There's 13 Years Of Extra-High Density D

In this age of information, the voracious appetite for magnetic data storage capacity is never satisfied. Each new generation of computers brings higher performance and demand for more and more memory.

In personal computers and workstations, new applications like desktop publishing, computer-aided design and medical imaging are stretching the limits of conventional floppy disk and disk drive technology. And new technologies like digital audio tape and high definition television are placing unprecedented demands on recording techniques and media.

Every 4 MB Extra-High Density disk you buy will carry the symbol ED—ED tells you you're buying Toshiba technology.

Toshiba Corporation anticipated this developing logjam in storage capacity as long ago as 1978, when it began research and development activity into a promising alternative to conventional longitudinal magnetic recording technology. That alternative—perpendicular recording—if perfected and made producible, promised to increase the recording density of magnetic media by at least an order of magnitude.



Today, in 1990, Toshiba's intensive research and development, led by Dr. T. Fujiwara, has resulted in the perfection of media that are optimized for perpendicular recording, and the production of commercially available 3.5 inch floppy disks with the remarkable capacity of 4 MB unformatted.

New Perpendicular Recording Technology

Today's conventional, longitudinal recording is reaching its limits for high density data storage. Using longitudinal recording, data is written into the magnetic medium by magnetizing adjacent cells *parallel* to the plane of the medium's surface. In perpendicular recording, magnetization of the individual cells occurs in a direction *perpendicular* to the plane of the recording medium.

To take advantage of perpendicular recording, Toshiba perfected the use of a new magnetic medium. This new medium is Barium Ferrite.

Disk And Drive Technology

Toshiba has ushered in the era of high density recording with the development of the new 3.5 inch extra-high density floppy disk utilizing the barium ferrite medium, and new associated floppy disk drive.

The double-sided disk has an extraordinarily high recording density of 35 kilobits per inch—more than four times higher than conventional floppy disks. Yet the disks have a track density of 135 tracks per inch, the same as in conventional 3.5 inch floppies. The barium ferrite disks feature extremely high reliability—dependable performance for more than 10 million revolutions.

For high density recording and playback using this new barium ferrite 3.5 inch disk, Toshiba made certain modifications to disk drive head and drive mechanical designs. This new Toshiba disk drive technology, licensed to companies around the world, preserves downward read-write compatibility with conventional 3.5 inch 1 MB and 2 MB disks.

Under license from Toshiba, many firms in the U.S. and Japan are proceeding to exploit barium ferrite technology and several have introduced commercial

Toshiba's development of the barium ferrite medium began in 1978, led by Dr. T. Fujiwara. Today, Toshiba holds the patents for barium ferrite as a recording medium.

A Chronology Of Important Milestones In The Development Of Barium Ferrite Media For Perpendicular Recording.

1978	12/82	7/85	1/86	4/87	9/87	4/88	9/88
Researchers at Toshiba R&D Center establish concept of barium ferrite as a medium for perpendicular recording.	*Barium ferrite tape demonstrated for the first time in the world at Toshiba Private Show.*	*Toshiba displays and demonstrates first 3.5" floppy disk and drive at National Computer Conference.*	*Toshiba Ba-Ferrite floppy disk selected as one of the top new products of 1985 by Nikkan Kogyo Shinbun.*	*Toshiba announces development of a Ba-Ferrite 3.5" 16 MB technology.*	*Toshiba announces a commercial version of Ba-Ferrite 3.5" 4 MB FDD and available licensing of FD/FDD technology.*	*At Comdex, Data Technology announces a 5.25" 20 MB FD/FDD product utilizing Ba-Ferrite media.*	*Toshiba and TEAC announce a Ba-Ferrite 3.5" 4 MB FDD that is 1" high and downward read/write compatible with 1 & 2 MB disks.*

Extra Effort In Every isk We Make.

products. Currently, standardization of the 4 MB technology has been progressing worldwide led by Toshiba and other manufacturers.

In addition to Toshiba, other companies are also extending the recording density of barium ferrite above the 20 MB range on 3.5 inch disks, by utilizing the superior characteristics of barium ferrite and new schemes for recording and tracking.

When you see this symbol on an Extra-High Density disk, that's your assurance that you're buying not only Toshiba technology—but Toshiba quality as well.

Other Applications Of Barium Ferrite Technology

Toshiba's barium ferrite technology shows equal promise for other high density applications such as computer data tapes, 8mm VCR tapes, DAT tapes and future high definition television VCR tapes.

The use of barium ferrite also allows high speed contact duplication of pre-recorded tape. The speed of duplication can be several hundred times higher than can be accomplished in machine-to-machine real time duplication.

All told, the enhancement of recording media embodied in Toshiba's barium ferrite technology applied to perpendicular recording promises to extend the density of today's magnetic storage products well beyond that available today. And the technology will certainly give rise to new media applications where high density, high performance and extremely high reliability are required.

For additional information about barium ferrite Extra-High Density disks, ask the company that developed the technology—Toshiba. Telephone 1-800-843-2108.

What's Barium Ferrite?

The particles used in conventional recording media are shaped like needles, and therefore difficulties arise in maintaining perpendicular orientation throughout the manufacturing process. Barium ferrite particles, on the other hand, are tiny flat platelets, hexagonal in shape, that can be readily arranged to have their easy axis of magnetization perpendicular to the platelet plane.

Barium ferrite has long been used as a permanent magnet material, but the particles for permanent magnets have grain sizes too large to be suitable for high-density magnetic recording. However, Dr. Fujiwara and Toshiba's researchers have developed ultra-fine barium ferrite particles with optimum shape, size and magnetic properties.

The Toshiba researchers also perfected a glass crystallization method for the manufacture of the ultra-fine barium ferrite particles.

The process begins by mixing glass, barium ferrite components and the ion substitution components and melting them at high temperature. The mixture is poured between rotating nip rollers for rapid quenching and forms glass flakes. These are heated again to crystallize them. The crystallized barium ferrite particles are extracted by dissolving the remaining compounds with acid, then rinsed and dried. This process produces very fine, separate particles of uniform size with excellent magnetization properties.

In the next step, a magnetic paint is made by mixing the barium ferrite particles in a mixture of binder resin and solvents and other ingredients. The magnetic paint then can be coated onto base polyester films and dried, and the surface smoothness enhanced by rolling. After curing, the films can be cut to form tapes, or punched out in the form of flexible disks.

11/88	12/88	2/89	3/89	2/90
Ba-Ferrite products at Comdex: Iomega 5.25" 44 MB, Brier 3.5" 21 & 43 MB, Insite 3.5" 21 MB & Qume/ Kodak 5.25" 20 MB FD/FDDs	*Toshiba introduces the JW-530, a Japanese word processor employing a Ba-Ferrite 3.5" 4 MB FD/FDD.*	*Logitec announces the LFD-302, an add-on subsystem for the PC98 series using a Ba-Ferrite 3.5" 4 MB FD/FDD.*	*Sharp introduces the DP-3000, a desktop publishing system using a Ba-Ferrite 3.5" 4 MB FD/FDD.*	*Canon introduces a desktop publishing system using a Ba-Ferrite 3.5" 4 MB FD/FDD.*

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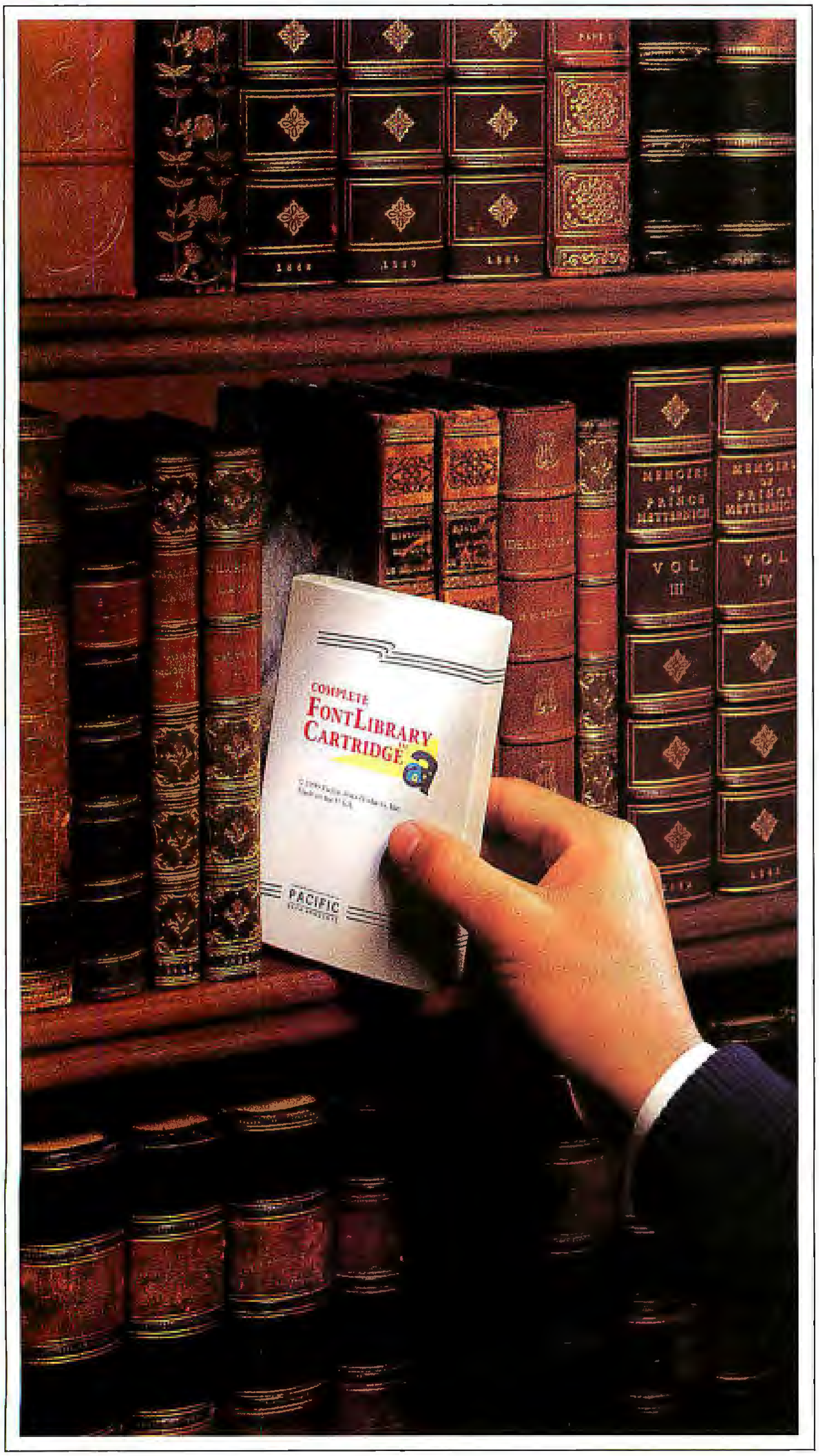

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Fax Boxes Keep Your Laser Printer Busy

Unless your laser printer is hooked up to a print server in a large LAN, it probably spends most of its time twiddling its electronic thumbs, patiently waiting for the next print job while happily running up your electric bill.

Two new products are designed to keep your laser printer much busier by using it to print faxes as they're received. **Fax-O-Matic** from Tall Tree Systems and **FaxConnection** from Extended Systems are both essentially receive-only fax machines that use a laser printer for output. Just having faxes on plain paper instead of that curly thermal paper that standard fax machines use is reason enough to go right out and buy one of these units.

OK, the name "Fax-O-Matic" does indeed conjure up images of, "It dices, it slices, it prints faxes." And it's ugly, too: a true black box. But Fax-O-Matic works perfectly. And at $399, it's by far the most inexpensive fax box available.

Setup is simple: I plugged the printer cable from my computer into Fax-O-Matic, plugged an included cable from the unit to my laser printer, and hooked up AC power and my fax line. Off I went. (There's also a jack for hooking up a standard fax machine for sending faxes.)

Fax-O-Matic works with any laser printer that's compatible with the Hewlett-Packard LaserJet. And you don't need gobs of RAM, either. If your laser printer has more than 256K bytes and less than a megabyte of memory, Fax-O-Matic prints faxes at 150- by 150-dot-per-inch resolution. On the other hand, if your printer has a megabyte or more, you can run a utility that tells Fax-O-Matic to print at 300 by 300 dpi. Of course, the high-resolution mode is truly useful only if the sending fax is using the "fine" mode.

This product is full of thoughtful touches. It automatically scales legal-size faxes to fit on an 8½- by 11-inch page. And if your printer is busy doing other things when a fax comes in, Fax-O-Matic stores up to 30 pages in its internal 512K-byte buffer. As soon as the printer is free, it prints the fax.

FaxConnection is a slightly different beast. It comes in an external version like Fax-O-Matic, but the unit I tested is an internal add-in board designed specifically for the LaserJet IID or III. It plugs into the printer's "optional I/O slot." This precludes using it with LaserJet compatibles, but it makes for a much more elegant installation. FaxConnection has a parallel port, a jack for your fax line, and another jack for hooking up a standard fax machine for sending.

Although it may look elegant, FaxConnection is considerably more of a pain to use than Fax-O-Matic. It has only a 256K-byte buffer for storing faxes (about 12 pages) if your printer is busy. In addition, it doesn't do automatic scaling of legal- to letter-size faxes. Receiving legal-size faxes requires legal-size paper, and you have to send a command to FaxConnection to tell it to receive a legal-size fax. The same holds true for telling the unit to print in fine mode. I had to use the DOS COPY command to send commands to FaxConnection.

FaxConnection has two other major disadvantages. First, it requires a laser printer with at least a megabyte of RAM. Second, it's considerably more expensive than Fax-O-Matic.

Both units, of course, don't require that your computer be turned on in order to receive and print faxes.

The idea of using your laser printer for receiving faxes isn't new, but Fax-O-Matic and FaxConnection are the first units to break the $1000 price barrier. Of the two, I've become quite fond of Fax-O-Matic. It beats FaxConnection on features and ease of use hands down. Fax-O-Matic does its job—and does it flawlessly. And at $399, it's a real steal.

—Stan Miastkowski

THE FACTS

Fax-O-Matic
$399

Requirements:
Hewlett-Packard LaserJet or compatible printer.

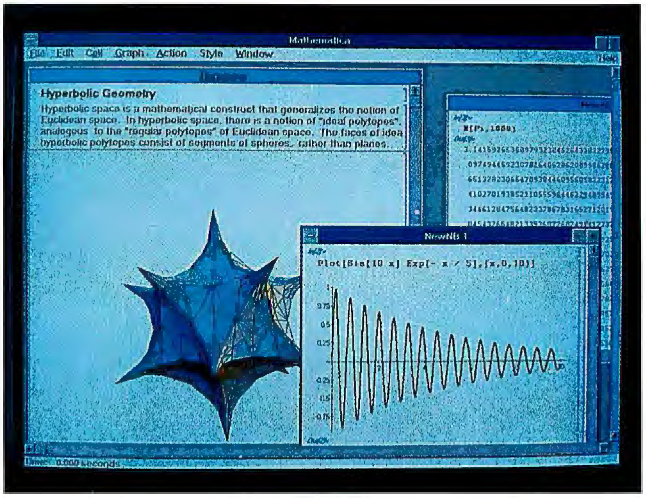
Tall Tree Systems
2585 East Bayshore Rd.
Palo Alto, CA 94303
(415) 493-1980
fax: (415) 493-7639
Inquiry 1165.

FaxConnection
$595; external version, $695

Requirements:
Hewlett-Packard LaserJet IID or III; external version, LaserJet or compatible printer.

Extended Systems
6123 North Meeker Ave.
Boise, ID 83704
(208) 322-7575
fax: (208) 377-1906
Inquiry 1166.

Mathematica Does Windows



THE FACTS

Mathematica for Windows 3.0
$995

Requirements:
A 386-based PC with at least 2 MB of RAM (preferably 4 MB) and a hard disk drive.

Wolfram Research, Inc.
100 Trade Center Dr.
Champaign, IL 61820
(217) 398-0700
fax: (217) 398-0747
Inquiry 1167.

Many people originally thought of computers as wonderful tools for mathematicians, and they have turned out that way. But desktop PCs were useless for mathematics until the advent of programs that could perform symbolic mathematics rather than just crunch numbers. The best known is Mathematica, because it is visually more exciting and available on a wide range of hardware platforms.

Mathematica has one big disadvantage, however. It is an enormous and powerful program that requires considerable computing horsepower. It first showed up on Unix systems and has rapidly spread to many of these. It then appeared on the Mac and also on 386-based PCs. But not all versions of Mathematica are created equal.

Two in particular, the Next version and the Mac version, include "notebooks" as part of the interface. Notebooks are part of a sophisticated interface onto Mathematica documents that combines features of outlining packages with features of word processors and hooks these up to the basic Mathematica tools. Thus, Mathematica notebooks become a powerful way to create, view, edit, and work with mathematically oriented documents of any kind. Notebooks are particularly useful as a way to distribute mathematical ideas or for teaching.

Wolfram Research has now added notebooks to a new version, **Mathematica for Windows 3.0**. This is a clean conversion of other versions of Mathematica to the Windows environment, but the program's processing demands do limit the kind of systems on which it will run under Windows. To run Mathematica for Windows, you need a 386-based system with at least 2 megabytes of RAM. Doing any significant amount of work will require a system with at least 4 MB. I found Mathematica for Windows much more friendly than the version for 386-based DOS systems. However, there is no change in what you can do.

One useful feature of this version is the ability to run only the interface portion of Mathematica on the local Windows system and use network features built into Mathematica to connect to a remote system that is running the Mathematica kernel.

Mathematica for Windows 3.0 is one of the first Windows 3.0 programs to require the use of a 386-based system, and it runs 386-specific code in its kernel. It also makes more intelligent use of the task-switching capabilities of Windows than other programs, since the interface and kernel run independently. This means that you can open a notebook, edit some equations, ask the kernel to evaluate them, and go on to other work while the kernel calculates the results, rather than being forced to wait for the answer.

Mathematica for Windows includes all the powerful capabilities of the other versions, including the ability to rapidly perform numerical calculations of all kinds to any desired precision, to manipulate a wide range of symbolic mathematical expressions and to plot and graph sophisticated two- and three-dimensional graphs of all kinds. Mathematica also includes a powerful structured programming language geared for use with mathematics.

There is some overhead to working with Windows for Mathematica, and as a result, Mathematica can be a little slower in the Windows environment than it is running under DOS.

Overall, Mathematica for Windows is a great addition to both the Windows application lineup and to Wolfram Research's lineup of versions of Mathematica. It should be of particular interest to the educational market, especially in areas where institutions rely on PC systems rather than Unix workstations.

—*Owen Linderholm*

Live, from IBM—It's Storyboard!

According to the "experts," desktop multimedia is a reality, and everybody needs it. But not many have been able to afford it—until now. **Storyboard Live!** is IBM's multimedia software, and it runs on everything from a 640K-byte XT to fully loaded 386 and 486 systems. It does a lot—still and animated computer-generated graphics and text, still and moving digitized video, and high-quality audio—but with some severe drawbacks.

Each function—such as storyboard editing, playback, and animation (sprite) editing—is housed in a separate executable file. A menu program puts up a graphic of huge buttons, and it lets you use the mouse to select the module of your choice. This is a waste; I thought it much easier to type the two-character program name from the command line.

The menu program is significant, however, because it is the first evidence of Storyboard Live!'s most serious flaw: its cheesy graphical interface. IBM, the famed long-winded proponent of cross-platform sameness in interfaces, has failed to enforce its own law in one program that cries out for it.

Interface aside, Storyboard Live! is capable of some nifty things. Even with the limited video and audio capabilities in my system, the software let me

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- **Complex extrusions**
- **Cross sectioning**
- **Block scaling**
- **On screen shading**
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$399

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CADKEY 3.12	$3,195.00	Solids $995.00 IGES translator $1,995.00
DataCAD with DC Modeler	$3,990.00	DataCAD Velocity $2,000.00
DesignCAD 3D ver. 2.0	**$399.00**	**NO expensive options! IGES Free, Shading Free**
MaxxiCAD 1.02	$1,895.00	N/A
Mega Model	$995.00	MegaDraw $195, List $295, MegaShade $395
MicroStation PC 3.0	$3,300.00	Customer Support Libraries $1,000.00
ModelMate Plus 2.8	$1,495.00	N/A
VersaCAD Design 5.4	$2,995.00	N/A

Source: Byte Magazine

BYTE MAGAZINE SAYS...

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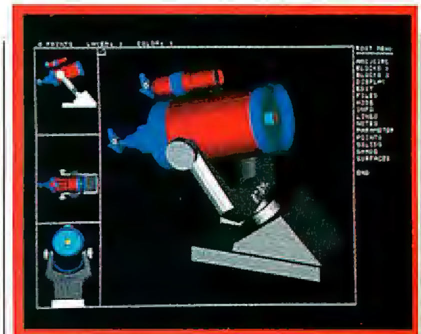
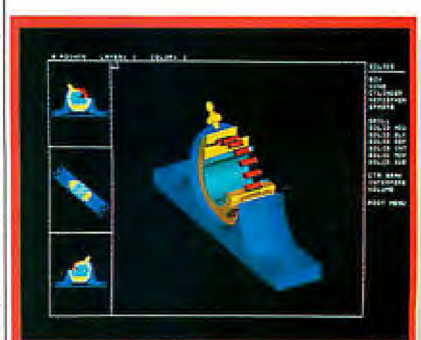
May 1989, page 178



Complete 3-Dimensional design features make it easy for you to construct realistic 3-D models. With full solid-object modeling capabilities you can analyze your drawing to determine the volume, surface area or even center of gravity! DesignCAD 3-D even permits you to check for interference between objects! Aeronautical Engineers can now find the center of gravity for a new airplane design with a couple of keystrokes. The Architect can determine the surface area of a roof for decking in a matter of minutes. The Civil Engineer can calculate the volume of a lake or dam in seconds. The Mechanical Engineer will know for sure if certain parts fit together without interference. The uses for DesignCAD 3-D are only limited by YOUR imagination!

HOW DO I GET ONE?

DesignCAD 3-D and DesignCAD 2D are available from most retail computer stores, or you may order directly from us. If you have questions about which program to purchase please give us a call. All you need to run DesignCAD 3-D is an IBM PC or compatible computer with 640 K RAM memory and a hard disk. Both products support most graphics cards, printers, plotters and digitizers. Free Information and a demo disk are available by faxing (918) 825-6359 or telephoning:



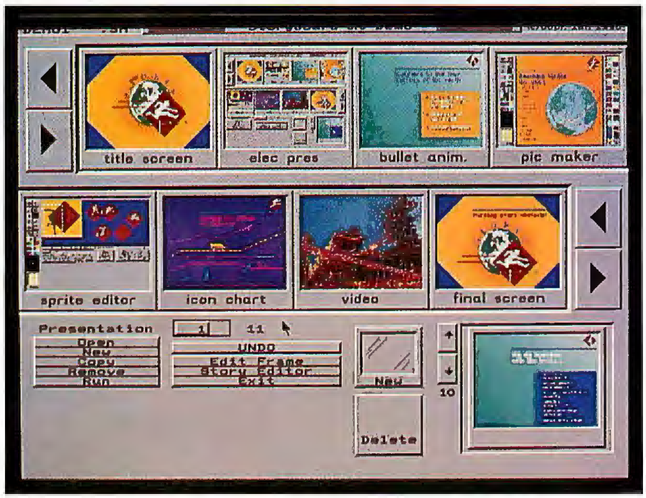
1-(918) 825-4844

American Small Business Computers • 327 South Mill Street • Pryor, OK 74361 U.S.A.

create presentations with precisely timed transitions and smooth motion of small graphical elements. It also was able to produce sound and music of surprising quality (but insufficient volume) from the system's internal speaker. This isn't new; a number of PC packages let you combine computer-generated graphics and sound.

The motion video, which I've seen demonstrated, plays back a slightly jerky series of captured video images. The colors are muted to squeeze into the limited palette of VGA or 8514/A, but the effect is impressive at first viewing.

Computer-generated animation is created in the sprite editor, which lets you create flip-book animations that can be played back in a rectangular area during a presentation. Still images can be generated with the Picture Maker or imported in a variety of popular formats. IBM supplies a library of 800 images and 11



THE FACTS

Storyboard Live!
$495

Requirements:
IBM AT, PS/2, or compatible with DOS 3.3 or higher, an EGA or better color display, and a hard disk drive.

IBM Corp.
Product Information Center
P.O. Box 2150
Atlanta, GA 30301
(800) 426-7699
Inquiry 1168.

fonts that you can use in your presentation screens.

Sound, graphics, sprites, and live video are knitted together in the Story Editor, which builds scripts in a multimedia programming language. The concept and approach of the editor are sound, and the capacity for the creation of powerful presentations, even interactive ones, is evident.

But, despite all this power and potential, IBM has saddled its flagship multimedia software package with an interface that is worse than lame. That's not to say you can't get used to it and get some real work done, but why should you have to battle with a cumbersome interface when other presentation programs don't require such sacrifices? If multimedia is to become standard on every desk, it won't be done with something like Storyboard Live! If this is the best IBM can do with desktop multimedia, my money's on Apple.

—Tom Yager

FileMaker Pro Gives the Old a New Look

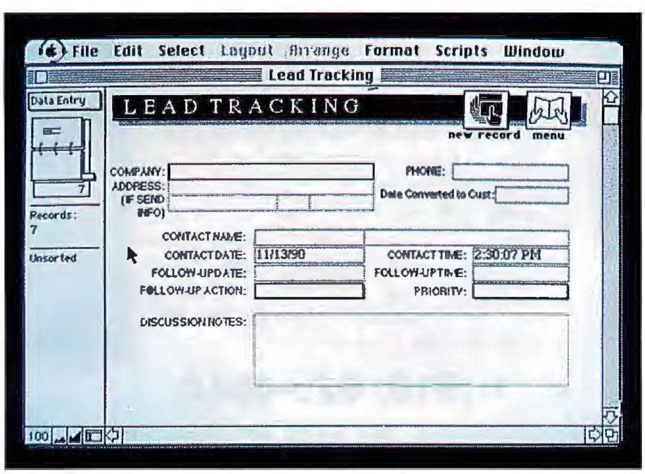
FileMaker from Claris has long held a reputation in the Macintosh market for being a reliable nonrelational database. It's also a favorite among novices because of its clean interface and forgiving performance. In fact, it's extremely hard to corrupt data within a file, even if you inadvertently power down during operations. FileMaker always tries to recover when you start it up again.

There are a number of significant changes in **FileMaker Pro** from the preceding FileMaker II. Most notable of these are the addition of a pop-up menu that changes between the layout views available for a database, improved import/export of information (i.e., it now handles comma-delimited text, Lotus 1-2-3, and DIF files), interactive buttons that are able to perform actions, enhanced layout tools, better data-entry checking functions, and multiuser support.

All these improvements are worthy and welcome, but the FileMaker database engine underneath remains basically unchanged. The face-lift that Claris has given the program removes some of the annoying quirks present in previous versions (e.g., the inability to change how you tab to fields once a layout is done) and retains others (e.g., date fields *must* include a day, even if you only want a month and year to be in there).

Although the promotional literature trumpets the scripting available in FileMaker Pro, I found it to be seriously lacking in scope. You must first perform the actions for a script—limited to switching layouts, finding records, sorting records, restoring page setup options and printing, or previewing a report—before you can set it up.

Editing the script is crudely possible only through the



THE FACTS

FileMaker Pro
$299; $99 upgrade for FileMaker II users

Requirements:
A Mac Plus or better with two 800K-byte floppy disk drives (a hard disk drive is recommended) and System 6.0 or higher.

Claris Corp.
P.O. Box 58168
Santa Clara, CA 95052
(408) 987-7000
fax: (408) 987-7440
Inquiry 1169.

choices available in a presented dialog box. Editing individual steps (e.g., in an Excel macro) is impossible. I found this quite limiting, and, thus, the scripting is of only marginal usefulness.

The multiuser support in FileMaker Pro is of the access variety, not true AppleShare with a central server. That is, you can grant other AppleTalk users access to some files or parts of files with a command, or restrict the file to your own use exclusively. Again, this is an improvement over FileMaker II's nonhandling of multiple users.

FileMaker Pro continues to deliver on the concept of the original FileMaker product: a reliable database that can be used for most noncritical applications. The additions made by Claris in FileMaker Pro enhance the utility of the program without introducing complications, and I continue to recommend the product to all users.

—Laurence H. Loeb

Instant Hard Disk Expansion

With today's emphasis on graphical-user-interface-based environments, lean-and-mean applications are a thing of the past. Not only do many of today's programs hog RAM, they often require many megabytes of hard disk storage space. Add some data files, and that 20- or 40-MB hard disk drive that once looked so large begins to quickly become cramped for space.

Hard disk drives are expensive, so, rather than buying a new high-capacity model, you can just add **Stacker** and nearly double your hard disk space instantly.

Stacker performs this minor magic through the process of compressing your data on the fly and decompressing it when you call up a file.

The product comes both in a software-only version and as an 8-bit add-in card. The card uses Stac Electronics' proprietary real-time compression chip, a well-accepted chip that's widely used in tape backup systems.

I tested both the software and hardware versions on a 33-MHz 386 clone equipped with an already-large 170-MB Quantum SCSI drive. Both of these versions use a small (30K-byte) device driver and create virtual disk volumes for storing all the compressed data.

Both also have one of the easiest-to-use installation programs I've ever seen. Installing the coprocessor card is a snap; there are no cables to hook up. The installation program individually checks a variety of memory locations until it finds a free one that it can use.

Even my clone, which has every slot filled, didn't confuse it, although the manual clearly told me that I had to temporarily disable my 386Max memory manager before installation.

The same holds true with Quarterdeck Office Systems' QEMM.

The coprocessor-card installation also has an incremental installation option that creates compressed volumes even if you don't have much space left on your disk.

This is all automatic and apparently foolproof. There's a SWAPDISK utility that renames the new volume to match the drive where the original files were. This eliminates having to change application setups and your CONFIG.SYS or AUTOEXEC.BAT files.

Since the software version of Stacker "steals" processor cycles, I expected large delays when I accessed files. With my 33-MHz processor and 15-millisecond hard disk drive, the delay was barely perceptible.

It would probably be much slower with a slower processor and hard disk drive. With the Stacker card, I had no noticeable delay.

In most cases, Stacker doesn't quite double storage space. The actual compression ratio varies from about 1.3-to-1 for dense .EXE files all the way to 2-to-1 (or even much more) for text files.

On a typical hard disk drive of mixed program and data files, the average comes to about 1.7-to-1. Stacker doesn't try to hide the fact at all; it comes with a utility that tells you this.

The bigger your hard disk drive, the more of a value Stacker is. And if you're like most users, you probably won't want to compress your entire hard disk. Stacker is handiest when you're squeezing big data files and for archival storage.

It's only natural to get a bit uneasy about using a product that stores your data in an otherwise-unreadable format. In particular, what happens if the Stacker card fails?

Stac Electronics has added a feature that I found very reassuring: If the coprocessor card fails, Stacker's device driver detects the failure and automatically switches to the software-only compression/decompression. To me, that's more than enough to prevent lost-data worries.

—Stan Miastkowski

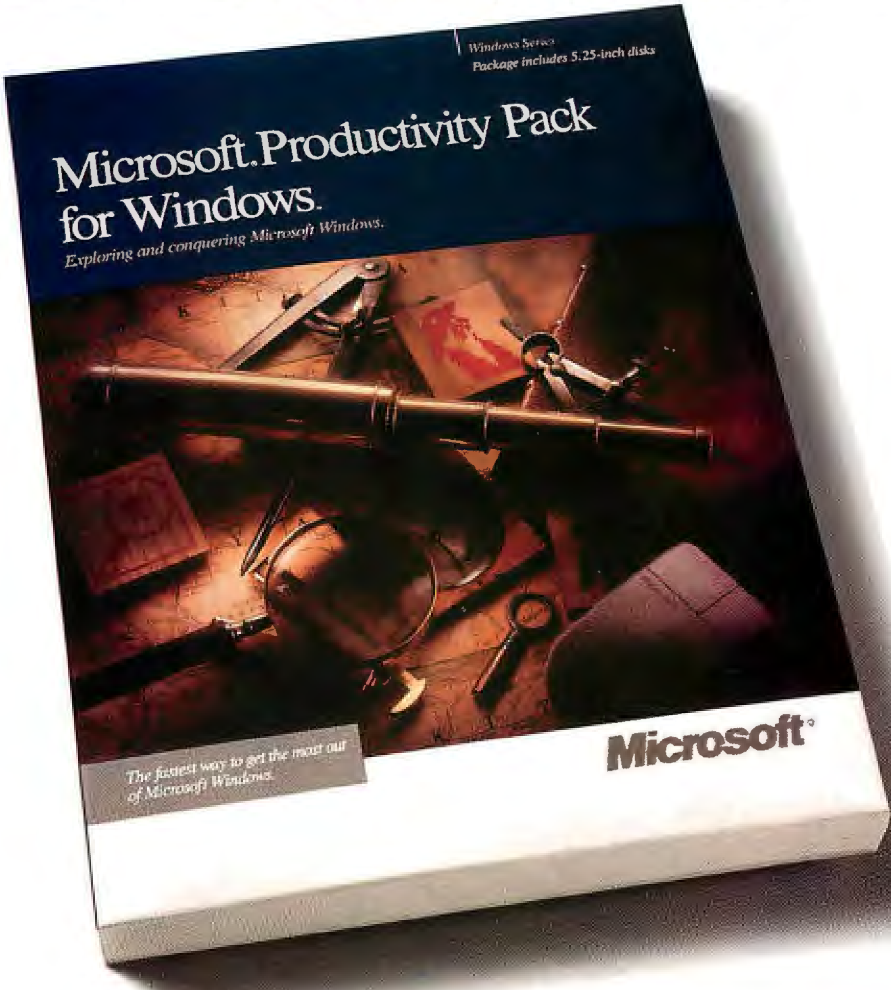
THE FACTS

Stacker
software version, $129;
coprocessor version, $229

Requirements:
IBM PC or compatible running DOS 3.0 or higher with a single free 8-bit expansion slot (for the coprocessor version).

Stac Electronics
5993 Avenida Encinas
Carlsbad, CA 92008
(619) 431-7474
fax: (619) 431-0880
Inquiry 1170.

The fastest way to break into Windows.



To get comfortable with the Microsoft® Windows™ environment, there's only one thing you have to do. Use it.

But now you can get even more out of Windows 3.0. Even faster. With the brand new Microsoft Productivity Pack for Windows.

It's really three tools in one:

Learning Windows, a colorful tutorial that lets you explore everything from the basics to the fine points.

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Despite its low cost, the HP DeskJet 500 gives you a lot of high-end features. Such as multiple fonts, scalable to 127 points through Windows support. Two print modes – portrait for letters or landscape for spreadsheets. And industry-standard compatibility that lets you plug in and start printing.

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HEWLETT PACKARD

*Suggested U.S. list price.

New Extras for Excel

■

Andrew Reinhardt

Microsoft has given the latest release of its Excel spreadsheet the simple but evocative name "version 3.0." With such a name, you might wonder if the new Excel 3.0 will bask in the golden glow of Windows 3.0.

That vision, however, may be a bit grandiose: Excel 3.0 isn't as radical a change from its predecessor as Windows 3.0 was. But it does offer substantial new features that will strengthen Microsoft's position in the emerging battleground of Windows spreadsheets. With Informix Software's WingZ now available for Windows, and Lotus poised to deliver a Windows version of 1-2-3, Microsoft couldn't afford to rest on its lead in the graphical user interface (GUI) spreadsheet arena.

With some of the new capabilities in Excel 3.0, Microsoft is merely playing catch-up, especially to WingZ, a competitor on the OS/2, Windows, and Macintosh platforms. For instance, like WingZ, Excel 3.0 now lets you place charts directly on the worksheet, rather than confining them to separate windows. It also supports three-dimensional graphics with user-definable rotation and perspective. And like Lotus 1-2-3/G, Excel now includes a Solver utility for multivariate goal seeking.

Some of Excel 3.0's capabilities set it apart from all its competitors. These include a new outlining feature, borrowed from the word processing world, that works surprisingly well. Excel also incorporates Microsoft's Object Linking and Embedding (OLE) technology and supports the direct manipulation of objects.

THE FACTS

Excel 3.0
$495

Requirements:
For Windows 3.0: 286 or higher with 1 MB of RAM, a hard disk drive, and an EGA or better display; for OS/2 1.2: 286 or higher with 2.5 to 4 MB of RAM, a hard disk drive, and an EGA or better display; for the Mac: Mac Plus or higher with a hard disk drive and System 6.02 or higher

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(206) 882-8080
fax: (206) 883-8101
Inquiry 976.

Ease of Use

Despite the addition of several new features to Excel 3.0, Microsoft says that its primary design goal was to make the spreadsheet easier to use. A "ribbon" tool bar across the top of the screen, like the one in Word for Windows, offers shortcuts to common procedures such as cell formatting, outlining, and charting. Many actions have been made more intuitive by Microsoft's applying the rule that the mouse double-click is a gateway to more detail. And features like "best-guess" summing and user-definable styles and templates make building a model faster and easier.

Perhaps the most interesting of these features is Autosum, represented on the ribbon by an icon labeled with a Greek sigma. If you create a series of cells, highlight the next empty cell in the row or column, and then select Autosum, Excel will propose a formula that adds the cells in the series. If Excel guesses correctly, you can accept the formula with a mouse-click; if not, you can quickly edit it. This is a much-needed shortcut for the most commonly used function in a spreadsheet.

Other icons let you call up drawing tools for adding lines, rectangles, and circles directly onto a worksheet or for creating a quick chart (by choosing a range of cells and letting Excel make a smart guess at the graph).

To lure dyed-in-the-wool Lotus 1-2-3 users to Excel, Microsoft includes a remarkable help system just for Lotus loyalists. By using the familiar slash key, 1-2-3 users can access the Help menu, which is available in two modes. In the demonstration mode, you enter 1-2-3 keystrokes (the Lotus menu tree appears in the Help dialog box), and Excel translates them into its own commands and carries them out for you while you watch. In instruction mode, the Excel equivalents of 1-2-3 sequences are listed in a brief summary note, which you can tear off and stick on your worksheet, just like a yellow Post-it note.

Collapsing Complexity

Whether your worksheet contains a bill of materials or a balance sheet, chances are you have regions of cells that are subordinate to others; for example, months totaling into quarters or territories adding up to regions. Excel 3.0 lets you structure this information in an outline form so that you can choose the level of detail in which you wish to view your data (see the photo).

Up to eight layers of nested outlines are supported on both the horizontal and vertical axes. You can move from one level to another by clicking plus or minus icons (which can also be hidden) on the

Version 3.0

for Windows 3.0, the Mac, and OS/2

features 3-D graphics, outlining,

and a graphically impressive Solver

edge of the sheet. Or you can jump instantly from a fully exploded view that would, for example, display every row in your income statement to a completely collapsed view that would show only your company's bottom line.

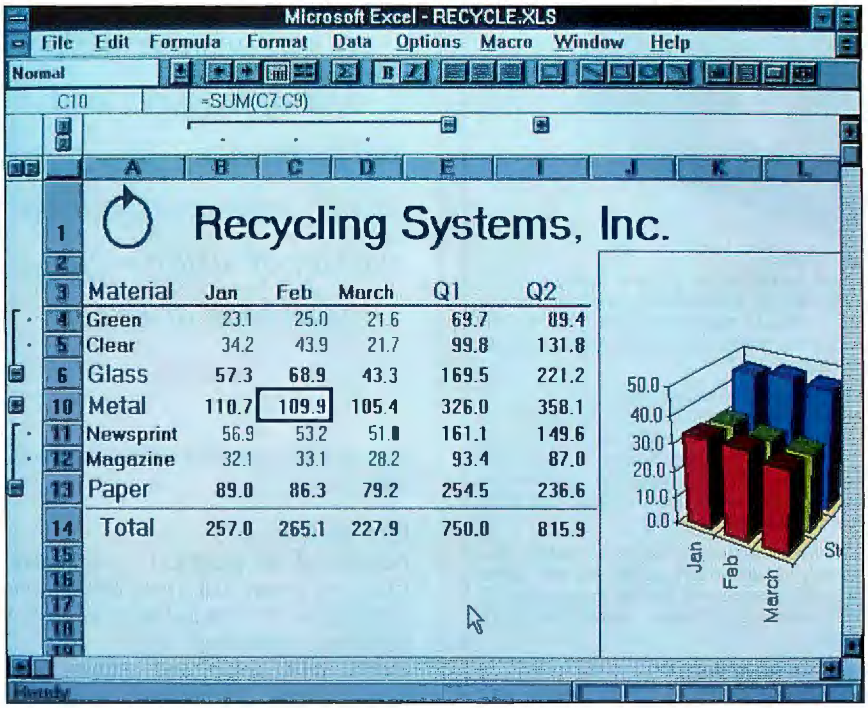
Amazingly enough, you don't have to develop an outline from scratch: Excel can construct an outline automatically by analyzing the worksheet and looking for regions of cells that are added together. Even a Lotus 1-2-3 worksheet can be imported and restructured into outline form.

Making the Link

The most important innovation of Lotus 1-2-3 release 3.0 was its introduction of multipage 3-D spreadsheets, which are especially useful for consolidating similarly structured sheets into a master sheet. Microsoft has declined to add the same capability to Excel; instead, worksheets are maintained as separate files, and you can link cells by including a source filename and cell address in a formula.

To simplify the process of consolidating data, Excel 3.0 supports "name-based linking," in which connections are made not by cell address but by the name of a range. Therefore, you can link to a master sheet all references to "research expenses" in subsidiary sheets. Microsoft says that the direct-mapped linking of 1-2-3 can lead to mistakes if, for example, a cell used in a formula is deleted but the formula is not rewritten. Name-based linking can be more time-consuming to set up, but it is insensitive to the physical structure of source worksheets.

Excel 3.0 also supports a variety of external links. Through the clipboard, you can import text and graphics from other applications on a one-time basis. Using



Excel 3.0 has several new features. It lets you place charts directly on the worksheet (right); its "ribbon" tool bar (top) offers shortcuts to common procedures; and it has outlining symbols (shown at the left of the screen and below the ribbon). The plus icons indicate collapsed ranges (Q2 and Metal), while the minus icons show expanded ranges.

PHOTOGRAPHY: PAUL AVIS © 1991

the Paste Link function, you can set up a dynamic or "hot" link to an external object, and any changes made to it in the source application will be reflected in Excel. And double-clicking on an object imported from a program that supports Microsoft's new OLE technology will bring up the program that created it.

To help connect spreadsheets to the world of servers and databases, Microsoft will bundle with Excel 3.0 a copy of Q+E, a query and edit utility developed by Pioneer Software. Q+E lets you use Excel as a front end to several databases, including Microsoft's SQL Server, Oracle, dBASE, and IBM's OS/2 Extended Edition.

If you need a spreadsheet with lots of features and performance—and most of all, with unassailable clarity of vision—take a hard look at Excel.

Picture This

Because of its graphical environment, Excel has always had strong presentation capabilities. Version 3.0 adds only a few functions, including support for 3-D charts, more colors and patterns, and picture charts. The gallery of graphics options includes 3-D column, area, pie, and line graphs, all of which you can adjust for rotation, vertical viewing angle, and perspective.

Picture charts are graphs in which traditional bars or lines are replaced with images that you supply. Thus, for example, you could illustrate a chart of bakery sales with stacks of doughnuts.

Solve Me a Riddle

The Solver and Backsolver in 1-2-3/G generated much excitement and were quickly copied by Lotus's competitors. Excel 3.0 is the first Windows spreadsheet to include these capabilities. You can use Excel's Solver, which is actually a separate application supplied with the spreadsheet, for single- or multiple-variable goal-seeking. For example, you can maximize the value of one cell by changing the value of another, or you can jiggle a complex production plan with many variables and constraints to arrive at optimum profitability.

If you're a real power user, Microsoft's Solver offers a lot of flexibility and options. You can limit the amount of time or number of iterations used to achieve a solution, specify a level of precision, or constrain the Solver to a linear model. You can also customize the methods that the Solver uses, choosing tangential or quadradic extrapolation, forward or central differencing, and quasi-Newton or conjugate gradient searching.

By combining the Solver with graphics and Dynamic Data Exchange, Excel 3.0 lets you use a chart as a scratchpad for modeling. This feature is called Dragging Data Points: You create a chart, and then, by simply dragging graph points with the mouse, you can automatically change the numbers in the original spreadsheet that created it. If the point that you want to change is dependent on a formula, the Solver pops up automatically and asks you which variable you want to adjust.

Many Products, One Vision

For the last several years, Microsoft has been steadily working to unify all its graphical software applications (whether intended for use on the Mac, Windows, or OS/2 Presentation Manager) so that they all look and behave the same way. The most recent versions of Word, for example, sport almost identical features across all platforms, and even the character-based version 5.5 has a new pull-down menu interface that uses the same commands as its GUI siblings. Besides trying to achieve consistency across many platforms for each application, Microsoft has also made different applications look the same; thus, Excel looks like Word, which looks like PowerPoint.

Excel 3.0 is the ultimate realization of this plan. As astonishing as it may seem, most volumes of the documentation are the same, whether for the Mac or an Intel-based platform. Microsoft has succeeded in making the hardware platform irrelevant, which is good news for users in mixed network environments. If you need a spreadsheet with lots of features and performance—and most of all, with unassailable clarity of vision—take a long, hard look at Excel. ■

Andrew Reinhardt is BYTE's associate news editor in New York. He can be reached on BIX as "areinhardt."

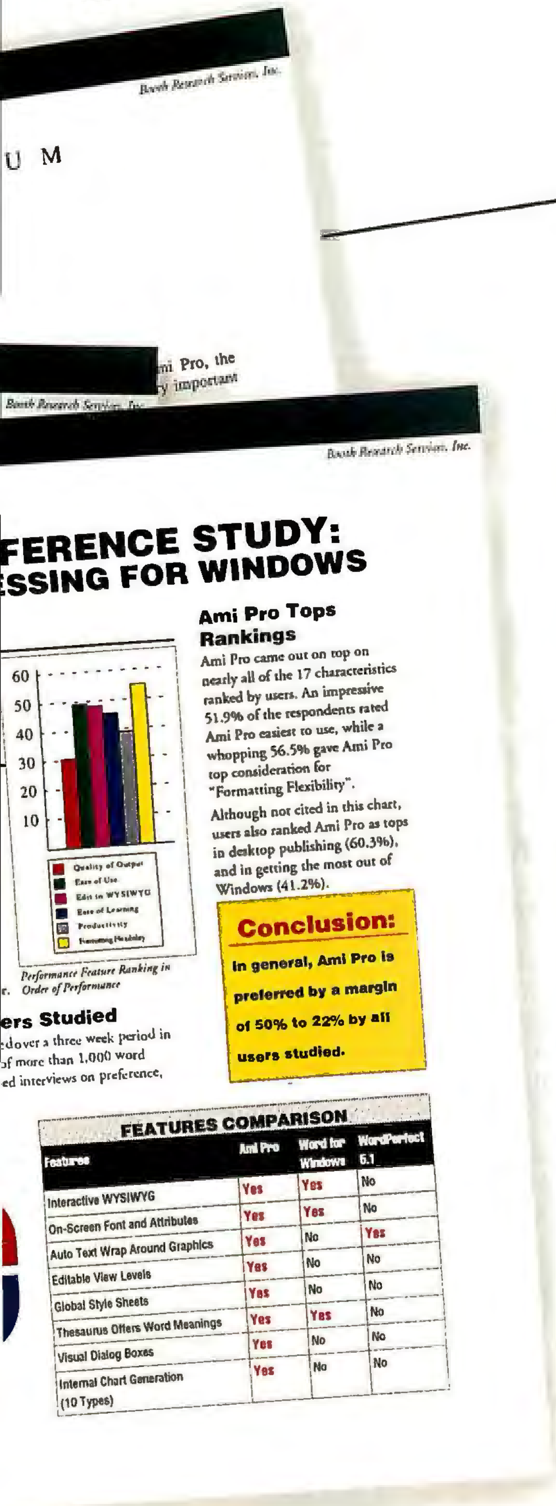
Here's what they're saying about Ami Pro from Lotus.

"Independent User Survey For Windows.™*"			
Word Processing Features	Ami Pro *for Windows*	Word for Windows	WordPerfect for DOS
Best Overall	50%	22%	16%
Ease of Learning	47%	28%	8%
Ease of Use	52%	23%	8%

*Independently commissioned Windows word processor Usage and Attitude Study conducted November 1990

Circle 197 on Reader Service Card (RESELLERS: 198)

ey're saying it.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...SSING FOR WINDOWS

Ami Pro Tops Rankings

Ami Pro came out on top on nearly all of the 17 characteristics ranked by users. An impressive 51.9% of the respondents rated Ami Pro easiest to use, while a whopping 56.5% gave Ami Pro top consideration for "Formatting Flexibility".

Although not cited in this chart, users also ranked Ami Pro as tops in desktop publishing (60.3%), and in getting the most out of Windows (41.2%).

Performance Feature Ranking in Order of Performance

Conclusion:

In general, Ami Pro is preferred by a margin of 50% to 22% by all users studied.

...ers Studied

...d over a three week period in ...of more than 1,000 word ...ed interviews on preference,

FEATURES COMPARISON

Features	Ami Pro	Word for Windows	WordPerfect 5.1
Interactive WYSIWYG	Yes	Yes	No
On-Screen Font and Attributes	Yes	Yes	No
Auto Text Wrap Around Graphics	Yes	No	Yes
Editable View Levels	Yes	No	No
Global Style Sheets	Yes	No	No
Thesaurus Offers Word Meanings	Yes	Yes	No
Visual Dialog Boxes	Yes	No	No
Internal Chart Generation (10 Types)	Yes	No	No

STYLE SHEETS

Ami Pro comes with more than two dozen style sheets that have the page layout already set up and ready to go. So you can produce professionally designed business letters, memos, reports, presentations, newsletters and more—in just the time it takes to type in text.

EXPERTS AGREE

It's easy to see why users prefer Ami Pro from Lotus two to one over Microsoft® Word for Windows™ for overall features and ease of use. And why it's received top ratings from virtually all the industry experts, racking up such coveted awards as PC World's Best Buy. The Buyers Assurance Seal from InfoWorld. And PC Magazine's Editor's Choice.

"Ami Pro received a score in Ease of Use of the User Interface that was fully 10 points higher than the next highest score, and came in 14 points ahead of the score WordPerfect™ 5.1 drew from its buyers," according to PC Week's Corporate Satisfaction Poll.

PC Magazine says, "Ami Pro has the friendliest interface and the widest range of functions...[It] is easier to use than almost any program with comparable powers."**

Ami Pro is the word processing program that takes full advantage of the Windows environment, combining power word processing with the power to create professional documents fast. And with its icons and interactive features, Ami Pro is incredibly easy to learn and use. So what do you say? You've just learned about five major Ami Pro features.

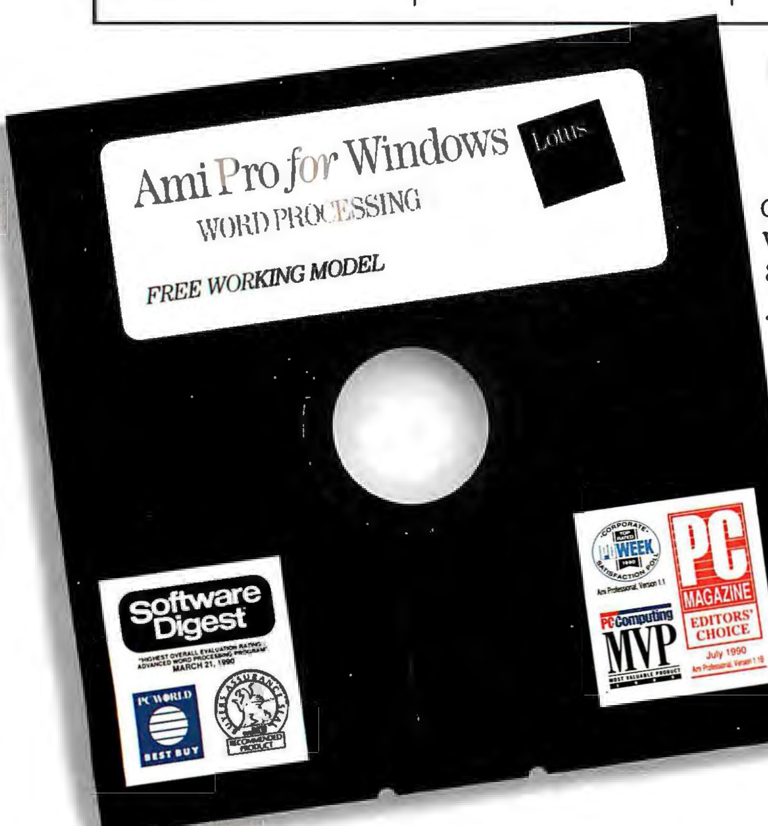
Now to find out about the other 355—and how to get a free working model—turn the page.

**Reprinted from PC Week July 2, 1990. PC Magazine Dec. 11, 1990. Copyright ©1990 Ziff Communications Company.

Circle 199 on Reader Service Card (RESELLERS: 200)

This says it all.

Automatic Backup
Automatic Timed Save
Block Manipulation
Bookmarks
• Named By User • Go To
Charting
• 3D Charting • Edit Chart with Draw Tools • Legends • Multiple Styles Per Type • 7 Chart Types
Copy Text and Graphics
Cursor Movement
• Begin/End of File • Character • Line • Page • Paragraph • Sentence • Top/Bottom of Screen • Word
Customizable Icon Bar
• Choose From Over 45 Functions • Quick Access to Features
Customizable View Level
• 10-400% • Fully Editable
Cut and Paste
Date Insertion
• Today's Date • Date Printed • Date Last Edited • Definable Style
DDE (Dynamic Data Exchange)
• Two-way • Paste Link • Text and Graphics • Via Macro Language
Defaults
• Backup Options • Date Styles • Dictionary Paths • Display Options • Document Path • Draft Mode Colors • Footnote Options • Hyphenation Hot Zone • Pair Kerning • Printer • Icon Bar Icons • Undo Levels • View Level
Delete
Dialog Boxes
Document Annotation
• Notes • Show/Hide • Go To Notes • Date/Time Stamp • Stacked Notes
Document Descriptions
• Author Name • Operator Name • Revision Number • Creation Date • Revision Date • Renameable Fields • User Defined Fields • Display with Directory • Print with Document
Drawing
• Cut/Paste Objects • Circles • Arcs • Squares • Rectangles • Rounded Boxes • Diagonals • Polygons • Polylines • Group Objects • Snap-To Grid • Fill Patterns • Line Widths • Text Rotation • Type Text
File Import/Export
• AdvanceWrite • ASCII • DBase • DCA Final Form • DCA Revisable Form • DIF • E-Mail • Enable • Lotus WKS, WK1, WK3 • Microsoft Word • Microsoft Word for Windows • Multimate • Navy DIF • Peachtext • Rich Text Format • Samna Word • Windows Write • WordPerfect • WordStar • Wordstar 2000
File Management Functions
• Copy • Rename • Delete • Move • Sorted File Listing
Font Control
• Unlimited Number of Fonts • WYSIWYG • Limited Only by Printer
Footnotes
• Auto Numbering • Bottom of Page • Endnotes • Number Style Option • Reset Number Option • Separator Line
Forms Capability
• Format Complicated Forms • Fill-In On-Screen • Print on Preprinted Form • Protect Areas
Frames
• Anchor to Text • Auto Text Wrap Around • Background Shade • Contain Text or Graphics • Fixed Position On Page • Lines Around • No Text Wrap Around • No Text Wrap Beside • Overlay Frames • Repeat on Multiple Pages • Resize Frames
Glossary
• Large Record Size • Speed Key Access
Go To
• Any Page Number • Fast Next Item Access • Go To Frame, Footnote, Note, Various Marks in Document
Graphics Control
• Edit PIC Files • Drop Anywhere on Page • Float Graphic w/Text • Place in Box • Proportional Scaling • Fit in Frame • Rotate in Single Degree Steps • X-Y Scaling • Gutter/Binding Margins
Graphics Import
• CGM • EPS • HPGL • Lotus PIC • PCX • TIFF • WMF
Hard Space
Headers/Footers
• Alternating • Floating
Help
• CBT Tutorial Available • Context-Sensitive • Indexed • Point & Shoot • Hypertext Linked • Full Macro Documentation On-Line
Hyphenation
• As-You-Type • Soft Hyphen • Consecutive Hyphen Control • On Paragraph Basis • Hot Zone
Image Processing
• Control Brightness, Contrast of Scanned, Gray Scale TIFF Pictures • Sharpen Edges • Smoothing • Invert Image
Index Generation
• Generate from List • Mark in Text • Multiple Level Indexing • Hyper Links from Index Back into Document
Insert/Typeover
Kerning
Line Numbering
Line Spacing Control
Macros/Programming Language
• On-Line Macro Documentation • Record/Play • Assign to Function Key • Assign to Menus • Create Menus • Variables • If • Go To Statements • Case Statements • For/Next • Prompt for Input • Subroutines
Math Calculations
Measurements
• Centimeters • Inches • Picas • Points
Merge
• From ASCII Files • From Comma Delimited Files • From DIF Files • From WK* Files • From dBase Files • From Ami Pro File • Label Print Function • Preview Before Print • Three-Level Boolean Conditional Record Inclusion
Open Multiple Documents
Page Breaks
• Manually Inserted • With Paragraph Style
Page Formatting Control
• Margins • Page Size • Snaking Columns • Line Around Page • Line Between Columns • Portrait/Landscape
Page Numbers
• Any Location on Page • Reset Page Number • Five Formats for Number
Paragraph Styles
• Quick Access with Styles Box • With Function Key • Controls: Font, Alignment, Spacing, Page Breaks, Ruling Lines, Bullets, Numeric Format in Table, Hyphenation
Printing Color
Print Options
• Over 130 Printers Supported • Number of Copies • Page Range • Reverse Order • Collate • Print Document Description • Crop Marks • On Preprinted Form • Printer Bin Control for First/Rest Pages • Portrait or Landscape
Real-Time Pagination
Revert to Saved Version
Search and Replace
• Case Insensitive • Forward or Backward • Header/Footer/Footnote • Skip • Replace • Replace All • Search for Style • Search by Attribute • Wildcards
Section Outline Numbering
• 6 Levels • Number Paragraphs • Numbered Lists • User-Defined Reset
Snaking Columns
• Up to 8 Columns • Column Balancing • On Screen • Variable Width • Variable Spaced
Sort
• Alphabetic • Numeric • Ascending • Descending • By Paragraph • By Word • By Number of Lines • 3 Levels—3 Words Within each Level
Spelling Check
• 130,000 Word Dictionary • Add to Dictionary • Correct Multiple Occurrences • Entire Document • Selected Text • International Dictionaries • Rest of Document • Skip All Occurrences • Statistics Report • Unlimited User Dictionary Size
Status Line
• Column Number • Document Name • Insert/Typeover • Line Number • Page Number
Style Sheets
• 27 Professionally Designed • Control All Formatting in Document • Document-Only Styles • Global Styles
Tables
• Up to 256 Columns • Column Width Control • Row Height Control • Auto Row Height • Lines around Cells • Shaded Cells • Connected Cells • Formulas: Four-Function Math, Sum Function, Absolute/Relative Cell Address • Insert Rows and Columns • Numeric Alignment and Formatting
Table of Contents
• 3 Levels • Separator Choice
Tabs
• Center • Leader Dot • Left • Numeric • Right
Text Enhancements
• Bold • Double Underline • Initial Caps • Italic • Lowercase • Overstrike • Small Caps • Subscript • Superscript • Underline • Uppercase • Word Underline
Thesaurus
• 1.4 Million Alternatives • Definitions • Gives Inflections • Synonyms
Undo
• Four-Level • Customizable
Unlimited Document Size
Vertical Centering
Widow/Orphan Control
Word Count



Call 1-800-831-9679 for your free working model of Ami Pro.

With all these advanced features, you couldn't ask for a more powerful or easier to use word processor than Ami Pro. But you could ask for a free fully functional working model*—just by dialing our toll-free number.

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Ami Pro™ *for Windows*™
from
Lotus®

Lotus Word Processing Division, 5600 Glenridge Drive
Atlanta, GA 30342, 800-831-9679, 404-851-0007

*Lacks some features including thesaurus, spell checker and ability to save files. InfoWorld's Buyers Assurance Seal awarded August 13, 1990 to Ami Pro 1.2.

Circle 201 on Reader Service Card (RESELLERS: 202)

OS/2 Goes on a Diet

Big Blue targets Windows 3.0 with a leaner, meaner, and faster version of OS/2

■

Stan Miastkowski

When IBM announced OS/2 1.3 last October, many people immediately dubbed it OS/2 "Lite" because of its claimed ability to do more, faster, with lower RAM and hard disk drive requirements. IBM, of course, isn't into cute product names. The product that appeared on my desk in December is officially named OS/2 SE (for Standard Edition) 1.3. In many ways, it is OS/2 Lite. But as far as features and abilities are concerned, OS/2 1.3 is no lightweight.

In its latest incarnation, OS/2 has been trimmed down to go one-on-one with Windows 3.0. It is an ironic situation indeed. After all, Microsoft developed OS/2. But the Redmond software mavens have all but abandoned OS/2 as the orders and bucks roll in for Windows 3.0. IBM isn't hitching a ride on the Windows bandwagon. The changes made to OS/2 for version 1.3 come from the coding wizards at IBM. And it's obvious that Big Blue isn't going to give up on OS/2 despite its lack of market acceptance (at least, so far).

Red Herrings and Other Fish

Ever since its introduction, OS/2 has been the operating system that users love to hate. Admittedly, it was pushed on a market that was largely quite happy with DOS. OS/2's early versions were slow and buggy and used huge amounts of RAM and hard disk space. More important, that nifty-looking Presentation Manager (PM) interface lacked the all-important applications that made it viable. Fortunately, all that has changed, but the perceptions haven't—yet.

The realities of operating environments for the 1990s often seem to depend on marketing pressures and user prejudices rather than technical details. OS/2 was widely criticized for requiring a minimum of 4 megabytes of RAM. True enough. But at the same time, Windows 3.0 users have been finding that while the graphical user interface runs in a 286-based system with a single megabyte, you really need at least 2 MB and, ideally, more. With retail prices for a megabyte of RAM hovering in the $50 range, the whole thing is a red herring. The bottom line is that both Microsoft and (especially) IBM want you to buy hardware. And getting the most from Windows and OS/2 often requires updated hardware.

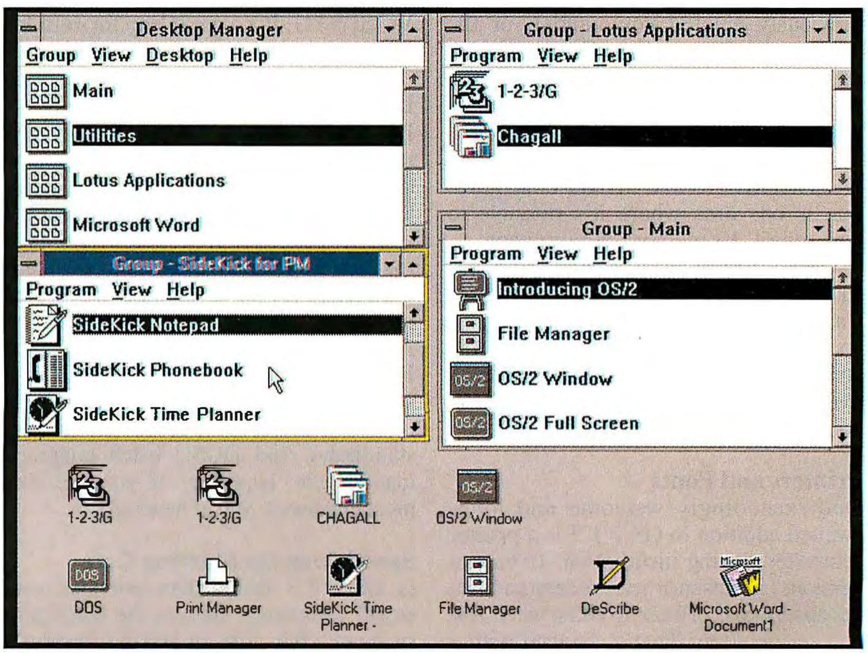
A Little Horse-Trading

OS/2 indeed drops your basic system RAM requirements from 4 MB to 2 MB. That opens up a large potential market of lower-capacity systems for OS/2. Of course, there's a performance price to pay. Like Windows 3.0, OS/2 1.3's multitasking makes extensive use of *swapping*. In the \OS2\SYSTEM\ directory sits a deceptively small (1572-byte) program named SWAPPER.EXE. The swapper, along with numerous (although not-so-obvious) changes to the core operating-system code, is the key to OS/2 1.3's smaller memory needs and faster performance.

OS/2 1.3's swapper is faster and more intelligent than its predecessors. It is essentially a system resource controller that makes sure that the maximum amount of RAM is available for applications. OS/2 1.3 requires less RAM because the swapper moves unneeded operating code into a hard disk file. Swapper also keeps the DOS Box code sitting on the hard disk until you double-click on the icon.

During setup, OS/2 1.3 (as did earlier versions) creates space for a SWAPPER.DAT file on your hard disk that has a maximum size of 512K bytes. If you have a large hard disk, you can specify a swap file as large as you want. But there's a trade-off: Making the file larger can improve system performance, but making it too large can also degrade performance; it takes longer to write data into or read data from a huge file.

It was easy to see that OS/2 1.3 kept



OS/2 1.3's lower memory requirements let you run many applications concurrently.

my hard disk drive from sitting idly by. In fact, the amount of hard disk file swapping is truly amazing. But since OS/2 is a true multitasking operating system, the dancing red light on my hard disk drive didn't adversely affect overall system performance.

What is the bottom line of RAM requirements? If your system has 2 MB of RAM, you can easily run OS/2 1.3 and at least two major applications.

Getting Up and Running

Setting up OS/2 1.3 takes time and patience. Some of the more irksome parts of the process have been eliminated, and a few new features have been added. The biggest decision that I had to make was whether to use OS/2's High Performance File System. If you're installing OS/2 on a hard disk that already has DOS on it and you want to run the *dual boot* feature (i.e., starting either DOS or OS/2 at boot time), you'll have to forgo the HPFS. But if you can forgo booting DOS, the HPFS is the only way to go. Although it's not new in version 1.3, it remains one of OS/2's hidden gems. The HPFS is fast, using on-the-fly location optimization and integrated disk caching to dramatically improve overall performance. It's like having one of those expensive hardware-caching disk drive controllers hooked up to your system.

Also new in OS/2 1.3 is *selectable setup*. Unlike the previous OS/2 setup utilities, 1.3 didn't ask me whether it should add serial-device support, retrieve-command support (a quick way of recalling previously entered commands), or the command reference help. Instead, it assumed that I wanted all these features. I was given the choice of disabling them later on when the setup utility asked me if I wanted to use the default configuration or customize it. The default configuration is one area where it's possible to fine-tune 1.3's memory requirements.

OS/2 is a hard disk space hog. It needs 11 MB of storage for a full-fledged installation. If your hard disk space is tight, you can forgo a few features (like the command reference). But you still need 8 MB of hard disk space for a minimum configuration.

Printers and Fonts

One exceedingly welcome and long-awaited addition to OS/2 1.3 is a printer setup step during installation. In earlier versions, its absence was understandable because OS/2 printer drivers were few and far between. That's changed with a vengeance; OS/2 1.3 supports nearly 100 printers, along with a couple dozen plotters. And it's not just IBM printers that are supported. The list is quite long and complete.

Most important for serious users, OS/2 1.3 now comes with full-featured drivers for the Hewlett-Packard LaserJet (all flavors) and PostScript printers. It's in the PostScript realm that OS/2 1.3 really shines. In the spring of 1990, IBM decided to implement Adobe font technology across its entire product line, and OS/2 1.3 is the first to see the fruits of this decision. OS/2 1.3 includes Adobe Type Manager, which has twelve "core" scalable outline fonts that come in matching screen and printer flavors. If you're using a PostScript printer, you get true WYSIWYG. It's a great leap forward for OS/2.

THE FACTS

OS/2 SE 1.3
$340; upgrade from prior versions, $100; upgrade from DOS 3.0 or higher, $285

Requirements:
IBM AT, PS/2, or compatible with at least 2 MB of RAM and between 8 and 11 MB of free hard disk storage.

IBM Corp.
U.S. Marketing and Services
1133 Westchester Ave.
White Plains, NY 10604
(800) 426-2468
(914) 642-3000
Inquiry 977.

REXX the King?

For advanced users, another feature new to OS/2 1.3 is REXX. REXX isn't new but has been confined to IBM's mainframe and minicomputer markets. It's a general-purpose procedural language that Big Blue has designated as the standard language for developing interpreted procedures for all Systems Application Architecture systems, which means all IBM products. Essentially, REXX is a sophisticated batch language that offers a myriad of features for those who (understandably) find DOS's batch language insufficient. However, if you are like most end users, you'll never use it.

Speed from the Starting Gate

Is OS/2 1.3 faster than previous versions? Definitely. Besides the intelligent swapper, the core operating system's crucial loader has been completely rewritten. It can now load data in larger blocks than its predecessors, resulting in fewer I/O cycles. Also new is IBM's implementation of the previously unused data-compaction abilities of OS/2. Taken together, it means faster performance.

How much faster? IBM says that in a "memory-constrained environment" (meaning 2 MB), file accesses are "significantly faster" than in previous versions of OS/2. Using a relatively wimpy 20-MHz 386-based AT clone with a fast (15-millisecond) hard disk drive, I found an overall performance increase over OS/2 1.2 of from 25 percent to 40 percent using standard OS/2 applications, such as Lotus 1-2-3/G and the DeScribe Word Publisher; your mileage may vary.

According to IBM, OS/2 1.3 is even faster in network access. I wasn't able to test the claims, but an IBM spokesperson told me that it now loads programs off a network server "two to three times faster" than version 1.2.

Tying It All Together

After several false starts and disappointing incremental upgrades (punctuated by a few public spats between IBM and Microsoft), OS/2 is finally an integrated and complete product. It took IBM to do the job. Version 1.3 is remarkably stable and bug-free. I used it with a wide range of the increasingly available OS/2 applications and threw it curves by opening multiple copies of the same application. Even with a dozen programs open and running concurrently, OS/2 never even flinched; I encountered no incomprehensible error messages or system hang-ups. The same can't be said for Windows 3.0. OS/2 remains the only *true* multitasking environment.

There are realities that can't be overlooked. Sure, you can run OS/2 1.3 in a system with 2 MB. But if you want to get some real work done with several different applications, you're better off with 4 MB or more. The same can be said about Windows 3.0.

The battle isn't over yet. By now, it's clear that OS/2 isn't going to take the operating-system market by storm. But the argument that it does not work, lacks printer drivers, or uses too many system resources is now moot. It still has a long way to go to overcome the Windows 3.0 juggernaut, but unlike Windows (which is cobbled onto a now-ancient operating system), OS/2 SE 1.3 along with PM is a next-generation integrated operating environment. ■

Stan Miastkowski is the BYTE senior editor for new products. You can reach him on BIX as "stanm."

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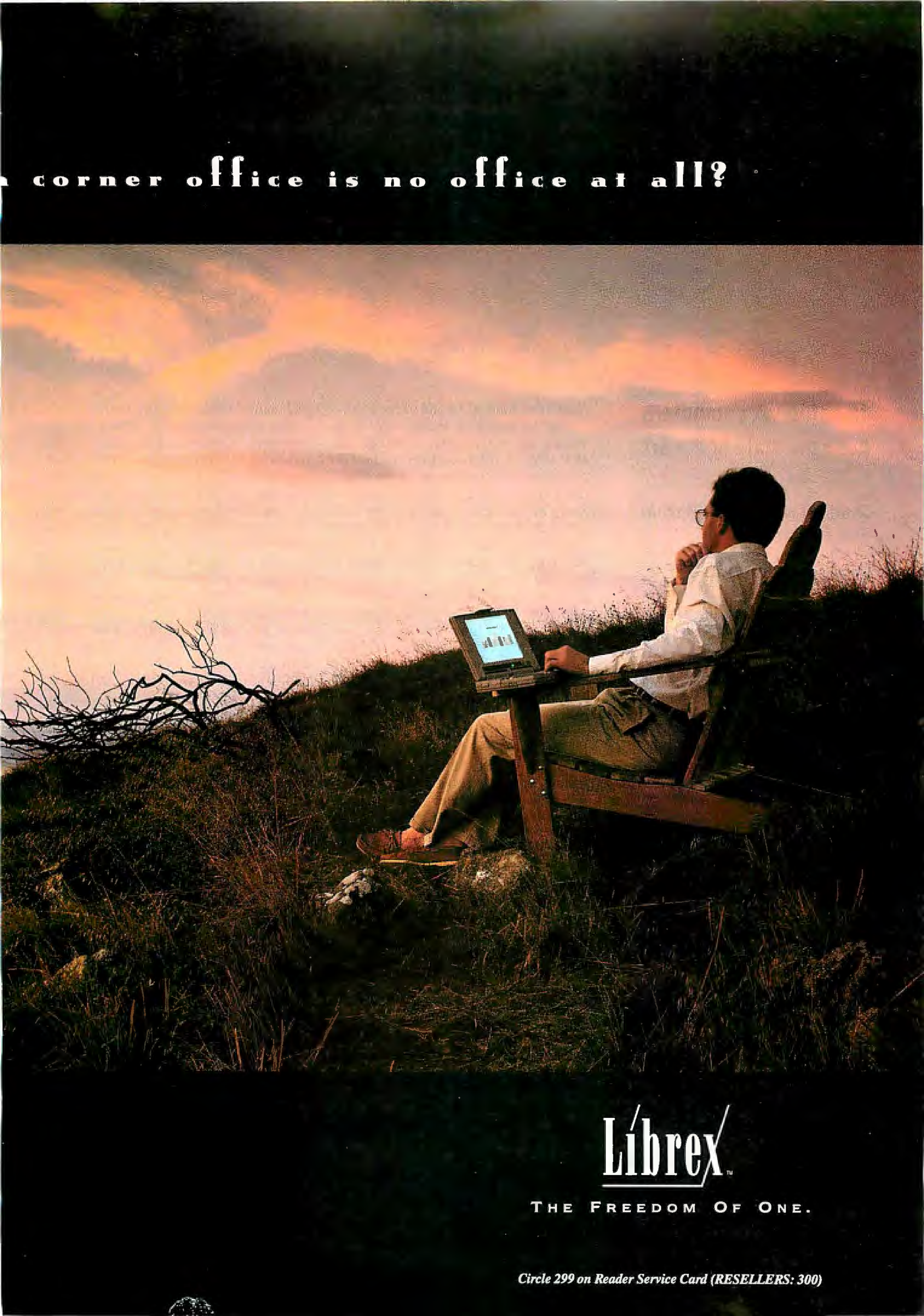
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Perfectly Portable

15 notebook computers push the state of the art

Stanford Diehl, Stan Wszola, and Michael Nadeau

Portable computing has come a long way since the debuts of the Osborne 1 and the Compaq Portable 10 years ago. As advancing technology has increased power and decreased form factors, portables have given way to laptops and now to notebooks—computers that weigh less than 8 pounds and are no bigger than their namesakes.

The original portables are to the notebooks what Ford's Model T is to the modern automobile. The newest notebook computers weigh less than one-fifth as much as the first portables and hold up to 10 times as much RAM—all for a price not much more than that of the original Compaq Portable.

These are exciting times for purchasers of notebook computers. The latest models are lighter, smaller, and more powerful and have better displays than ever before. We've sorted through the many notebook computers, and our report on the 15 we reviewed should help you pick the machine that best meets your needs. The features table on page 150 describes each notebook in detail. We've also created a new set of benchmarks for testing the notebook computers, including BYTE's new battery-life test (see the text box "From the Testing Notebook" on page 152). The benchmark results appear in the figure. Finally, because choosing a notebook computer is also a matter of personal preference, we have included subjective comments on our experiences using the machines in the office and on the road.

The 15 notebook models BYTE reviewed are the Compaq LTE/286 and LTE 386s/20; the Texas Instruments (TI) TravelMate 2000 and its sister machines, the CompuAdd Companion and the Sharp PC-6220; the Grid 1810; the NEC UltraLite 286V; the Sanyo MBC-17NB and two identical machines, the Ogivar Internote 286 and the Zeos Notebook 286; the Tandy 1500 HD; the Toshiba T1000LE and T1200XE; the Zenith MinisPort HD; and the Psion MC-600.

All these machines measure no more than 12.4 by 11 by 2.2 inches, weigh less than 8 pounds, and have 20-megabyte or larger hard disk drives. They accept at least 1 MB of memory, support EMS memory, run on batteries, and operate under PC-DOS or MS-DOS. The Psion MC-600 notebook computer didn't meet all of our criteria but has some unique features that may make it worth considering (see the text box "Psion's Notebook with Flash" on page 154).

Since You Asked...

To better understand what BYTE readers consider most important in selecting a portable computer, we sent out over 1000 survey forms asking subscribers for input. Notebooks have a strong allure: Almost 60 percent of those replying said they're thinking of buying a notebook computer this year.

We also asked what features they consider most important in a notebook computer. Not surprisingly, minimal size and weight topped the list. Most of those responding wanted *both* hard and floppy disk drives, and they ranked battery life as the next most important factor. Then came low price, good performance, VGA graphics capability, and durability. Much to our surprise, only 20 percent of the respondents thought that keyboard quality was a major issue. We disagree. Even if you are not a touch-typist, you'll find it tiring to use a cramped keyboard with undersized keys, short key travel, and many function-key overlays.

Our recommendations reflect our experiences with the 15 notebook computers in this review, weighted against the criteria that readers defined as most important. (For a quick synopsis of what to look for when you decide to buy, see the text box "Choosing a Notebook Computer" on page 159.)

Rating the Features

Desktop machines have become commodity items, but notebook computer designs and the features offered vary considerably. Here are some key factors that differentiate these machines.

Size and weight. All the notebook computers in this review fit in a standard-size briefcase, but some took up more room than others. In any case, when you throw in an AC power supply, an external floppy disk drive, floppy disks, and a manual or two, there isn't room in your briefcase for much more.

The same goes for the notebooks' weight, which ranges from 7.9 pounds for the Toshiba T1200XE down to 4.4 pounds for the TI TravelMate 2000. The relatively heavy T1200XE is easy to carry by itself, but when you add a power supply, a spare battery, and any other peripherals that you need, the total weight averages out to several pounds more.

Power. Battery life is the great limiting factor for all portables. For notebook computers, it's even more of a problem, because the battery must be proportional in size to the other components. A large battery gives you more computing time but adds extra weight and bulk.

All the computers we tested run on nickel-cadmium batteries, which provide a steady voltage and can be recharged quickly. Their only major disadvantage is that you must fully discharge them before recharging. If you don't, such batteries develop a "charge memory" that cuts battery life. Recent advances have minimized this problem, but a number of notebook computer manufacturers still

PHOTOGRAPHY: PAUL AVIS © 1991

NOTEBOOK FEATURES

Notebook computers differentiate themselves more on features than on performance. Size, weight, and pricing are important, but don't forget to check expandability, display and keyboard quality, and battery life. Zeos's Notebook 286 received high marks in all these areas.

Computer	Compaq LTE/286	Compaq LTE 386s/20	CompuAdd Companion	Grid 1810	NEC UltraLite 286V	Ogivar Internote 286	Psion MC-600
Processor/speed (MHz)	80C286/12	386SX/20	80C286/12	V20/10	80C286/12	80C286/12.5	80C86/7.68
Math coprocessor	80C287	80387SX	80C287	None	None	None	None
Memory (min./max.; MB)	640 KB/2.6	2/10	1/3	1/2	1/5	1/5	768 KB
Memory upgrades user-installable?	Yes	Yes	Yes	No	Yes	No	Yes
System unit							
Dimensions (inches; L,D,H)	11 x 8.5 x 1.9	11 x 8.5 x 2.2	11 x 8.5 x 1.4	12 x 10.4 x 1.8	12.2 x 9.6 x 1.7	12.3 x 10 x 2	12.4 x 8.9 x 1.9
Weight (pounds)	6.9	7.5	4.4	6.7	6.5	6.6	4.9
External power supply							
Dimensions (inches; L,D,H)	5.2 x 2 x 3.2	5 x 2 x 3	6.5 x 1.4 x 3.5	6.2 x 2.1 x 3.1	6.7 x 1.6 x 4.3	8.1 x 2.2 x 3.3	None
Weight (pounds)	0.9	0.9	0.9	1.5	1.6	1.38	—
Keyboard							
Number of keys	80	80	79	81	78	82	84
Detachable keyboard?	No	No	No	No	No	No	No
Key travel (mm)	2	2	2	3.5	2	3.5	3.5
Display							
LCD type	Backlit	Sidelit	Backlit	Backlit	Backlit	Sidelit active matrix	Nonbacklit
Graphics resolution (maximum) in pixels	640 x 200CGA	640 x 480 VGA	640 x 480 VGA	640 x 400 EGA	640 x 480 VGA	640 x 480 VGA	640 x 200 CGA
Gray scales	4	16	16	12	16	32	8
Viewable screen area (inches; W x H)	8 x 4	7.2 x 5.4	8 x 6	8.5 x 5.3	8 x 6	7.5 x 5.75	8.5 x 5.5
External video port?	Yes	Yes	Optional	No	Yes	Yes	Optional
Internal hard disk drive	20-MB Conner	30-MB Conner	20-MB PrairieTek	20-MB Conner	20-MB PrairieTek	20-MB Conner	1- to 8-MB flash EPROM
Floppy disk drive (size/capacity)	3½/1.44 MB	3½/1.44 MB	3½/1.44 MB (external option)	3½/1.44 MB (external option)	3½/1.44 MB (external option)	3½/1.44 MB	3½/1.44 MB (external option)
Battery type	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium	Nickel-cadmium or alkaline
Claimed battery life (hours)	3½	3	2	2	2½ (2 batteries)	2	12 (nickel-cadmium); 20 (alkaline)
Battery recharge time (hours)	8	1½	2	12	4 (2 batteries)	1	14 (nickel-cadmium)
Device ports							
Serial	1	1	1	1	1	1	1
Parallel	1	1	1	1	1	1	1
Expansion options							
Internal modem	2400 bps	2400 bps	2400/4800 bps data/fax	2400 bps	2400 bps	2400 bps	2400 bps
RAM disk?	No	No	No	No	No	No	Yes
Expansion chassis?	No	Yes	Yes	No	No	No	No
Bundled software (DOS, utilities in ROM):	Utilities	Utilities	DOS 4.01	DOS 3.3 and Lap-Link in ROM	DOS 4.01	DOS 4.01	DOS 3.2 and Lap-Link III in ROM
Warranty (years)	1	1	1	1	1	1	1
FCC Class B certification?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Price[2]	$3499	$6499	$2895	$2895	$3699	$2999	$2995

[1] Optional second battery extends operating time to 5 hours.
[2] Prices reflect base memory and storage configuration.

recommend that you discharge the battery fully before recharging.

Most notebooks will run on batteries for 2 to 3 hours, depending on how you use them. Heavy use of the hard disk drive, keeping the backlighting on maximum brightness, or using an internal modem quickly reduces battery life.

All the notebooks feature power-conservation options that let you set inactivity time-outs for one or more subsystems. If there is no activity on the keyboard after a set period, the computer shuts off power to different components, such as the hard disk drive, LCD, backlight, modem, floppy disk drive, and I/O ports. Some vendors, including Compaq, NEC, and TI, provide a standby feature that switches the CPU to low power after you press a key or a period of inactivity has elapsed. Toshiba's auto-resume feature lets you turn off the machine while an application is running. When you power it on again, the application resumes where it left off. Power-conservation functions can greatly extend battery life, but time-outs don't help during a continuous, uninterrupted session.

All these computers have removable batteries that let you swap in a fresh spare on long trips. The NEC UltraLite 286V has two batteries; the Toshiba T1000LE holds an optional second battery in the modem slot. Both let you replace a battery without having to stop what you're doing on the computer.

Display technology. Notebook computers use backlit or sidelit LCDs that consume relatively little power and are lightweight. LCDs work by twisting light waves. Older LCDs put light through a 90-degree twist (called single-twist nematic), which produces a relatively low-contrast display. Newer LCDs put light through a 180-degree twist (supertwist) or 260-degree twist (triple supertwist) to improve contrast. Supertwisting is also what gives newer displays, such as that of the TravelMate 2000, their blue color.

Some new displays make use of faster active-matrix (also known as thin-film-transistor) technology. In an active-matrix display, each pixel has its own transistor, which allows precise control of

NOTEBOOK FEATURES

Sanyo MBC-17NB	Sharp PC-6220	Tandy 1500 HD	TI TravelMate 2000	Toshiba T1000LE	Toshiba T1200XE	Zenith MinisPort HD	Zeos Notebook 286
80C286/12.5	80C286/12	V20/10	80C286/12	80C86/9.54	80C286/12	80C88/10	80C286/12.5
None	80C287	None	80C287	None	None	None	None
1/5	1/3	640 KB/1.64	1/3	1/9	1/5	1/2	1/5
Yes	Yes	Yes	Yes	Yes	Yes	No	No
12.3 x 10 x 2	11 x 8.5 x 1.4	12.2 x 10 x 1.6	11 x 8.5 x 1.4	12.2 x 10 x 1.7	12.2 x 11 x 2	12.4 x 9.8 x 1.3	12.3 x 10 x 2
7	4.4	6	4.4	6.5	7.9	6	7
8 x 2.2 x 3.4	6.5 x 1.4 x 3.5	3.6 x 1.3 x 2.2	6.5 x 1.4 x 3.5	5.75 x 1.75 x 3	5.75 x 1.75 x 3	7.25 x 3 x 1.4	8 x 2.1 x 3.3
1.4	0.9	0.5	0.9	1.4	1.4	1.4	1.4
82	79	84	79	82	82	80	82
No	No	No	No	No	No	No	No
3.5	2	3.5	2	3.5	3.5	2	3.5
Sidelit active matrix	Backlit	Backlit	Sidelit	Sidelit	Sidelit	Backlit	Sidelit active matrix
640 x 480 VGA	640 x 480 VGA	640 x 200CGA	640 x 480 VGA	640 x 400 CGA	640 x 400 CGA	640 x 200CGA	640 x 480VGA
32	16	16	16	2	2	4	32
7.75 x 5.8	8 x 6	7.6 x 4.6	8 x 6	7.6 x 4.9	7.75 x 4.87	8.4 x 3.1	7.75 x 5.8
Yes	Optional	No	Optional	No	Yes	Yes	Yes
20-MB Conner	20-MB PrairieTek	20-MB Conner	20-MB PrairieTek	20-MB Conner or JVC	20-MB Conner or JVC	20-MB Conner or PrairieTek	20-MB Conner
3½/1.44 MB	3½/1.44 MB (external option)	3½/1.44 MB	3½/1.44 MB (external option)	3½/1.44 MB	3½/1.44 MB	3½/1.44 MB	3½/1.44 MB
Nickel-cadium	Nickel-cadium	Nickel-cadium	Nickel-cadium	Nickel-cadium	Nickel-cadium	Nickel-cadium	Nickel-cadium
2	2	3½	2	3[1]	2½	3	2
1	2	4	2	4	3	3	1
1	1	1	1	1	1	1	1
1	1	1	1	1 (or floppy port)	1 (or floppy port)	1	1
2400 bps	2400/4800 bps data/fax	2400 bps	2400/4800 bps data/fax	2400 bps	2400 bps	2400 bps	2400 bps
No	No	Yes	No	Yes	Yes	Yes	No
No	Yes	No	Yes	Yes	No	No	No
DOS 4.01	DOS 4.01; LapLink	DOS 3.3; DeskMate	DOS 4.01, LapLink, and Battery Watch in ROM	DOS 3.3; utilities	DOS 4.01	Dos 3.3 and FastLynx in ROM	Utilities; DOS 4.01
1	1	1	1	1	1	1	1
Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$2999	$3995	$1999	$3999	$2499	$3199	$2399	$1995

voltage for each pixel. Pixels can have a range between off and on that permits halftones and an improved gray-scale range. The machines from Sanyo, Ogivar, and Zeos feature active-matrix VGA displays at a full resolution of 640 by 480 pixels with 32 gray scales. These machines run graphical applications such as Windows 3.0 quickly and with amazing clarity.

Backlighting overcomes inadequate ambient lighting and increases the contrast between the image and the display background. Most notebooks have a fluorescent backlight; the NEC and Grid machines have electroluminescent backlighting, which isn't quite as bright.

Data storage. It's a quiet testimony to the quality and technical innovation of Conner Peripherals and PrairieTek that practically every notebook computer uses their hard disk drives.

Most notebook machines come with 20-MB hard disk drives. These drives have a single 3½-inch platter with a typical average access time of about 25 milliseconds. Using multiple platters can increase storage limits to 40 or 60 MB. Compaq's LTE 386s/20 is the leader in data storage with its 60-MB 19-ms Conner hard disk drive. Grid has added a interesting twist by making its hard disk drive removable. You can swap in different drives, and the company plans to introduce a desktop version so you will be able to move the hard disk drive from your notebook to your desktop computer.

When vendors added hard disk drives to their notebooks, some eliminated the internal floppy disk drive (although you can still buy external floppy disk drives for these machines). These companies say that you can do without the floppy disk drive and transfer files to a desktop computer using a file transfer program such as Traveling Software's LapLink III. Some vendors bundle LapLink or a similar utility with their machines. LapLink is fast, but it's not always convenient to run the necessary cables into the back of your desktop machine. A floppy disk drive has the added benefit of letting you make quick backups of important data when you're on the road.

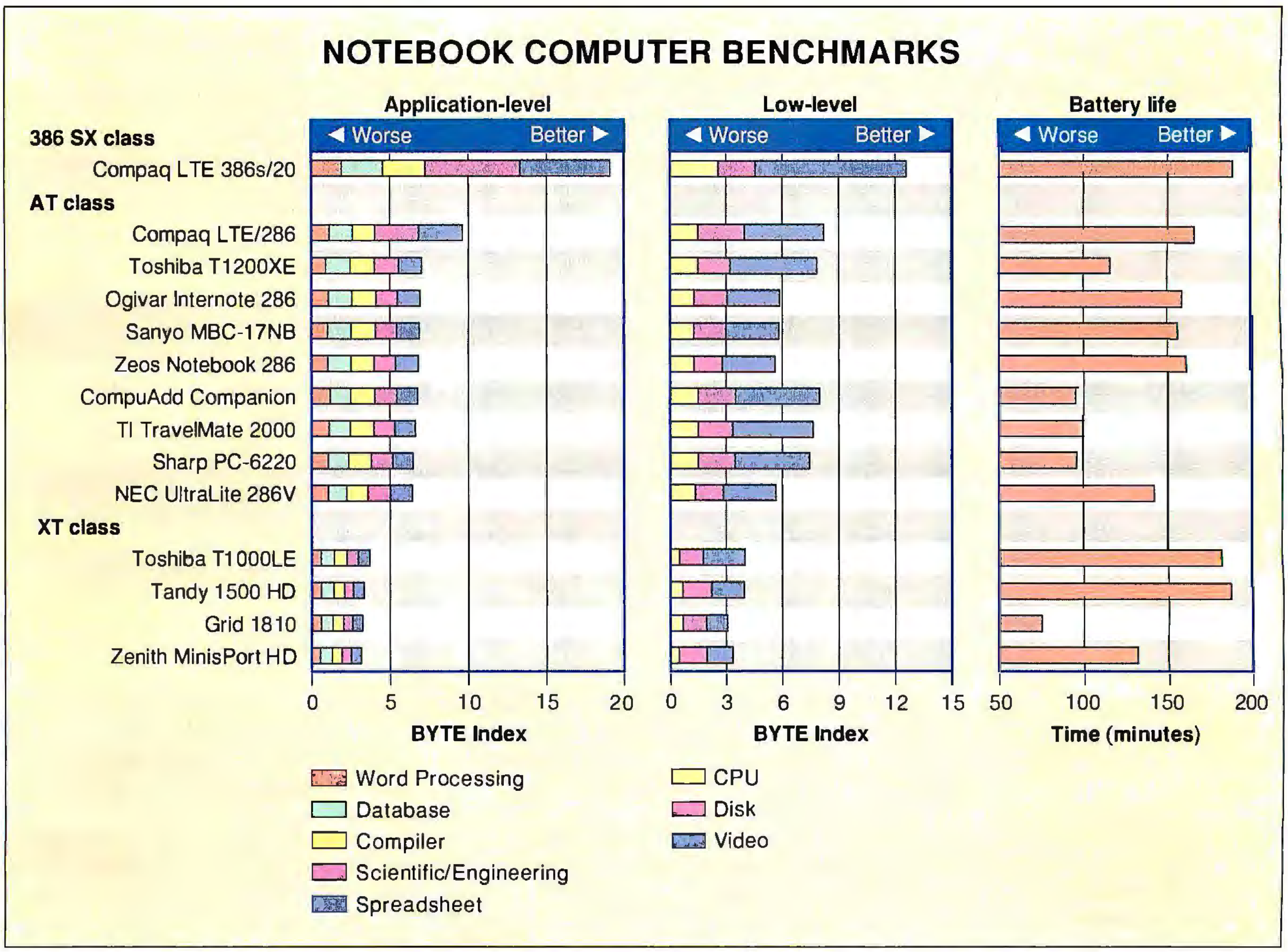
From the Testing Notebook

Most people use notebook computers differently from their desktop counterparts, so a few changes to the BYTE benchmark suite were in order this month. We ran the standard low-level CPU, disk, and video tests, but we modified the application benchmark suite to emphasize typical notebook computer applications (for a complete rundown on the application benchmarks, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990).

Specifically, we have added a second suite of word processor benchmarks to the WordPerfect suite, eliminated the desktop publishing and CAD categories, and scaled down the database benchmarks. We substituted Lotus 1-2-3 release 2.2 for release 3.0 and added Borland's Quattro Pro, a spreadsheet designed to accommodate 808x-based systems. We have kept the compiler and engineering applications in modified form.

Our new battery-life test gauges battery life under simulated working conditions. It consists of a TSR program that opens a text document, pumps characters into a file at a consistent rate, and automatically saves the file at 1- and 5-minute intervals until the battery has completely discharged.

We didn't enable any power-conservation features during our tests, so it's not surprising that our results generally fell short of the vendors' battery-life claims. You may get slightly better results, depending on how you work and what applications you run, but the test gives you a good idea of how the machines compare.



We tested performance using the standard low-level benchmarks and a modified application benchmark suite. We used Lotus 1-2-3 release 2.2 instead of release 3.0, scaled down the database tests, and added XyWrite and Quattro Pro. Performance varied little within each CPU class. The Compaq machines both included FPUs, which skewed the results to their advantage. The battery-life benchmark, which simulates a steady word processing session, clearly differentiates the machines we tested. Because our tests don't take advantage of power-conservation options, the results are a relative yardstick against which to make comparisons. Your mileage may be better or worse, depending on how you use your computer. The most robust batteries reside in the Compaq, Tandy, and Toshiba machines.

Some machines, such as the two Toshiba models, feature battery-backed RAM disks. A RAM disk is more expensive per megabyte than magnetic media, but it's fast and requires less power than a hard disk drive. Zenith's MinisPort HD maintains separate lithium batteries that power the RAM disk, so you don't lose data when the main battery runs down. Psion's MC-600 has the most intriguing data storage system. It uses Intel's flash-memory chips to create a solid-state disk drive that doesn't need battery backup.

Keyboards. None of the notebook keyboards had the size or feel of a good desktop keyboard. Squashing a standard 19-inch, 101-key keyboard into an 11- or 12-inch form factor does require compromises. Some vendors do away with separate function, cursor, numeric, and page-control keys, overlaying these functions on other keys. Some manufacturers lower the height of the key caps and shorten the key travel from the standard 3.5 millimeters to 2 mm to help keep the case height low.

How well these keyboards work is a subjective consideration that depends on the applications you use and how well you type. As touch-typists, we held these machines to a high standard, but don't take our word for it. We strongly recommend trying out any keyboard before you decide to buy.

Durability. We didn't go so far as to drop the notebook computers to see if any would break, but we did try each machine in a variety of environments. Some computers are more fragile than others and require more care—particularly the displays. One of the units with a flimsy screen, the Compaq LTE/286, went on a business trip and returned with a cracked screen. We're not sure how it happened, but the message is clear: Notebook computers require special care.

We also found some I/O port covers annoying. The Sanyo, Ovigar, and Zeos machines all have fold-down plastic covers held in place by small plastic pins that can easily break off. The TI, Sharp, and CompuAdd machines have sliding plastic covers that are difficult to remove and fall off easily if not properly inserted.

Expandability. All the notebook computers have a slot for an internal modem; the TI, CompuAdd, and Sharp machines offer a data/fax modem option. Some notebooks, such as the LTE 386s/20 and the TravelMate 2000, have an optional expansion chassis that allows you to install add-in boards. The TravelMate expansion chassis occupies the modem slot.

COMPAQ LTE/286 and LTE386s/20

Both of the Compaq notebook machines bear a striking family resemblance, but beneath the exterior, the LTE 386s/20 has a completely new design that incorporates Intel's 20-MHz 386SX. The LTE/286 uses a 12-MHz 80C286 processor. Both accept a math coprocessor and include floppy and hard disk drives. The 386s/20's 2.2-inch-high case—which is slightly thicker than the LTE/286's case—makes that notebook the tallest machine in the group. Both Compaqs are relatively light and easy to carry.

The LTE/286 includes a 20-MB hard disk drive and 640K bytes of RAM for $3499. The LTE 386s/20 comes with 2 MB of RAM and a 30-MB hard disk drive for $6499. Memory upgrades are user installable, but Compaq's $549 list price for its proprietary 1-MB single in-line memory modules is a bit steep.

The LTE/286 uses a backlit LCD that supports CGA graphics at 640 by 200 pixels with four gray scales. The LTE 386s/20 has a more desirable sidelit LCD that offers VGA at 640 by 480 pixels with 16 gray scales. Of the systems that support VGA, the LTE 386s/20's display was one of the best.

The LTEs share the same keyboard layout, using overlays for the numeric keypad, arrow, PageUp, PageDown, Home, and End keys. Compaq shortened the key travel to 2 mm to save space for the floppy and hard disk drives mounted beneath the keyboard. The keyboard has a good feel, however, despite the short stroke.

The batteries slide into both LTE models through a side door, but the batteries are not the same in both machines. Compaq rates battery life at 3½ hours on the LTE/286 after an 8-hour recharge; the LTE 386s/20 can go for 3 hours between 1½-hour recharges. Our 286 ran for about 2¾ hours; the 386s/20 held up for slightly more than 3 hours during testing.

You can conserve battery power by setting system inactivity time-outs for the hard disk drive, display, and CPU. The Standby switch on the front panel is handy for pausing operations and then resuming later where you left off. It turns off the display and hard disk drive and puts the CPU into low-power mode.

The LTEs performed better than the other machines in this review, but both had math coprocessors installed. Since no other machine included a math chip, this skewed the results.

Both Compaqs feature standard-size serial and parallel ports, a mouse connector, a numeric keypad connector, and a video port. The LTE/286 also includes a connector for an external floppy disk drive. All I/O ports sit underneath a delicate-looking plastic flip-down cover on the LTE/286. The LTE 386s/20 has a more macho sliding cover and a connector for an optional expansion chassis.

Psion's Notebook with Flash

Psion's MC-600 uses Intel's flash-memory chips as its storage medium and has a long battery life, which makes it ideal for use during long trips. The machine's 80C86 CPU runs at 7.68 MHz—a bit slower than the other notebook machines we tested. The non-backlit retardation-film LCD supports CGA graphics at a resolution of 640 by 200 pixels. The LCD has better contrast and a wider viewing angle than older LCDs, but it can't beat a backlit screen in poorly lit areas.

In place of floppy and hard disk drives, the Psion MC-600 uses "solid-state disks," Intel's nonvolatile flash-memory chips that can emulate a hard disk drive. The machine comes standard with a 1-megabyte internal RAM disk as drive C. You can expand the SSD capacity to 8 MB by installing 1- and 2-MB memory "packs" in the machine's four slots, but storage isn't contiguous: Each pack becomes its own logical drive. The MC-600 doesn't include an internal floppy disk drive but offers an external device as an option. The basic system (which costs $2995) includes 768K bytes of RAM (only 640K bytes is accessible), the 1-MB internal RAM disk, LapLink III, and DOS 3.2.

The CMOS flash-memory chips offer faster performance than EEPROMs, requiring 1 second for electrical erasure, 2 seconds for reprogramming, and 135 nanoseconds for high-performance reads. According to Intel, it is possible to erase and reprogram the flash-memory chips at least 10,000 times.

Without backlighting or disk drives to consume power, the MC-600 goes longer than most notebook computers between recharges. It can squeeze 20 hours out of eight AA alkaline batteries or 12 hours from a set of nickel-cadmium batteries. Setup screens let you configure time-outs for the display and keyboard, and a CPU power-saver mode switches the processor to low power when waiting for keyboard input.

The unit is very quiet. There are no whirs, clicks, or other bits of distracting noise associated with hard and floppy disk drives. The MC-600 has a full-travel keyboard with an XT-style layout and small, separate buttons for PageUp, PageDown, Home, End, Insert, and Delete.

The computer and its flash-memory upgrades aren't cheap. A Zeos Notebook 286 with a 20-MB hard disk drive, floppy disk drive, sidelit VGA display, and 1 MB of RAM costs $1000 less. But the MC-600 is sturdy and should work well in situations where quiet operation and long battery life are important.

Our LTE/286 developed cracks in the plastic case just above the floppy and hard disk drives. Compaq says that it has redesigned the case and is fixing machines with this problem at no charge. The 386s/20 has a slightly different case design and did not exhibit any flaws.

The LTE 386s/20 is the fastest, most expandable, and most expensive notebook computer we tested. Both Compaq machines include excellent documentation. The LTE/286 set the standard in the 286 notebook arena. Other machines, however, now give you more for your money.

These three 80C286-based notebook PCs, designed by Sharp and TI, are all manufactured in the same TI plant in Austin, Texas. (Sharp manufactures its own model for sale overseas.) There are subtle differences among them. TI adds its own power management utility and includes DOS and LapLink in ROM. But the most obvious difference is price. The TI and Sharp systems come in at just under $4000 in our test configuration; the CompuAdd Companion sells for $2895. But typical dealer discounts on the TI and Sharp machines put their street prices about on a par with the mail-order CompuAdd.

These 4.4-pound machines are the smallest and lightest PCs we reviewed and have the most "curb appeal"; that is, when we put all the notebooks on a table in the BYTE Lab, editors passing by tended to gravitate toward the TravelMate, the PC-6220, or the Companion.

Although their size and innovation draw a crowd, these machines aren't necessarily your best choices.

The designers had to make sacrifices to achieve that wonderful form factor. The battery, rated at 2 hours, lasted only about 1 hour and 40 minutes during our tests. An optional battery "slice" connects to the rear of the machine, adding about 2.3 inches of length and 1.9 pounds of weight to the unit. The battery slice should provide about 3 more hours of battery life. The keyboard offers no typing angle (a fault nearly all the other notebooks shared), and its placement (it's set back about an inch from the front of the unit) and limited key travel might prove uncomfortable in heavy-duty typing sessions. Some keys (PageUp, PageDown, Home, and End are the most important ones) are embedded. That is, you must also press the Fn key to activate them. This will be awkward for some applications.

A floppy disk drive is available only as an external option. For the most part, these trade-offs are reasonable; we don't see how anyone could build a better commercially viable notebook PC in this form factor and with this processing power, given the limits of current technology.

What gives us pause, though, is the design of the case. The tension from the screen's hinge flexes the plastic above the keyboard to an uncomfortable degree on all three units. The thin display feels flimsy and offers little protection for the LCD. And the doors covering the various ports and slots aren't hinged; they snap off and can get lost easily.

Performance-wise, the TravelMate, PC-6220, and Companion were leaders among the 80C286-class notebooks, providing the most punch per pound—or per square inch. The machines also accept a math coprocessor—a feature that will come in handy if you're working with complex spreadsheets on the road.

The VGA display was crisp, with good contrast—not the best we've seen, but close. A pop-up utility lets you adjust the gray-scaling for greater contrast when necessary.

We don't recommend any of these small PCs for environments where they might get rough use, and touch-typists might opt for a notebook with a better keyboard. But the size and capabilities of these units are simply irresistible. If portability is your main concern, and you and your applications can live with the trade-offs, then any version of this very luggable notebook would be an excellent choice.

The 1810 doesn't have the black magnesium case that's become a Grid trademark, but it has the same rugged feel and some interesting features. Powered by an NEC V20 microprocessor, the Grid 1810 posted performance numbers in the same range as the XT-class notebooks. Unfortunately, the 1810's battery life doesn't measure up to that of the other machines in its class.

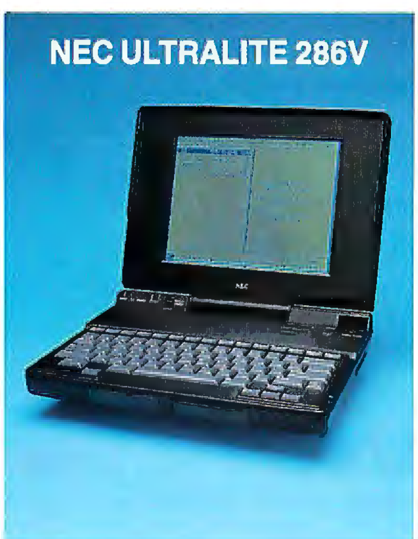
The 1810's keyboard is excellent. The keys have a firm tactile response, snappy recoil, and full 3.5-mm travel. Grid put the cursor keys in an inverted T shape at the bottom right corner of the keyboard. The right Shift key is reduced in size, but the unit has dedicated keys for PageUp, PageDown, Home, and End. The Insert and Delete keys sit to the right of the F1 through F10 function keys on the top row of the keyboard. When combined with a special blue function key, the Insert and Delete keys double as the F11 and F12 keys. Function key combinations can also change the processor speed, disable the speaker, power down the disk drive, turn off the backlighting, or place the unit in full standby mode. You can also set power-conservation time-outs by invoking the setup program.

The electroluminescent backlit LCD supports 640- by 400-pixel EGA graphics with 12 gray scales. Visibility was good under all lighting conditions. Slider knobs below the screen control the contrast and backlighting levels. The screen looked good in all lighting conditions, although the backlit display was not as bright as the sidelit models we tested.

The 1810 supports a maximum of 2 MB of memory, and you cannot install memory upgrades yourself. Only the Tandy 1500 HD (1.64 MB) and the Psion MC-600 (1.768 MB) have lower memory ceilings.

The 1810's most unique feature is its removable 20-MB hard disk drive, which slides easily from the side of the unit. There are no switches to set or plugs to pull. You can buy a couple of spares and keep different applications on separate removable disk drives. Grid's announced desktop module, which lets you plug the removable hard disk drive into your desktop system, wasn't available at press time. The 1810 offers an external floppy disk drive only.

In the Grid tradition, the 1810 is technologically advanced, rugged, elegant—and overpriced. The $2895 list price (for a unit with 1 MB of RAM, a 20-MB hard disk drive, and DOS and LapLink in ROM) makes it the most expensive notebook computer in its class. Other notebooks offer more for your money.



The UltraLite 286V keyboard has one of the best layouts of the machines we tested; it has large Enter, Shift, Control, and Alt keys and separate cursor-control keys. But the short, 2-mm key travel may annoy some touch-typists. The keyboard also doesn't offer much tactile feedback.

The basic 286V includes a 12-MHz 80C286, 1 MB of RAM, a 20-MB hard disk drive, DOS 4.01, and two batteries for $3699. NEC offers an external floppy disk drive as an option.

The case design for the 286V is sleek and matte black with rounded corners. A fragile-looking fold-down plastic panel covers the I/O ports. The screen display did flex slightly when handled, but the case should hold up fine if you give it reasonable care.

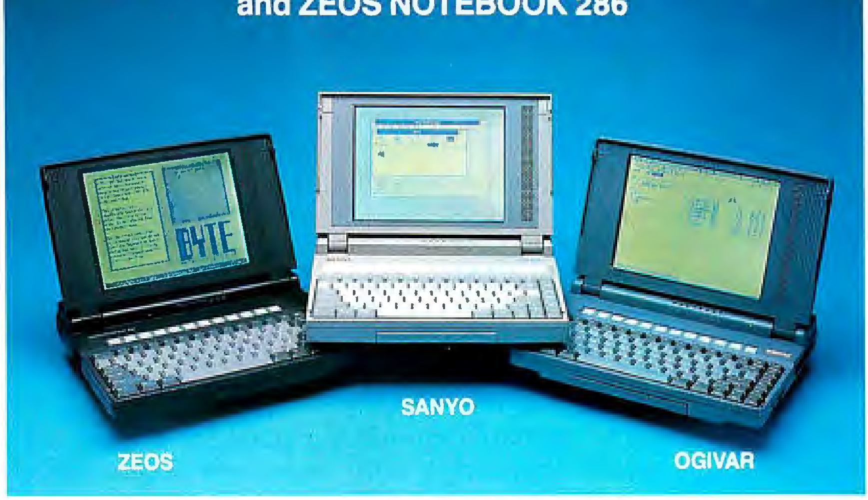
The 286V's electroluminescent backlit LCD supports VGA modes at up to 640 by 480 pixels with 16 gray scales. Still, its image quality wasn't on a par with that of the Sharp/TI/CompuAdd trio, and the contrast and brightness controls did little to improve screen clarity.

The machine includes dual battery packs that fit under the case, and you can recharge one battery while you use the other. LEDs on the front panel blink and change color to indicate battery status.

Power conservation revolves around the Standby/Resume switch on the front panel, which operates like the Compaq LTE's switch. The standby mode saves power during intermittent use; the resume mode turns off power for extended periods. Both modes let you return to the exact state the machine was in when you last used it. Standby mode turns off power to the hard disk drive, screen, and any peripherals connected to the computer but preserves RAM and CPU register information. You press any key to resume operation. Resume mode cuts power to all subsystems while preserving RAM and CPU register information. You press the on/off switch to resume operation. You can set up the 286V to trigger either mode after the inactivity time-out period you specify has elapsed.

You add memory by installing a 1- or 4-MB RAM card on the motherboard. The 286V also has a slot for one battery-backed 256K- or 512K-byte RAM or ROM card. NEC offers ROM versions of Lotus 1-2-3, Metro, Agenda, XyWrite III Plus, WordPerfect, WordStar, and Microsoft Works. ROM-based application programs execute in ROM and use less power than applications run from the hard disk, but we suspect that most people will forgo using these expensive cards and just load their applications onto the hard disk.

OGIVAR INTERNOTE 286, SANYO MBC-17NB, and ZEOS NOTEBOOK 286



These three 80C286-based machines share the same basic Sanyo design; the only differences are cosmetic. Prices for a 1-MB machine with a 20-MB hard disk drive, a floppy disk drive, and DOS 4.01 range from $1995 (Zeos) to $2999 (Sanyo and Ogivar).

These compact units appear to be more sturdy than some other units we tested, and the active-matrix displays—developed by Ogivar—are outstanding. The sidelit LCD seems brighter than that of other backlit models. It supports full 640- by 480-pixel VGA graphics with 32 shades of gray. If that's not good enough, you can plug your own VGA display into the external video port. Sanyo conveniently tucked the brightness and contrast controls below the right edge of the keyboard on the side of the unit.

The keyboard has a squishy feel, despite the full 3.5-mm travel. A complete complement of function keys lines the top of the keyboard, and Sanyo placed the cursor keys in an inverted T at the bottom right corner. You use the Fn key to access the PageUp, PageDown, Home, and End functions. If your software uses these keys liberally, you may find this layout unacceptable.

Built around a 12.5-MHz 80C286, this group of machines posted average benchmark times. The Sharp/TI/CompuAdd machines, Compaq LTEs, and Toshiba T1200XE all performed slightly better. This advantage was more noticeable while running the low-level tests than when running the application suite, however.

The Ogivar, Sanyo, and Zeos notebooks all did particularly well on the battery-life tests, consistently lasting over 2½ hours. When the battery runs down, you can pop in a spare or recharge the battery in only 1 hour. The external power supply measures 8 by 2 by 3½ inches; only the MinisPort's power-supply brick is larger.

The units fold into a compact 7-pound shell. All three appear to be solidly constructed, durable machines. A row of indicator lights lies on the main unit, just below the screen, remaining visible when the screen is folded down. A handle pops out from the front of the unit for easy carrying.

For the most part, only small nuances differentiate these three models; that is, until you come to price. The Notebook 286, a mail-order machine, costs $1000 less than the Internote 286 or the MCB-17NB at list price. Even with dealer discounts on the Ogivar and Sanyo machines, the Zeos system will maintain an edge. The company has made a breakthrough by pricing the Notebook 286 under $2000—a price that makes it competitive with the XT-class notebook machines.

These three models strike the best balance between power and portability. You get an acceptably small shell, but you don't have to give up a floppy disk drive or a rugged housing.

TANDY 1500 HD

Tandy's 1500 HD isn't the fastest XT-class machine, but it has several notable features, and Tandy's many retail outlets make servicing easier. Tandy powers the machine with a 10-MHz V20 processor. The basic system, at $1999, includes 640K bytes of RAM, a 20-MB

Choosing a Notebook Computer

When you're selecting a notebook computer, portability has top priority. But portability involves not just the system unit's dimensions and weight, but the size and weight of the external power supply and any optional equipment you plan to carry as well.

You should also consider battery life carefully. A system should be able to run for at least 2 hours between charges. Most units have standard power-conservation features that dim the backlighting and power down the hard disk drive when the unit isn't in use. Several machines also offer a handy standby function that shuts down virtually the entire system and then, at the touch of a key, resumes operation where you left off.

No matter how careful you are, your notebook computer will face some rough treatment when you travel. All these machines need looking after, but some don't seem quite as sturdy as others. In particular, you should check how well the case protects the display.

If your main notebook applications include word processing and entering data into simple spreadsheets, performance isn't your overriding concern. Here an XT-class notebook will do a perfectly adequate job.

Don't sell yourself short on an upgrade path; someday you may want more RAM for EMS memory or a RAM disk. Check the maximum memory size and availability of other options you may want, such as an expansion chassis.

These computers have personalities, so you should try before you buy. Although we aim to be objective, keyboards and displays are often matters of personal taste—particularly when you are running applications that require VGA mode. Make sure that you like typing on the unit and can read the display clearly in a wide range of lighting situations.

With notebook computers, you don't always get more for your money. If you decide to pay a little extra for a notebook, make sure that you are getting the extra features that you need: more disk space, a faster processor, or longer battery life.

hard disk drive, a 3½-inch 1.44-MB floppy disk drive, and Tandy's DeskMate desktop manager. You can configure memory above 640K bytes as EMS memory or as a RAM disk, but the machine accepts only 1.64 MB of RAM.

The unit's backlit LCD is easy to read in all lighting conditions, but it only supports 640- by 200-pixel CGA-mode graphics with 16 gray scales. Screen controls include a contrast slider but no intensity knob. You can toggle the backlighting on or off with a key combination.

The 1500 HD's full-travel keyboard sports a good layout with more keys (84) than any other machine we tested, except for the Psion MC-600. Tandy includes a complete set of function keys, and separate PageUp, PageDown, Home, End, and arrow keys. Unfortunately, the function keys are undersized. The Fn key controls can turn off backlighting and disk activity. There's also a hot key for placing the 1500 HD in standby mode by powering down the display and the disk. You control power conservation through the DeskMate user interface or from the DOS command prompt.

The 1500 HD folds into a 6-pound shell and has a sturdy plastic housing. Tandy rates battery life at 3½ hours; in the Lab, the 1500 HD lasted over 3 hours—better than any other machine except the Compaq LTE 386s/20. Your average should be better if you have the power-conservation features enabled. Recharge time is a relatively short 4 hours.

The 1500 HD's $1999 price makes it an excellent buy in its class.

TOSHIBA T1000LE and T1200XE

The Toshiba name has become synonymous with laptop computers. Toshiba's notebook entries, the T1000LE and T1200XE, have similar construction and features but differ in performance.

The T1000LE packs in a 9.54-MHz 80C86 processor, 1 MB of RAM, a 20-MB hard disk drive, a floppy disk drive, a battery, and DOS 3.3 for $2499. The T1200XE substitutes a 12-MHz 80C286 processor for $3199. The LE boasts more expandability than any other notebook in its class. It supports up to 9 MB of RAM and offers an optional expansion chassis for future expandability. The chassis, which plugs into a proprietary port in the rear of the unit, wasn't available at press time. The T1200XE accepts up to 5 MB of RAM.

Both Toshiba models include bright sidelit LCDs with CGA modes of up to 640 by 400 pixels and two gray levels. Sharpness and clarity are excellent, on a par with the Ogivar/Sanyo/Zeos trio.

The T1200XE has flat control knobs for brightness and contrast, but getting the screen just right can be tricky. The T1000LE's side-mounted screen controls are easier to use. The T1200XE offers an external video port; the T1000LE does not.

Both keyboards lack a good tactile response, but the layout is adequate. They offer separate PageUp, PageDown, Home, End, and cursor-movement keys. The complete set of function keys on the top row and the Control key aren't full-size, however. Special function keys change the CPU speed, and on the T1200XE a function key diverts the video signal to the external port. This same function key also accesses a special pop-up window that reports system settings, such as current battery capacity. This is one of Toshiba's unique touches.

Another is the resume mode. When the Toshiba machines ran out of juice during the battery-life tests, we recharged them and turned the units back on, and the tests resumed right where they left off—with the TSR program still loaded and active. This impressive feature might just prevent accidental data loss.

The T1000LE's batteries lasted just over 3 hours, rivaling the Tandy and Compaq batteries. The T1000LE has an option for a second battery, which extends the operating time to 5 hours but occupies the modem slot. The T1200XE doesn't accept two batteries, but the battery life is acceptable, if not impressive.

Both Toshiba machines are rugged, with the exception of the flimsy port covers. The Toshiba name carries a steep list price, but street prices are competitive. The T1000LE is especially enticing as a low-end model.

ZENITH MINISPORT HD

The original MinisPort was a technological marvel. The new MinisPort HD still maintains an edge as one of the most portable units that we've seen. The strong case is more durable than that of most other notebook computers, yet the unit weighs only 6 pounds and fits comfortably under your arm. It also has a handy carrying handle that folds into the case when not in use. The base machine includes 1 MB of RAM, a 20-MB hard disk drive, a floppy disk drive, DOS 3.3, and a few utility programs for $2399.

The machine has undergone some changes. The MinisPort HD uses the same 10-MHz 80C88 processor, but Zenith has dropped its experiment with proprietary 2-inch floppy disk drives in favor of a standard 3½-inch 1.44-MB model.

The keyboard has relatively flat keys that travel only 2 mm. When touch-typing, we couldn't always tell from the keyboard response whether the machine was getting all the characters. The cursor keys double as the PageUp, PageDown, Home, and End keys.

The MinisPort's fluorescent backlit LCD is dimmer and more faded-looking than the LCDs on the other systems we tested. Nevertheless, readability is good under all lighting conditions. The MinisPort has the smallest viewable screen area in the group, and its graphics capabilities aren't earthshaking: CGA mode at 640 by 200 pixels with four shades of gray. The screen tilts back 180 degrees—a unique feature that we found useful.

The MinisPort HD performed about on a par with the other low-end notebooks. Battery life, rated at 3 hours, was slightly over 2 hours when running the battery-life test. Both the Tandy 1500 HD and the Toshiba T1000LE performed better here.

The MinisPort includes DOS 3.3 and FastLynx, a self-cloning serial-port file transfer program, in ROM. Like the Toshiba and Tandy machines, the MinisPort lets you configure extra memory as a RAM disk, but the machine accepts a maximum of only 2 MB of RAM. If you need a machine for word processing or other simple tasks and that will take some abuse, we wouldn't hesitate to recommend the MinisPort.

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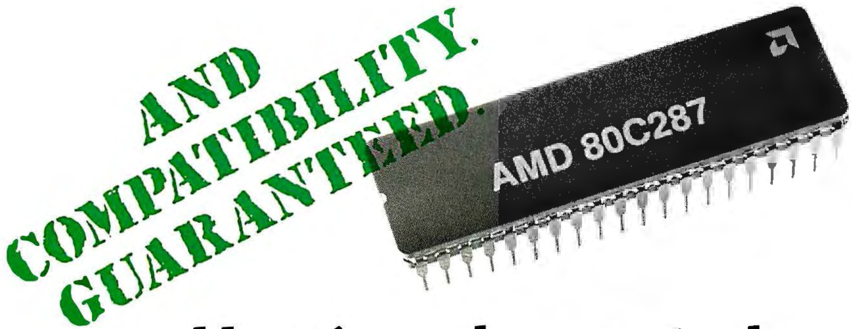

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must make. If you absolutely must have the most totable notebook available, you can't do better than the 80C286-based CompuAdd, Sharp, and TI machines. However, you'll pay for the privilege. These units are the most expensive in the group, with the exception of the Compaq LTE 386s/20. You'll also forgo an internal floppy disk drive. We didn't care for the keyboards on these models, nor did we give them high marks for durability. If you're going to carry one around, we suggest keeping it tucked safely in a briefcase during trips.

When broken down by CPU class, the machines differ little in terms of performance. The 386SX-based Compaq LTE 386s/20 takes the top spot for performance—and price. But if you want a notebook computer with SX power, we think you should wait for the market to develop. A slew of 386SX notebook machines should be hitting the stores as you read this. We'll take a detailed look at these new machines in a later issue.

The 80C286-based performance heat was too close to call. The Compaq LTE/286 held a slight advantage, but it included a math coprocessor. Had the other machines had coprocessors installed, the results might have been closer. Likewise, none of the XT-class notebooks distinguished itself on the performance tests, but if you're considering one of these machines, speed probably isn't your primary criterion.

With the Zeos Notebook 286, you get 80C286 power, a VGA display, and an internal floppy disk drive.

For most notebook users, an XT-class machine will do the job. You'll sacrifice some speed, and you won't get a VGA display, but you will get longer battery life and an attractive price. All four of the low-end notebooks—the Grid 1810, Tandy 1500 HD, Toshiba T1000LE, and Zenith MinisPort HD—are rugged. Of the four, we liked the T1000LE best because of its superior display and extra features, such as resume mode. There's only one problem with going that route: the Zeos Notebook 286. For roughly the same price, you get 80C286 power and a VGA display. Why settle for less?

The Zeos Notebook 286 looks like a clear winner. But check out the identical Ogivar Internote 286 and the Sanyo MBC-17NB. Your local computer store may cut you a deal, although the Zeos price of $1995 will be hard to beat. The CompuAdd Companion is lighter and smaller than the Zeos machine, but it costs $2895. The Zeos machine also includes an internal floppy disk drive, a bright sidelit LCD, and a better keyboard. ■

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(713) 370-0670
Inquiry 1105.

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(Companion)
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Zeos International, Ltd.
(Notebook 286)
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Inquiry 1117.

SOFTWARE

John M. Dlugosz

Libraries with Class

While many software developers greeted the introduction of C++ for the PC with great excitement, others stood fast and waited. Early compilers had a very limited set of standard classes, forcing programmers to waste time building object frameworks around ordinary C library functions.

Today, a number of C++ class libraries are available that can handle everything from complex math to graphical user interfaces (GUIs). Each of the five C++ libraries that I reviewed works with either Zortech's C++, Borland's Turbo C++, or both, and produces DOS executables. System requirements will vary, depending on your specific programming project and the compiler you choose.

C++/Views

CNS's C++/Views ($495) has three parts: a general-purpose Smalltalk class tree, classes for writing Microsoft Windows applications, and a class browser.

The class browser is modeled after the Smalltalk browser, but it shows a few rough edges in its implementation. You have to keep a one-to-one correspondence between classes and source files, and each source file can only contain members of the proper class and nothing else. There doesn't seem to be a way to handle nonmembers or global variables at all, except by using the `main()` function, which is in a separate file by itself.

To get the browser to find your headers and the source code for the library, you have to set an environment variable. The only way to do this is to quit Windows and set the environment variable in the boot shell; there is no way to change the variable while Windows is running. The browser has a simple configuration file; CNS should have added a search path setting to that.

After familiarizing myself with the C++/Views browser, I tried to rebuild one of the sample applications. The browser generates the make file, linker file, and other files that you need to recompile the project. It does not have an option to launch the compiler, so I opened a DOS-shell window and ran it from that.

The make file did not work, because the DOS MAKE command could not find the include files. The only way to get it to work is to delete the references to .H files from the make file manually, or to copy all include files into the current directory. The company says that this problem will be fixed in a future release, which will include full path names of files in the dependency list.

Most of the problems I had with C++/Views were due to its poor installation program, which was unable to compile as installed and had an incorrect linker response file. You must first alter the script that generates the linker response file, depending on which linker you have. The procedure is described in the READ.ME file, though.

The class library is modeled on Smalltalk's library. It's a hierarchy rooted with an object class and will be quite familiar to Smalltalk programmers. It also has a well-designed underlying architecture for dealing with event-driven programs. There is a notifier that takes care of dispatching Microsoft Windows messages throughout your program. A View class takes care of interactions with Windows for the most part, and the application itself should be separate from the Windows messages and interactions.

The Windows classes provide a much cleaner object-oriented interface than the typical Windows Software Development Kit library does. You call virtual functions for various messages. For instance, instead of writing a Windows function with a big `switch` statement in it for handling each message type, you simply derive a class and redefine the functions of interest. You use member functions of this Windows class instead of Microsoft Windows primitive calls, which makes programming much easier and less error-prone.

C++/Views is a mostly successful attempt to make C++ look like Smalltalk. The class hierarchy, the browser, and the model/view/controller structure are all borrowed from Smalltalk. Even the examples in the manual are taken from Smalltalk texts. However, the terminology used in the manual is also that of Smalltalk, not C++.

If you wish you were using Smalltalk (or perhaps porting from it), this is a very good product for you. But if you are comfortable with C++, you might feel alienated by C++/Views.

Financial MathLib++

Greenleaf Software's Financial MathLib++ ($199) is a library for business applications. It features a fixed-point numeric type that can handle large decimal numbers with exact precision, several date classes, and functions commonly required by financial applications.

The installation program is fairly robust. It can copy the libraries from the release disks or rebuild them if you have the source option (source code is free to registered users). I planned to install large and small models, and since the manual said that only the large model with VROOMM was on the disk, I told the program to rebuild. It seemed to take forever to compile. In fact, I read part of the manual and had a snack, and it was *still* compiling.

Interestingly, each file contains only a few lines. In general, each file is a single function, which is what you want in a fine-grained library, so you don't link in code you don't need. The main problem is the include files. The full set of include files is brought into the program, even though you are only compiling a single member from a single class and often don't need anything other than that class definition.

The foundation of the library is the Decimal number class. Floating-point is unsuitable for many applications, because the binary representations of numbers do not behave in the same way as decimal numbers. For example, 0.1 cannot be represented exactly in binary. The Decimal class is a numeric type that behaves exactly like decimal numbers. It offers a 64-bit mantissa, which gives 18 or 19 significant digits. The exponent is in base 10. Any decimal number you write with less than 19 digits is represented exactly.

The Decimal class stores its data in a format that matches the C representation of the decimal number. This format lets you use the code in assembly language functions easily and share it between C and C++ implementations. Greenleaf Software explains that the code is protected so that friends and members can access it but other classes and functions cannot. Yet the company includes a public declaration that completely removes all protection from it. All the arithmetic operators are defined for Decimal, as are conversion operators to other arithmetic types and strings, and constructors taking various arithmetic types and a string (so you can specify values that would be inexact as a compile-time literal).

The company also provides iostream support for this class. Financial MathLib++ recognizes the formatting flags, such as width and precision, but it does not recognize other important flags (e.g., fill character, justification, and showpoint flags). It only applies the precision setting if the width is nonzero and crashes if the width is 32 characters or greater. The input function also has problems: It will break at a white space instead of the first nondecimal digit and crash if there are over 80 characters before a space, and it does not set the `ios` error flag if the input does not look like a decimal.

The program also has input and output functions that are enhanced versions of `printf()` and `scanf()` and know about the new types. However, they know about the C versions, not the C++ versions, of these types. For example, you have to use the `(DEC*)` cast on a decimal before passing it (note that C++ cannot implicitly convert, because this argument is in the ellipses part of the parameter list).

In addition to the Decimal class, Financial MathLib++ has DecimalArray, which is a typical vector class using Decimal as the element type. There are also several date classes, which you can use for different effects and purposes in financial calculations. These classes include Date360 (used in bond functions), Date365, and Date365NoLeapYear.

Besides supplying a number class suitable for use in financial functions, Financial MathLib++ has many functions for using them. There are functions for interest, amortization, cash-flow analysis, annuities, depreciation, and bond functions. Statistical functions are also included.

All in all, the Decimal class is quite useful, and it could prove essential in programs that need BCD-like math (especially since the BCD classes that come with Turbo C++ don't work correctly). The overloaded operators and other aspects of the class are all very good.

However, the rest of the library looks like it was too hastily converted from C. The C++ I/O is flawed, and most I/O has to be done with C-like functions. It would be nice if the various Date classes had a common base class, virtual functions for days between dates, and so on. Besides the I/O, the only real problem I found was the lack of `const` on some parameters. Most functions are OK, but you can't pass a `const` for the interest rate when calling `Amortize()`, for example.

M++

Dyad Software's M++ 2.0 ($295) is a library for dealing with matrices and linear algebra concepts. It has array classes for various element types, including all the built-in arithmetic types and complex numbers. Arrays of up to four dimensions are provided, and you can add more dimensions if you get the source code. Ragged and rectangular arrays are also possible.

The manual's instructions are quite clear, and a quick-reference card is also provided. The program is quite intuitive, and its intended audience should be able to use the library with little or no further instruction.

There are functions for creating, redimensioning, and filling matrices. For example, you can fill all elements with the same value, stepped values, or random numbers with the `fill()`, `seq-`

`Add()`, `randUniform()`, and `randNormal()` methods. There are also functions for printing matrices to C++ iostreams, ASCII files, and binary files. The program can read back matrices in any of these formats.

M++ includes just about every mathematical function you're likely to have heard of. But if that's not enough, there are generalized inner and outer functions, row iterators, and other functions that can apply user-supplied functions to elements in various ways.

Naturally, elements can be accessed. You have a choice of bounds-checking or no bounds-checking on a global level. Besides accessing a single element (with `operator()`), you can access subarrays. You can, for example, take just the first and last columns and treat that as a two-column array.

For using M++ in analyses, there are handy little functions such as `solve()`, which solves simultaneous linear equations. If you have to do several linear equations with the same coefficients, you can speed things up by using an LU-decomp class. The only thing I could think of that was missing from the package was the handling of eigenvalues.

One strange feature of M++ is the copy constructor. It makes a shallow copy by aliasing the actual data of the matrix. The manual points out that this feature is somewhat dangerous to use. On the other hand, the Assignment feature simply makes a copy of the data. I wonder why the software was implemented this way.

The instructions explained how to set the INCLUDE and LIB environment variables (for use with Zortech C++) or the CFG file (for use with Turbo C++). There is a simple test program that creates and prints a matrix; it did not compile on the first try. Zortech's linker was smart enough to explain that I had compiled the sample in small model, and the library was in large model. Dyad Software should have supplied a one-line batch file to compile the example (or serve as a typical example of the command line to use).

M++ 2.0 is a highly specialized library. It works very well for those who need special arithmetic. In addition, those who do numerical analysis or statistics may find C++ a better choice than other languages because of this library.

Tools.h++

Rogue Wave's Tools.h++ ($200) contains not one but two sets of collection classes. One is similar to Smalltalk, but with some noticeable differences. The classes lack a single root, and there is no object class. Anything that is derived from the Collectible class can be stored in one of the collection classes. The idea is to take a class that already exists and add Collectible to it to create a new class when needed. For example, there are a String class and a CollectibleString class; they are derived from both the String and Collectible classes. A small section in the manual adequately discusses the design issues and why the design is done this way.

There is also a set of `typedef`s that give some of the classes Smalltalk-type names. For example, a binary tree class becomes known as SortedCollection. You can change the `typedef` associations to suit your preference.

A second set of collection classes is based on the generic macros. They create new classes as needed to hold different data. It is a fairly complete set of classes that includes vectors, linked lists, and queues.

The documentation does not provide a summary of the library's contents, but browsing through the reference guide turned up a few interesting items. Class BTreeOnDisk is a B-tree index manager. It can be used with other classes in the library as an efficient indexed file system. The RWDate class provides Julian date manipulation.

The manual gives details on how to use the library for each supported compiler, showing which compiler switches are used. The only thing you need to do is point the compiler at the include files and choose the correct library during linking. A number of sample programs are given; among them are make files for both the Borland and Zortech compilers. Everything worked on the first try.

The Tools.h++ library is clean and easy to use. The collection classes fit well into existing code and don't take over a program.

Zinc Interface Library

Zinc Software's Zinc Interface Library ($199.95) is a library for developing the user interface of a program. It supports windows that can be moved and resized, and it sports pull-down menus and dialog boxes. What is interesting is that the library can be used to make text-mode as well as graphics-mode programs. In fact, it makes programs that can run in both modes.

I found the supplied sample programs sluggish when running in graphics mode with a Hercules card. With a VGA card, performance was downright slow. One particularly annoying aspect is that when you move or resize a window, mouse operations are much slower than normal. In text mode, however, the performance is very good.

My first impression while using Zinc Interface Library was that it should operate the same way Windows or other GUI systems (e.g., GEM, the Amiga, and the Mac) do, so I found it difficult to use at first. My presuppositions got in the way. The program will actually be very easy to understand for users who don't know anything about GUIs.

You can create a window, but there are no rendering functions. Instead of drawing something on a window (e.g., in response to a redraw message of some kind), the window is filled with window objects. Thus, you don't draw a string on

COMPANY INFORMATION

CNS, Inc.
(C++/Views)
Software Products Dept.
7090 Shady Oak Rd.
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(612) 944-0170
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(M++ 2.0)
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(Financial MathLib++)
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fax: (214) 248-7830
Inquiry 1062.

Rogue Wave
(Tools.h++)
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Zinc Software, Inc.
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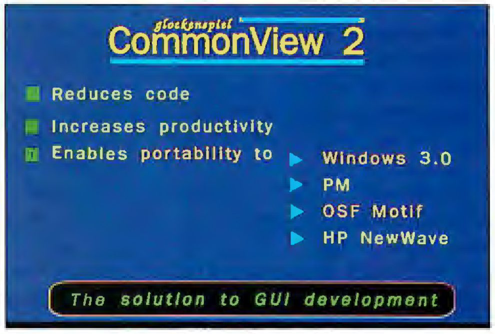

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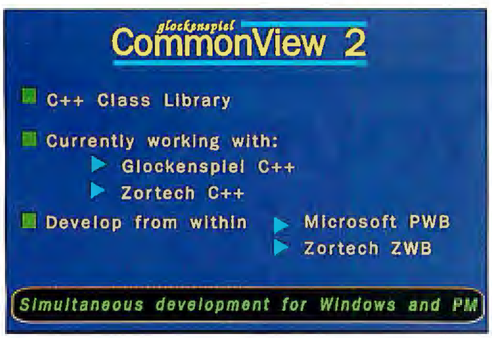

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a window, but create a string object and stick it on the window. Then you can forget about it.

Interestingly, there are no graphics functions. The only graphics are icons, which you stick on windows. I called Zinc Software technical support and described an application I was trying to write that contained a window with a graph on it. I was quickly routed to someone who was an expert in that area, and he straightened out my conceptual problems and referred me to a file on the Zinc BBS that demonstrated what I was trying to do.

From the company's BBS, I downloaded a program that did graphics by creating new window-object types for lines, circles, and such. However, Zinc Interface Library had to create a new device type (derived from the normal one) to handle it. There was no redraw function in the window-object class; rather, the device class had a giant `case` statement in it to draw each window object.

Zinc is not a general-purpose graphics library; it is meant for forms, menus, and dialog boxes only. It is fairly easy to use and can be customized (although creating a table with palette or event codes in it is easy in principle but tedious in practice). But it doesn't do anything else, and it is rather difficult to extend. It is possible to add your own editing fields and other types to the window-object classes, but there are no instructions for these operations in the manual.

After creating a window, you stick all the fields and buttons and such on it. There are objects that enhance the window (adding the border, title, and maximize, minimize, and system buttons) and the menu. Other window objects let you place text, icons, and editing fields on the window. Once the window is all set up, there is nothing more for your program to do; the Zinc event manager takes care of everything. You can have the results of your editing stay in the field objects until you check their new values, or have your program's variables automatically updated when the user modifies the objects associated with them.

In addition to the windowing support and the event manager, there is support for context-sensitive help and error reporting. A utility lets you build help files, and various window objects can have associated help messages. The error system lets you activate your own code and actions when run-time errors occur within the library. This feature lets you have a uniform approach to all errors and integrate Zinc Interface Library's errors into the methods you use to handle errors in the rest of your program.

The documentation is fairly helpful. The theory and architecture is explained first, followed by a series of sample programs. For more information, a technical reference and more sample programs are included. However, only the public interface is documented. How to extend the library (the protected interface) is not covered. You can download other examples covering more advanced items from the company's BBS, but there is no documentation to go with them.

Zinc Interface Library is comparatively easy to use. However, you should make sure you know just what it is before buying it, or you could be disappointed. My only other criticism is that the library uses too much text in ALL CAPS and could benefit greatly from default parameters.

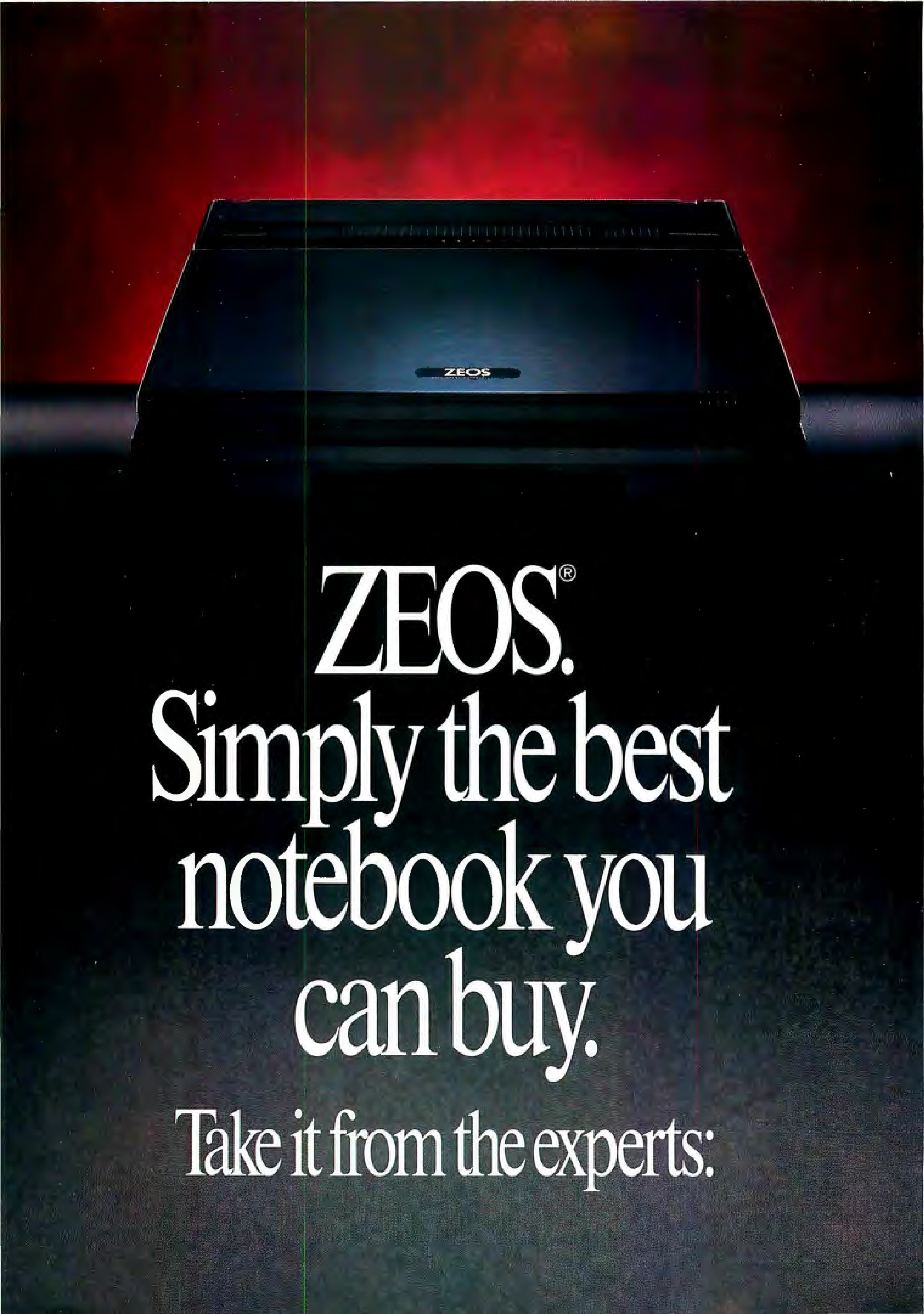
A New Frontier

Proponents have long insisted that object-oriented technology is naturally suited for certain tasks, and the libraries reviewed here offer a glimpse of the success achieved thus far. Things look good for object-oriented programming, but there is still a long way to go. Programming interfaces for operating systems and standard GUIs would benefit greatly from OOP wrappers, but very little of that has been done yet (at least in DOS). Until a programmer can write an entire application in C++—I/O and all—there will continue to be resistance. But promising solutions are just around the corner.

By far, the greatest competition that OOP languages and libraries face is not one another, but conventional languages such as C. Wooing programmers away from their familiar environments and into the turbulent world of C++ is a difficult task, but these stoic vendors deserve credit for being among the first to risk their capital on a foray into the fledgling C++-class library market. Users, programmers, and these vendors' present and future competitors will all be watching their progress carefully. ■

John M. Dlugosz is a programmer, writer, and consultant based in Plano, Texas. He can be reached on BIX as "jdlugosz."

Circle 131 on Reader Service Card (RESELLERS: 132)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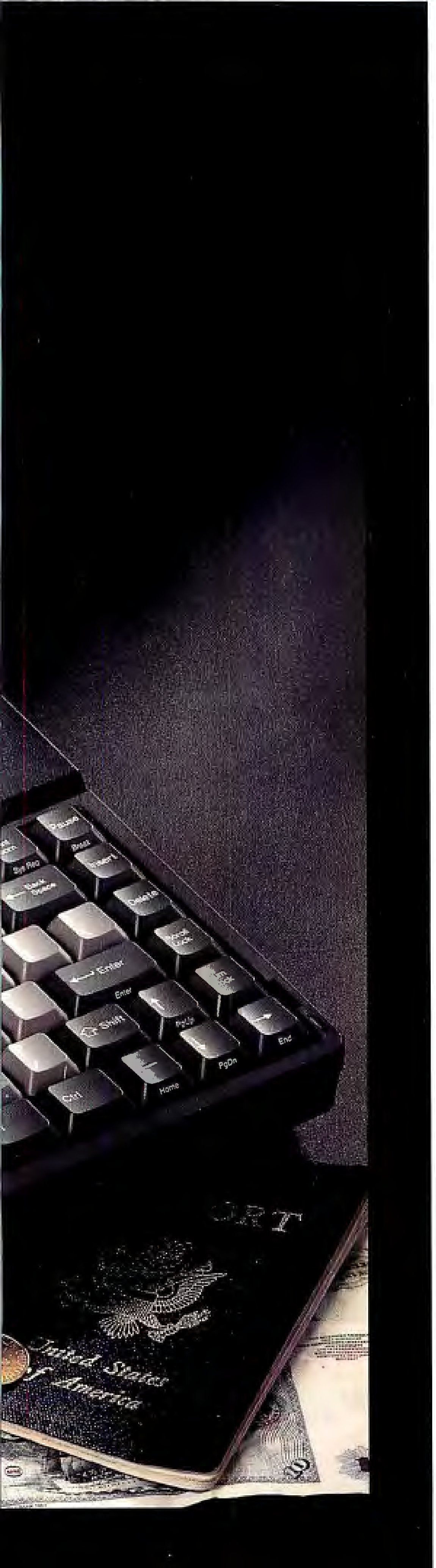

ZEOS NOTEBOOK

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"THERE'S A NEW KING OF THE HILL"
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"King of the Hill... Impressive... The best price-performer... An outstanding value... A steal... The number one contender..." We couldn't have said it better ourselves. The experts love the new ZEOS Notebook. And you will too. At only $1995 for our '286 version and $2295 for our new 386SX, you simply can't find a better notebook anywhere!

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While most notebooks don't include a floppy drive at all, you're really going to appreciate your ZEOS notebook's industry standard 3.5" floppy. It makes loading software and transferring files a breeze. Simply toss in your 1.44 and it's done. Anyway, can you imagine a desktop system without a floppy? We couldn't either. That's why your ZEOS notebook has one. It's great!

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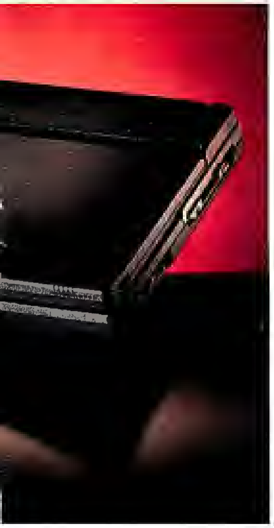

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Tom Yager

REVIEW

The Littlest SPARC

Photo 1: *The Sparcstation IPC's tiny case is just large enough to hold up to 24 MB of RAM, one 3½-inch SCSI hard disk drive, one floppy disk drive, and two SBus expansion cards. The taller case is the expansion unit, housing a SCSI hard disk drive and a tape drive.*

A colleague of mine recently quipped that the trend toward miniaturization of systems would result in a workstation contained in a mouse. That's a laughable concept, but the Sun Sparcstation IPC is an obvious embodiment of that same "smaller is better" spirit. Sun has crammed a complete workstation into a trademark-beige case roughly 4¾ by 9½ by 10½ inches (see photo 1). And when I say *crammed*, I mean it.

Fill 'er Up

The IPC that I reviewed arrived almost fully loaded: 24 megabytes of memory, 207 MB of internal hard disk storage, two serial ports, a thick Ethernet port, an external SCSI connector, an audio I/O connector, a color frame-buffer board, SunOS 4.1, and OpenWindows. The only internal expansion option left was a single SBus slot. This configuration will run you $13,495, but the base machine with 8 MB of RAM, a 207-MB hard disk drive, operating-system software, and a 17-inch monochrome monitor comes in at just $7995.

As photo 2 shows, Sun has packed components into the IPC. The lid snaps to the top of the unit, secured by a single screw. This is no ordinary lid, however: It's lined from stem to stern with components. Sun fastened the hard and floppy disk drives, fan, and power supply to it. The IPC's designers thoughtfully made the cables attaching the top and bottom halves long enough to permit the opened assembly to lie flat for inspection or alteration.

Internally, there's room for only one 3½-inch SCSI hard disk drive. With storage densities on the rise, that won't be a limiting factor for long. The standard 207-MB internal hard disk drive has enough room to hold all of SunOS 4.1 and OpenWindows. That will get you started, but you'll want to hook up another hard disk drive for applications and data files. Externally, the sky's the limit. The SCSI port on the back of the machine supports expansion devices such as Sun's combined disk/tape subsystem (the taller box in photo 1). Another option is to network to one or more Network File System– or Remote File System–based file servers.

I applaud Sun's ingenuity in designing a box that takes up practically no space on a desk, but I wonder if anyone needs something so small. The keyboard dwarfs the system unit, and the base of the 16-inch Sony Trinitron monitor is larger than the IPC—it hangs over on all sides. I would rather have had room for another internal drive or more than 24 MB of memory.

The rest of the hardware is what I've come to expect from Sun. The keyboard and mouse both operate smoothly (although some BYTE editors see the optical mouse, which requires a stiff plastic pad, as a throwback to the Dark Ages). The Sony monitor's clarity and color accuracy enhance every graphical user interface (GUI) the monitor displays. The front-mounted 3½-inch floppy disk drive is a high-density model with motorized eject—a nice touch. Using SoftPC from Insignia Solutions (not included with the IPC), I copied DOS files to and from the floppy disk drive and ran DOS applications on a software-emulated 286.

Through OpenWindows

I wrote at some length in the Sparcstation 2 First Impression (see "Son of SPARCstation," December 1990 BYTE) about the beauty of Sun's SunOS 4.1 and OpenWindows 2.0. I had more time with it on the IPC, and Sun's software has earned my respect.

OpenWindows is an application environment that allows X Window System, Open Look, SunView, and News (and, optionally, DOS) programs to share a single display. News blends the flexibility of PostScript with the portability of X Window 11.4, making scalable fonts and graphics available to developers.

SunOS 4.1, whose engine purrs beneath OpenWindows, is also something of a melting pot. Sun has positioned it as a stepping-stone to Unix System V release 4. SunOS is now compatible with System V, as well as with POSIX 1003.1 and X/Open XPG2 specifications (both are based mostly on the System V Interface Definition). Separate directories contain commands whose behavior is specific to one of the supported flavors of Unix.

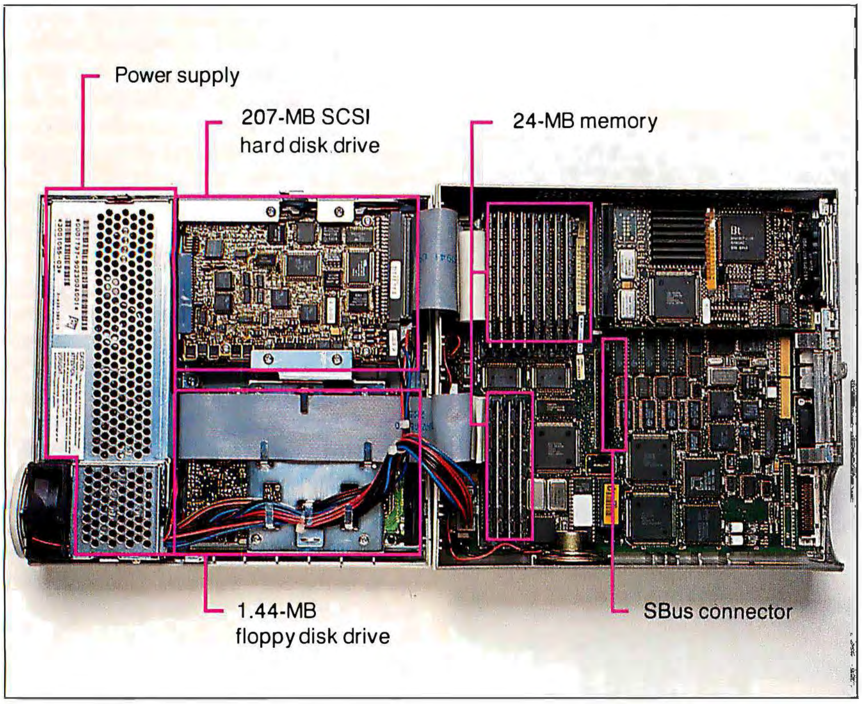

Photo 2: *The interior of the Sparcstation IPC shows just how much Sun has packed into this tiny box.*

Sun Sparcstation IPC

Company
Sun Microsystems, Inc.
2550 Garcia Ave.
Mountain View, CA 94043
(415) 960-1300
fax: (415) 969-9131

Sun Microsystems Europe, Inc.
Bagshot Manor, Green Lane
Bagshot, Surrey GU19 5NL, U.K.
44-0276-51440

Components (as reviewed)
Processor: 25-MHz SPARC
Memory: 24 MB of RAM
Mass storage: 207-MB SCSI hard disk drive; 3½-inch 1.44-MB floppy disk drive
Expansion: Two SBus slots
Display: 1152 by 900 pixels, 256 colors; 16-inch Sony Trinitron color display
Keyboard: Sun-standard 107-key with optical mouse connector
I/O Interfaces: SCSI, thick Ethernet, audio I/O, and dual serial ports

Price
$13,495

Inquiry 1228.

You select your favorites by placing the appropriate directories in your shell's PATH variable. They all coexist, so if you want the System V behavior of `ls` but BSD Unix behavior for `ps`, you can arrange it. Existing Sun users are probably most accustomed to SunOS's BSD seasonings, but Sun's cooperation with AT&T in System V.4 development has resulted in a significant shift in focus.

The cross-environment compatibility simultaneously is and isn't all that it's cracked up to be. Can you execute X, SunView, and News/PostScript code on a single display? Yes, but there are a few "gotchas." One SunView application I tested, Island Graphics' Write, Draw & Paint, had trouble manipulating the mouse cursor. Moving it from the SunView window to an X window sometimes caused a phantom pointer to remain frozen in the SunView window. One SunView dialog box also had a small rectangle missing, through which the X root window was visible. Moving it, forcing a screen refresh, and iconifying and deiconifying it all had no effect.

The other dent in OpenWindows relates to its handling of fonts. Technically, there's nothing that should keep you from being able to run OpenWindows applications on an X terminal or other display of your choice. The Open Look implementation on System V.4 stores the needed fonts and bit maps in a format that allows X terminals and remote X servers to share them.

On the other hand, OpenWindows fonts are *not* in a shareable format. It took me an hour to figure out how to convert the OpenWindows cursor and glyph fonts and load them into the BYTE Lab's Altos System 5000 (running The Santa Cruz Operation's Open Desktop). I got them converted (Sun provides a `convertfont` utility) but had to build the needed `fonts.dir` font table file by hand. After all this effort, I was able to get an Open Look window manager session running on Open Desktop. This was good for amazing some BYTE editors (Open Desktop is OSF/Motif-based) but not much more; no OpenWindows applications would run. To manage that, I would have had to translate dozens more fonts, hand-tool a lengthy font directory entry for each of them, and fill holes in the color database.

What makes X Window so special is its effortless cross-platform global application environment. Sun should supply a directory with the needed font and bitmap files, translated for standard X servers and accompanied by a `fonts.dir` font database and an `rgb.txt` color database. X terminals and other servers could then mount this directory remotely, point the X server at it, and get running with minimal hassle.

Coming the other way, OpenWindows is flawless; any X application that you can run, even those that include OSF/Motif interface elements, runs on the X11/News server in OpenWindows. It includes the entire set of X11.4 fonts, a few extra ones, and even some that allow DECwindows applications to display on Sun screens (Sun has its own DECnet-compatible network software that makes connections to Ultrix and VMS systems).

A Likable Development

Sure, the IPC is a cute little box, but can you do any *real* work with it? In this business, that's often codespeak for "what's it like to develop on?" To find the answer, I donned my developer's cap and went straight to work.

The BYTE Unix benchmarks compiled the first time without errors. That's not much of a feat, since we wrote them as generically as possible. To toss the system a curve, I chose a fairly complex X application: the superbly written `xv` X Window GIF file viewer. This application makes heavy demands at both compile and run time. I had to change the `make` file to look for the X libraries and header files in different directories. Convention dictates that they will be in `/usr/lib/X11` and `/usr/include/X11`, respectively. On the IPC that I tested, Sun

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286 processing in a computer that's notebook size, 1.4″ thin and 4.4 lbs. light.

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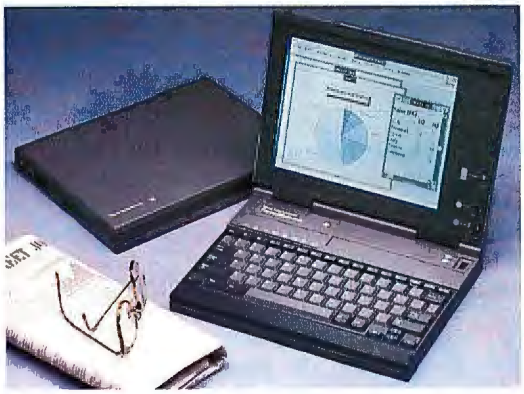
This sleek, 4.4-lb. notebook computer gives you the power of a PC-AT® in an ultrathin 8½″ x 11″ package. It's designed to fit your workstyle — wherever you work — in the office, at home or on the road. Just slip it in your briefcase with your file folders, journals and other business materials, and you're ready to go.



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You'll appreciate the technology behind the 10″ diagonal VGA display. It's a remarkable feature for a computer that's notebook size. The high-resolution 640 x 480 supertwist screen easily handles demanding windowing and graphics applications.

More features to meet your application needs.

The TM 2000 has the power to run your favorite software — 12 MHz 80C286 processor, 20MB hard disk drive and 1MB of RAM. A built-in, rechargeable battery lets you work up to two hours. With an optional add-on battery, you can work up to five hours — enough for coast-to-coast flights.

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In addition, we've loaded MS-DOS® and LapLink™ in ROM, and preformatted the hard disk.

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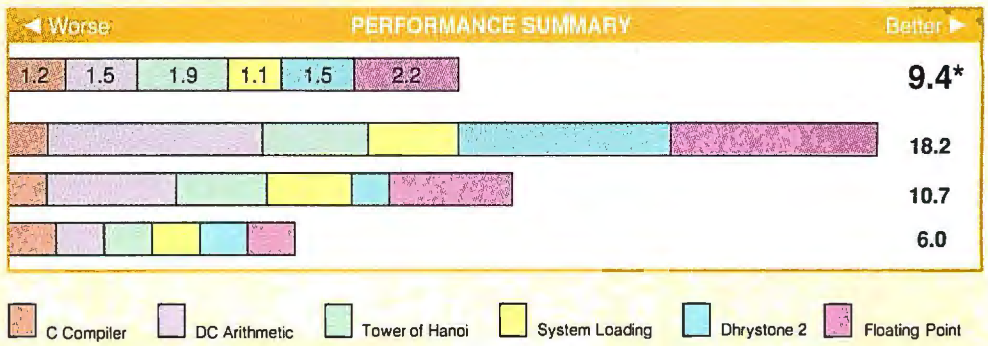
TEXAS INSTRUMENTS

UNIX BENCHMARKS



HIGH-LEVEL PERFORMANCE

	Time	Index
* **C Compiler**	1.73	1.20
* **DC Arithmetic**	0.42	1.50
* **Tower of Hanoi** (17-disk problem)	0.30	1.87
System Loading[1]		
1 concurrent background process	3.37	1.20
2 concurrent background processes	4.83	1.20
4 concurrent background processes	8.13	1.18
* 8 concurrent background processes	15.40	1.12

LOW-LEVEL PERFORMANCE

	Time	Index
* **Dhrystone 2** (without registers; Dhry./sec.)	21304	1.54
Arithmetic (10,000 iterations)		
Arithmetic overhead	0.18	4.00
Register	3.90	0.75
Short	4.20	0.84
Integer	3.90	0.80
Long	3.90	0.80
* Floating Point	5.40	2.21
Double	3.97	3.33

	Time	Index
Throughput		
System call overhead (5 x 4000 calls)	0.80	1.38
Pipe throughput (read and write 2048- x 512-byte blocks)	0.80	1.15
Pipe-based context switching (2 x 500 switches)	0.40	1.57
Process creation (100 forks)	2.20	0.56
Execl throughput (100 execs)	4.90	0.70
Filesystem throughput (10-second test in Kbytes/sec.)		
Read	281	N/A
Write	280	N/A
Copy	265	N/A

* Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with 8 concurrent background processes), Dhrystone 2, and Floating Point tests.

[1] System loading was performed using Bourne shell scripts and Unix utilities.

Note: All times are in seconds unless otherwise specified. Figures were generated using the BYTE Unix benchmarks version 2.6. Indexes show relative performance; for all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1. N/A = Not applicable. For a description of all the benchmarks, see "The BYTE Unix Benchmarks," March 1990 BYTE.

had installed them in a tree under /home/openwin. I could have built a symbolic link to make the directories appear where the make file expected them, but it was easier to change the make file.

A few minutes later, without any grumbling, the compiler kicked out a 147K-byte xv program. 147K? That same program occupied over 400K bytes when compiled under Interactive Unix. I thought something was wrong, but xv loaded and executed when asked. Ah, the wonder of dynamic binding. As for the execution, xv performed perfectly. Its complex manhandlings of the X toolkit all did what they were supposed to do.

Another test involved working up a short Open Look example. Again, Sun's directory assignments don't match those discussed in the System V.4 documentation, but all the libraries and header files are there. This application gave me a bit of trouble (which I created), but I used Sun's dbxtool graphical debugger to track it down. This is part of Sun's Desk Set productivity tools, and it works nicely. In simplest terms, it's an Open Look GUI that feeds textual commands to the dbx debugger. Just having dbx available (as opposed to System V's sdb) is reward enough, but the graphical interface makes it a snap. I used the mouse to set a breakpoint, start the program, and step through to the trouble area. It took me no more than 5 minutes to learn the debugger and isolate the problem. *That's* user-friendly.

If you want to talk about developer-friendly, you have to look at a tool that Sun ships standard with the developer's release of OpenWindows: the Graphical User Interface Design Editor. GUIDE is a simple OpenWindows interactive design tool; you draw the graphical interface you want, and GUIDE spits out an intermediate file. You then run that file through either gxv or gxv++ to produce C or C++ output.

Working with GUIDE couldn't be easier. The C code that gxv produces is split into two parts: One contains the nitty-gritty interface code (which you don't usually want to edit), and another contains the *stubs*—skeletal routines that set up handlers for interface objects. You edit the stubs file to make the objects behave the way you want and then compile the whole thing using the make file that gxv creates. What a breeze. The gxv_merge program eases the task of adding new objects to your interface. It blends your custom code into a newly generated stubs file. And gxv supplies default stubs that let you compile and test your interface (you also can test it from within the interface builder). All objects are active,

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TEXAS INSTRUMENTS

but they just display messages on the standard output when activated.

When I said that GUIDE is simple, I meant it as a compliment. However, while it's easy to use, it's also somewhat limited. Some important elements, such as frames around groups of objects, are missing entirely. Adding such things involves editing the "forbidden" interface code, and you'll lose those changes when you use GUIDE and trigger a C code regeneration.

However, these problems are not unique to GUIDE; managing user-supplied changes is the bane of any interface design tool. If you recognize its limitations, GUIDE is a helpful tool. It might not be as useful to developers of commercial applications as it is to in-house developers and others who need to build tools that help inexperienced users. [Note: *GUIDE's name has been changed to Developer's Guide, a name more fitting for a manual than for a programmer's tool.*]

Can I Have One?

It's hard to work with the IPC for any length of time without becoming attached to it. The size of the box—supposedly one of its strongest selling points—is meaningless to me. What I saw was an inexpensive color workstation that blew me away. Whether I wore my user's, developer's, or reviewer's hat, I found myself wrapped in an environment that I was loath to leave.

Sun has positioned the IPC well against other workstations and priced it so that its main competition is high-end PCs. The IPC's 25-MHz SPARC processor compares well with a 33-MHz i486 (see the benchmark table), although the i486 has a slight floating-point edge.

Performance aside, by the time you buy everything you need to support Unix and color graphics on an i486-based PC, you've spent at least as much as you would on the IPC, and the robustness of the operating-system and GUI software is nowhere near that of SunOS and OpenWindows. Even though this software is proprietary, both the operating-system and GUI components adhere to so many open standards that this issue is moot.

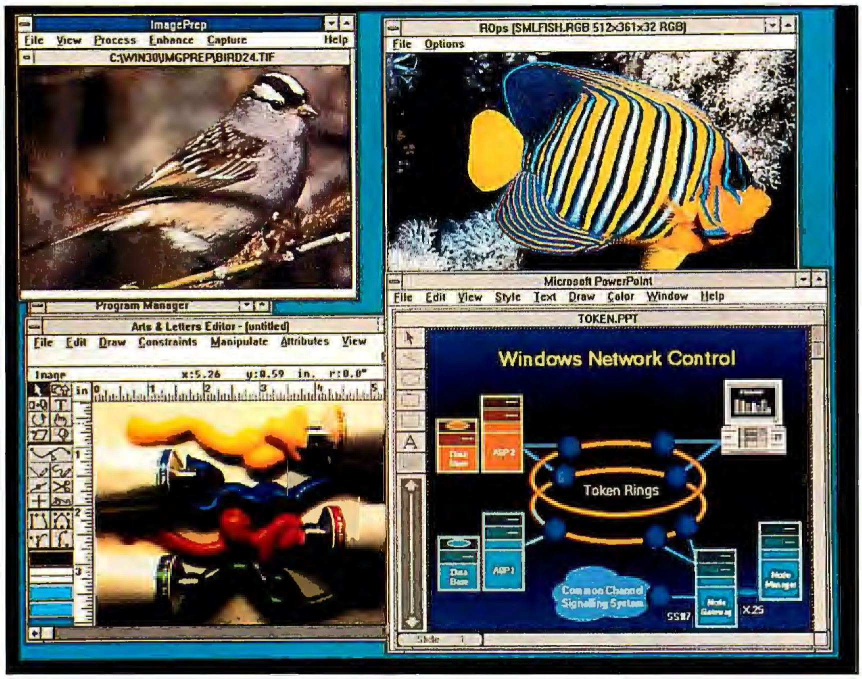
The IPC, and the similarly priced SPARC clones that will follow it, might place SPARC as a Unix commodity, a position that even Intel would envy. I can't imagine spending $10,000 on any single-processor 386 or 486 system now that the IPC is here. ■

Tom Yager is a technical editor for the BYTE Lab. You can reach him on BIX as "tyager."

Greg Loveria

REVIEW

PS/2 Blues Disappear with First 16.7-Million-Color MCA Adapter



I produced this image using the 1024MC Colorboard and a PS/2 Model 70 386 running Windows 3.0. Arts & Letters design and layout software imported the scanned 24-bit color TIFF image of an artist's oil paints. Microsoft's PowerPoint provided the network layout image. Finally, ImagePrep, which comes bundled with the Colorboard, imported a scanned 24-bit TIFF image of the small bird. I then used ImagePrep to capture the entire 24-bit, 1024- by 768-pixel display in ColorLab Processed Image (CPI) and TARGA (TGA) file formats for transmission to a slide service bureau. (Images courtesy of RasterOps, Computer Support, Microsoft, and Computer Presentations. Slide conversion courtesy of Image Center.)

When IBM wanted to develop a 24-bit color display board for its Micro Channel architecture computers, it approached RasterOps, a leader in Macintosh-based 24-bit display technology. This overture produced a business partnership and RasterOps' new 1024MC Colorboard, the first 24-bit color adapter to use the PS/2s' Micro Channel bus.

The Colorboard, although a bit pricey at $4395, solves an old problem. Previously, design firms or graphic artists requiring 24-bit color (a must for photographic imaging or color prepress work) had to use a Macintosh or an ISA-bus machine equipped with a raster graphics adapter, such as Truevision's Targa series. With the Colorboard, previously "blue" PS/2 owners can now display 16.7 million colors on any standard multiscanning Super VGA monitor.

The Colorboard supports Windows 3.0–based 24-bit display applications and OS/2 Presentation Manager (PM)—although at press time RasterOps could not supply final OS/2 software drivers, so those were not tested. ImagePrep ($295 from Computer Presentations), a 24-bit Windows 3.0 image-processing, conversion, and compression program, comes bundled with the unit.

I tested the Colorboard in two different PS/2 Micro Channel machines: a 16-MHz Model 55 SX with 2 megabytes of extended memory, and a 25-MHz 386 Model 70 with 8 MB of extended memory and an Intel 80387/25 math coprocessor. Both systems ran DOS 3.3.

I soon found that operating Windows 3.0 on the 16-MHz Model 55 SX was just too slow and cumbersome. Some windows, such as Program Manager, took a full 5 to 10 seconds to open. With the board installed in the faster Model 70 system, Windows 3.0 operations fared better, but it was still slower than running Windows 2.11 on my 386/25 ISA system in a 24-bit Texas Instruments Graphics Architecture (TIGA) environment. But despite this sluggishness, the Colorboard/Windows 3.0 environment is still functional, and the 24-bit color at the 1024- by 768-pixel Super VGA resolution is nothing but inspiring.

Space-Saving PALs

The full-length, 16-bit Colorboard provides VGA pass-through for a one-monitor solution. The pass-through monitor must be a multiscanning display capable of 1024- by 768-pixel Super VGA resolutions. (A PS/2's standard on-board VGA circuitry, using IBM's mainstream 8512 or 8513 monitor, can only display 640 by 480 pixels by 16 colors or 320 by 200 pixels by 256 colors.) I used a Relisys RE1520 auto-switching Super VGA monitor to test the adapter and its VGA pass-through functions.

The Colorboard is essentially a frame buffer with 3 MB of on-board video RAM: It has no on-board graphics processor. The board carries six proprietary RasterOps chips—three 2400-0004 application-specific ICs and three programmable-array-logic (PAL) chips—to downscale the major 24-bit display component circuitry.

The PAL chips work with the board's software drivers to control video RAM and VGA bus I/O, capture, and pass-through functions. Unlike a TIGA display adapter's software/hardware interface, PAL chips cannot be updated with new driver software improvements.

In standard VGA pass-through mode, the Colorboard captures as graphics in VRAM the PS/2's 31.5-kHz VGA output signal (including text). The board does this via the PS/2's Micro Channel bus. It then converts the PS/2 VGA signal into a 48-kHz signal for redisplay by the Colorboard at its 1024- by 768-pixel noninterlaced Super VGA resolution. Unlike a Targa board, the Colorboard doesn't have video or scanner input connections. You must use a separate scanner or video camera I/O board to generate images.

Flawless RGB

I installed RasterOps' Windows 3.0 software driver, 1024.EXE, in my AUTOEXEC.BAT file, which, after I rebooted, switched the adapter and multiscanning monitor into 1024- by 768-pixel by 24-bit color mode. Three flawless red, green, and blue 24-bit color gradations filled the screen as a board self-test.

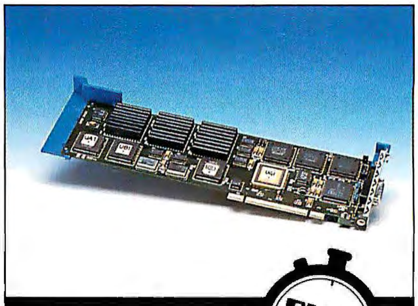
At the DOS C > prompt, the VGA text pass-through at the 1024- by 768-pixel resolution was legible, but it was constricted to a 4- by 5-inch box on the 16-inch screen. I didn't find any mention of this in the manual, but RasterOps' technical support provided a quick solution: Enter the command 1024 MULTI at the DOS prompt to switch the board back to full PS/2 VGA pass-through display at 640 by 480 pixels by 16 colors at 31.5 kHz. I invoked this command for full-screen DOS operation of non-Windows applications, such as XTreePro Gold and WordPerfect 5.0.

CorelDraw 1.2 standard CDR drawings take on a whole new dimension of color with the board. However, in CorelDraw, color TIFFs are not viewable but simply represented as an outlined bit-map object. But using Computer Support's Arts & Letters design software, I could import, rescale, rotate, and view color 24-bit TIFF and bit-map images.

Since I couldn't run OS/2 or PM, I used Microsoft's PowerPoint to generate a 24-bit color slide show. I was impressed with ImagePrep's slick management of TGA, PCX, GIF, and BMP files, as well as its image-file cross conversions, true-color display, and 1024- by 768-pixel, full-screen, 24-bit capture capabilities (see the photo).

With the Colorboard in the 386 Model 70 running Windows 3.0, I simultaneously opened multiple 24-bit display windows at the 1024- by 768-pixel Super VGA resolution. Starting at the lower left and working counterclockwise, I used Arts & Letters design and layout software and imported a scanned 24-bit color TIFF image of an artist's oil paints. I later maximized this window and output the image as a four-color separation via four Encapsulated PostScript image files as used in prepress and printing applications.

Next, I opened an 8-bit "network layout" image from a PowerPoint slide show. I imported a scanned 24-bit RGB image of a fish, scaled it (no pun intended), and displayed the image using ROPS.EXE, a RasterOps display/demo utility. Finally, I used ImagePrep to import a scanned 24-bit TIFF image of a small bird. With ImagePrep, via a single hot key, I screen-captured the entire 24-bit, 1024- by 768-pixel Windows 3.0 display in both ColorLab Processed Image (CPI) and TARGA (TGA) file formats for the final image.



BYTE LAB

1024MC Colorboard

Company
RasterOps Corp.
2500 Walsh Ave.
Santa Clara, CA 95051
(408) 562-4200
fax: (408) 562-4065

Hardware Needed
IBM PS/2 with 16-bit MicroChannel/VGA pass-through bus slot; 1024- by 768-pixel multiscanning monitor

Software Needed
Microsoft Windows 3.0

Price
$4395

Inquiry 1221.

Expanding MCA's Color Range

Although the speed of Windows 3.0 on the Colorboard is slow at present, I still feel confident enough to recommend it because of the board's beautifully crisp 24-bit display at Super VGA resolutions. An updated 1.1 version of the Windows 3.0 driver and a Colorboard with reprogrammed PAL chips should arrive by the time you read this. This should greatly enhance speeds for all machines across the PS/2 Micro Channel platform.

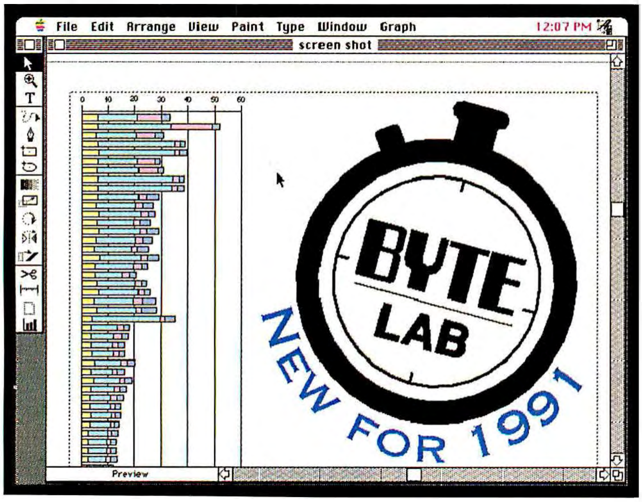
Designers and artists currently using a PS/2 Micro Channel system should consider the Colorboard as an alternative to purchasing a new system just to work in 24-bit color. Thanks to hardware like this and Windows 3.0-based software like PageMaker 4.0, Arts & Letters, and ImagePrep, professional publishing and imaging on the PC platform in true 24-bit color is really here. ■

Greg Loveria has worked with raster graphics imaging and display products for three years as a computer graphics and desktop publishing consultant, animator, and technical writer in Binghamton, New York. He can be reached on BIX c/o "editors."

Tom Thompson

REVIEW

An Artist's Old Tool Learns New Tricks



Adobe Illustrator 3.0's graphing tool plotted the BYTE Lab data in the stacked bar chart. The text for the watch logo demonstrates how Illustrator can wrap characters around a curve.

Adobe Illustrator, first introduced for the Macintosh in 1987, is an "object-based" drawing application, so called because it treats a drawing's components, such as curves, circles, and text, as geometric objects. Since the artwork is a set of mathematical objects, it reproduces accurately on high-resolution output devices such as laser printers or typesetters, a necessity for camera-ready work. Combined with a suitable high-resolution output device, Illustrator and the Mac made an unbeatable combination for professional graphics work. A later version, Illustrator 88, provided color support.

Unfortunately, for the last year or so, Illustrator 88 has been showing its age. It didn't take kindly to 32-Bit QuickDraw at first, although numerous minor revisions (up to version 1.9.5) helped eliminate most of the sporadic crashes. But Illustrator 88 still didn't display artwork in the direct 16- and 24-bit color modes: You had to accept a dithered 8-bit color approximation.

Also, while Illustrator 88 had flexible drawing tools, its text-handling capabilities were poor. Entering text in a drawing meant a circuitous trek through a dialog box where you keyed in the text string (no longer than 255 characters, please), selected its typeface, and then got plopped back into a drawing window. You could not fit text to a curve, and you could not kern the characters. This text problem was acute enough that many artists used Illustrator to sketch a drawing and then imported the drawing into Aldus FreeHand (a competing object-based drawing application) to add the text.

Adobe Illustrator 3.0

Company
Adobe Systems, Inc.
1585 Charleston Rd.
Mountain View, CA 94039
(415) 961-4400
fax: (415) 961-3769

Hardware Needed
Mac Plus or higher with 2 MB of RAM and a hard disk drive

Software Needed
System 6.0.3; Adobe Type Manager 2.0 (provided with Illustrator)

Price
$595

Inquiry 1000.

The Third Time's a Charm

Needless to say, Adobe Systems didn't let Illustrator languish too long. Illustrator 3.0 corrects the problems mentioned above while adding important new features.

First, Illustrator 3.0 works properly in the 32-Bit QuickDraw environment. This allows you to preview artwork in a 24-bit color window, giving you a better idea of how the artwork will appear in final form. Second, the bottom scroll bar on the drawing window displays a text prompt that informs you of the function of the selected tool. Additional prompts appear here to guide you through using the tool. It's a nice touch that helps both the novice and occasional user make the best of a complex drawing application.

Third, Illustrator makes a quantum leap in text handling. Text processing has its own menu now, whereas before it was just a choice in another menu. Gone also is the cumbersome dialog box: You can type text directly into the drawing window. You can have the text wrap within an object (e.g., a circle) or around an object (perhaps a corporate logo within a block of advertising text). That latter example is important, because limits on text length are gone. You can actually flow large amounts of text into a drawing, wrapping text within hidden rectangles to lay out an entire ad page, and then add spiffy graphics as well.

You can also fit text along an arbitrary curve drawn with the Freehand tool. If you want the curve to be visible, you can specify an offset to displace the text above or below the curve. You can also generate outlines from text, which is useful for special effects. Note that Illustrator 3.0 requires Adobe Type Manager 2.0 (which is bundled with the program) to produce the outlines.

Charting a New Course

Also new to Illustrator 3.0 is a Graph tool. With it, you can whip out professional graphs and charts in no time. Clicking on the Graph tool opens a spreadsheet-style window where you can type in numbers and text. Alternatively, you can import tab-delimited ASCII text from a file. This input text file must be "clean"—that is, composed of ordered data. The first row and column must consist of text (for the graph's labels). After that, the rest can be numbers. If one axis of a graph is "years," you must precede the value (1989, perhaps) with a nonbreaking character (produced by pressing the Option key and space bar), or else Illustrator attempts to use the dates as graph data.

You have a choice of graphing styles: column (grouped or stacked), line, area, pie, and scatter. Illustrator creates the graph as a set of grouped objects, so you can easily scale the graph as a whole to fit, or change its colors. You can also assign complex graphical objects to the graph's bars. For example, using a single coin image, Illustrator can plot bars as stacks of coins in a graph that displays corporate profits. Be aware that such

graphing operations are slow and memory intensive: On a Mac IIci with 4 megabytes of RAM, Illustrator couldn't plot such a chart in its 2-MB MultiFinder partition. I had reboot the Mac under the Finder, giving Illustrator about 3 MB of memory to complete the graph.

Field Test

Illustrator 3.0 runs on a Mac Plus or higher with 2 MB of RAM and a hard disk drive. I tried it out on a Mac IIci equipped with 4 MB of RAM, a 80-MB hard disk drive, and a SuperMac Spectrum/24 PDQ display board and monitor; a Mac Plus with 2 MB of RAM and a Hard Drive 20; and a Mac Classic with 2 MB of RAM and a 40-MB hard disk drive. While Illustrator 3.0 does run on the 68000-based Macs, complicated designs seemingly take forever (several minutes) to load and preview. You can manage simple designs and layouts on these systems, however. On the Mac IIci, complex color blends and text operations went smoothly and rapidly. Drawings with intricate blends looked superb when viewed in the 24-bit direct mode on the SuperMac monitor.

Version 3.0 still has a few warts, unfortunately. While the Blend tool is easier to use than in the past, it still creates unsightly blobs composed of black lines in the drawing window. While you can use a Hide Selection menu choice to get these black masses out of the way, I wish Illustrator could implement the blends transparently. Nor can you edit the artwork in the preview mode: You must constantly flip between the artwork and preview mode to check out the result. Both features are well implemented in Aldus FreeHand 2.0, and I wish that Illustrator could handle them as elegantly.

Illustrator 3.0 is a major improvement. It eliminates the limitations in text and color handling that hampered Illustrator 88. Now, graphic designers can create *entire* ad pages, complete with the text, within Illustrator. The Graph tool will have artists who do the charts for magazines and corporate reports doing handstands: Now the graphs can be done in record time, and they're typesetter-ready to boot.

For those who already own Illustrator, it's definitely time to upgrade. For those who are looking for a versatile drawing application that can tackle both text and graphs, as well as artwork, Illustrator 3.0 is a excellent choice. ■

Tom Thompson is a BYTE senior editor at large. You can reach him on BIX as "tom_thompson."

Rkjfs jdu kop qeiot ksi tcew tsot deg uf orjln.

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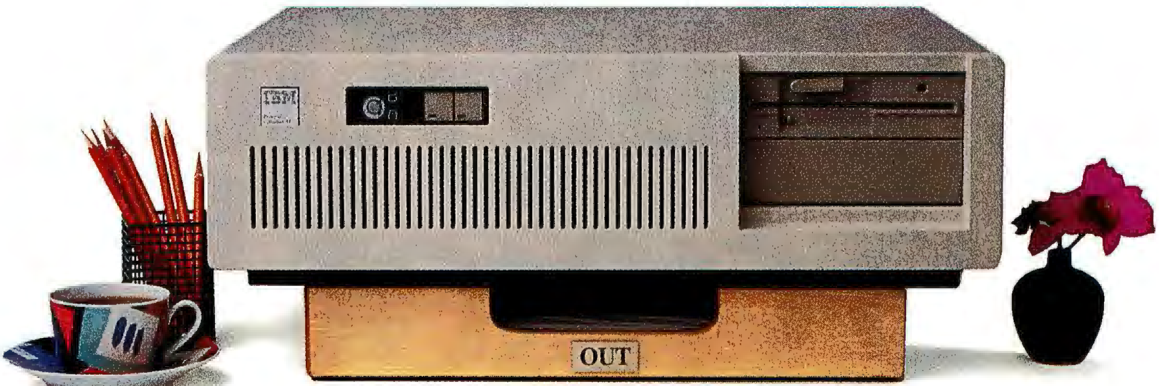

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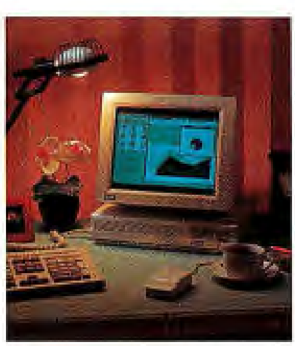

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FALCO

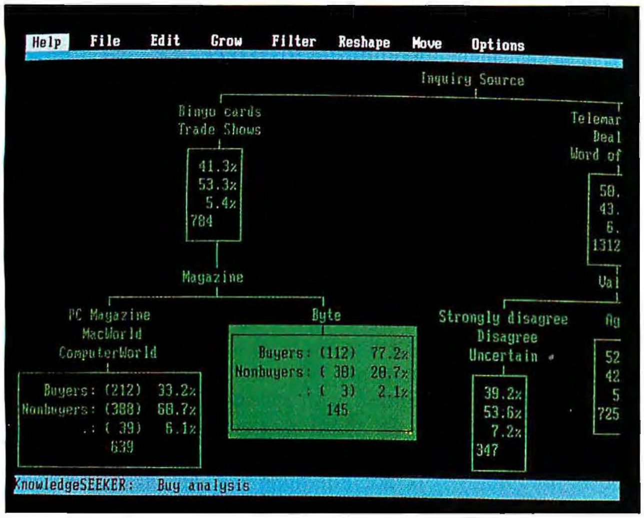
440 Potrero Avenue, Sunnyvale, CA 94086-4117

Circle 82 on Reader Service Card

Minna Levine

REVIEW

Statistical Analysis for the Executive



KnowledgeSeeker creates a tree structure of your database that depicts the major statistical splits it found using X² *and F-tests.*

Every executive is involved in an endless quest for a magic formula to locate buyers for products. Some can afford to try to lure buyers with media ads, direct mail pieces, and troubadours at trade shows. Others must rely on dealers and hearsay. All these executives could easily fall under the spell of a sorcerer who could conjure up an image of potential buyers hidden in the marketplace.

KnowledgeSeeker is such a sorcerer. This package for IBM PC compatibles promises to reveal the secrets that are buried in your customer data and other places. Like any sorcerer, KnowledgeSeeker does its work behind screens and with a "black box." But unlike a sorcerer, it achieves its effects not through mystical means but through statistical ones. You give it some basic descriptive data about individuals or institutions, and it identifies the most telling characteristics that distinguish the buyers from the nonbuyers.

For example, suppose you have a database of customer contacts that includes the source of the contact (e.g., telemarketing, "bingo" cards, or trade shows), the products of interest, the customer's identity (i.e., company and position), whether a purchase was made, and follow-up queries about the decision process. KnowledgeSeeker can take this database and, with a few key presses or mouse-clicks, produce a screen diagram classifying buyers and nonbuyers by the characteristics in the database that most differentiate them.

Like all true wizardry, this package has wide application; it's not confined to just business applications and market research. It can help medical researchers determine which presenting symptoms are most likely to lead to a serious illness and which patients benefit from which therapies. Engineers can use it to explore signal detection algorithms. Policymakers can delineate subgroups for whom to target programs.

Statistical Intelligence

What distinguishes the statistical procedures in KnowledgeSeeker? The basic features are similar to those found in other statistical packages: KnowledgeSeeker identifies differences in a key behavior among segments of the database, and it then uses one of two common statistical procedures to test the significance of the differences—X^2 tests of independence of pairs of categorical variables, and F-tests of differences between means of continuous variables for subgroups. KnowledgeSeeker differs from other packages in its degree of user involvement in applying the statistical tests, its method of applying the statistical procedures to the data, and its pictorial representation of the results in a tree diagram (see the photo).

The diagram depicts the total sample as a tree trunk. More detailed samples with distinctive patterns of the behavior of interest (e.g., buying behavior) appear as branches. To develop the tree, KnowledgeSeeker searches through tests of each database characteristic's impact on the behavior variable. It finds the characteristic that is most statistically significant and uses this characteristic for the first split in the tree.

For example, suppose that 51 percent of those who got a recommendation from a dealer bought the product, in contrast to 41 percent of those who marked bingo cards. If this difference of 10 percent between inquiry source subgroups is more significant than the difference between buyers' percentages for company type (e.g., manufacturing or accounting companies), then the first branches of the tree will represent the inquiry source subgroups. Furthermore, if two source subgroups are not significantly different, but both of them differ from a third, KnowledgeSeeker combines the two similar subgroups into one branch of the tree.

KnowledgeSeeker then repeats this process. It tests the impact of the database characteristics on the behavior within each of the subgroups formed by the first splitting. The variable that leads to the best split at one node may not be the one that splits best at a second node. For example, the way to distinguish the buyers among bingo card respondents may be to know the magazine that contained the card. Of those contacted by telemarketing, however, the most distinctive characteristic of buyers may have been their rating of the product. The end result of these splits is a tree whose branches depict, for a quick inspection, market segments with varying probabilities of buying behavior.

The advantages of KnowledgeSeeker over other statistical packages are clear. Other packages require the analyst to sift

---

BYTE LAB

KnowledgeSeeker 2.0

Company
FirstMark Technologies, Ltd.
14 Concourse Gate, Suite 600
Ottawa, Ontario, Canada K2E 7S8
(800) 387-7335
(613) 723-8020
fax: (613) 723-8048

Hardware Needed
IBM XT, AT, PS/2, or compatible with 640K bytes of RAM and a hard disk drive

Software Needed
MS-DOS 3.2 or higher

Price
$495

Inquiry 1075.

through reams of reports and cross-tabulations. The analyst then has to consolidate similar segments using a multistep, manual process of recoding categories after evaluating the numbers or checking the contribution to X^2 for each cell in a table.

Splitting nodes is KnowledgeSeeker's automatic default method, but there are many more ways to explore the database. These options set the package apart from others that provide the tree techniques. For example, although the automatic mode may select the best splits at each node, KnowledgeSeeker lets you easily force particular splits at nodes by clicking on a node (with a mouse) and making a menu selection, so you can inquire about interactions among characteristics of concern.

In addition, although KnowledgeSeeker displays what it determines to be the best split, it also reports how many other splits at that node are statistically significant. With a menu selection, you can successively display each additional important split at a node. A split that statistically may be slightly less significant may be more important for your decision making.

Two other features in KnowledgeSeeker are rare in statistics software: a validation procedure and a translation of the tree into a series of decision rules. The validation procedure involves generating a random sample on which to base the tree formation and then testing the model's classification of the remainder of the database. The rule system generated for a tree can be in generic form, such as the following:

```
Rule_1 IF
        Inquiry source = Cards
        Magazine = BYTE
THEN
        Buy = Buyers 77.2%
```

Alternatively, it can be in Prolog expressions.

The quality of the tree graphics is excellent, especially when displayed on an EGA or VGA color screen. You can use menu selections, mouse pointing and clicking, and arrow keys to move the screen display easily to different parts of a tree. The graphics drawing and redrawing were fast on my 386-based system and VGA display. According to the company, a feature slated for a future upgrade will translate the trees into bar charts that can be exported to other graphics packages.

The quality of the printed output was also impressive. You can print to an ASCII file, an ASCII (basic dot-matrix) printer, a LaserJet II, or a PostScript printer.

Room for Improvement

Two aspects of the package need improvement: the manual and the speed of data management. Even though the software and manual are aimed at managers without strong statistical backgrounds, the documentation covering the statistical underpinnings of the techniques is inadequate. A paper about the statistical methodology (i.e., its relationship to CART [Classification and Regression Trees] and CHAID [Chi-squared Automatic Interaction Detector]) and other relevant material was sent on request, but more of this information should be included in an appendix.

In addition, the sample data analysis that is carried out throughout the manual is not adequate for depicting the software's full potential. The manual's instructions for using the package to perform all analyses were clear and concise, but the subtleties of the statistics and adjustments to methodology were glossed over.

The package's other inadequacy is the slow speed of data importing and database definition. KnowledgeSeeker can import WKS, WK1, dBASE III Plus and IV, and ASCII delimited or fixed-format files. After I specified the data file and fields, the program took 12 minutes (on a 20-MHz 386) to read and process a relatively small ASCII file of 2000 observations and 20 variables before it could create any tree. Variable labeling and data type definition took even longer—45 minutes of processing, after the labels were typed in.

These processes are done infrequently, however, and the speed of the more crucial feature, the tree construction, was adequate for a database of this size. The program does not currently use extended or expanded memory, although the company promises that the next upgrade will include this ability.

KnowledgeSeeker is a worthwhile addition to any data analyst's or manager's bag of tricks. Whether you use the package alone to aid decision making or as a guide for planning and evaluating other modeling, the analysis time that you'll save will be well worth the cost of the software. ■

Minna Levine is a market research and statistics consultant with Alphastat Research Corp. of Belmont and Sharon, Massachusetts. She can be reached on BIX c/o "editors."

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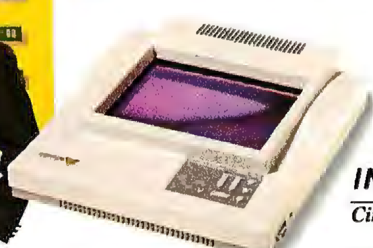

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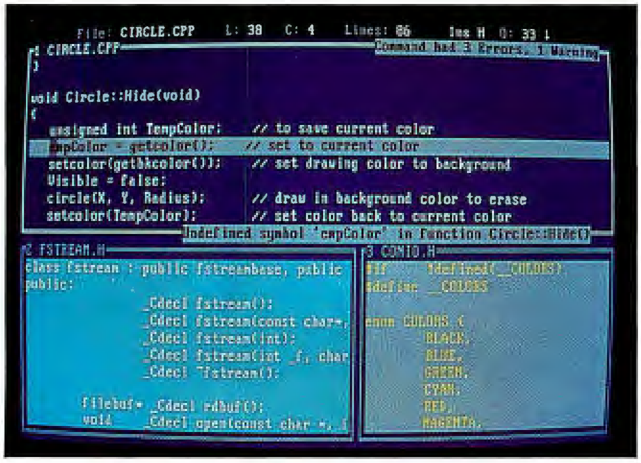
Tom Yager

REVIEW

Concern for the Editing Environment



PIEdit brings its windowed, multifile interface to DOS, OS/2, and PC Unix. Here, the editor is highlighting errors in the code that were reported by the compiler.

PIEdit 4.00

Company
The Iliad Group, Inc.
77 Geary St., Fifth Floor
San Francisco, CA 94108
(800) 473-2053
fax: (415) 563-2149

Hardware Needed
DOS machines: 512K bytes of memory;
OS/2 machines: 2 MB recommended;
700K bytes to 1.2 MB of hard disk space

Software Needed
DOS 3.0, OS/2 1.1, AIX, Xenix, or Unix System V release 3.2

Price
386 Unix, Xenix, and AIX version, $349;
DOS version, $195; OS/2 version, $249

Inquiry 1229.

When it comes to Unix programming, there are two camps: One believes that command-line interfaces and Spartan surroundings are the way to go, and another wants life made as easy as possible. PIEdit, a full-screen programmer's editor from The Iliad Group, falls somewhere in between. It is neither a boring, featureless editor nor a hand-holding, gushy interactive environment. The front of the manual says "Professional Programming Environment," though; does that mean that Iliad missed its mark?

By any standards, this is one heck of an editor. It operates in a full-screen mode, with text windows that can be moved and resized. There is no arbitrary limit on the number of windows and files you can have open at once, and there are facilities for easily moving data between windows. You can scroll-lock windows to each other so that they scroll together, making it easier to compare data.

PIEdit is a programmer's editor, and some of its features were obviously invented by developers who found other editors lacking. Automatic file saving, expression evaluation, unlimited undo, and on-line help have all been included. What makes PIEdit an *environment* is its ability to call up a compiler for application building and syntax checking. The error log is captured and interpreted; you can hop from one error to the next, the cursor moving to the erroneous line as each message is examined.

Finally, as one might expect, PIEdit is programmable. At the top level, it supports keyword expansion, key-map redefinition, and macros with conditionals and loops. At a lower level, you can expand macros to drive the editor in any direction you like; every command that is available through the keyboard can be called up as a function in PIEdit's macro language (PML). PML supports structured statements such as `while` and `for`, making it possible to produce self-running scripts of enormous complexity.

Still, it is likely that most people using PIEdit will never delve that far into its advanced capabilities. One of PIEdit's strengths is that it offers a nearly identical set of functions to DOS, OS/2, AIX, and 386 Unix users. I decided to start by getting a feel for PIEdit as a basic editor.

Editor Basics

To use PIEdit as just an editor is to ignore its advanced features, but there's no denying that the majority of your time running it will be spent simply entering and editing programs. Boring stuff, I know, but if an editor doesn't *feel* good, who cares if it can do your laundry?

I ran PIEdit on an Advanced Logic Research 25-MHz PowerVEISA 486 with 13 megabytes of memory, a Paradise 8514/A Plus card, an Orchid ProDesigner VGA adapter, and a Seiko CM-1430 monitor. I installed it under Interactive Unix 2.2 and Interactive X Window System 1.2. PIEdit is not an X application; I tried running it that way because so many programmers work in that environment.

On my system, PIEdit was easiest to run on either `xpcterm` or the text console, Interactive's X terminal emulator with PC key mappings. PIEdit did not run well on a raw `xterm`, but it might have with some changes to the `xterm` terminfo entry.

On any display medium that has the IBM-type line-drawing characters mapped, PIEdit will draw its windows and dialog boxes with smooth, single-width lines. It doesn't sense this capability; you need to provide a "-o" switch on the `pi` command line to make it happen. Scrolling under Unix was a little sluggish, owing mostly to the `curses` display routines and the bordered text windows. It is still quite usable, and Iliad claims that its DOS editor scrolls much more quickly.

With a typical PC keyboard, you should feel right at home. The special keys work as labeled, and F1 even calls up help. The context-sensitive version amounts to a single reverse-video line of text that appears near the cursor, describing acceptable actions. The broader type of help is menu-driven, with a sensible index and a scrolling window. PIEdit operations are split into types in the menu; I had no trouble zipping right to the topic that needed clarification.

There's also a quiescent sort of help that appears when you press one of the command prefix keys (e.g., Control-F for file, Control-B for block, and Control-G for goto) and do nothing for a couple of seconds. The editor assumes that you are confused and puts up a menu of possible commands. This feature saves you from having to remember every command sequence—if you can get in the neighborhood, PIEdit will find the right house for you.

PIEdit's strengths are mostly in the little things. Take filename completion, for

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REVIEW

example. When you use Control-FO to open a file, you can use wild cards in the filename. Press Control-F, and PIEdit makes a menu of files matching the wild card (it also shows each file's size and modification date).

It's difficult in such limited space to relate what a solid basic editor PIEdit is. The default key bindings make so much sense that common ones became automatic to me after only a few sessions. The on-line help and quick-reference card helped me use the ones I hadn't memorized yet.

Cross Platform and Compiler Sensitive

Beyond simple editing, PIEdit has quite a bit to offer, even if it is a little difficult to get to. To keep things as generic as possible (remember, this editor runs under several different environments, and it works with various languages), PIEdit's interface to the compiler, linker, `make`, `lint`, and other tools is fairly primitive. You need to fill PIEdit's environment with the command line you intend to use with each tool. This will take some fiddling to get just right, but once it is set, the editor will "understand" the error reports and help you work through them.

Working in C, the editor has a facility that lets you quickly check the syntax of the file you're working on. PIEdit calls the compiler, asks it to compile but not link, and pulls in any reported errors. This facility is so quick it almost seems like a part of the editor, and it is very handy.

The macro capability has two faces. One lets you capture keystrokes to a file and then play those keys back with a user-defined key press. You can insert holes for input and timed waits into your key stream.

This simple facility is supplanted by PML, which lets you mix editor commands with structured statements to create *real* programs. There are some limitations, of course, since the programs can't do direct file I/O or directly interface with other languages. Combined with the editor's ability to change its key mappings and other behavioral settings, PML rounds out PIEdit's versatile repertoire. PIEdit is a quality multiplatform programmer's editor, loaded with features, and one you should consider even if your environment already includes an editor. ■

Tom Yager is a BYTE technical editor with 11 years of professional programming experience. He can be reached on BIX as "tyager."

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Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products previously reviewed in BYTE.

Torture Test: Two 386/33 Systems Survive the BYTE Lab

During a six-month tour of duty in the BYTE Lab, Club American's Hawk I (left) and Arche Technologies' Legacy 386-33 held up remarkably well.

Hawk I

Company
Club American Technologies, Inc.
3401 West Warren Ave.
Fremont, CA 94539
(415) 683-6600

Components (as reviewed)
Processor: 33-MHz 386; 33-MHz 80387 math coprocessor
Memory: 4 MB of SIMM RAM; 64K-byte static RAM processor cache
Mass storage: 5¼-inch 1.2-MB floppy disk drive; 150-MB Maxtor ESDI hard disk drive
Display: 16-bit Everex Viewpoint VGA; Evervision analog color monitor
Keyboard: 101-key IBM Enhanced-style layout
I/O Interfaces: Two serial ports; one parallel port

Price
$4139

Inquiry 1226.

Legacy 386-33

Company
Arche Technologies, Inc.
48881 Kato Rd.
Fremont, CA 94539
(415) 623-8100

Components (as reviewed)
Processor: 33-MHz 386; 33-MHz 80387 math coprocessor
Memory: 8 MB of SIMM RAM; 128K-byte static RAM processor cache
Mass storage: 5¼-inch 1.2-MB floppy disk drive; 3½-inch 1.44-MB floppy disk drive; 120-MB QIC tape drive; 360-MB Maxtor ESDI hard disk drive
Display: 16-bit Tseng Labs VGA; Arche analog color monitor
Keyboard: 101-key IBM Enhanced-style layout
I/O interfaces: Two serial ports; one parallel port

Price
$10,755

Inquiry 1225.

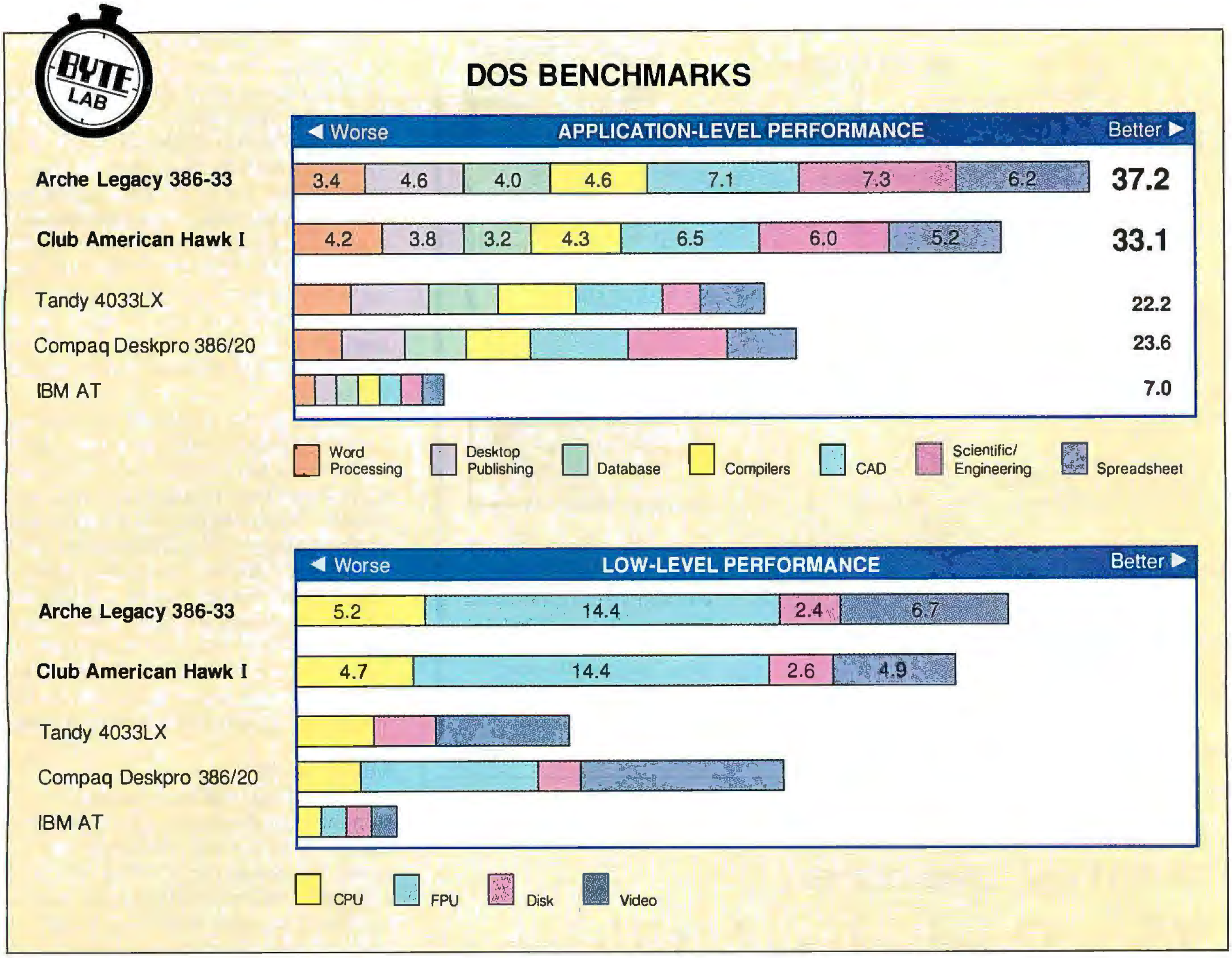
Unless it fits in your pocket, a 33-MHz 386 system no longer reflects cutting-edge technology. But as these machines lost groundbreaker status, they gained attributes that the latest and greatest systems can't possibly offer: proven reliability, mature designs, and affordable prices. In the year or so that desktop 33-MHz machines have been around, We've had a chance to see how they work in the real world.

We put two 33-MHz systems, an Arche Legacy 386-33 and Club American's Hawk I, under a heavy workload in the BYTE Lab over the last six months. The Lab staff used the Arche to test SCSI drives and caching disk drive controllers, and we configured it as a NetWare 386 file server; we used the Hawk in the SCSI and disk drive controller product focuses as well, and as a platform for testing math coprocessors and dozens of new Windows applications.

Test-bed duty in the BYTE Lab places excessive stress on a system. We disassembled and reassembled these machines dozens of times, we swapped countless boards in and out of the expansion buses, and we repeatedly slid hard disk drives in and out of the drive bays. We also ran in-depth tests with a wide variety of software. Extended lab duty loosens connections, wears out expansion slots, and occasionally results in major component failures. Both products stood up to this abuse remarkably well.

Trivial Troubles

Each machine did suffer a minor problem during its stay. We had difficulty initially partitioning the Hawk's Maxtor 150-megabyte ESDI hard disk drive—the DOS 3.30 `fdisk` program only saw 40 MB and couldn't build a stable extended partition. DOS 4.0 had the same problem. As it turned out, Club had improperly formatted the disk at the factory. We fixed it by doing a low-level hard disk format using the hard disk drive controller's ROM-based format program. We remapped the drive for use with DOS (it has more than 1024 cylinders) and performed a reformat and remapping to get the drive, BIOS, and DOS in sync. After that, everything worked fine.



For all benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.30 = 1. Higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies relative performance at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word Processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBASE IV; Compilers: Microsoft C 5.1 and Borland Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1.1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1.

The BYTE Lab introduced version 2.0 of the DOS benchmarks in the August 1990 issue (see "BYTE's New Benchmarks: New Looks, New Numbers"). Benchmark results for machines reviewed under previous versions aren't directly comparable. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

The Arche Legacy 386-33's problem was more unusual: When we installed some caching hard disk drive controllers, the system took several minutes to boot from the hard disk drive. This occurred with the preliminary Arche BIOS that came installed on our test machine, which was one of the first out of the factory. We replaced the BIOS ROM in our Legacy with a later version and had no further problems.

With these exceptions, both machines handled all the tasks we handed them. But if reliability was roughly on par, performance wasn't equal; the Legacy is noticeably faster (see the benchmark graph). Our low-level benchmarks bear this out, rating the Legacy 10 percent better in CPU speed and 37 percent faster on the Video tests. Overall, the Legacy was 12 percent faster on the application benchmarks.

In addition to the size of its processor cache—128K bytes versus the Hawk's 64K bytes—the Legacy employs a unique cache design that evidently improves performance. Arche claims that its proprietary approach to cache, DMA, and memory management enhances performance. Both Arche and Club use a write-back, rather than a write-through, cache design. Write-back caches buffer memory writes as well as memory reads.

Benchmarks sometimes report performance differences that don't show in day-to-day use. But there was a noticeable performance gap between these machines even without the objective tests. I found myself choosing the Legacy when I needed to run a demanding job.

The Legacy and the Hawk use Maxtor ESDI hard disk drives coupled with a track-buffering ESDI controller, and each turned in good low-level disk benchmark results. The Legacy included a 360-MB Maxtor XT-8380 hard disk drive and an UltraStor controller with a 32K-byte buffer (Arche refers to this controller as the Arche Breeze); Club supplied a 150-MB Maxtor XT-4170 and a Disk Technology buffering controller. Although the drives differ substantially in capacity, both offer roughly the same average access times—14 milliseconds on the Hawk and 14.5 ms on the Legacy. The BYTE low-level benchmarks ranked disk performance for these two systems as roughly equivalent.

Both systems accommodate up to 8 MB of single in-line memory module

RAM on the motherboard, and both let you expand memory using proprietary 32-bit memory cards. The Hawk has one 32-bit slot that, when filled, brings the maximum system RAM up to 16 MB. The Hawk also has six 16-bit expansion slots and one 8-bit slot. The Legacy has two 32-bit slots that bring total memory capacity to 32 MB. Four of the remaining expansion slots are 16-bit, and two are 8-bit. Each system used up one 8-bit and two 16-bit slots in its tested configuration—one for video, one for an I/O card, and one for the hard disk drive controller.

Comparing the machines' ergonomics doesn't provide much contrast. Both have similar keyboards—each with a better feel than typical mail-order clone keyboards, if you like your keyboards with stiff resistance (in the IBM style) as I do. The Hawk's Everex Evervision monitor worked fine, but the Legacy's Arche analog color monitor displayed colors inaccurately; it gave colors in some areas of the screen a faint brown hue. Also, the monitor's bezel makes the screen on the Arche look a little too round for my taste.

Money vs. Power

After working with both machines nonstop for several months, I wouldn't hesitate to buy either one. Although both are at the low end of the 33-MHz 386 price spectrum, their pricing differs by a wide margin. The as-reviewed prices can't be used for fair comparisons in this case; the configurations are too different. But even when these systems are similarly equipped, the price difference is clear.

Configured with a VGA color monitor, 4 MB of RAM, a 150-MB hard disk drive, and a 5¼-inch floppy disk drive, the Hawk costs $3449. The closest Legacy configuration includes a 104-MB hard disk drive and costs $7380. The numbers aren't quite comparable (Arche sells through dealers and Club sells mail-order), but even assuming a street price for the Legacy that's 25 percent off list, the Hawk is considerably cheaper.

Clearly, the Legacy and the Hawk are built to last. To choose between the two machines, you must decide how much you're willing to pay for performance. On a dollar-for-dollar basis, the Hawk delivers more power for your money. The Legacy's faster video and CPU make it a better choice for CAD or other graphics-intensive applications. But you pay over 50 percent more for less than a 50 percent increase in power. The performance title belongs to the Arche Legacy, but the Club Hawk I wins at the bottom line. ■

—Steve Apiki

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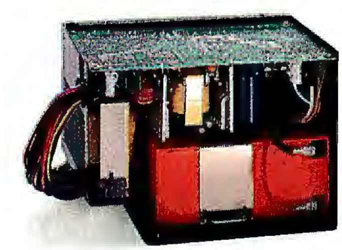

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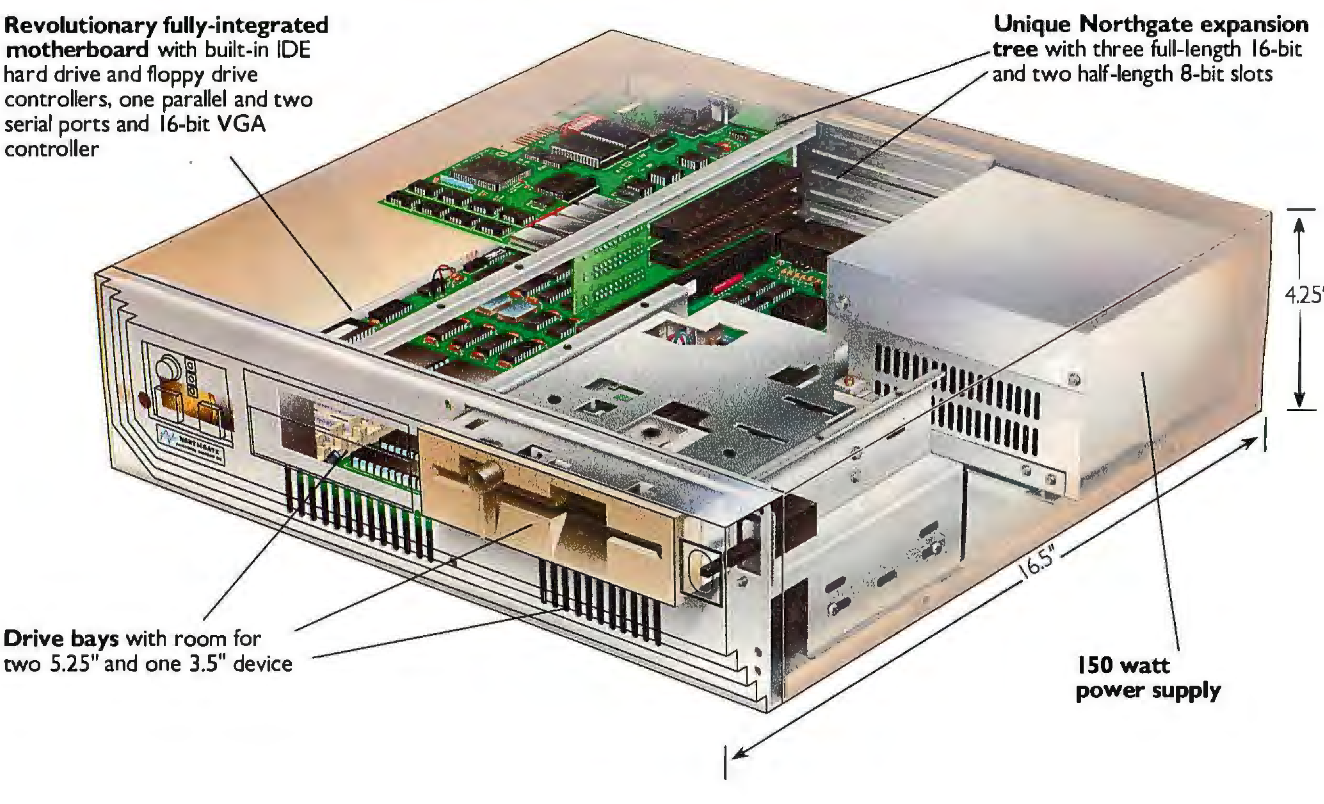

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Laptop Technologies

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The original, the dream of the laptop/notebook/hand-held computer of today—and of the future—came from Alan Kay, creator of the Dynabook concept. While the actual Dynabook machine itself has never been built, the concept bears within it the seeds of necessary technologies, some of which are coming to fruition today.

BYTE recently interviewed Alan Kay and asked him to comment on the Dynabook concept and on the future of laptop/notebook/hand-held computing. In "Dynabook Revisited with Alan Kay," Bob Ryan presents information from that interview.

Laptop or desktop, each computer requires at least four primary capabilities: input, output, processing, and storage. The options for the laptop version, depending on its size, are more limited than those for the desktop version. However, new technologies are arising that work around these limits in each of the four primary areas.

Input methods for laptop/notebook/hand-held computers are particularly limited by the size of the device. For instance, the keyboard on a hand-held computer would be too small for touch-typing. Thus, other methods of input become more practical.

For one, pen-based input doesn't require a keyboard, doesn't make a tapping noise, but *is* mobile. In "The Point of the Pen," Robert M. Carr discusses these and other advantages to using the pen for input and describes, in detail, PenPoint, GO's new operating system for pen-based computing.

For another, with the birth of the graphical user interface, present-day computing practically requires a pointing device, and mice are less than convenient in a mobile society. In "Touch-and-Feel Interfaces," Andrew Reinhardt explores a variety of built-in pointing devices for laptop and smaller computers.

Output forms remain similar to those for desktop computers, but the constraints under which they must operate differ. For example, a laptop display screen must be relatively flat and easily read in a variety of lighting conditions. Liquid-crystal technologies dominate the laptop market, but new options abound. In "LCDs and Beyond," Nick Baran examines the state of the art in laptop display technologies.

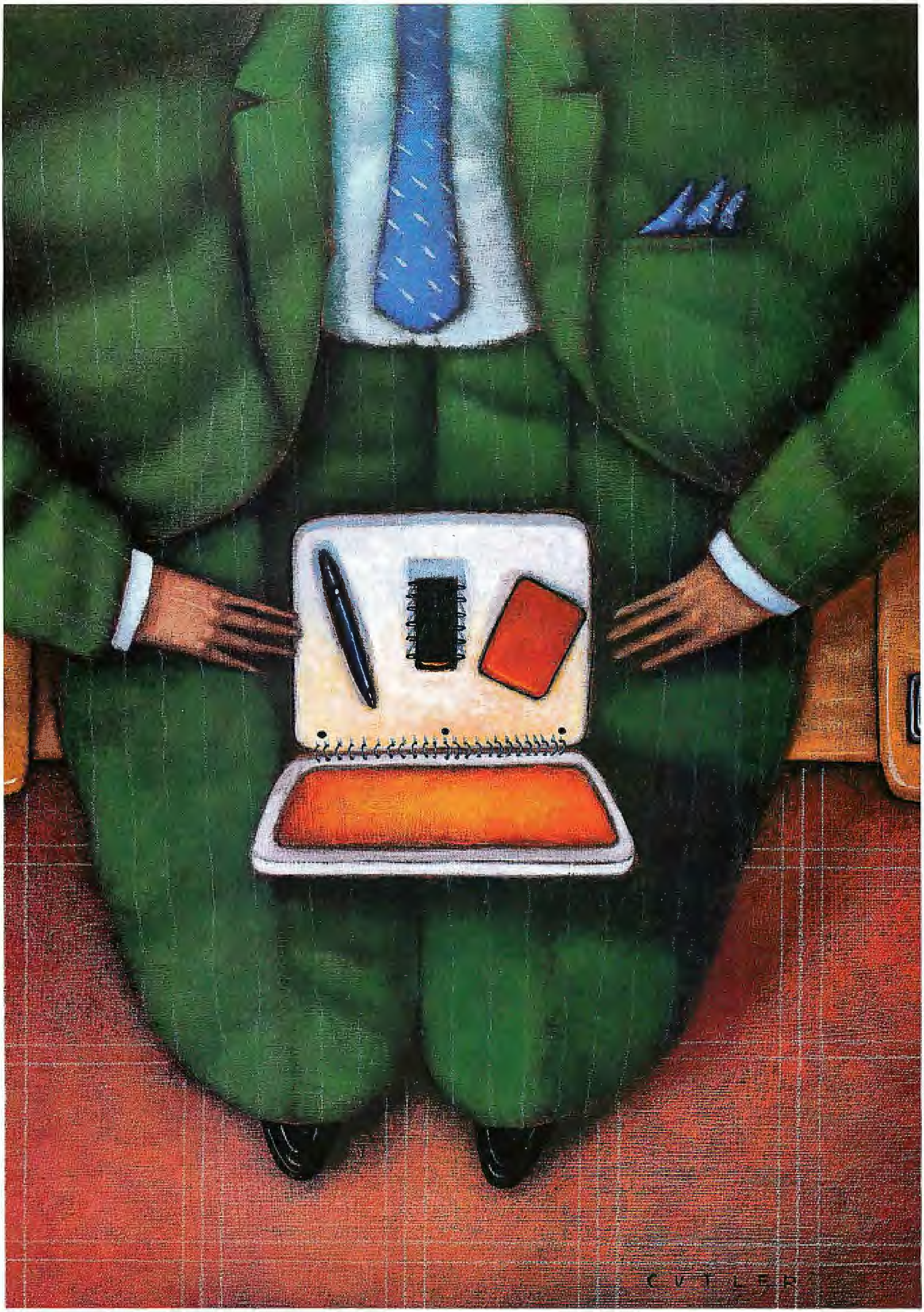
As an aside, a suit has been filed claiming that some Japanese companies are "dumping" flat screens on the U.S. market. The implications for display manufacturers and laptop computer companies—and even for the U.S. economy—are serious and costly. In the text box "Displays—Down the DRAM Drain?" Frank Hayes explores the ramifications of this suit, for business and for buyers.

With processor speed increases and size decreases occurring quite regularly, what's new for laptops is the integrated processor, which combines all the components of an AT-compatible computer on a single chip. In "Destination Laptop," Doug Gephardt and Mark C. Klonower describe this chip and how it meets the size and power restrictions of the laptop/notebook/hand-held world.

Size and power restrictions also affect the type of storage that is practical in a pocket-size computer. Would you rather carry a hard disk drive or a credit-card-size solid-state memory card? In "Memories in My Pocket," John Reimer describes memory cards, storage that's small enough and light enough to be practical in notebook computers.

Faster, smaller, faster, smaller—is there an end in sight? Laptops, notebooks, and even hand-held computers are in a race to see which of them will become the fastest and the smallest computer around. In the process, a lot of new technologies are coming to the fore. This is, however, only the beginning. Today, the pen—tomorrow, the voice.

—Jane Morrill Tazelaar
Senior Editor, State of the Art



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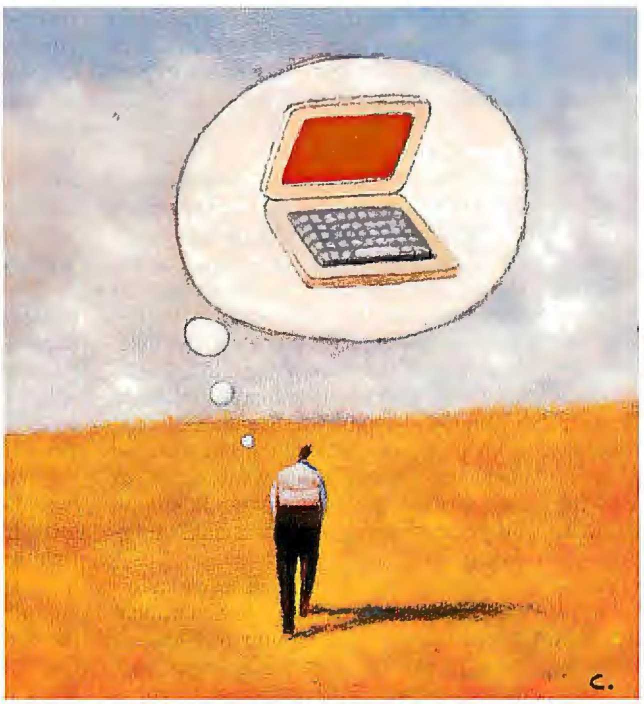
Dynabook Revisited with Alan Kay

Is the reign of the desktop computer about to end?

Bob Ryan



You cannot talk about future laptops without talking about Alan Kay and the Dynabook. Kay, presently an Apple Fellow, has been one of the most influential figures in computing for the last 20 years. His work in user interface design has changed the way millions of people work with their computers.

The Dynabook name has been appropriated by more than one company to describe its laptop computer. These machines, however, have little in common with the Dynabook as defined by Alan Kay. In a recent conversation with BYTE, Kay gave us his views on computers of the future and their effects on society.

Initial Concept

The Dynabook is a concept that Kay came up with in the late 1960s. It was the result of his realization that the computer is actually another form of media.

"In 1968 I saw two or three things that sort of changed my whole notion of computing. The way we had been thinking about it was sort of Doug Engelbart's view that the mainframe was like a railroad, owned by an institution that decided what you could do and when you could do it. Engelbart was trying to be like Henry Ford. A personal computer, as it was thought of in the sixties, was supposed to be like an automobile.

"In 1968 I saw Seymour Papert's first work with kids and Logo, and I saw the first really great handwriting-character-recognition system at Rand. It's a fabulous system. And that had a huge influence on me because it had an intimate feel.

"When I combined that with the idea that kids had to use it, the concept of the computer became something much more like a supermedium. Something more like superpaper. And it was in 1968 that I made the cardboard model [of the Dynabook]. The reason I called it a Dynabook was I didn't want to use the word *computer*, and I wanted to suggest that it was something like a medium and that it would have something like the same impact that the Gutenberg technology had."

Kay originally conceived of three physical forms for future computers: a head-mounted display, the familiar notebook form, and a far-future wristwatch form suggested by the work of Nicholas Negroponte.

"In its Dynabook form, the computer of the future is a notebook with a million-pixel screen, eight processors, and both wireless and cabled networking."

Kay felt confident that such small forms were possible, given the work of Gordon Moore.

"The third thing that influenced me strongly was reading a paper by Gordon Moore, who of course went on to found

Intel. In this paper he formulated one of the versions of Moore's Law, which is the prediction that all good things [such as transistor density on a chip] would double every two years. I knew enough physics to understand some of the technical parts of it and was convinced that he was right. The game I played was, when could we have a Dynabook? The answer was sometime in the late 1970s, early 1980s, if we really worked on it.

"I started designing the machine in the late 1960s. I went to Xerox Palo Alto Research Center with the explicit purpose to make the machine. As it turned out, Xerox sort of punked out midway in the thing. All we did was invent workstations and Macintoshes, and stuff like that.

"Laptops in 1995 will be very much like the Dynabook model of 1968. We'll have digital cellular and other kinds of broadcast digital networks as well as wired networks; we'll have the computing power that we need; and we'll have the screens that we need. The user interface in 1995 will still be pretty much Mac-like—mostly a manipulation interface—but the end-user programming will be much better than it is with HyperCard. It will be something where a lot of the things you construct in a tool-based way will be agents. That's what I'm experimenting with right now with the school project I'm doing for Apple, and I'm convinced that that is possible."

The Interface Factor

Kay envisions the Dynabook as the third paradigm in the evolution of human-computer relationships. The first is the timesharing/DOS paradigm, where the interface acts as a control panel that gives you access to the functions of the computer. The second is the Macintosh-style interface, where the main job of the interface is to make the user aware of the possibilities of the machine. In effect, the user learns from the computer.

"The Mac is like a magic mirror; it reflects the user's intelligence back at him. The big problem with DOS is that it tries to tell the truth by presenting the computer to the user as it exists at some technical level. What you really want to do is lie. The Macintosh shows you something that isn't actually true."

According to Kay, the third paradigm is intimate computing, where the main job of the computer is to learn from the user. "The Mac-style interface doesn't get thrown away; it's what makes the interface friendly. Then you start populating it with some active entities (agents) as well as the passive ones (data structures).

The main job of the computer will be to learn from the user.

I trace agents back to John McCarthy in the late 1950s and his 'advice taker' paper. McCarthy's notion was that someday we are going to be hooked up to an information utility that is as pervasive as our power and lighting utilities. These resources will be so great that we'll have to employ artificially intelligent software agents that can take advice from us without having to be directly programmed.

"The forcing function for the mainframe computer was business need; the forcing function for the desktop computer was integrated circuits, and the forcing function for the Dynabook is pervasive networking. The idea is that even when you're in a car or out in the park or something, you are continuously connected to packet switching."

The Case for Agents

The idea of intelligent software agents acting on behalf of the user was not a part of the original Dynabook concept.

"That was where we stopped short. Agents were too hard to do back then. It was only like 10 years later, in 1978—after we got Ethernet going and the Macintosh-style interface going—that I realized that the Macintosh-style interface was not going to be strong enough to deal with pervasive networking and that we had to do agents whether we wanted to or not. I've been working more or less on agents since then, with occasional excursions.

"Agents constitute a different paradigm for a user interface. My emotional connection to a computer has always been in the form of a Mac-style tool-based interface. I used to be a professional musician, and I'd rather play in the orchestra than be the conductor. But it's quite clear that delegation systems are going to be the big things in the nineties.

"Now the true agent-based interface is farther on out than 1995, but by the end of the century there will be commercial systems that will be agent based. The Macintosh-style interface, Windows 9.0, or whatever it is by then, is going to be dominant, but at some point the weight of the potential resources you can get by employing agents over networks is going to start tipping the scales toward agents—just as it took four or five years for the Macintosh style to start dominating DOS. At some point, what you want to do starts forcing you to find better leverage."

Agents and AI

To have intelligent agents that can learn from us and deal with the vast amounts of information made available by pervasive networking, Kay believes that we need a better way of doing AI.

"The Cyc project [headed by Doug Lenat at Microelectronics and Computer Technology in Austin, TX] says that while we can build problem-solving entities right now—that we're pretty good at it—such entities have no context. We don't want omnipotent genies solving problems with our information systems unless they live in our world socially. There is a famous story about the Unix agent at Berkeley. When someone typed 'I've just run out of file space, I need some more,' the agent responded 20 seconds later with 'Now you have plenty of file space.' The agent had deleted a third of the guy's files! From the standpoint of AI, you have to give it high marks—it made a correct interpretation and gave the guy what he wanted. But it didn't have the context to realize that what it did was inappropriate.

"The Cyc project is all about modeling common sense. Doug Lenat is one of the two or three smartest guys in the country in computer science, and he's been working on it for seven or eight years now, and he's done a lot of good stuff. He may fail—it's hard to succeed on something like this the first time out—but he's leaving a good trail.

"What we need in software agents is flexible competence, and the competence part is easier than the flexible part. Five or 10 years from now, we'll judge our AI systems not on how smart they are but on how well they are able to explain themselves to us. If you think about that, that is sort of the way we judge people. We don't want to work with an antisocial genius who may go off and blow up the world or something. Our trust is based on some sort of social interaction where we have some sense of what the other entity's motives are. That's going to extend very strongly into an AI interface. We'll be satisfied with stupider agents that can give us a good sense of what their strategies are when we set them out on some problem to solve.

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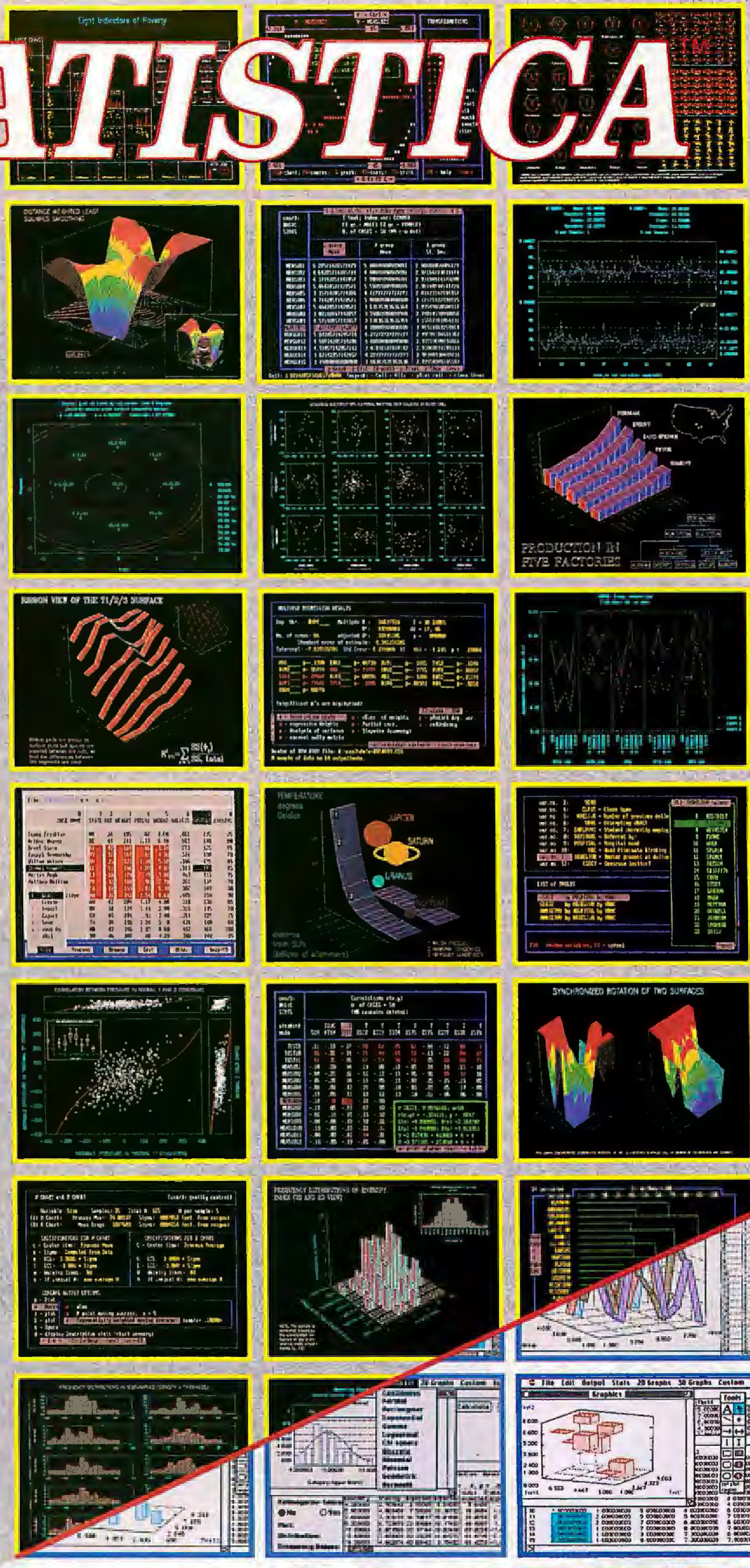

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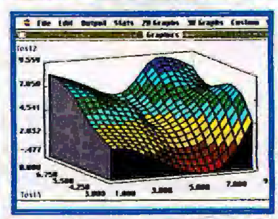

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Using agents as an interface into a pervasively networked world is more than just a technical problem. Kay has even greater concerns about how humans will react to agents.

"When you start using agents, as a user-interface designer you put yourself behind the eight ball. You don't have anything nearly as intelligent as a human, so you have the possibility for the end user to get pissed off at the agent. The only thing like agents is humans, yet humans are a lot smarter. One of the goals of the user interface will be to get the user subliminally to understand the strengths and weaknesses of the interface.

"When you dump something a little like a human in there, your natural tendency is to start asking it questions about anything. Right away you put the poor AI in a place where almost certainly it can't give decent answers. So you have to do something in the user interface to temper the expectations of the user.

"I think there is a progression where we start off with the agents doing retrieval—from a wide variety of sources—of things that are of interest to us. People will sell them [agents] like applications. And gradually, the agents will get more flexible, and very likely people will start coming out with majordomo agents post-1995 that can handle the other agents. And you wind up having something that is like Marvin Minsky's Society of Mind, where you have a variety of different mentalities. This is the kind of system that Doug Lenat's Cyc is designed to handle."

The Impact of the Dynabook

To Kay, the true significance of the Dynabook is not the technologies that go into it—the displays, processors, input devices, AI-based agents, and so on—but the effect that intimate computing will have on our culture. He likens the effect of intimate computing to the effect that printing had on European culture.

"Marshall McLuhan pointed out that in the Renaissance a couple of things happened for the first time. One of them was the invention of true perspective. For the first time in the history of art, the observer was put outside the picture.

"The other was science, which requires that you step outside your sensory environment. Nothing discovered in science in the last 350 years has been in accord with common sense. McLuhan's theory was that the thing that made us step out of the frame was cold type.

"McLuhan's notion is that the printed book created the individual. You could take it away with you. You didn't have to be educated socially if you didn't want to be. You could take a book away with you and learn it all by yourself. The whole idea of perspective says *I'm* standing over here, *I'm* looking this way."

According to McLuhan, a new medium takes its initial content from the old. Thus, the books that Gutenberg made looked like illuminated manuscripts. Kay sees the same progression with personal computers; the initial forms took their content from timesharing VDTs.

"The desktop computer to me, at least since 1968, has been a passing phase. It's not an aberration, but it's like Gutenberg in that you invent something new, but you don't know what it is, so you put it in the old case.

"Aldus [Manutius] is my hero. He's the guy who wanted books that could fit into saddlebags, so he was forced not only to change the size of the book but also to invent a lot of modern typography in order to make the books legible. He couldn't use the imitation scripts that Gutenberg used for fonts. The really interesting stage was when Aldus realized that books had to be not just personal but intimate.

"So when I look at where we are right now with computers, it's somewhere between Gutenberg and Aldus, which means that nothing that has yet happened in computing actually counts. That's an interesting perspective. The laptop of the future is likely to be something much more like the final form of the computer. It will come into its own when the majority of software it runs isn't developed for desktops."

Dynabook and Skeptical Man

One effect Kay sees in the future is an extension of interest in simulations. He sees the Dynabook as a simulator that you can access readily and easily.

"If you had something that was easier to work with than HyperCard or Smalltalk, people could be doing more mock-ups. Give them a tool like a spreadsheet, and they start using it for forecasting. That's what everyone wants to know—what the different possibilities are."

Kay thinks that future computers will let you move beyond McLuhan's individual.

"If you tie interest in simulations together with pervasive networking and ask what impact that is going to have on a culture as a whole, I would say that it creates skeptical man. When you have something on your person at all times that is as innocuous as pencil and paper, that is continuously connected to the information utilities of our culture, and that you can use to play what-if games based on the information, there's going to be far less you have to take on faith.

"The retrieval systems of the future are not going to retrieve facts but points of view. The weakness of databases is that they let you retrieve facts, while the strength of our culture over the past several hundred years has been our ability to take on multiple points of view. That's what simulations allow you to do. Databases will be replaced by active simulations that no longer contain embalmed slices of a company at different points of time but active simulations of the company. You'll be able to test out the company in different environments based on competitive pressures and stuff."

Of course, the effects of skeptical man extend beyond business.

"Our basic drives are very similar to those of other animals, but we have this much stronger superstructure that, especially if used well, is able to channel all this energy into symbolic pursuits that are pleasurable. To me that's what civilization is all about. It's not repression, as Freud suggested. What you want in a civilization is a way for people to express their deep drives that is not destructive. Intelligence gives us another world that we can live in besides the physical world.

"To some extent we are symbol systems. The way that we see the world is different from the way an unselfconscious culture thinks about the world. Our whole notion of cause and effect is different. We have roughly the same mental structures we had a couple of hundred thousand years ago. What has changed is not our IQ but the representation systems we use to think about the world. Every time we change one of those significantly, we actually change ourselves.

"I think that when you start laying over these larger symbol systems, you start channeling the fairly direct impulses people have into art, invention, theater, sports, and all those kinds of things that are a good way of having cathartic experiences without going out and bashing people. It is very difficult to predict the kind of world that the computer is going to bring, but certainly, for me, it's the next big thing since Gutenberg. And yet, the sad thing is, if history repeats itself at all, it isn't going to affect most people in the way you'd really like it to. Of course, when we're in a transition period, it's very hard to draw curves about what the future will be like."

The Future of Computers

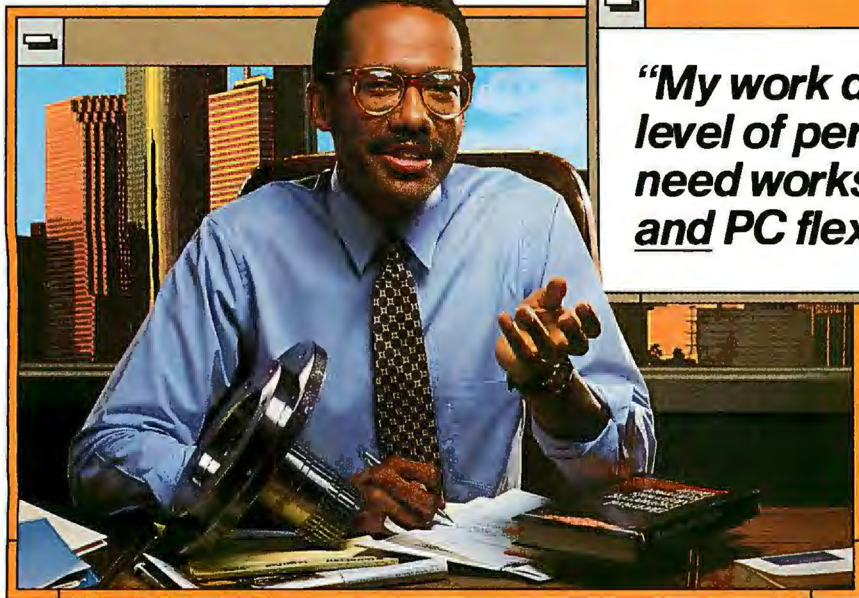
While Kay sees future computers as having a profound effect on our culture, he sees a more prosaic future for the computer itself.

"According to Moore's Law, and considering some of the fabrication technologies I've seen recently, we'll have 100 million instructions per second for the desktop by 1995 and a couple of thousand MIPS by the year 2000. Most computers will be smart-memory computers where the processors and memory are amalgamated. Because most of the cost of computers is in the packaging, the Dynabook might be something that is deposited. The whole thing could be one monolithic entity. There is nothing to fix on it; you melt it down when it doesn't work anymore.

"What that says is that the Dynabook is like something you buy in a stationary store or a clothing store. It was Aldus's notion that something isn't really *in* the culture until you can afford to lose it. It may not be made by any of the present manufacturers because they see the computer as one kind of thing, and its destiny appears to be very different.

"When I give a talk, I always ask everyone in the audience carrying a computer to hold it up. At some point, I won't be able to use that ploy, because everyone will have one, and it will be no big deal to carry it into a talk. You don't have to plan on taking notes; you just have it with you because you always do. I think that's the destiny of computers: to be mundane." ■

Bob Ryan is a BYTE technical editor. You can reach him on BIX as "b.ryan."



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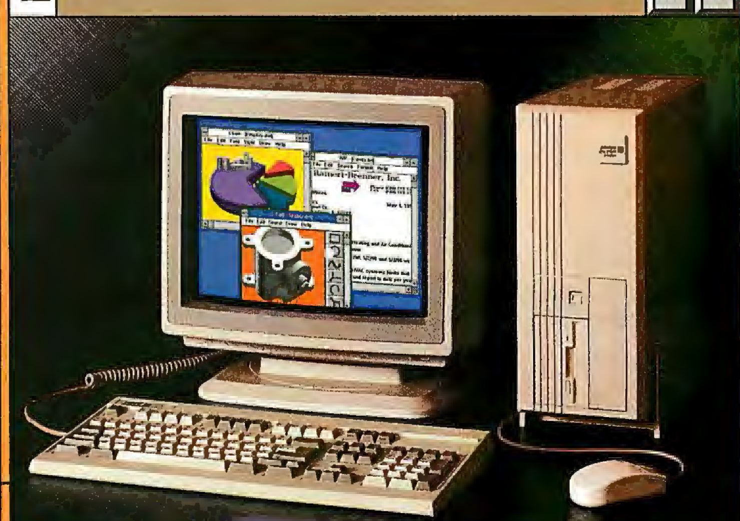

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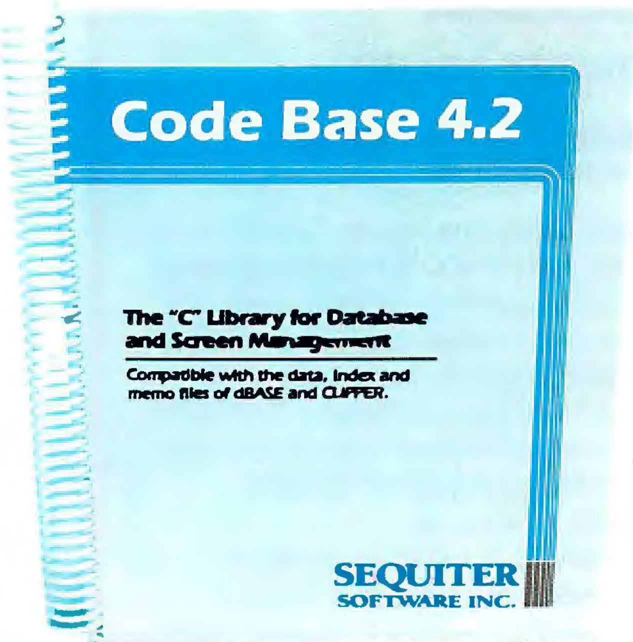

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The Point of the Pen

GO's vice president of software examines the new PenPoint operating system

Robert M. Carr

The laptop computer, no matter how small it becomes, is still fundamentally a desktop computer. This makes laptops difficult for noncomputer initiates to learn and operate. In addition, it's hard to use laptops in a meeting, and it is nearly impossible to use them while standing up.

Pen-based computers, on the other hand, are powerful tablet-like devices that operate more like notebooks than computers. As their name implies, you control such computers with a special pen that the screen senses. You write directly onto the screen, and the computer translates the handwriting into ASCII text. You issue commands to the computer using familiar gestures such as insertion carets, circling, and scratching out. If you're on the go, you operate a pen-based computer just like the traditional notebook it resembles.

PenPoint is a 32-bit, object-oriented, multitasking operating system designed expressly for the unique needs of mobile, pen-based computing. It packs the capabilities of operating systems such as OS/2 into a compact implementation that does not require a hard disk drive.

Why build a new operating system for pen-based computers? Because continuing advances in microcomputer electronics have made possible a dramatic change in the way computers are used. PenPoint is the first operating system specifically designed to be driven primarily by a pen. Because of this, PenPoint includes many new elements not found in traditional graphical user interfaces (GUIs). Two of the most important elements are the *notebook user interface* (NUI) and *gestures*.

The NUI

The notebook metaphor is PenPoint's major organizing interface. This interface provides a quick-reference style of access where you can find all the information that you need with just a few quick taps of the pen. PenPoint's notebook metaphor provides the familiar and flexible concepts of pages and sections (see screen 1).

A notebook *page* is synonymous with a document in a desktop computer. With pages, you never have to deal with separate files and programs (unless you transfer information to other computers). Instead, each document is itself a live piece of user data. You simply move from page to page and always see the data just as it was when you last left it, scrolled to exactly the same location you exited from.

PenPoint notebooks can contain hundreds or thousands of pages. As this would be too many processes to have running simultaneously, PenPoint transparently performs the bookkeeping steps of starting and stopping processes (e.g.,

ILLUSTRATION: DAVE CUTLER © 1991

Making Sense of Scribbles

PenPoint's input subsystem generates low-level event messages for all pen activity on the screen. These low-level events are grouped into higher-level aggregates called *scribbles* that are translated by the handwriting-translation (HWX) subsystem into either text characters or command gestures. These translations, in turn, are dispatched to the appropriate objects via an input distribution model that includes filtering, grabbing, inserting, and routing of input up and down the window hierarchy.

The current HWX engine runs as a background process. It operates in real time (i.e., 3 characters per second) on a 16-MHz 286 processor and occupies about 100K bytes of memory. Another 100K bytes is required to hold a general-purpose spelling dictionary. HWX tolerates characters that overlap, touch, or share strokes, and it handles inconsistent input from the same person (i.e., a user may shape the same character in different ways at different times).

The first version of HWX recognizes neatly printed random English-language text containing mixed uppercase and lowercase letters, numerals, and punctuation. The text can also be both "boxed" and "ruled-line" handwriting (i.e., you have the option of writing into character boxes or on ruled lines).

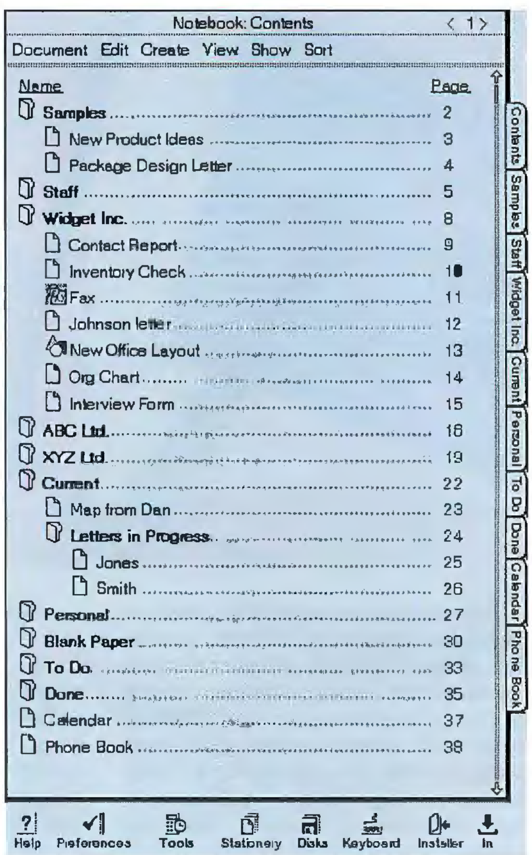
After a small amount of training, users typically experience accuracy rates of four out of five words translated correctly, the fifth word having an easily correctable error (i.e., a word-level accuracy rate of 80 percent to 90 percent). This is equivalent to a raw character-accuracy rate of 90 percent to 97 percent.

The recognition process works as follows: The recognition engine is based on a *blackboard model*, where data from multiple knowledge sources is combined and sorted using a dynamic programming algorithm. These knowledge sources include predefined information, such as PenPoint's 100,000-word dictionary and standard rules for punctuation usage, and context-sensitive aids supplied by the application, such as specific word lists for a given input field. One of the default knowledge sources is the character-shape recognizer.

The recognition engine examines scribbles as it receives them. It performs character recognition by comparing character shapes against a set of prototypes for each character. PenPoint comes with a preinstalled set of hundreds of prototypes that work well for most writers. You can "train" the prototypes through a brief handwriting session, during which the operating system builds additional prototypes for your own unique style of shaping characters.

Under PenPoint, the pen is a respectable data-entry device. With time, it will only get better. Because PenPoint provides standard programming interfaces to all applications, it insulates them from the specifics of any particular handwriting-recognition algorithms. Therefore, the algorithms can be improved over the years without disturbing a growing base of applications.

Although PenPoint is designed primarily for pen-based input, you can use an optional keyboard for high-volume data entry. PenPoint also has a pop-up "virtual keyboard" that you use for text input by tapping on it with the pen.



Screen 1: *The PenPoint notebook user interface. The page number is at the upper right; tapping the pen on it advances the notebook to the next page. To the right are tabs associated with pages or sections of the notebook. At the bottom is the bookshelf; the icons represent various PenPoint services.*

running applications) and loading and saving application data when pages are turned.

Pages are numbered in the top right-hand corner. You "turn" pages with a pen tap or pen flick on the page number. For visual feedback, page turns include a special graphical effect that resembles the turn of a physical page. Tabs appear down the notebook's right side and are attached to any page or section you desire. If there are more tabs than will fit on the screen, they overlap and can be dragged with the pen tip. Touching a tab turns immediately to that page in the notebook.

A notebook's first page contains a table of contents that looks and operates like its book equivalent. Touching a page number here turns the notebook to that page. If you wish, pages can be "floated" to achieve a traditional overlapping window display. You can create *sections* that contain a group of pages. Sections can also contain other sections. This allows you to organize information as you see fit.

At the bottom of the PenPoint screen is a *bookshelf* area where systemwide objects and resources are represented as icons. PenPoint's standard bookshelf includes objects for on-line help; "mail support" functions (which are described later); functions for modifying the system's configuration to meet your preferences; a virtual keyboard; an installer for applications, fonts, and resources; and a disk viewer that provides a table-of-contents view when you access external file systems. You can place additional objects there, including documents and other notebooks.

Gestures

Under PenPoint, the pen is the primary input device, although keyboards are supported as an option. The pen does not require an on-screen cursor, since the pen tip itself indicates the screen location. You use the pen for pointing (by touching the screen), data entry (by handwriting), and action (by using *gesture commands*).

PenPoint provides a standard, rich, gestural language that is based on common intuition about pen-editing marks. The heart of the gestural user interface is the set of core gestures shown in figure 1. These gestures work consistently across all applications, providing common commands such as select, insert, delete, options, move, copy, and help.

Look at the example of deleting a word in screen 2. In a mouse-driven interface, you double-click the mouse to select the word and choose Delete from a menu (or issue a keystroke equivalent, such as Control-X). But in PenPoint, you can simply draw an *X* over the word to delete it. Likewise, you can put a word in boldface by drawing a *B* over it.

The pen can also perform editing and data-entry tasks. To modify existing text, you would draw a small caret where you want to insert text. In response, a gap opens in the text and a writing pad object appears (one of the many standard PenPoint support objects), as shown in screen 3.

While you print with the pen, PenPoint performs handwriting recognition as a background process. When you close the writing pad, the resulting ASCII text is then handed to the application. (For further information on the handwriting-translation subsystem, see the text box "Making Sense of Scribbles" at left.)

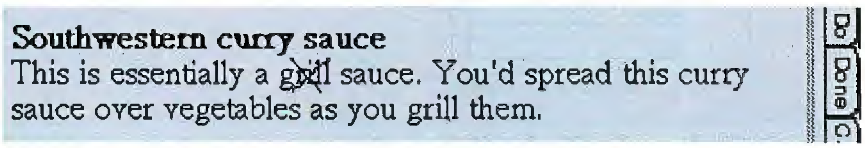
Under PenPoint, the location of a gesture controls its intended meaning. For instance, when you draw the letter *O* in a handwriting area, it is translated into ASCII 79 (a capital *O*). When you draw it over application data (e.g., a word), it is translated into an edit command. And when you draw the *O* into an object-oriented drawing program, it is translated into the command to create a circle object. Such location-specific gestures provide an intuitive interface style that's free of confusing modes.

Throughout this process, the application is in full control of the interpretation and meaning of the pen strokes. This allows it to control the translation and determine which object the pen's "ink" should affect. However, applications do not have to deal with the interface at this level unless they have special needs. PenPoint system classes handle everything necessary for recognizing gestures. Applications can choose to receive just gesture messages.

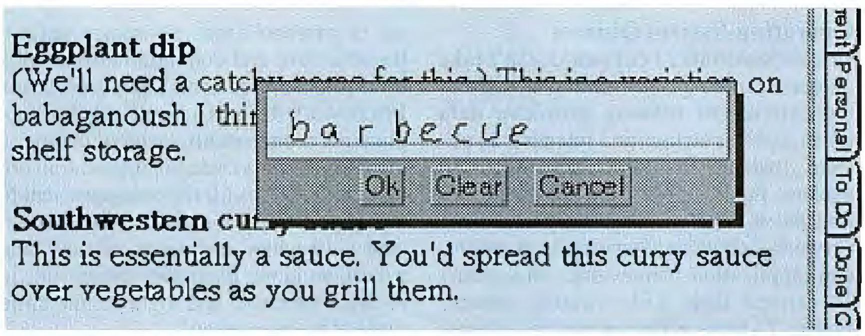
CORE PENPOINT GESTURES

Tap	·	Select/Invoke
Press-hold	●	Initiate drag (move, wipe-through)
Tap-hold	· ●	Initiate drag (copy)
Flick (four directions)	|	Scroll/Browse
Cross out	X	Delete
Scratch out	═	Delete
Circle	O	Edit
Check	✓	Options
Caret	∧	Insert
Brackets	[ ]	Select object, adjust selection
Pigtail (vertical)		Delete character
Down-right	L	Insert space

Figure 1: *Basic pen gestures recognized by PenPoint. The gestures indicate both what you want to work with (the operand) and what to do (the operation) in the notebook. They are also location-dependent: A circle drawn on a writing pad has a different meaning than a circle sketched in a drawing application.*



Screen 2: *Deleting a word with the pen.*



Screen 3: *The writing-pad object, for inserting text. As you print on the writing pad, a background process performs character recognition.*

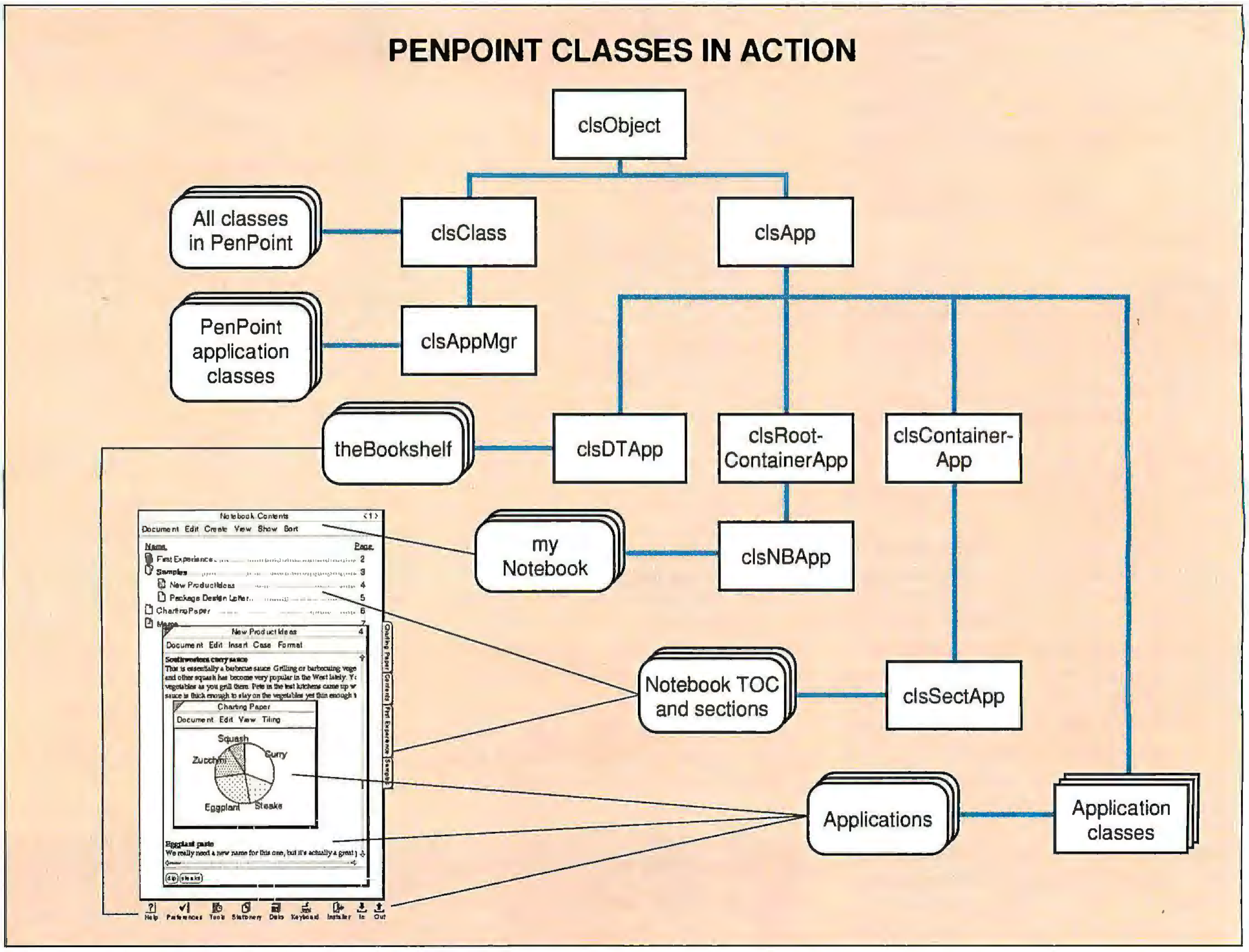


Figure 2: *The hierarchy of bookshelf, notebook, section, and application in the PenPoint NUI is a direct reflection of the PenPoint class hierarchy.*

Operating-System Objects

Unlike Smalltalk, PenPoint doesn't take object-oriented programming (OOP) to the extreme of treating primitive data types, such as strings and integers, as objects. Instead, PenPoint uses objects to package public application programming interfaces. The window, graphics, file, network, input, handwriting-translation, and application-framework subsystems all express their APIs through classes. Figure 2 shows a few of the 250 classes and 1500 messages that are available in PenPoint.

Only PenPoint's lowest layer, the kernel, is accessed via function calls. The result is the best of both worlds: The architecture has the modularity and flexiblity of an object-oriented system, while most subsystems and key algorithms are in traditional C code and benefit from its speed of execution.

All PenPoint applications must adhere to PenPoint's Application Framework, a set of protocols that rigorously defines the structure and common behavior of a PenPoint application. The Application Framework defines a set of standard application components, which comprise the application's code, an application object that receives all the messages sent to the application, a resource file, an instance directory, a process window, and a main window. Each application runs in its own process, and lightweight child threads are supported.

Through the Application Framework, applications inherit a wide variety of standard behaviors. Some of these behaviors include document properties, gesture recognition and response, moving and copying data, live embedding of other applications, printing, spelling checking, search and replace functions, and on-line help. New code is required only to add new functions or to modify (i.e., override) specific aspects of an object's default behavior. Applications automatically save their internal state in a directory. There is no need for you to save or load the application's state explicitly from one session to the next.

In addition to normal applications that run when you turn to their specific page, PenPoint provides a well-defined service manager architecture that supports background server applications, such as databases and network connections. Applications can query PenPoint as to the presence of services and then establish message-passing connections to them.

Embedded Document Architecture

One unique aspect of PenPoint's Application Framework is its Embedded Document Architecture, which provides the ability to embed a live instance of one application inside other applications. For example, a text document can, without any special programming, embed any other PenPoint application, such as a spreadsheet or a business graphics

application, within itself.

Screen 4 shows a text document with two applications embedded in it: a live, running drawing program and a live, running signature pad (the latter is a built-in object in PenPoint). The result is that all PenPoint applications can provide a true compound-document capability in which you can seamlessly mix and match applications.

Other operating systems copy static data from one application to another. This usually requires that the receiving application accept a variety of data formats from the Clipboard and Dynamic Data Exchange transfer mechanisms. While PenPoint supports this transfer mode for pure data, the norm is for the receiving application to simply embed an instance of the application that already knows how to edit and display the data.

PenPoint's implementation uses live application embedding. The entire notebook metaphor and user interface are implemented as a set of bundled system applications. Although you simply see these collectively as "the notebook," they are, in fact, distinct applications.

The application hierarchy behind the notebook starts with a notebook application that is the hierarchy's root. This notebook application, in turn, embeds each application that represents a document (i.e., page) in the notebook. The notebook application embeds section applications for each section in the notebook. The sections, in turn, embed other applications and sections.

PenPoint uses the notebook for several of its specialized user interfaces that require structure and navigation: the Create, Help, and In Box/Out Box subsystems are all instances of the notebook application. The notebook architecture also supports multiple notebook instances, such as notebook subclasses that are RAM-resident or disk-based.

Mobile Connectivity

With laptop computers, you typically have to wait until you have a connection to a network, telephone line, or printer before using an E-mail, fax, or print command. Therefore, you have to go through the clerical work of keeping lists of those files that need to be sent or printed. But it is much more efficient to address an E-mail message as soon as you finish composing it. Your mind is free to handle the next task while the computer performs the task of tracking pending operations.

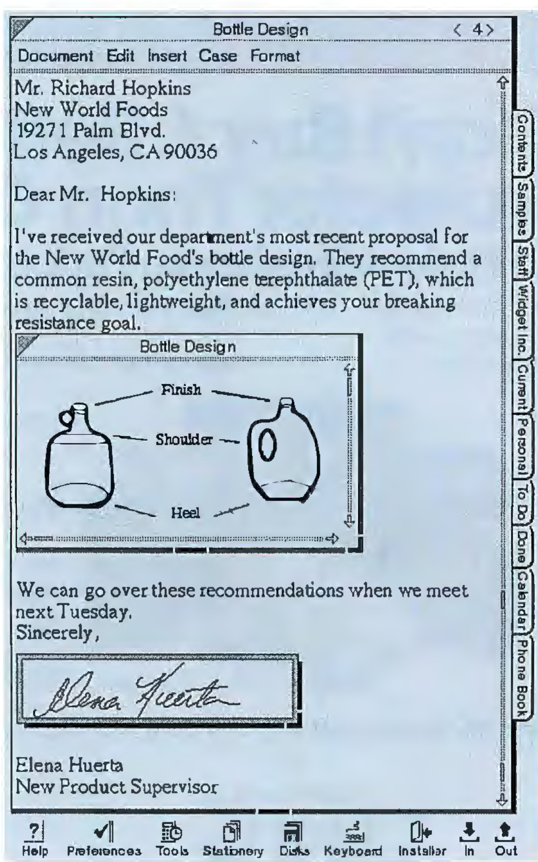
Mobile pen-based computers can connect and disconnect many times a day to different computers and networks. For this reason, PenPoint supports multiple "auto-configuring" network *protocol stacks* that you can dynamically install without having to reboot the operating system. A protocol stack is a layered set of protocols, each of which handles a specific communications task (e.g., establishing and maintaining connections, transporting data, and presenting data to the application). With PenPoint, you can install and configure devices, device drivers, and network protocol stacks on the fly.

The file system is a strict superset of the MS-DOS file system; all PenPoint-specific information is stored as an MS-DOS file within each MS-DOS directory. At the same time, PenPoint provides many of the standard features of traditional file systems, including hierarchical directories and extended features, such as 32-character filenames, memory-mapped files, object-oriented APIs, and client-specified attributes for files and directories. This approach is used for mapping to other file systems as well. Additional installable volume types are also supported; these include RAM volumes, remote volumes (for access to PC, Macintosh, and file servers), and a Macintosh Hierarchical File System volume.

Once PenPoint gives an application access to an MS-DOS or Mac file, it is ultimately the application's responsibility to read and write specific data formats. PenPoint builds in a standard import/export architecture and user interface to allow applications to share common file-format filters and to standardize the invocation of these filters. As a result, you can point to a desktop file right from PenPoint's screen, convert it automatically into a PenPoint application's internal format, edit the file, and then write the file back to the desktop computer in an existing format, all with just a few taps of the pen.

You can establish and break network connections at will by plugging in or unplugging cables or by walking in and out of the range of wireless communications. PenPoint provides automatic connection and detection management. Its applications handle breaks gracefully, suspending all interruptible operations until the connection is reestablished.

However, mobile pen-based computers are often incommunicado. PenPoint therefore builds in native support for deferred data transfer through its In Box and Out Box architecture and user interfaces. Out Box is a central extensible queuing service for all connection-dependent transfer operations. You can



Screen 4: *Two applications, a drawing program and a signature pad, embedded in a text application.*

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Impressions of GO and PenPoint

Owen Linderholm

To provide a platform for software development, GO Corp. has developed a pen-based notebook computer for developers to use with the PenPoint operating system. This GO hardware system looks exactly like a thick standard-size notebook—until you open it. Inside, it looks more like a large laptop LCD than a computer. You can also use a 386 system with a digitizing tablet with PenPoint.

The Hardware

This development system is shaped like a sheet of paper with a screen on its surface. I/O connections and some simple controls are on the sides. The screen, approximately 5½ inches wide and 8 inches high, is on the front of the unit.

The computer also holds the input stylus, a cordless device that looks almost like an engineering pen or pencil. The stylus interacts with an electromagnetic field that passes across the surface of the screen. Thus, the system can tell where the stylus is and whether it is touching the screen.

The system I saw was based on a 16-MHz 286 with several megabytes of memory, and it had a port for plugging in an external floppy disk drive. GO expects final PenPoint-based systems to use the 386 architecture (perhaps initially the 386SX). These systems will require fairly large amounts of RAM, perhaps as much as 4 MB.

PenPoint itself takes up a lot of memory space, and the system will probably keep most of its data in RAM during daily use. Then when you return to your desktop system, you can save the data to a central or more permanent system. However, PenPoint stores application data very compactly, and 1 MB of RAM can hold about 100 pages of mixed textual and graphics data.

PenPoint-based systems will probably have some form of mass storage: either a small 2½- or 3½-inch hard disk drive, or perhaps flash-memory cards that you can remove and reinsert. Other possible peripherals include modems, fax modems, and LAN connections, both wired and wireless.

The Software

A lot of the design of PenPoint and the systems that will use it is based on changing the status quo. Existing laptops are seen as cut-down versions of desktop systems that are not useful in situations calling for true portability.

GO's design for PenPoint presents a new paradigm. It completely eliminates the standard mode of input for existing computers—the keyboard. It is designed in such a way that using the system really is like writing on a notepad.

An idea that I heard discussed at GO is a note-taking application that would allow you to simply take notes as you would on a pad of paper. Those notes would appear on the screen exactly as written, including corrections, annotations, and sketches. The application would store them until later, when you could review and edit them and selectively convert them to computer form via the built-in handwriting recognition. You could also enter diagrams and sketches into a drawing package.

This type of application would allow the computer to literally function as a pad of paper while you use it in public. Then, at a later time, it would take advantage of the data storage and analysis capabilities of a desktop computer—something no traditional laptop system could hope to do.

Perhaps PenPoint's most impressive feature is its ease of use. Although advanced users may feel comfortable typing, far more people know how to use a pencil than know how to type. GO has added a few stylus "gestures" in PenPoint that correspond to standard pencil use. These gestures are intuitive and easily learned—crossing something out deletes it, for example.

The Users

Using the system and its controls is difficult to describe, perhaps because it is so natural. The notebook metaphor with tabs and a table of contents is obvious and elegant. Just about the only concept that new users must grasp is that pointing the stylus at something is equivalent to saying "go right to this." Due to pen-based computers' ease of use and true portability, GO believes that by the end of the 1990s, the market for them will be as big as the market for desktop computers is now.

One area in which PenPoint systems will be used is for light data entry, which would entail writing letters rather than books, filling in forms with a mixture of words and multiple-choice selections, calculating totals on data entered into a form, and sketching basic designs rather than modeling them in exact detail. Where pen-based systems in general—and PenPoint in particular—will excel is in the vertical applications area. Two of the software companies founded expressly to write software for PenPoint—Slate and PenSoft—both believe this strongly and are at work on applications to allow users to customize systems for their own particular vertical markets (see the text box "Pen-Based Applications" on page 220).

The object-oriented nature of PenPoint makes this customization easy to do. Applications can use services within PenPoint freely by instantiating them. In addition, applications can use each other. PenPoint uses the notion of pieces of stationery—virtual electronic paper that has a structure. Each piece of stationery can have areas within it that are designed so that different types of applications can use them.

For example, a piece of proposal stationery could have separate spaces for text entries and graphical or drawing entries. Any application that has been identified as being able to handle a particular kind of stationery could write to these areas—a word processor in the text-entry space, and a drawing package in the graphics area.

This object-oriented structure extends throughout the operating system, making it easy for applications developers to replace PenPoint services with customized services of their own. This makes it easy for developers to write applications that you can customize in many ways: for example, combining the flexibility of programming a spreadsheet with a database form-entry design that includes graphical data entry.

A Computer for Everyone

All this flexibility in the applications software area is made possible by using a computer that really is as easy to use as a notebook—for everyone. There is still a long way to go, however. No other companies have produced compatible hardware systems yet, despite considerable help from GO, which lets them use the information it has gained from making its development system.

Nevertheless, GO has shown that pen-based computing is possible and that uses for such systems do indeed exist. What remains to be seen is whether people are ready for a truly usable portable computer.

Owen Linderholm is a BYTE news editor. You can contact him on BIX as "owenl."

install transfer-agent services that extend the Out Box to work with specific destinations, such as printers, file transfers to other computers, E-mail protocols (e.g., MCI Mail and Mail Handling System [MHS]), and faxes. The user interface for the Out Box is a small floating notebook that provides a section for each Out Box transfer service.

Outbound information needs addressing, and PenPoint has built-in standard Print and Send commands that allow communications services to be tightly integrated with PenPoint applications. The Send command brings up extensible addressing mechanisms that let you send a single document to multiple destinations. PenPoint provides a standard address-book API that lets you use your favorite address-book application to store E-mail and fax information along with any address-book information that you want to keep.

Few people have the time to read all their E-mail at their desk when they're plugged into the network. PenPoint's In Box accumulates all received E-mail and faxes so that you can disconnect from the network and peruse them during the odd moment between meetings or at home in the easy chair. The In Box architecture is symmetrical to that of the Out Box and is similarly extensible by installable transfer services.

PenPoint and Hardware

Within a few years, mobile pen-based computers will be available in a wide range of sizes and configurations. Standard sizes will start with today's classic notebook form factor: about 8½ by 11 inches, with a full-size screen. Smaller steno-pad and shirt-pocket sizes will become popular for those users who believe that ultimate portability is of utmost importance and page-size screens are not necessary. Larger desktop "visual tablets" that attach to standard PC architectures will serve the desktop pen-based market.

The smaller steno-pad and shirt-pocket pen-based computers will typically require a *one-tiered* memory architecture. That is, they will have RAM but no backing store (i.e., hard disk drive). The larger computers will often be more traditional *two-tiered* architectures with RAM and backing store.

Desktop computer operating systems were designed around a large, inexpensive backing store. Therefore, they run poorly (or not at all) in one-tiered hardware; or they require prohibitively expensive amounts of RAM, to simulate disk space, or ROM, which is difficult to

Pen-Based Applications

Owen Linderholm

The pluses of pen-based computing are many. For one, a pen-based computer will make it easier for a wider range of people to gain access to computers than can use them today. However, the minuses exist as well. In fact, the biggest problem facing developers isn't hardware, it's software. It will take a revolution in mind-set to change software developers' thinking to address the issues raised by using a pen rather than a keyboard.

The major PC software companies, such as Word Perfect, Lotus, and Borland, have announced an interest in developing software for the GO PenPoint operating system. Currently, though, the most interesting developments in the new pen-based community are coming from start-up companies whose bread and butter depends solely on pen-based software.

Two of these, PenSoft and Slate, are tied very closely to GO; in fact, their offices are within 1 mile of GO's facility. Both are taking the same fundamental approach: Software for pen-based systems must be designed from scratch.

Perhaps the biggest reason for this approach is a simple but very fundamental observation: Pen-based software neither needs nor uses a cursor. The idea of a cursor, along with all its associated block operations, is redundant in pen-based systems. A new concept replaces it: directly manipulating objects with gestures.

Both PenSoft and Slate recognize that working with PenPoint requires adopting and adding to the object-oriented, layered nature of the operating system. Products for pen-based computing need to be designed around pen entry rather than by simply trying to layer pen entry on top of an existing keyboard-based application.

Slate and PenSoft recognize three major arenas of applications that are suited to run on these systems. The first is software that already exists and will be ported. This is where such companies as Lotus and Borland are known to be working and is of the least interest to the new companies.

PenSoft

The second arena is applications that currently exist on PCs but aren't yet truly successful. For instance, PenSoft is working on a personal information manager (PIM) that will make full use of the pen-based capabilities of PenPoint.

The big advantage of having a pen-based system as a PIM is that you can carry it around and use it all the time. Everything you write down is entered into the PIM, and you can rapidly and naturally keep track of all kinds of information, including notes, contacts, phone numbers, and so forth. (PenSoft's product won't be available until final hardware systems using PenPoint ship, hopefully sometime this year.)

Slate

The third arena is for completely new software that either was impossible or had not been thought of before pen-based systems appeared. This is where Slate is headed with its Professional Application Development System (PADS). Slate expects that a great deal of the early demand for pen-based systems will be generated by vertical market applications, especially those based on collecting and distributing data using forms.

PADS is intended as a framework for third-party developers to create custom pen-based applications for PenPoint. PADS is based on a sophisticated database engine that transparently recognizes, reads from, and writes to a wide number of database formats, including dBASE and several popular mainframe formats. This database-engine layer filters data between remote databases and individual PenPoint-based systems.

Pen-based systems accept data and use a forms-based interface to display it and interact with it. This forms interface consists of two parts: a user interface and a forms user-interface designer. The interface looks like a form that is truly electronic and smart. You can query it and have results displayed as collections of forms. You can fill in one field and have others filled in intelligently for you.

The designer section allows the developer to customize forms and lay them out, assign database fields, and perform sophisticated searches, links, and pattern matches. It also allows the addition of intelligent fields that look up data and perform calculations.

Slate wants all PenPoint programs to use the database engine for PADS. It is installed as a standard layer that uses the object-oriented capabilities of PenPoint. Thus, PADS makes all the features of the database engine available to all applications. This object-oriented technique lies at the heart of what GO is trying to do with PenPoint: make appli-

update. Although small applications exist for disk operating systems, most of the best-selling applications typically require several megabytes of disk space apiece.

In contrast, PenPoint is designed to run as a standard operating system on a full range of pen-based hardware, and it runs very well on both one-tiered and two-tiered memory architectures. PenPoint builds in paged virtual-memory support, allowing it to work efficiently in architectures that include backing store, such as desktop hard disk drive-based systems. With PenPoint, you can choose between small RAM-only machines and slightly larger machines with or without hard disk drives.

PenPoint Applications

Although the notebook metaphor may give you the impression that all installed applications and the operating system are part of a seamless whole, the two are, in fact, cleanly separated. This allows easy distribution, installation, and deinstallation of PenPoint applications by third parties.

PenPoint is a compact operating system, and its applications are even more compact. PenPoint's object-oriented design achieves its compactness through a high degree of code sharing. Furthermore, it keeps only a single copy of code in the computer. This is possible because PenPoint relocates executable code at application installation time, not at application load time, as is traditionally done.

For applications that are relocated into memory at load time, there must be an additional copy of unrelocated application code on the disk. This, in effect, cations and services available across the PenPoint operating system to all other applications.

Slate took further advantage of the object-oriented nature of PenPoint in designing its user interface. The company has added a number of user-interface techniques to PenPoint that make the interface even more intelligent and easy to use. One of these techniques is called *targeting*. This technique helps PADS recognize where a gesture was intended to be, even when it is sloppy or too large.

For example, in PenPoint, you draw a cross to indicate a selection that you wish to delete. Slate has extended this so that a huge, hastily drawn cross can be interpreted as deleting a relatively small field on a form. The Slate technique recognizes where the center of the cross was drawn and what the closest field to that point is, and it can therefore ascertain what you wish to delete. Although this technique may not sound very useful, in practice it becomes easy to delete fields.

Another use of targeting is in data entry. It can be very tedious to fill in complex forms and always keep your writing in the small boxes provided. PADS lets you enter data by writing input letters that are much larger than the intended field and extend across the page. The program spots that the data starts in a particular field, and once you enter the data, the program puts it into the appropriate field. This is a great boon when you need to move around while entering data.

Slate also includes *smart fields* that pop up "pick lists" of available choices. As you enter more data, these pick lists grow to include any recently entered values. They cut down on the amount of writing that you have to do. The programmed fields will look up data to go with values that you have already entered. In this way, PADS often allows you to complete complex forms by entering only a few data values.

These kinds of technical innovations are the sorts of changes that GO hopes will occur as pen-based computers become more accepted. They are also changes that are difficult for standard software companies to make, since they are concentrating on keyboard-based software.

The developer's version of PADS should be available by the time you read this. A commercial release intended for end users as a "pen-based dBASE" is planned for release later this year.

Ease of Use Is Key

Companies like PenSoft and Slate are relying on the pen-based market to be radically different from that of regular desktop, keyboard-based PCs. They are also doing their best to make sure that pen-based computing really is an intuitive and realistic alternative to keyboard-based computing.

If the pen-based market materializes, then companies like PenSoft and Slate will be well positioned for the future. However, the key to this lies in whether lots of first-time computer users will be attracted to them.

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doubles the total storage requirement. In contrast, once PenPoint installs an application, only a single copy of its code (the relocated executable) resides in the PenPoint machine until you deinstall it.

PenPoint's standard for application distribution is 3½-inch 1.44-MB MS-DOS floppy disks. Every PenPoint-capable machine has access to a 3½-inch floppy disk drive (either built-in, via a base station, or through an MS-DOS desktop PC).

When you place an application-distribution disk into the floppy disk drive, the operating system automatically senses it and brings up an application-installation dialogue. If you then confirm that you want to install or update the application, all the requisite application code and resources are installed in the PenPoint machine. Application code is relocated at this time. PenPoint will also ensure that all the classes that the application requires are installed and are of the correct version.

The bottom line is that PenPoint, with several installed applications and user data, runs very well on a computer with only 4 MB of semiconductor memory and no backing store at all.

Current Status

The first commercial version of PenPoint runs on the Intel 386 processor in its native 32-bit flat-memory mode. The operating system provides basic software support for hardware connections through a high-speed serial link, an RS-232C port, a parallel port, and a SCSI port. The first remote file system to be implemented on PenPoint is TOPS, which provides strong connectivity to both PCs and Macs. (For a first-hand impression of PenPoint, see the text box "Impressions of GO and PenPoint" on page 218.)

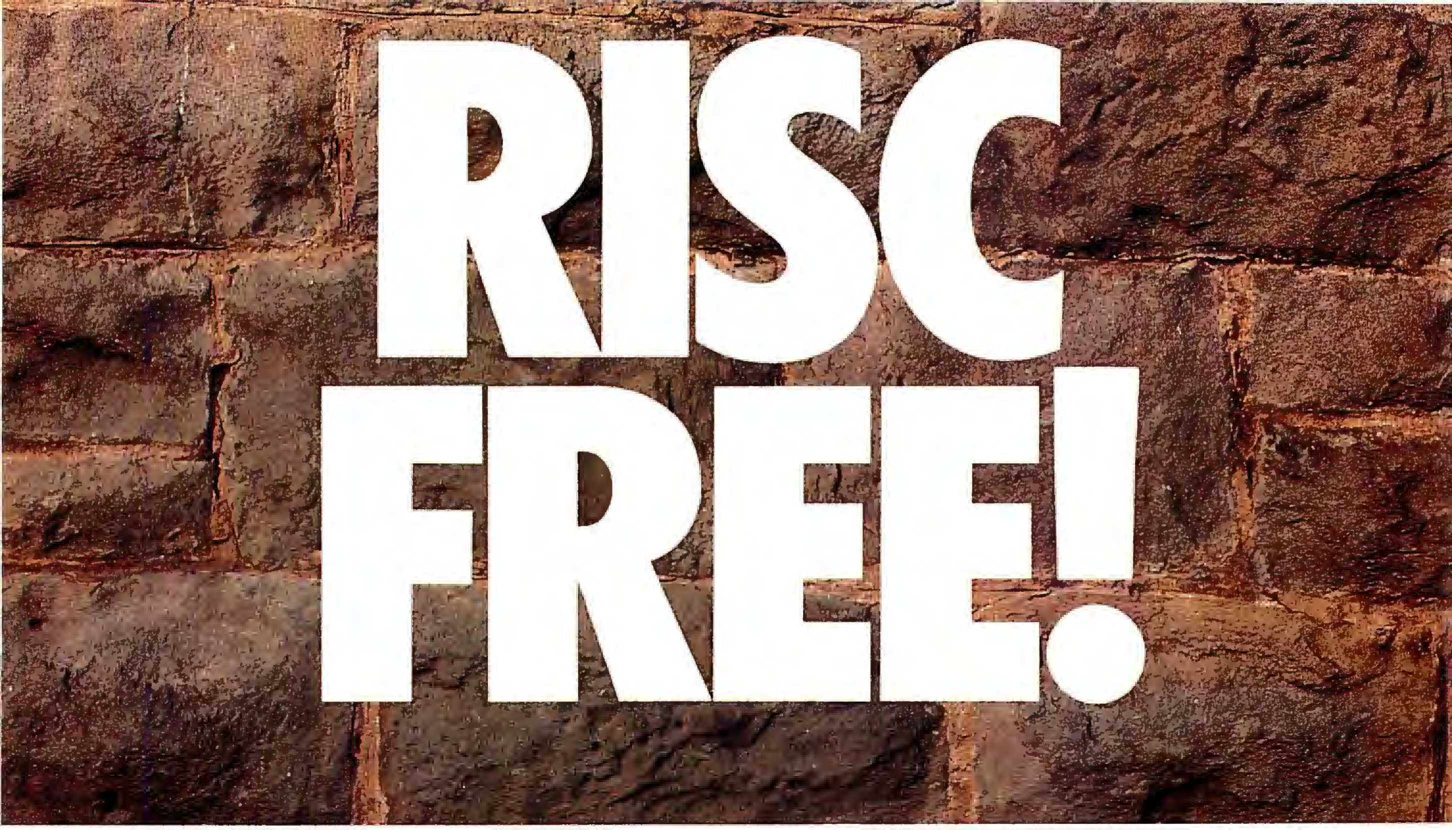
PenPoint application programs are written in ANSI C using standard IBM PC development tools. You can debug the applications using a source code symbolic debugger with PenPoint running on either a desktop PC or on the target pen-based hardware.

You implement the OOP techniques by making C function calls into PenPoint's Class Manager subsystem. Because the operating system is written in C and is designed for portability, it can be transferred to a variety of other processor architectures, including high-performance, low-power RISC chips. (For a look at some newly announced applications for PenPoint, see the text box "Pen-Based Applications" at left.)

PenPoint was developed by GO, a company that was founded in 1987 to develop general-purpose, mobile, pen-based computing. To date, approximately 85 worker years of development effort have been invested in the operating system. GO's approach to developing the pen-based market is to form partnerships with a wide variety of computer hardware and applications software companies. In July 1990, GO announced that IBM was PenPoint's first licensee, and IBM announced that it was developing a computer designed expressly for PenPoint.

The only proposed alternative to PenPoint for mobile pen-based computing is to adapt existing desktop GUIs by adding a "pen-compatibility box" that would emulate the mouse and the keyboard. Such a minimally adapted GUI remains trapped by its heritage: It offers all the complexities of the keyboard and few of the benefits of the pen. In contrast, PenPoint proposes a fresh start: the simplicity of the pen. ■

Robert M. Carr is vice president of software at GO Corp. (Foster City, CA). He can be reached on BIX c/o "editors."



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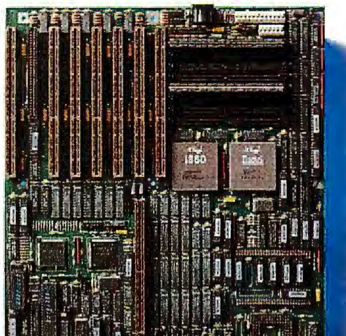

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Touch-and-Feel Interfaces

Built-in pointing devices replace mice in notebooks and laptops

Andrew Reinhardt

In comparison to the cumbersome toggle switches and punched-card readers of the past, the keyboard was a huge breakthrough in human-computer interaction. Typing is a fairly efficient and familiar process, and keyboards require relatively little processor overhead or esoteric, expensive technology.

But designers of notebook computers confront an inherent problem with keyboards that is a function of human physiology: Fingers are only so small. The tiny Poqet portable, measuring 8¾ by 4⅓ inches, pretty well defines the minimum realistic size for a keyboard; anything less is impractical for word processing or other text entry. So, making computers still smaller and lighter will eventually require abandoning the keyboard for some other input scheme.

Equally important, the keyboard, for all its popularity, is still a very unnatural interface. Typing requires training, produces data-entry errors, and demands a lot of elbow room—and it's not well suited for increasingly prevalent graphical user interfaces. Laptops of the near future will have to include built-in pointing devices to support GUIs.

Aside from alternative pointing devices, there are also emerging *input* alternatives that will once again radically alter the nature of human-computer interaction. The most immediate is handwriting recognition, available now in the Grid Systems Gridpad, the Scenario DynaWriter, and a few other portables. A slew of new notebooks that recognize handwriting are expected this year from companies such as GO, Momenta, Superscript, and NCR, and software start-ups such as Slate are aiming to develop a new class of pen-based applications. (For more on pen-based computing and GO, see "The Point of the Pen" on page 211.)

In the more distant future, desktop and portable computers may be able to recognize speech, which is the most intuitive interaction of all. Alternatives to keyboards need a lot more horsepower—in the case of speech recognition, perhaps hundreds of millions of instructions per second. Current research in digital signal processors and neural networks may reduce the raw processing power required by today's brute-force pattern-matching voice-recognition schemes, but, even so, it will be some time—perhaps five to 10 years—before it will be practical to talk to your laptop. (For more on voice recognition, see the State of the Art section on Computing Without Keyboards in the July 1990 BYTE.)

Making a Point

The shift from character interfaces to GUIs implies the need for a pointing device on every computer. For desktop

ILLUSTRATION: DAVE CUTLER © 1991

Photo 1: *The Mac Portable offers a built-in trackball, which can be moved to the left of the keyboard for left-handed users or replaced with a numeric keypad. Trackballs are gaining popularity on the desktop, but they may demand too much space to be feasible for notebook computers.*

Photo 2: *Psion's MC400 laptop incorporates a touchpad that lets you "point and drag" with your fingertip. The touchpad's aspect ratio is different from the screen's; it had to be squeezed in above the keyboard, so its horizontal resolution is about twice its vertical resolution.*

systems, the choice is usually a mechanical or optical mouse, although space-saving stationary trackballs are also a popular option. One noteworthy trend is the increasing popularity of digitizing tablets or digitizer/mouse hybrids, such as the Wiz from CalComp (Anaheim, CA). These devices are gaining some acceptance outside of CAD/CAE as general-purpose pointers.

But for a laptop or notebook computer, a mouse or digitizer is often impractical. It's a hassle to carry around that extra piece of equipment, and a mouse requires a smooth surface to work on. Anyone who has ever seen a laptop user on an airplane rolling a mouse up his or her leg will understand the problem. System vendors are thus considering other, built-in pointing devices, including mini-trackballs, touchpads, touchscreens, the Isopoint, and the Home Key.

• *Trackballs*: The Mac Portable (see photo 1) was the first laptop designed explicitly to run a GUI, and the engineering trade-offs required to achieve that capability are evident. Apple needed a mouse substitute, so it provided a built-in trackball. To avoid the ghosting typical of conventional LCD screens, Apple used a cutting-edge active-matrix display that was thick, heavy, and expensive. The result was a machine that succeeded as a Mac but failed as a portable.

The problem with mini-trackballs in laptops is that they use a lot of space but don't perform as well as their deskbound cousins. To be effective, a trackball has to be large enough to roll around your palm and heavy enough to acquire momentum. Apple's trackball is a nice size, but if it were any smaller, it would become a fingertip device and require too many revolutions to move the cursor from one side of the screen to the other.

• *Touchpads*: Psion has taken a different approach with its MC200 and MC400 laptops (see photo 2). Built into each system above the keyboard is a $5\frac{1}{2}$- by $1\frac{7}{8}$-inch resistive-membrane touchpad that uses a finger as a pointer. The touchpad adds very little weight to the system, but it consumes a lot of surface area. Its main drawback may be lack of comfort. It can be awkward to use, since you have to reach up over the keyboard to get at it. And although the touchpad's resolution matches the screen's, pointing at individual items accurately can be difficult. The finger is, after all, a fairly blunt instrument. Psion isn't the only company to use touchpads. Key Tronic makes a standard keyboard that includes an optional multi-mode touchpad for pointing and choosing or freehand drawing.

• *Touchscreens*: Scenario makes a 286 portable called the DynaVision (see photo 3) that packs a double punch: It includes a built-in CD-ROM drive, and it uses a touchscreen as its primary input device. (A keyboard and mouse are available as options.) Although the system runs DOS programs, Scenario also sells a development package for creating special touchscreen applications.

Scenario's touchscreen uses surface acoustic-wave technology. High-frequency acoustic waves are propagated over the surface of the glass screen, and the dampening of the waves by a fingertip determines the *x*, *y*, and *z* coordinates. The resolution is 25 dots per inch across the screen, or about 40,000 points, each of which can resolve up to 16 levels of pressure.

The primary benefit oftouchscreens is directness of interaction. Your finger becomes the cursor, and you can make selections without the intervention of an external pointer. The drawbacks are, typically, added weight and power consumption, slower response times, and lower resolution, which makes touchscreens impractical for drawing applications.

Most problematic is that touchscreens can be awkward to use. Your arm is typically outstretched and can easily tire, while your fingertip obscures the display—you have to pull it away sometimes to read screen text and icons. And touchscreens are inadequate for sustained text entry. But, as their popularity in information kiosks attests, touchscreens are very nonthreatening to novice users.

• *Isopoint*: One of the most promising new pointing devices is the Isopoint, invented by Craig Culver of Culver Research (Woodside, CA). The Isopoint is a small, sliding cylinder positioned between two selection buttons. To move the cursor from side to side, you move the cylinder back and forth with your thumb; to move the cursor up or down, you spin the cylinder. The Isopoint, manufactured by Alps (San Jose, CA), is now being used in two portables: the Outbound Systems laptop (see photo 4) and the Gridcase 1550SX (see photo 5).

Outbound's ingenious Mac-compatible laptop takes a different approach than the Mac Portable, using a conventional LCD to reduce cost and weight, and employing an Isopoint to save space. The Outbound's Isopoint is an earlier version than the one used in the Gridcase and is somewhat bigger and bulkier. The Isopoint used in the Grid looks to the system exactly like a Microsoft Mouse.

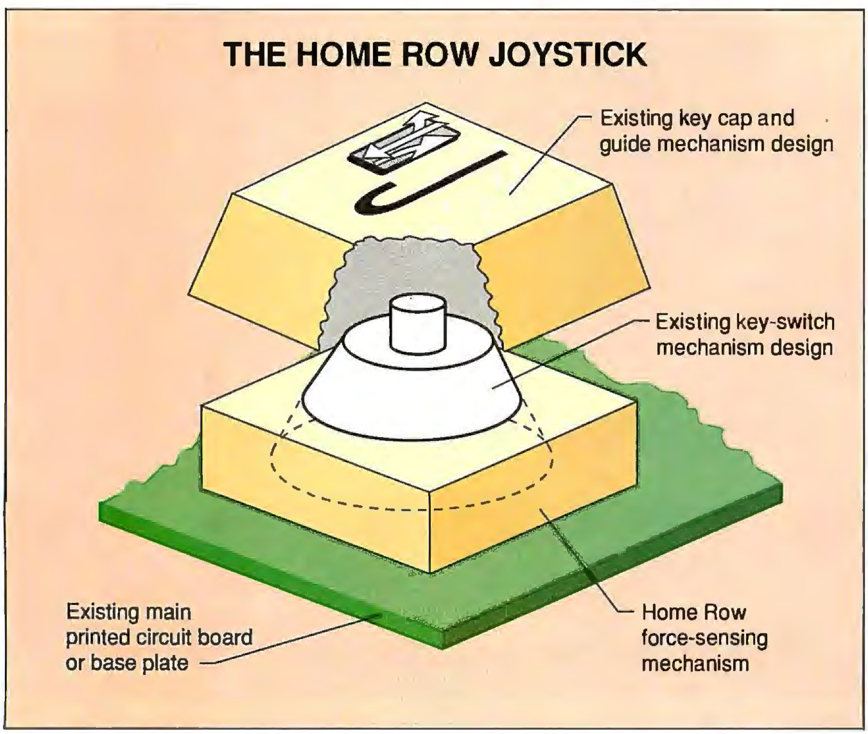
The Isopoint is a displacement, or position-sensing, device, which means that you can whip it from side to side and move the cursor equally fast. Yet Culver himself terms it only a partial success; he is working on other devices that will provide even more tactile feedback and will be both easier to use and more precise, especially for drawing.

• *Home Row*: Another mouse alternative that is sparking interest among laptop makers is the so-called Home Row or KeyMouse (see the figure), a miniature joystick hidden beneath the *J* key. Under

Photo 3: *The Scenario DynaVision (formerly the DynaBook) is a portable information retriever with a built-in CD-ROM drive, glass touchscreen, and "point-and-shoot" query environment. The screen resolves 40,000 touchpoints, each of which has 16 levels of pressure. The machine also runs DOS programs with an optional keyboard.*

Photo 4: *The Outbound Systems Macintosh-compatible laptop sacrificed the Mac Portable's cutting-edge display and trackball in favor of a normal LCD and the first use of the Isopoint pointer. Outbound's Isopoint is 4½ inches long and 1 inch high, and it resolves 101.6 pulses per inch of travel. Its low power usage keeps overall power consumption to a minimum.*

Photo 5: *Grid Systems was the first company to deliver a laptop designed specifically to run Windows: The Gridcase 1550SX has a 386SX CPU and an Isopoint. Grid's Isopoint is a later iteration than the one on the Outbound, smaller in dimensions and higher in resolution. It emulates a Microsoft Mouse.*



This pointer-in-a-keyboard uses no real estate and costs nearly nothing. The Home Row is a joystick embedded in the J key; when another key is toggled, the J key rocks on its base, moving the screen cursor. Key Tronic is manufacturing OEM keyboards with this feature under the name "KeyMouse."

normal circumstances, the *J* key acts as usual, but when you press a combination of keys (Control-*J*, Caps Lock-*J*, or Alt-*J*, depending on the keyboard design and desired mode), it becomes a joystick for moving the cursor or drawing on the screen. When the joystick is activated, the *S*, *D*, and *F* keys become "mouse buttons," letting you perform mouselike functions without removing your hands from the keyboard.

The Home Row device, developed by Home Row, Inc. (Clackamas, OR), is currently manufactured by Key Tronic under the name KeyMouse and has been incorporated into notebook computers from Astarte and AEG Olympia. Its obvious advantages are very low manufacturing cost, estimated by Home Row as $3 to $5 more than that of the normal keyboard, and space savings from not needing room for a separate pointer.

The disadvantage is that Home Row is a force-sense device: Like a cursor arrow key, it moves not in proportion to displacement (like a mouse or an Isopoint), but as a function of duration. Accelerator keys let you speed up cursor movement, but you can't really zip across the screen with a stationary pointer.

A Means to an End

The trend in pointing devices, in Craig Culver's view, ought to be toward subtlety, comfort, and more complete sensory feedback. The mouse fails, because it requires gross movement of the whole arm. The trackball, like the mouse, steals a hand away from the keyboard and requires vigorous motion to move the cursor all the way across the screen.

Touchscreens and touchpads suffer from a lack of tactile feedback; they are stationary, and their surfaces are undifferentiated, so the feedback mechanism is purely visual. And none of today's options takes advantage of auditory feedback, which can subtly enhance the precision, comfort, and quality of your interaction with the computer.

It's also important to remember that these pointers, no matter what their technology, are simply designed to replace a mouse. In the words of Herman Pope, a senior engineer at Texas Instruments, "A pointing device is only a means to an end; the display itself is the user interface." Only when handwriting and voice systems come into common use will you see a shift in the fundamental user-interface paradigm. ■

Andrew Reinhardt is an associate news editor for BYTE in New York. You can reach him on BIX as "areinhardt."

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Circle 159 on Reader Service Card

LCDs and Beyond

Although liquid crystal technologies dominate the laptop display market today, the future is an open question

Nick Baran

When you think of an ideal laptop computer, you envision a machine with a high-resolution monochrome or color display readable in virtually all lighting conditions. You want one that consumes no more than a few watts of power and has large mass storage, low weight, and, most of all, a reasonable price. But this ideal laptop still does not exist. The biggest obstacle to be overcome (aside from lawyers and trade commissions; see the text box "Displays—Down the DRAM Drain?" on page 232) is the state of display technology.

Lightweight, compact, high-resolution color displays with minimal power consumption still elude display manufacturers. And the top-of-the-line displays that approach the ideal remain extremely expensive and in short supply.

For example, the Macintosh Portable uses a state-of-the-art monochrome thin-film transistor (TFT, also known as active-matrix) LCD that requires about 1 watt of power. It's a nice display, but the 68000-based machine costs around $6000. That's a lot of money for a machine based on the same microprocessor used in the original 128K-byte Mac. Compaq's new LTE 386 uses an edge-lit VGA-resolution supertwist LCD and starts at $6499. Such prices are keeping high-performance laptop machines from gaining widespread acceptance.

Supertwist and Thin Films

Generally, higher-quality laptops still use supertwist LCDs with plastic-film optical compensators that eliminate the bluish/yellow tinge that is common on standard supertwist LCDs. These "film-compensated" displays provide a white background and highly readable text and gray-scale capability. While most laptop displays offer VGA resolution of 640 by 480 pixels, Japanese display manufacturers have produced monochrome supertwist LCDs with resolutions of 1024 by 768 pixels.

Still, TFT LCDs offer major advantages over supertwist LCDs, particularly in color applications. While the conventional supertwist LCDs use strips of electrodes in the *x* and *y* directions that are shared by all the pixels on the screen, the TFT display has a separate transistor for each pixel, allowing direct addressing of each pixel and much better contrast and performance than can be attained using conventional LCDs. (For a technical description of LCD and TFT technology and other display technologies, see the In Depth section in the September 1988 BYTE.)

Shining Through

Most LCDs include a backlighting mechanism to provide readability in most

ILLUSTRATION: DAVE CUTLER © 1991

lighting conditions. Backlighting, however, is the main source of power consumption in LCDs. Apple's TFT display for the Mac Portable is reflective rather than backlit; it thus allows low-power operation, but it also limits the lighting conditions under which the display is readable. Reflective displays are acceptable in black-and-white implementations like the Mac Portable, but backlighting is a must in color LCD applications.

The need for backlighting is perhaps the biggest hurdle facing the display industry. Says David Mentley, a consultant

The need for backlighting is perhaps the biggest hurdle facing the display industry.

to the display industry for Stanford Resources, "the big power hog is backlight." For example, Mitsubishi's new TFT, 16-color, 640- by 480-pixel, 10-inch display requires 135 W. NEC's new color TFT, 640- by 400-pixel, 7-inch monitor demands 90 W.

In addition, TFT displays still face manufacturing and yield problems. They mount a separate transistor for each pixel on a glass substrate or panel. The transistor panel can therefore have as many as a million transistors. The complete display consists of layers containing the transistor electrodes and the photolithographic pattern, called the *matrix film*, which defines the color characteristics of the display. The process of manufacturing these layers is currently quite complex and time-consuming, and it's subject to high defect rates, resulting in yields of about 20 percent.

TFT and Color

A monochrome active-matrix display has one transistor associated with each pixel. With a color TFT display, each pixel comes with three transistors that define its red, blue, and green components. In addition, a TFT display adds a color filter to the LCD "sandwich."

A TFT color filter consists of alternating stripes of red, green, and blue filtering material. The stripes can be either horizontal or vertical. They overlay the corresponding transistors that control red, green, and blue color characteristics of the pixel in the active matrix.

To produce a particular color at a particular pixel, the driver circuitry of the display activates the transistor that corresponds to that color. This untwists the nematic material in the liquid crystal, letting light from the backlight pass through the crystal to the overlying filter. The light then takes on the color of the corresponding filter before passing to the surface of the display. Because the light passes through a polarizing filter, it irradiates in just one direction from the display, producing a sharper image than conventional CRT technology.

With three colors per pixel, you can create any of eight colors, depending on the state of the transistors for each pixel. Future displays will be able to generate even more colors by varying the intensity of light transmitted through each color in the filter.

Because each pixel needs three transistors, the resolution of a color display will be one-third the monochrome resolution in either the horizontal or vertical direction, depending on whether vertical or horizontal stripes are used in the color filter. The action of the color-filter layer can be deactivated, resulting in a high-resolution monochrome display.

While color TFT LCDs exhibit the crispness of monochrome TFT displays, they are even harder to manufacture due to the additional two transistors per pixel and the presence of a color filter. They also require a more powerful backlight and therefore use more power. As a result, color TFT displays, which are hand-assembled, have very low manufacturing yields. They are available in low quantities and are extremely expensive. The price to an OEM for a typical color TFT display is several thousand dollars. Despite these obstacles, Japanese companies are developing this technology.

The manufacturing problems associated with color TFT technology, however, may keep prices high enough and quantities low enough to create an opportunity for other display technologies. In the laptop display arena, TFT technology still appears to be more promising than electroluminescent or gas-plasma displays, which are often mentioned as alternatives. These displays suffer from high power requirements and poor color fidelity. Gas-plasma displays have a red-orange tinge, while color EL displays still lack a good blue phosphor, which dampens their appeal in the commercial market.

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Displays—Down the DRAM Drain?

Frank Hayes

While flat-panel displays continue to advance technically, they're facing a big setback on the commercial front. A group of small U.S. manufacturers claims that Japanese companies are dumping flat screens in the U.S.—a charge reminiscent of dumping complaints made against foreign makers of DRAM chips in the late 1980s. At that time, the Department of Commerce slapped punitive tariffs on Japanese chip makers that forced the price of memory to skyrocket. Could the same thing happen with flat-panel displays? And if it does, what will it mean for laptop makers—and buyers?

Seven Against Japan

The group of small U.S. companies behind the dumping complaint call themselves the Advanced Display Manufacturers of America. The seven ADMA members are Cherry Display Products, Electro Plasma, Magnascreen, Ovonic Imaging Systems, Photonics Technology, Planar Systems, and Plasmaco. In July 1990, the group filed a petition with two U.S. government agencies, the Department of Commerce and the International Trade Commission, claiming that a dozen Japanese companies had sold flat-panel displays for less than "fair-market value," in violation of the Tariff Act of 1930.

The Japanese companies named in the petition are Toshiba, Hitachi, Fujitsu, Matsushita Electric Industrial, Seiko Epson, Sharp, Hosiden Electronics, Kyocera, NEC, Optrex, Seiko Instruments and Electronics, and Matsushita Electronics. That list comprises a who's who of the LCD screen industry, while the American plaintiffs are small companies that for the most part make non-LCD screens like electroluminescent (EL) screens and gas-plasma displays.

The complaint involves only large flat-panel displays—those with at least 120,000 pixels. It thus includes laptop screens big enough to handle CGA or higher resolutions, but not displays for pocket calculators or those on some home appliances.

The ADMA companies claim they're in the same situation as the American chip makers whose prices were undercut by Japanese and other foreign semiconductor vendors half a decade ago. Then, demand for 256K-bit DRAM chips was heavy—so heavy that even the booming U.S. semiconductor industry couldn't supply enough.

Foreign chip makers began to master DRAM production techniques and joined in the market. In fact, between climbing PC sales and the prospect of a memory-hungry OS/2 on the horizon, the projected market was so great that in a matter of months, dozens of foreign chip factories began producing DRAM chips.

But when sales of PCs slacked off, there was suddenly an oversupply of DRAM chips. Memory chips glutted the market, sparking a price war—a bonanza for PC buyers, but a catastrophe for American semiconductor companies. Those chip makers complained to the government that the foreign chips were being dumped. Despite protests by computer companies, the government agreed, imposing tariffs and penalties against foreign chip makers that sent the price of DRAM chips temporarily skyrocketing.

However, the tariffs didn't revive the sagging U.S. DRAM-chip industry. Companies such as Intel, which had once done a sizable part of its business in memory, abandoned the market for more lucrative areas, such as microprocessors. A few large companies continued to turn out memory chips for their own use (most notably AT&T and IBM), but the only remaining major U.S. suppliers of DRAM chips are Texas Instruments, which sells much of its production to IBM, and Idaho-based Micron Technology.

In fact, so completely did American companies abandon the memory market that, when a government-sponsored consortium called Sematech was formed to manufacture American DRAM chips, U.S. companies refused to come up with sufficient funding to start production.

No Price War

Unlike DRAM chips, where U.S. memory makers lost their market in a price war, flat-panel displays have never been a strong point for American companies. The most common displays—and the ones most in demand because of their easy readability and low power requirements—are LCD screens. Liquid crystals were first discovered by researchers at RCA in 1963, but American companies didn't pursue the technology. The Japanese companies did, though—in particular Sharp, which introduced a calculator with an LCD screen in 1973.

Since then, the LCD market has largely belonged to Japan. American companies have introduced alternative flat-panel technologies, such as gas-plasma and EL displays. Except for sales to the Department of Defense, however, American companies haven't made much headway. Japanese companies have used their lead to develop LCDs into larger and easier-to-read displays: supertwist, active-matrix, and, most recently, color.

And unlike with DRAM chips, the flat-panel business has seen no price wars. In fact, until recently, the high cost of flat-panel displays made laptop computers significantly more expensive than comparable desktop models. Manufacturers have had trouble keeping up with the demand, especially for the higher-quality screens. Apple, for example, went to Japan for the Mac Portable's active-matrix LCD screen and still had trouble getting the quantities that it wanted.

Other U.S. computer companies also say they've had to go to the Japanese to get LCD technology in the size and quantity they need. And even Zenith, which has bought non-LCD flat-panel displays from U.S. manufacturers such as Planar Systems, says it has had trouble getting those screens in the quantities it requires.

Thus, if Japanese companies have dominated the flat-panel display business for years—and there's more business than Japanese *or* American companies can handle—why is there suddenly an antidumping complaint? American display makers say prices have dropped so low they can no longer make enough profit to stay in business. But other recent government actions may have as much to do with the petition as the continuing decline in prices.

First, until recently, some American flat-panel makers have contented themselves with selling primarily to the Department of Defense, whose "cost-plus" contracts guaranteed a profit for military suppliers. But between deficit-trimming budget cuts and the easing of Cold War tensions, there haven't been as many military contracts available. In addition, some flat-panel makers were hoping they'd get government subsidies to help develop high-definition television. But hopes for government support of HDTV development were put on hold when Congress failed to vote for it in 1989.

Dumpsters?

Are the Japanese companies dumping? That depends on your definition. The most common definition (and perhaps the least accurate) is "selling a product for less than it costs to produce." Actually selling a product at a loss is unusual, simply because it can't go on for long. If a company loses money on every item it sells, it will soon go out of business.

Another definition is "selling products for less than a fair price." What a fair price is, of course, is the big question when it comes to dumping complaints. If a Japanese company sells a display for less in the U.S. than in Japan, is the U.S. price unfair? (The accused companies say their pricing is based entirely on business issues such as market conditions and order size.)

Is the price too low if a company chooses not to soak early customers for the cost of developing the technology and earns back its development costs over, say, a decade instead of a year? (Japanese companies point out that, like many large American companies such as IBM and AT&T, they pay for long-term research over a long period of time. But the Department of Commerce insists that "fair pricing" requires that the development costs be paid off in a short time—sometimes as little as a year.)

The Japanese companies complain not only that they're penalized with a double standard, but that they can't even tell when they have violated fair-price guidelines. Under the Tariff Act of 1930 (a protectionist law passed at the start of the Depression in hopes it would shield American jobs from foreign competition), the Department of Commerce refuses to tell foreign companies—or anyone else—the formula used for determining fair prices.

At the International Trade Commission's hearing on the dumping complaint last August, representatives of the Japanese companies also pointed out that LCD screens shouldn't be lumped in with gas-plasma or EL displays because the different technologies have different markets. The ITC rejected that argument. The Japanese makers also argued that active-matrix LCD screens—which aren't made by U.S. manufacturers—should be treated separately from passive-matrix LCDs. The ITC rejected that argument as well.

Several U.S. laptop computer makers testified against tariffs at the hearing, suggesting that they would make LCD displays too expensive to import into the U.S. If that happened, they hinted, they'd have to manufacture their laptop computers outside the U.S., thus dodging the tariffs by importing complete machines instead of the foreign LCD screens. (But those statements may have hurt more than they helped. One Japanese representative commented that the ITC commissioners hearing the case "seemed to feel the computer companies were just being selfish.")

In the end, a panel of four ITC commissioners ruled unanimously that there was evidence that U.S. flat-panel manufacturers were being hurt by the Japanese pricing policies. The case now moves to a Department of Commerce investigation, which may eventually recommend tariffs or other penalties.

Tariffs, Higher Prices

What's likely to happen? If history is any guide, the results of the Department of Commerce investigation are a foregone conclusion. Both Japanese LCD makers and American computer manufacturers now expect that tariffs will be levied, resulting in higher prices for laptops and portable computers made in the U.S. using Japanese flat-panel displays.

As they did when tariffs were imposed on foreign DRAM chips, large American companies that can do so will move manufacturing of those products overseas to avoid the tariffs—shifting jobs from Texas and California to Taiwan and Korea. But the smaller companies that can't move jobs overseas will not be able to compete.

The tariffs aren't likely to help U.S. flat-panel display makers, since they don't make the technology those large vendors want. But it may have a major impact on prices of laptops from Toshiba, NEC, Sharp, and other Japanese companies. If the Department of Commerce, as seems likely, decides to penalize the Japanese with tariffs on products other than just flat-panel displays—which happened in the case of DRAM chips—all Japanese laptops and portable computers could rise in price, and the tariffs might extend to other products (e.g., LCD-screen TVs) as well.

And there's another possible effect of tariffs: U.S. computer makers could face losing access to the state of the art in LCD screen technology for their own products. If Japanese companies can't sell their own laptops because of high tariffs, they could refuse to sell their best screens to American companies, insisting instead that American vendors contract out laptop production to Japanese manufacturers. That means that U.S. computer companies might have to choose between hiring a Japanese company to build their products or making do with second-rate technology.

In the long run, the cost to produce flat-panel displays—especially LCD screens—will continue to fall. Conventional monochrome LCD screens are getting cheaper to make. Top-of-the-line active-matrix and color screens are still expensive and in short supply, but they will also come down in price as manufacturers climb the learning curve for these products. And there probably won't be a glut in LCD screens comparable to the DRAM-chip glut that sparked the memory-dumping complaints, since LCD screens can also be used for portable TVs and other consumer products.

But although flat-panel displays are not in the same situation as DRAM chips, they're likely to follow the same path. And in the short run, tariffs will mean expensive laptops and exported jobs—and no real help for the U.S. flat-panel display industry.

Frank Hayes is a former BYTE West Coast news editor. He can be reached on BIX as "frankhayes."

The new stacked-panel passive-matrix LCD monitor from In Focus Systems, which was shown at the Fall Comdex '90.

Although TFT color LCDs may dominate the laptop market in the next few years, competing technologies may give TFT a run for its money.

Passive-Matrix Displays

One new technology contender in the PC display market is stacked-panel passive-matrix. It has been pioneered by In Focus Systems of Tualatin, Oregon. Until recently, the company specialized in the production of LCD projection panels, but it has now moved into PC displays.

According to In Focus Systems' technical backgrounder, "the display system is formed by stacking two or more LCD panels that are tuned to subtract different portions of the color spectrum from light passing through the stack. Together the panels cooperate to produce a full range of true colors."

In other words, rather than addressing each pixel by means of a separate transistor, as in TFT displays, this system uses conventional LCD panels aligned in a stack. Each panel is tuned to one of the subtractive primary colors: cyan, magenta, and yellow. When all pixels are off, a backlight provides a white background. Pixels are turned on in the LCD panels to subtract cyan, magenta, or yellow from the white background to obtain other colors.

In Focus Systems announced its first commercial implementation of the stacked-panel concept at Comdex last November, introducing a 10-inch full-color display consisting of three super-twist LCD panels. The monitor (see the photo) offers VGA resolution of 640 by 480 pixels and can display up to 4913 colors, according to In Focus Systems. It uses a 50-W incandescent backlight and weighs about 6 pounds.

The passive-matrix display technology introduced by In Focus Systems has promise. Because it uses conventional LCD panels, it does not have the manufacturing problems that currently plague TFT technology. On the other hand, the passive display system requires a complex optical backlighting scheme involving mirrors and reflectors, which adds to the bulk and power requirements of the display.

According to Mentley, the display has considerable potential for desktop presentation applications, but it needs to be refined for use in laptop computers. There is also some question about the response time of stacked-panel passive-matrix displays. Currently, the response time (about 250 milliseconds) is not fast enough to display moving images on the screen, but In Focus Systems says that it's working on a threefold reduction in response time.

The full-color LCD introduced at Comdex will sell for $1400 to $2500 to OEMs. In Focus Systems says it has licensed the technology to an unnamed laptop manufacturer. It will be interesting to see if In Focus Systems can gain enough support to compete with the manufacturing and engineering muscle of the Japanese manufacturers who back TFT display technology.

Field-Emission Displays

Field-emission displays take advantage of the basic principle of the CRT. The major difference between FEDs and current CRTs is the replacement of the bulky, high-voltage "hot-cathode" electron gun with micron-size cone-shaped structures called "cold cathodes" or "field-emission cathodes," which can excite electrons with voltages much lower than those required by traditional CRT electron guns. (They also generate much less heat, which is why they are often called cold cathodes.) The typical operating voltage of a cold-cathode FED is about 1000 volts, versus 25,000 to 30,000 V in a conventional CRT.

The microscopic size of the cold cathode allows the production of very thin, flat CRTs using arrays of field-emission cathodes configured in an x,y matrix addressing scheme. While much of the R&D work on FEDs was performed at Stanford Research Institute, the leader in their commercial development is Coloray in Fremont, California.

The FED currently under development at Coloray consists of two pieces of glass separated by a space evacuated to a pressure of 10^{-6} torr (1 torr is equal to 1/760 atmosphere). The faceplate contains a phosphor screen, as in a conventional CRT, while the rear plate (baseplate) contains the array of cold-cathode field emitters and the row and column driver chips. A diagram of the assembly is shown in figure 1.

A cross section of the FED is shown in figure 2. The cathode emitters are deposited on a pattern of row and column electrodes on the baseplate. From 10 to 100 emitter tips are deposited at each intersection of the row and column electrodes to provide redundancy, emitter uniformity, and, as a result, high manufacturing yields. The tips of the field emitters emanate electrons through holes in the baseplate that are only 1 micron in diameter. The resulting electron beams strike the phosphor dots on the faceplate in the same manner as in a conventional CRT.

The resolution of the display is controlled by the design of the phosphor pattern on the faceplate (the density of the cathodes on the baseplate exceeds the requirements of the highest CRT resolutions). According to Coloray, a typical

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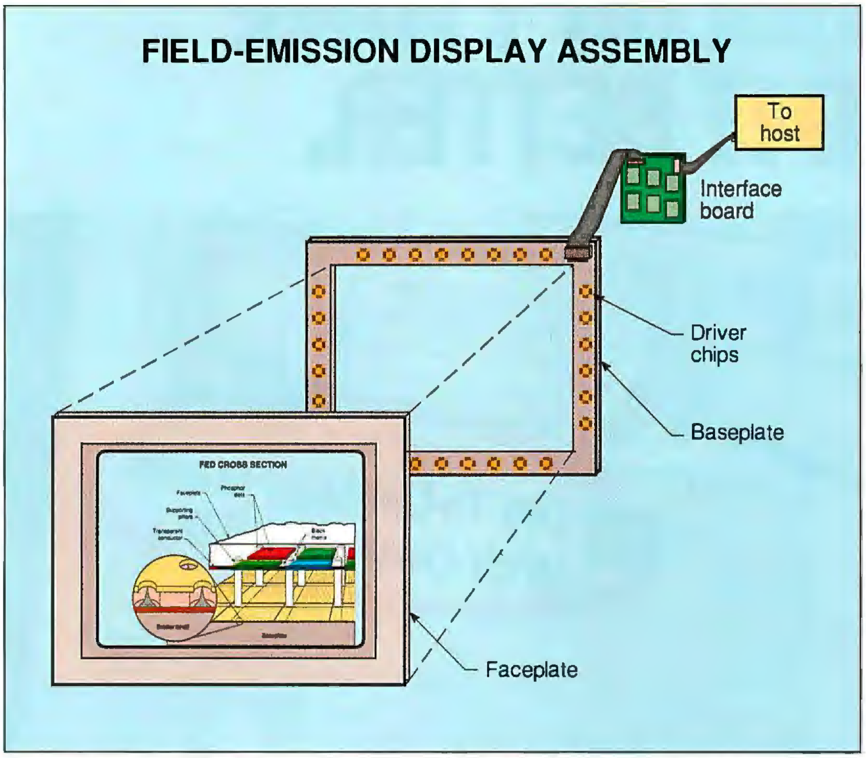

Figure 1: *The faceplate contains a conventional phosphor screen. The baseplate contains the field-emitter cathode array. (Courtesy of Coloray Corp.)*

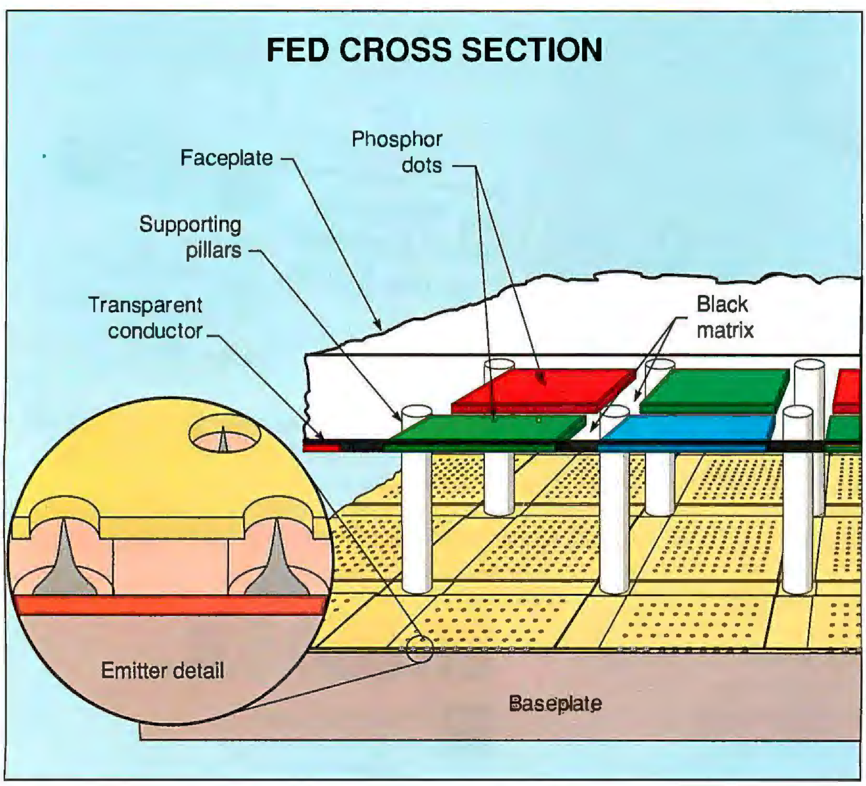

Figure 2: *A typical PC display will have faceplate and baseplate thicknesses of 1.1 mm, with a spacing of only 0.1 mm. The emitter holes are only 1 micron in diameter. (Courtesy of Coloray Corp.)*

PC display would have baseplate and faceplate thicknesses of 1.1 mm separated by a space of 0.1 mm.

Proponents of FED technology claim that it offers the best of both the CRT and flat-panel worlds. The FED is anticipated to provide about three times the brightness of current backlit LCDs, as well as high manufacturing yields and reliability. Coloray projects that a 10-inch FED monitor displaying 16 million colors will require only 2.4 W of power. Coloray also expects the FED to be priced competitively with other types of color displays.

The FED is a "very elegant, underno-ticed technology," says David Mentley. However, Coloray doesn't expect to have commercial products ready for at least another two years. A French research laboratory, LETI, has demonstrated a prototype 6-inch FED monitor and has also performed durability testing for over 3000 hours. Basically, the technical feasibility of the FED has been demonstrated. The next step is to harness the resources needed to bring a commercial product to market. As Mentley says, "It's not a technology issue but a business-plan issue."

Don't Hold Your Breath

While promising developments are on the horizon, display technology is not changing as rapidly as other aspects of computing. High-yield manufacturing of TFT LCDs is still a few years away. The passive-matrix stacked-panel LCD has potential but faces technical hurdles. FED technology may be the most interesting, but even the greatest technologies can falter without sufficient funding and marketing presence. Clearly, Coloray hopes to attract investors and partners to help create the necessary momentum and funding to launch FED technology.

In the meantime, you'll have to make do with the less-than-ideal laptops available today—machines that scrimp on the display or cost an arm and a leg. The future, however, belongs to those technologies that will deliver CRT quality at a laptop price. ■

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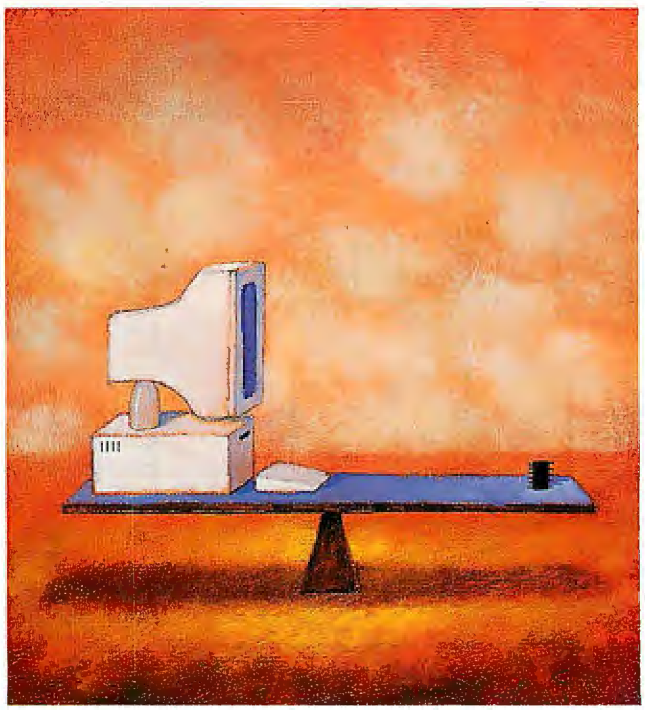

Do you remember your first hand-held calculator? You could pick it up and punch a few buttons, and in a matter of seconds your answer would pop up on one of those funny seven-segment displays. Before that, all calculators were large, cumbersome machines that sat on office desks. The evolution of calculators from large desktop behemoths to ever more powerful hand-held versions is a dramatic example of electronic integration—accomplishing more in a smaller space for less money.

Although calculators are perhaps a more familiar example, integration in personal computers has been equally dramatic. In the early days of the IBM PC, the only clones available were from manufacturers who simply duplicated IBM's discrete-chip design. There was little difference between machines, and prices were relatively high. The market changed radically, however, when many of the fundamental blocks of the system architecture were integrated into what are now called chip sets. These blocks include bus- and memory-control logic and the standard AT peripherals (counter/timer, real-time clock, and DMA and interrupt controllers).

The seemingly small change of the integration of system logic into chip sets has had an enormous effect on the PC industry. With a chip set, a company does not need the technical resources available to IBM to make a PC-compatible computer. It simply combines a chip set with a cookbook design, and voilà—it has a PC.

Nowhere has the move to integration been felt more than in portable computers, where it has enabled the creation of battery-powered, DOS-based personal computers. Today, you'd be hard pressed to find a laptop (much less a notebook or a palmtop) that is not designed around an integrated chip set. The next logical step in this integration path is what Advanced Micro Devices (AMD) calls the integrated processor. Simply put, the IP integrates the basic chip set and the microprocessor onto a single piece of silicon. The first example of this integration technology to hit the market is the Am286LX/ZX IP.

Design Goals

The goal in designing the Am286LX/ZX was to integrate all the non-memory-based functional blocks that are found on the original AT motherboard (i.e., everything but the DRAM chips, BIOS EPROMs, and ROM-based 8042 keyboard controller). In addition, the IP contains several enhancements that address the all-important power-consumption issue in the portable computing market. The IP was also designed for a fully static CMOS process to achieve the lowest-power device possible. Figure 1 shows a block diagram of the Am286-LX/ZX.

The functional blocks in the design of the Am286LX/ZX include an 80C286 microprocessor core, a counter/timer, DMA controllers, interrupt controllers, a real-time clock (RTC) with extended static RAM (SRAM), an enhanced clock generator, an enhanced bus controller, an advanced DRAM controller with full EMS 4.0 support, and direct-connect interfaces to an ISA system. In addition, the LX version has power-saving features needed for battery-powered systems. These include both staggered and slow refresh support and two clock-control modes to allow quick production of an AT-compatible portable system. This article focuses on the LX version.

Am286LX Overview

In meeting the design goals described above, AMD had to include the core elements common to all AT-architecture systems, enabling the two most important facets of the integration dynamic—faster and easier system design and lower core-system cost.

The features of the LX can be grouped into three general sections: the 80C286 and standard peripherals, system-control logic, and external interfaces.

The CPU and Its Companions

The heart of an AT-class machine is the 286 microprocessor. The LX maintains the complete functional features of the standard CMOS 80C286, including the full 286 instruction set, address space, internal memory organization, and operating modes. In addition, the core has been designed to be fully static. Thus, you can operate the IP anywhere from its maximum speed down to DC conditions (completely stopping the clocks), depending on processing and power usage requirements.

Beyond the CPU, the IP features a three-channel, general-purpose, 8254-compatible 16-bit counter/timer. The timer conditions its frequency source input to produce the programmable events needed by the operating system. These include the system-timer tick, speaker output, and refresh request.

Two identical 9517-/8237-compatible DMA controllers and a page register are also integrated into the LX. These act together to perform processor-independent transfers of data between I/O and the

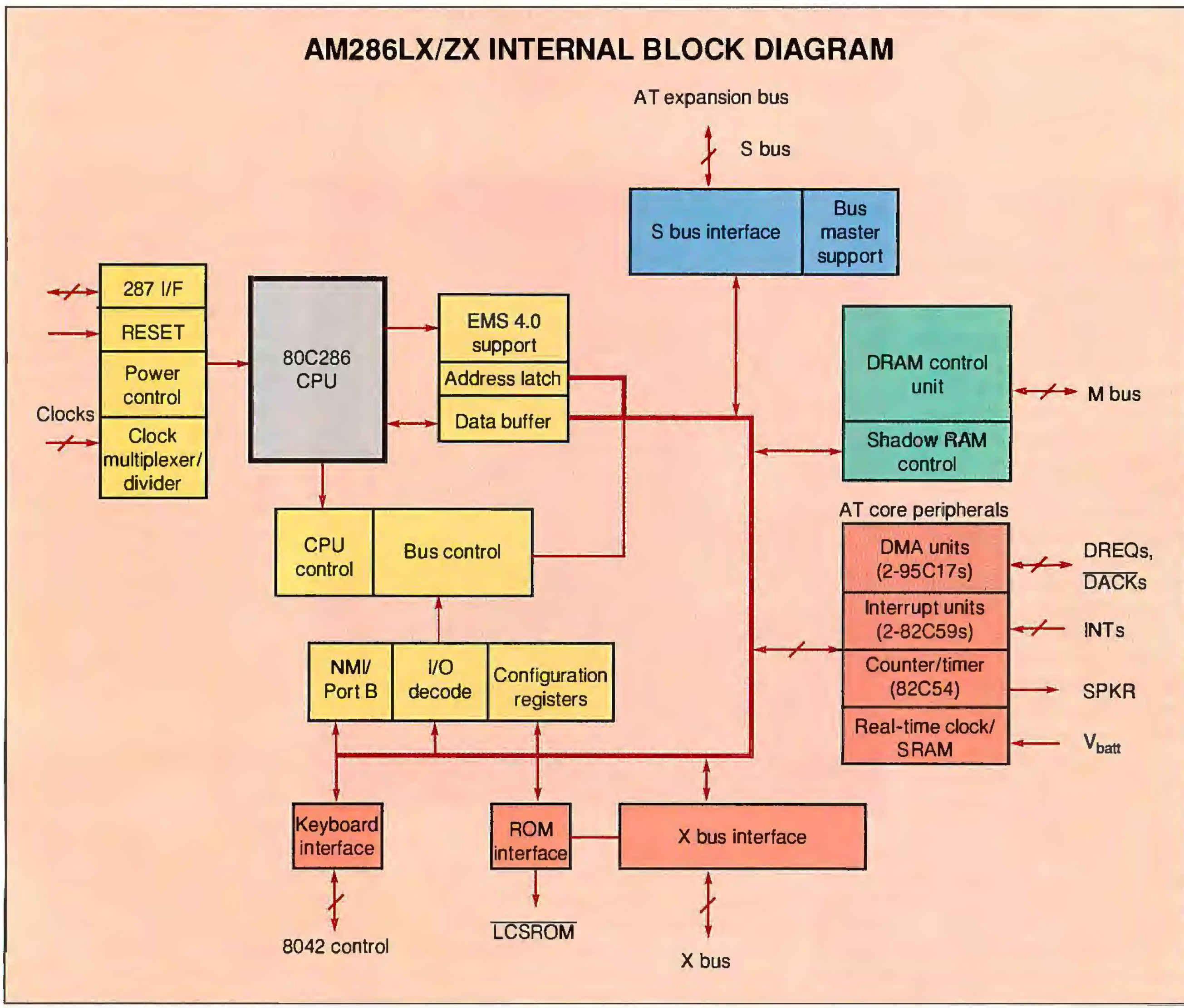

Figure 1: *Add a BIOS, keyboard controller, and memory to an integrated processor, and you have an AT-class computer. The IP takes portable computing integration to a new level.*

memory space, such as copying floppy disk data to local memory. These 8- or 16-bit transfers help decrease data transfer latency time and also free the CPU for other work.

The LX contains two 8259-compatible interrupt controllers that are cascaded to prioritize up to 15 completely asynchronous events. The controllers free the CPU from monitoring events by flagging it only after an event has occurred. These events could be anything from a keystroke to an incoming character from a modem.

The final standard peripheral implemented with the LX is an RTC. It combines a complete time-of-day clock with an alarm, a 100-year calendar, a programmable periodic interrupt, and 114 bytes of SRAM. The device serves not only the obvious function of keeping the system time, but also that of storing the system's configuration and other nonvolatile information when the system is turned off.

System-Control Logic

The IP provides flexible clock selections for the CPU clock, 80C287 clock, AT expansion bus clock, and keyboard clock. Each of these has independent multiple sources and dividers available. The IP provides configuration registers to select and divide these clocks on the fly to meet a portable system's constantly changing demands.

In today's portable arena, these flexible clock dividers are mandatory. It is not uncommon to need the full speed and power of your system one second for a calculation or repagination, and the next second to find the processor simply waiting for a keystroke. You want these on/off transitions to be easily software-controlled and invisible. Two clock-stopping modes found in the IP, when combined with the flexible clocking scheme, provide this capability.

In addition to enhanced clock control, the LX supplies a bus controller that oversees the routing of the addresses and data through the device for every type of data transaction. An example of this routing is a CPU write to video memory on the AT expansion bus. In addition to these expected functions, the bus controller includes enhancements to transform the controller into a dual-state machine design—one for high-speed, synchronous transfers between the CPU and either DRAM or internal register locations, the other for the typically slower ISA expansion bus. The latter can operate either synchronously or asychronously with the CPU.

Working with Memory

The LX IP also supports robust and easily implemented memory systems, providing zero- or near-zero-wait-state performance while maintaining low system cost by the use of inexpensive, slower DRAM chips.

The DRAM controller supports four

The LX contains two 8259-compatible interrupt controllers that are cascaded to prioritize up to 15 completely asynchronous events.

16-bit banks (plus parity) of DRAM. These can be implemented using 256K-bit, 1-megabit, or 4-Mb DRAM chips for a maximum of 8 megabytes per bank, with 16 MB total for all banks. There are none of the limits placed on DRAM sizing and bank matching found in many memory controllers. Any size of supported DRAM can be put in any bank, regardless of the contents of any other banks, producing not only a simple initial design but also flexible upgrading. In keeping with the design goal of the lowest possible chip count for the system core, two banks, totaling as much as the full 16 MB, can be directly connected to the LX.

The processor supports page-mode memory accesses to decrease memory speed requirements. Decreasing the information normally sent to a DRAM chip eliminates the need for wait states or costly, faster DRAM chips. For example, a DRAM chip gets its addressing information in two sequential transactions. The first, associated with the row address strobe (RAS) line, tells the device which subsection or "page" is to be accessed. The second, controlled with the column address strobe (CAS) line, specifies the exact location or "word" on the page. Page mode is simply the protocol that states, "until you are told differently, use the previous page again." If adjacent banks are detected as having the same size DRAM chips, a two- and even four-way interleaving scheme (doubling or quadrupling the page size) is automatically invoked to decrease the number of times that a full address is needed. However, when a full address is required, wait states must be added to the access.

The standard RAS-only refresh has been implemented and enhanced with both slow and staggered refresh options. These two options help reduce the large power requirement associated with the continual recharging that a DRAM chip needs to retain its contents.

The LX provides two options for the 384K bytes of memory between A0000 hexadecimal (640K bytes) and FFFFFh (just under 1 MB). The first option is called *shadowing*. It lets you copy the BIOS or other typically slow memory devices into this RAM area. All future accesses to the BIOS would then be routed to the copy located in fast DRAM. If the system has 1 MB of total local memory, another option allows this 384K bytes to be relocated to the addresses starting at 100000h (1 MB). The system then appears to have 640K bytes of base memory and 384K bytes of extended or expanded memory. This can greatly accelerate and enhance such programs as Microsoft Windows 3.0. The IP provides full hardware support for EMS 4.0. Two full sets of 64 EMS registers allow quick task switching by multitasking software.

Changing Processor Modes

The LX provides two features that enhance a system's ability to switch from protected mode to real mode: fast RESET and fast GATEA20. Normally, the system software calls a BIOS routine, which issues two commands to switch the processor from protected mode to real mode. Both these commands, RESET and GATEA20, are slowed by the inherent delay in the keyboard controller that executes them.

The LX bypasses the keyboard and implements these commands using the industry-standard port 092h location to perform the switch to real mode. These features greatly improve performance in operating environments, such as OS/2 and Windows 3.0, that frequently switch between protected and real modes during execution.

Although it is normally the main CPU of an AT-architecture motherboard, the LX contains a mode that allows it to act as a bus-master peripheral connected to the expansion bus of a host system. It can thus be the main CPU on a high-performance, bus-mastering add-in card, such as an intelligent disk drive controller or a network adapter. It directly supports ISA bus mastering and, with external logic, Micro Channel architecture and EISA systems. Selecting bus-mastering mode changes the operating mode of some of the ISA expansion bus pins to allow the IP to directly connect to the expansion bus of another system.

External Interfaces

All the external interfaces of the LX IP are designed for direct connection. No external "glue logic" is necessary to interface to a standard AT-architecture system. The LX controls the additional devices (e.g., DRAM, keyboard controller, and AT expansion bus peripherals) needed to complete a laptop without the space-consuming driver chips that are common in today's systems. This efficiency is critical to the portable market, where more and more functionality is integrated onto the motherboard itself. The LX also provides control signals to accommodate a docking bay or expansion box. In addition, direct connections are provided for both a math coprocessor (80C287 compatible) and keyboard interface (AT or XT type), as well as a full 16 MB of local memory.

The IP provides support for both 8- and 16-bit EPROM configurations. You can define this space to be as large as 256K bytes. The ability to write to the EPROM space has been added to support the new flash-type memories.

In addition to the EPROM and keyboard controller, the IP's X bus can be used to attach other I/O devices. Eight configuration registers are available to map any 8-byte I/O address range onto the X bus; it also supports 16-bit I/O. Any I/O devices such as serial ports, parallel ports, floppy disk drive controllers, and Intelligent Drive Electronics hard disk drive controllers can be attached to the X bus. Any of the four 8-bit DMA channels (0 through 3) can be mapped to the X bus as well. For example, a floppy disk drive controller would use DMA channel 2.

The Integration Advantage

While the IP has significant ramifications for the entire PC industry, its most important application is in portable computing. It has specific advantages for the laptop, notebook, and palmtop form factors, although across the board it should have much the same impact as chip sets have had: more computer for your dollar.

Laptops typically put more of a premium on functionality than either the notebook- or palmtop-class machine. These systems are expected to have the capability of a desktop. There is no compromise on expansion capability, disk size, display, keyboard, or performance. These features will be implemented even at the expense of battery life or system size and weight. By using the IP in a laptop design, the system basics take up less

While the IP has significant ramifications for the entire PC industry, its most important application is in portable computing.

space, leaving more room for the features considered necessary in a modern laptop. Furthermore, even though a system could be made fully loaded (with 16 MB of RAM, a modem, Ethernet, and so on), it generally makes more sense to market a minimum system that can be expanded via an expansion box or custom cards, or both. These options are supported through the LX's ability to connect directly to a large number of devices along with providing control signals for future expansion. (To see how you would design a typical laptop around the LX, see the text box "Inside a Laptop" on page 244.)

The next-smaller system is the notebook class. While a full set of on-board peripherals is becoming the norm for this class, it is never at the expense of battery life and system size. The only two subsystems that come close to breaking that rule (and together are the limiting factors for these machines) are the displays and keyboards. The small footprint and the elimination of external glue logic to connect peripherals is not only beneficial in achieving a small system, but essential in a world where power is measured in milliwatts.

Power Savers

Three features of the LX are helpful in managing battery power. The first is the fully static CMOS design. The nature of a good CMOS design is that its power usage is directly related to the chip's operational frequency. A device running at 8 MHz should use little more than half the power of a similar one operating at 16 MHz. Power consumption when a clock is not present (DC conditions) can be several orders of magnitude less than the power used at 10 to 20 MHz. The LX's ability to function under DC conditions, and thereby consume practically no power, is essential for power-sensitive designs.

The second feature that simplifies a notebook design is the IP's enhanced clock controller. Often, you don't need a computer's full power. For instance, you do not need the performance (and battery consumption) of a 16-MHz clock rate to enter data using your favorite word processor. Power management techniques monitor these activities and, with the use of the flexible clocking options of the IP, can change the system's performance as needed.

Two clock-stopping modes further enhance a system's power management abilities. The first is called CPU Stop Clock. When the CPU is not needed at all, the system can quickly enable a "doze" mode. This CPU clock-stopping mode can be used during disk accesses, DMA activities, program idle, or even between keystrokes, to extend a system's battery life far beyond its normal range.

A second clock-stopping mode is called System Stand-by. It is essential in implementing suspend/resume, which allows you to stop working on your system, close it up, and then at a later time continue your work simply by reopening your system case. The trick to this mode is not only saving power (it basically turns things off) but also remembering the system's previous state, including not only the memory contents but also the modes and contents of the on-board peripherals and the IP as well. The standby mode puts practically the entire LX processor into a state of suspended animation. This ultralow-power state freezes all actions of the IP except those that are necessary to perform DRAM refresh. It remains in this state until an interrupt is received, at which time it continues processing. All registers and modes are completely unaffected.

The final power-saving features the LX provides involve DRAM refresh. The power-saving modes are called *staggered* and *slow refresh*. The first relaxes the maximum system power requirement by staggering the refresh signal to the various RAM banks. The second allows

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Inside a Laptop

Doug Gephardt

The Am286LX integrated processor (IP) is just one piece of a laptop or notebook system. The synergy of the hardware and software in the system should give you a high degree of desktop-level functionality while transparently managing the system's power consumption to maximize the time of operation from the battery.

The following structured walk-through of a typical laptop/notebook system based on the LX describes the design issues involved in providing the most computing power for the longest period of time.

Figure A is a block diagram of a hypothetical laptop system that uses an LX IP. A notebook system would have a comparable architecture.

The AT Core

The IP is the brain of the system, providing all the functionality necessary to make this laptop a high-speed, 286-based AT compatible. It has direct interfaces to the system RAM via the memory, or M, bus. It accesses the ROM BIOS and controls the on-board I/O peripherals via the X bus, and it accesses the video subsystem and the rest of the AT-compatible world through the S bus (i.e., AT expansion bus).

The IP has two main functions relative to power management. It has to control its own power consumption by turning off internal clocks when so directed by the power management program, and it must perform the processing necessary for managing power in the system's peripherals. The peripheral power management logic in the system flags the processor with an interrupt when peripheral power management functions are needed.

Memory Subsystem

The main system memory in a laptop is normally an array of DRAM chips directly connected to the IP. You can use slow-refresh DRAM chips to minimize power consumption during system inactivity.

Another way to form the memory system is to use static RAM chips. The benefit of SRAM devices is their ability to maintain data with a very low standby current. Their drawbacks are cost and density, relative to DRAM chips.

On-Board Expansion Bus

The functional blocks accessed via the X bus include the BIOS; keyboard, floppy disk drive, and Intelligent Drive Electronics (IDE)-type controllers; numeric coprocessor; and peripheral power management.

The system BIOS ROM/EPROM is a nonvolatile, read-only storage device that holds the BIOS and the power management code, which hooks into the BIOS at critical places. This device could be implemented in a flash EPROM chip that can be updated or modified while still in the system.

The 8042 keyboard controller is a microprocessor with on-chip ROM and RAM. It receives scan codes from the keyboard and interrupts the IP at each keystroke. It can also handle a PS/2-style mouse port and can perform some power management functions, such as turning off the LCD backlight after a set period of keyboard inactivity.

The LX processor directly supports a numeric coprocessor. In the example, we chose the AMD 80EC287 not because it is made by our company, but because it features a power-saving auto-shutdown mode.

Several integrated floppy disk drive controllers are available that combine the basic 765-style controller with the phase-lock loops and driver logic necessary for a direct interface to a floppy disk drive. Some of these controllers support the new higher-density 2.88-megabyte floppy disks. "Combo I/O" chips integrate a serial port, a parallel port, and IDE hard disk drive interface functions. The LX device can be programmed to specify the I/O devices connected to its X bus. You could, in fact, connect an internal modem to one of the serial ports on the combo I/O chip. Modems are considered power hogs, so intelligent management of their power consumption is critical.

Peripheral power-control logic provides hardware support to control the power consumption of the system's peripherals. It monitors bus activity directed to the system's peripherals and detects when the system is idle. It then signals the IP (via a nonmaskable interrupt) to activate the power management code and slow down or stop the processor clock. The power-control logic can also selectively cut the power to the system peripherals to conserve total system power.

Using the AT System Bus

The display subsystem of the laptop in the example consists of an LCD VGA controller, a 640- by 480-pixel LCD flat-panel display, and a fluorescent backlight. The controller resides on the S bus and provides a VGA register-level-compatible display that has special features for driving LCDs. For example, it translates the "colors" into 16 or 32 levels of gray on the LCD. The main element of power consumption with the display controller is the constant accessing of the DRAM chips that hold the video data. The VGA controller should have power management features, including some kind of shutdown that stops video refresh and puts the controller into a low-power mode.

It is important also for the LCD flat panel to have power management control so that it can shut down into a low-power state as well. Normally, the fluorescent backlight consumes more power than any other single component in a system—sometimes as much as 40 percent of the total system power. Intelligent control of the power being fed to the backlight is critical in a battery-powered system.

You can include a half- or three-quarter-length AT expansion slot on the S bus. A notebook system might use a custom form-factor slot with a much smaller size. This internal slot could be used for a network interface or I/O port expansion. The power consumption of this card could significantly affect system battery life, so either the card itself or the system would have to control the power provided to the card.

An external docking bay is another use for the S bus. The most straightforward way to provide one is to place a connector on the system board that comes straight off the bus, possibly with some buffers to increase the drive capability of the signals. You can disable the LX's ability to map device I/O addresses onto the X bus, allowing docking-bay peripherals to supersede some of the motherboard peripherals (e.g., serial ports, parallel port, floppy disk drive) and take over their functions.

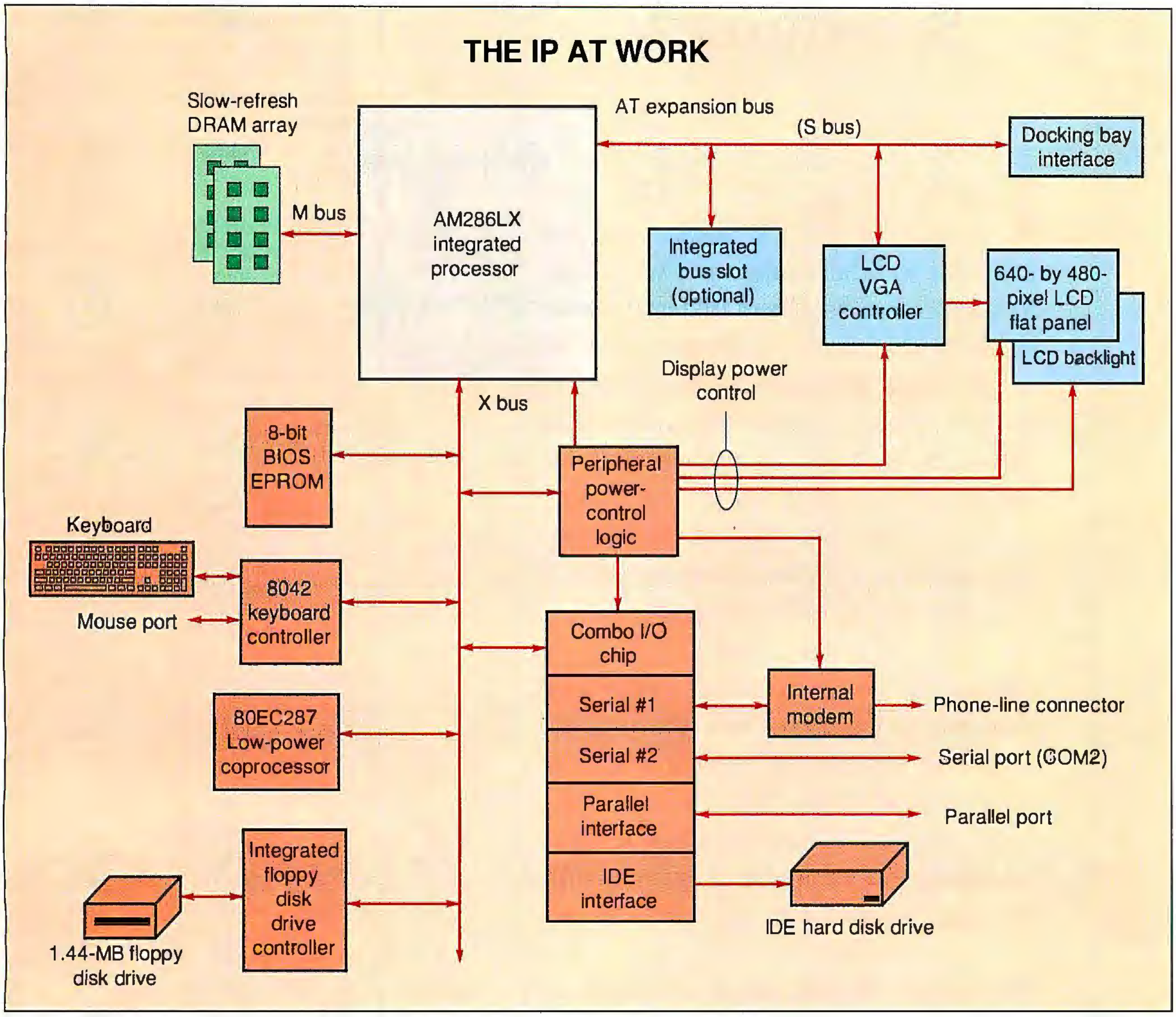

Figure A: *The Am286LX communicates with the outside world via three buses. The M bus accesses system RAM, the X bus talks to motherboard peripherals, and the S bus communicates with ISA peripherals.*

The Role of System Software

The BIOS of this laptop system must do several things differently than that of a desktop system. The laptop BIOS must resolve issues such as when to turn on the display backlight and hard disk drive, relative to the system and memory tests performed at power-up, because they have an effect on battery life. The BIOS must also be able to detect the presence of a docking bay, an external keyboard, or an external VGA monitor.

The power management code and the BIOS reside in the same physical EPROM device. This code constantly monitors the system's use, controlling power consumption to maximize battery life. Its functions include keyboard and screen-update time-outs to control the LCD backlight, modem power control, and hard disk drive power-down after a set period of inactivity.

The cutting edge of power management is the detection and handling of software-idle conditions. Here, the power management code performs such functions as slowing down or stopping the IP's clock when you aren't typing. The trick is detecting the idle state. Current software doesn't let the system know that the CPU is idle. Therefore, a combination of hardware and software methods must be employed to detect the idle state. Operating-system suppliers such as Microsoft and Digital Research are taking heed of the portable computing industry and are working toward solutions that will help power management software control power consumption during system-idle periods.

The Benefits of Integration

A block diagram of a laptop or notebook system is in many ways similar to that of a desktop system. The processor, memory, mass storage, display, and keyboard exist in both environments. But size and power constraints in the laptop/notebook arena introduce many behind-the-scenes design problems.

The LX provides a solution for the problem of size and power versus performance and functionality. The growing benefits of silicon integration and advancements in the area of system power management will make your future laptop a better one.

the support of DRAM chips that require less-frequent refresh cycles. These cycles can comprise a significant amount of the total power used by the system. Slow-refresh DRAM chips are quickly approaching power-consumption levels that were once the preserve of SRAM chips.

An IP in the Hand

The smallest portable DOS computers are the palmtops. The design goal here is to reduce the size of the active circuitry. In comparison to a laptop or a notebook, they have smaller keyboards, smaller-still displays, and longer battery life. As with the other types of portables, palmtops maintain the essentials of PC compatibility. The LX's 28-millimeter square package assists in achieving the smallest possible form factor.

Here the IP's large read/write EPROM space can be used to put DOS or Microsoft Works into ROM. The space could also support flash memory or ROM disk cards. The ability to connect SRAM to the local memory bus and the simplicity of an XT keyboard interface, along with the essential core contained within the IP, give the flexibility needed for the nonstandard approach these miniature systems take.

Functionality Plus

The LX is the first example of an IP—a device where the CPU and all its tightly coupled peripherals and logic functions are housed on one chip. For future laptops, it means ease of system design, smaller size, and longer battery life. It also means more efficient use of the limited circuit board real estate, making room for peripherals such as faxes, modems, and SCSI and network interfaces that significantly add to the functionality of the system. Manufacturers can concentrate on how to get more desktop functionality in a portable environment, and not on how to fit the core AT functionality within the target size.

This first IP starts a literal "space race" in processor integration. The challenge will be to integrate more and more peripherals onto the IP for increasing amounts of PC functionality on a single chip. It will enable AT-compatible systems that won't slow you down, either in speed, size, or weight. ■

Doug Gephardt is a member of the technical staff and Mark C. Klonower is senior applications engineer of Advanced Micro Devices' Personal Computer Products Division (Austin, TX). You can reach them on BIX c/o "dgephardt."

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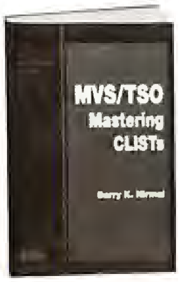

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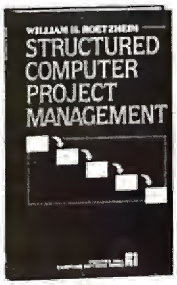

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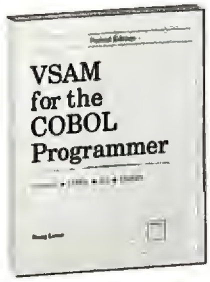

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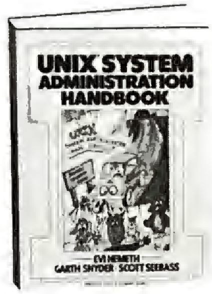

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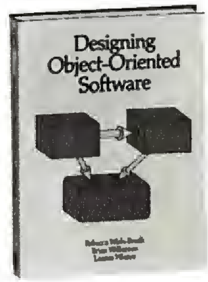

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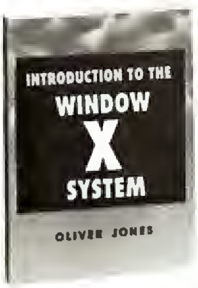

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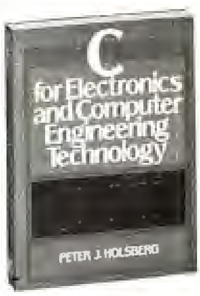

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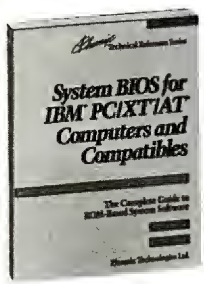

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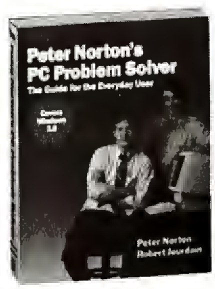

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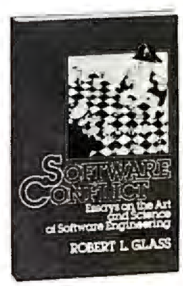

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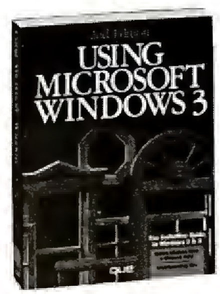

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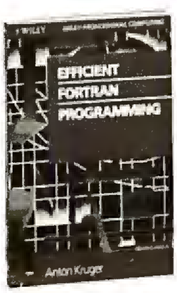

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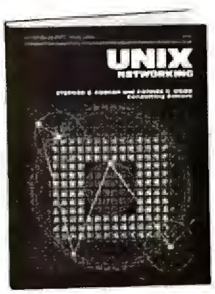

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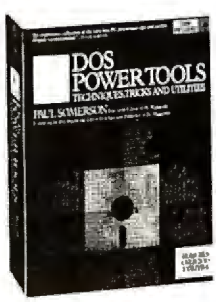

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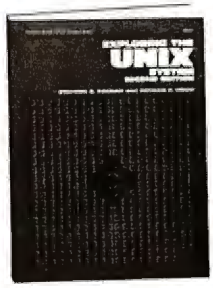

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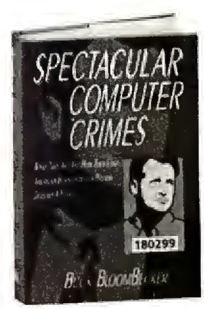

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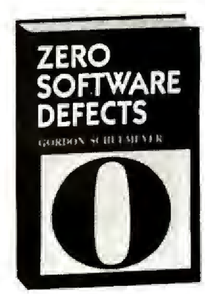

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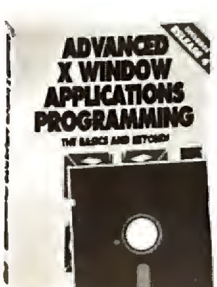

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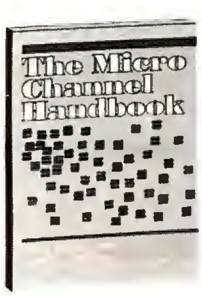

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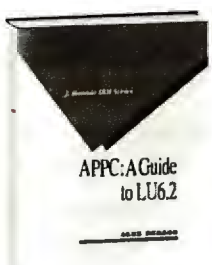

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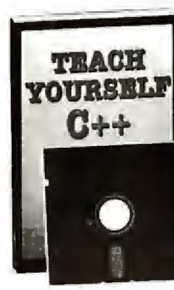

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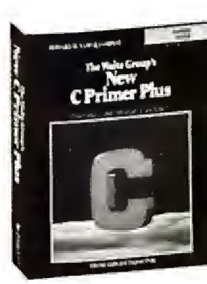

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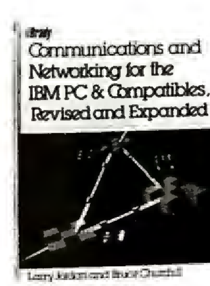

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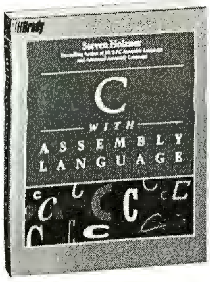

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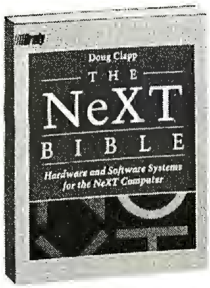

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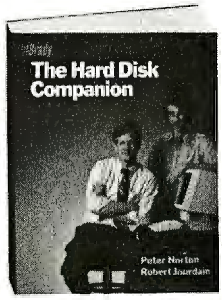

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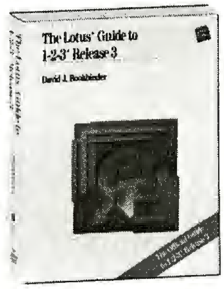

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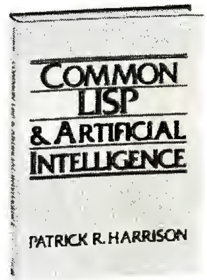

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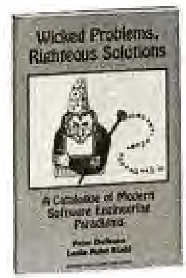

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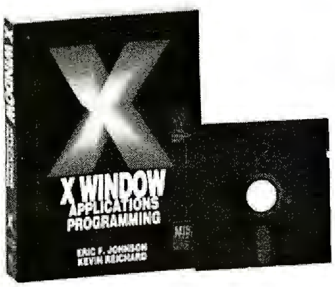

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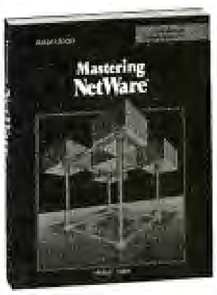

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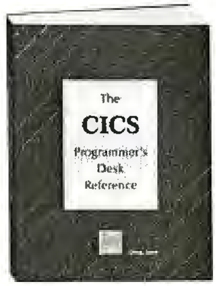

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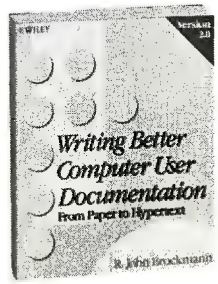

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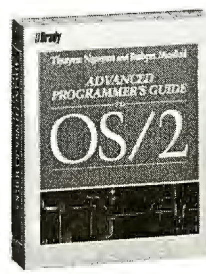

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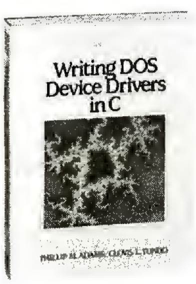

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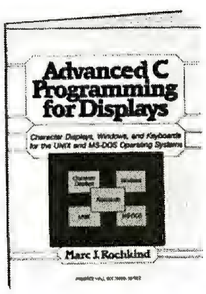

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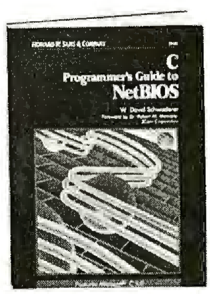

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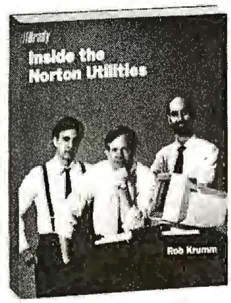

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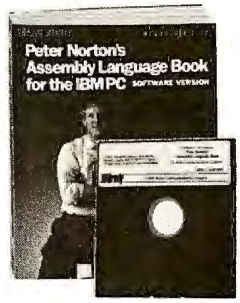

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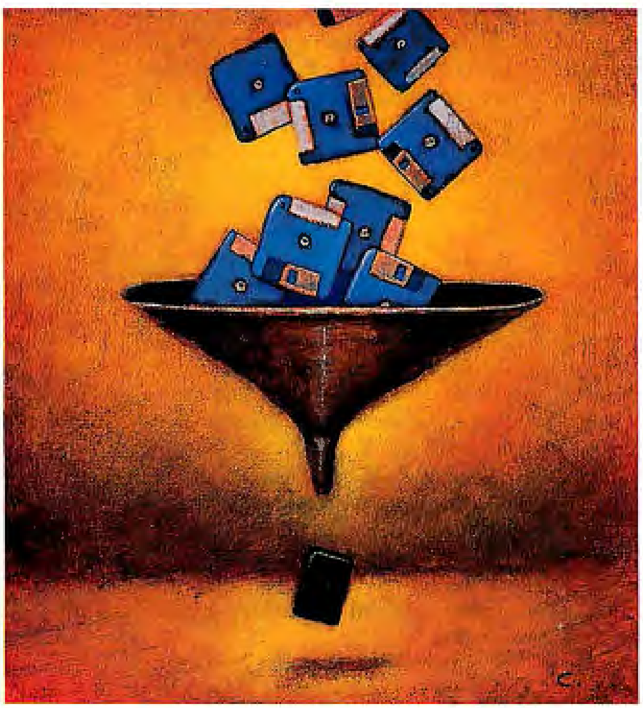
Memories in My Pocket

Data storage has evolved from paper to magnetic media to optical media to silicon "credit cards"

John Reimer

When your computer is finally small enough to fit in your pocket, the mass-storage memory device won't be a floppy or hard disk drive. It will be something far smaller, lighter, and less power-hungry. That "disk drive" won't be magnetic at all; most likely, it will be a solid-state memory card. With about the same dimensions as a credit card or a business card—just a little thicker—each memory card will be able to store several megabytes of data.



Actually, memory cards are here now. They have already found their way into laptop computers. And standardization is the key that has made the use of memory cards possible: the ability to interchange cards from different vendors among different computers. (For information on the standards process, see the text box "Toward a Standard" on page 252.)

The Standard Choice

Two standards groups, the Japanese Electronic Industry Development Association (JEIDA) and the Personal Computer Memory Card International Association (PCMCIA), have settled on a 68-pin standard for memory cards. This number of pins directly accommodates both 8- and 16-bit bus widths and, with multiple reads and writes per word, can provide for wider buses.

With high-speed semiconductor memory, the extra time needed for multiple writes pales in comparison with the overall speed improvement of memory cards over magnetic media. In addition, 68 pins provide room for additional functions and I/O capabilities. The 68-pin memory card was also the first to be implemented with execute-in-place (XIP) capability (executing on the card itself), adding credence to the choice.

Physical Issues

Once the 68-pin package was chosen as the PCMCIA standard, one important physical issue remaining unresolved was the question of hot insertions and withdrawals. The card, system, and data integrity must be protected in case someone should attempt to insert or remove a card while the system is powered up.

The pins on the plug that mates to the memory card are of three different lengths. The two 3.5-millimeter pins on the outermost edges are the shortest and are referred to as card-detect pins; the 4.25-mm pins are signal/data I/O pins; and the longest pins, measuring 5 mm, are for V_{cc} and ground. Ground is at the outermost edges of the connector, next to the card detect, and V_{cc} is in the center of the connector.

The ground and V_{cc} pins are the longest to ensure that, during insertion, power and ground are supplied before data can flow on or off the card. The early ground

Toward a Standard

In the mid-1980s, the applications for memory cards were mostly in consumer products, especially in video games, such as the Sega that contained a single ROM chip on its memory card. This 32-pin memory card provided an easy and relatively indestructible way to handle the ROM chip while avoiding possible damage due to an electrostatic discharge. Then, Fujitsu developed a 38-pin memory card with an 8K-byte EPROM that was suitable for use in office machines, such as font cards for laser printers and fax machine telephone-number storage.

The next step was a 68-pin card, also from Fujitsu, containing a high-density printed circuit board capable of accommodating newer IC packages. These packages include the thin, small-outline package and the chip on-board in which the unpackaged IC dies are bonded directly to the board and then encapsulated. (COB is the favored mounting technique for calculators.)

Starting in 1985 in Japan, a group called JEIDA (for Japanese Electronic Industry Development Association) formed a working group to standardize memory cards for personal computers. JEIDA had no specific operating-system orientation in mind, not even DOS. It had, however, selected 68 pins as its standard and, by 1989, were in the process of defining pin assignments.

At about the same time, Poqet Computer and Fujitsu Microelectronics, a major Poqet investor, chose this card-based technology as the most attractive disk drive alternative to use in manufacturing a full DOS-based computer that would fit in a coat pocket. Such a silicon diskless drive would be rugged, reliable, and noise-free and would reduce power requirements so that you could use small flashlight cells.

However, although the technology to produce such a computer was available, the lack of a memory-card standard would seriously inhibit its marketability. Imagine the confusion in a world where each diskless drive used different media and sector format as well.

Fujitsu and Poqet decided to start a standards effort for memory cards. First, they looked at existing standards groups to see if any were poised to set a standard for the card. The ideal group would have participation from companies in the mechanical, electrical, and software portions of the specification.

JEIDA had made considerable progress in the mechanical aspects but did not have adequate representation in the electrical and software aspects. Besides, it wasn't open to U.S. membership and was too far along to be open to alternate pin counts.

In 1989, the Personal Computer Memory Card International Association (PCMCIA) was formed, with members including electrical and semiconductor companies (Advanced Micro Devices, Mitsubishi, NEC, Amphenol, Chips & Technologies, Fujitsu Microelectronics, ITT Cannon, Intel, Micron Technology, OKI Electronics, Texas Instruments, AT&T, and National Semiconductor); software companies (Peter Norton Computing, Lotus, Microsoft, Traveling Software, and WordPerfect); and computer companies (IBM, Dell, Compaq, Databook, Epson, Grid Systems, Hewlett-Packard, MIPS, NEC, Poqet, and Sharp).

PCMCIA decided to approach the memory-card arena anew, to achieve international participation so that the final standard would be adopted internationally. However, Fujitsu and several others were already committed to JEIDA's 68-pin effort. NEC had introduced its UltraLite computer using its proprietary 60-pin card. Mitsubishi was promoting two cards, a 50- and a 60-pin card (different from NEC's 60-pin version). Atari's Personal Portfolio had its own card. In short, the market was beginning to fracture.

PCMCIA faced two tasks: arriving at a card standard that was flexible enough for future expansion and trying to halt the fracturing process with that standard. It was vital that other standards groups be involved, including JEIDA (now a member of PCMCIA). PCMCIA would also seek JEDEC and International Standards Organization (Geneva) approval for the cards' physical characteristics and software protocols.

By December 1989, three proposals were under consideration (proposals submitted to PCMCIA had ranged from 40 pins for a serial-based card to 128 pins): the 60-pin card from NEC, the 50-/60-pin card from Mitsubishi, and the 68-pin proposal from Fujitsu. The mechanical card choice, for both size and number of pins, was Fujitsu's. On the Monday following the Friday of the PCMCIA-standard press release, Fujitsu, NEC, and Matsushita all introduced products using the 68-pin card.

JEIDA's 4.0 and PCMCIA's 1.0 specifications for the 68-pin memory card have been released independently of each other but are 100 percent compatible. And both organizations are committed to ensuring that future versions remain compatible. I cannot stress too strongly that the PCMCIA standard is a major milestone in portable computing.

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also provides protection against electrostatic discharge. Likewise, during card removal, power and ground are maintained until the last possible moment. Placing the ground pins at the card edges also ensures that if the card is plugged in askew (i.e., leaning toward one side or the other), ground will always be made first.

The short card-detect pins, which are also placed at the card's edges, permit reads and writes once all the other pin connections are made. On withdrawal, the card-detect pins break, alerting the system that it is about to lose access to the memory card and should take protective measures.

The memory card is designed to operate in harsh environments. The connectors meet the various environmental specifications, as well as the insertion/withdrawal force limits set by U.S. Military Standard 202F. You can expect to obtain 10,000 insertions and removals in an office environment, and 5000 in a harsh industrial environment rife with noxious fumes.

The PCMCIA cards come in two different thicknesses: The type 1 card is 3.3 mm thick, and the type 2 card is 3.3 mm thick in the guide and contact area, while the rest of the card is 5 mm thick. The 3.3-mm thickness is sufficient for one-sided mounting of tape-automated bonding and chip-on-board (COB) mounted memory chips or for double-sided mounting of thin small-outline package (TSOP) devices. The 5-mm card provides extra thickness where needed. For example, such a card allows for the thickness required by the glass ultraviolet (UV) erase window used in an EPROM.

Two other physical issues also needed to be resolved: the location of the write-

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protect switch and the battery location for battery-backed static RAM (SRAM). PCMCIA members (see the text box) agreed that if you place the back of the card away from the connector, the write-protect switch should be on the right, and it should be in protect mode if it's pushed toward the edge of the card. The members also decided that the battery compartment should be opposite the write-protect switch on the left side of the card and facing up. This way, if the compartment is opened, the button-size battery won't drop out.

In addition, the card will have magnetic and x-ray interference specifications that will let you carry them through an airport metal detector or x-ray without compromising their data integrity. And for those interested in protecting data in case of nuclear attack, a gamma-ray specification will be included in rad units.

Electrical Issues

I/O capability is a major PCMCIA concern. The interface is robust enough to accept enhanced functionality for peripherals (e.g., modems, fax cards, and LANs). If the specification is implemented properly, you can have a computer with, for example, two PCMCIA-compatible slots and interchangeably plug in a memory card, a modem, or even expanded main memory.

Of course, with a business-card-size peripheral, one problem is where to put the connectors. The connection could be to a virtual connector on the card, through an expansion slot bus on the computer, or even via a fiber-optic cable connected to the card (see the table). Some pins are reserved for future use and should be left inactive to avoid compatibility problems later on.

Software Issues

Memory cards have three principal software-related issues:

1. selecting the file format to be used;
2. providing header information so that the system can identify the card (enabling the same card to be

PCMCIA MEMORY-CARD PIN ASSIGNMENTS

The 68-pin memory card that was chosen as the PCMCIA standard has a 16-bit-wide data path, as shown in signals D0–D15, and a 26-bit-wide address bus, A0–A25, for a maximum addressing range of 64 MB.

Pin	Signal	I/O	Function	Pin	Signal	I/O	Function
1	GND		Ground	35	GND		Ground
2	D3	I/O	Data bit 3	36	CD1	O	Card detect
3	D4	I/O	Data bit 4	37	D11	I/O	Data bit 11
4	D5	I/O	Data bit 5	38	D12	I/O	Data bit 12
5	D6	I/O	Data bit 6	39	D13	I/O	Data bit 13
6	D7	I/O	Data bit 7	40	D14	I/O	Data bit 14
7	CE1	I	Card enable	41	D15	I/O	Data bit 15
8	A10	I	Address bit 10	42	CE2	I	Card enable
9	OE	I	Output enable	43	RFSH	I	Refresh
10	A11	I	Address bit 11	44	RFU		Reserved
11	A9	I	Address bit 9	45	RFU		Reserved
12	A8	I	Address bit 8	46	A17	I	Address bit 17
13	A13	I	Address bit 13	47	A18	I	Address bit 18
14	A14	I	Address bit 14	48	A19	I	Address bit 19
15	WE PGM	I	Write enable (program)	49	A20	I	Address bit 20
16	RDY BSY	O	Ready/busy (EEPROM)	50	A21	I	Address bit 21
17	V_{cc}			51	V_{cc}		
18	$V_{pp}1$			52	$V_{pp}2$		
19	A16	I	Address bit 16	53	A22	I	Address bit 22
20	A15	I	Address bit 15	54	A23	I	Address bit 23
21	A12	I	Address bit 12	55	A24	I	Address bit 24
22	A7	I	Address bit 7	56	A25	I	Address bit 25
23	A6	I	Address bit 6	57	RFU		Reserved
24	A5	I	Address bit 5	58	RFU		Reserved
25	A4	I	Address bit 4	59	RFU		Reserved
26	A3	I	Address bit 3	60	RFU		Reserved
27	A2	I	Address bit 2	61	REG	I	Register select
28	A1	I	Address bit 1	62	BVD2	O	Battery voltage detect 2
29	A0	I	Address bit 0	63	BVD1	O	Battery voltage detect 1
30	D0	I/O	Data bit 0	64	D8	I/O	Data bit 8
31	D1	I/O	Data bit 1	65	D9	I/O	Data bit 9
32	D2	I/O	Data bit 2	66	D10	I/O	Data bit 10
33	WP	O	Write protect	67	CD2	O	Card detect
34	GND		Ground	68	GND		Ground

used in different operating-system environments); and
3. executing programs directly on the cards (XIP).

Like conventional magnetic-media drives, the data stored on a memory card must adhere to some file format. Instead of having the mechanical attributes of spinning media constrain the file format, the read/write/erase characteristics of semiconductor memory are the controlling factors. According to Mike Dreyfoos, chief engineer of Microsoft's MS-DOS division, the file format need not constrain the card to operate only within a particular version of an operating system.

PCMCIA recognizes that a large number of developers understand and have support software for the traditional floppy disk-type file-allocation-table system. PCMCIA adopted the basic MS-DOS FAT system on ROM and RAM cards. Since this approach imposes a block-oriented structure on a byte-oriented medium, it doesn't make the best use of the card's available space. But it is straightforward to implement, and the familiarity of this kind of storage speeds the development of early PC card products.

Flash memory, which is a promising semiconductor-memory technology (see "Store Data in a Flash," November 1990 BYTE), presents a thorny file management problem. Although it's byte-oriented for read/write, it is, at best, sector-oriented for erase. The FAT system must be modified.

To address flash memory, PCMCIA is adopting a special file system for it; it is essentially Microsoft's Flash File System, an extension of MS-DOS for use in a flash environment. Currently, FFS does not recover all memory used by erased files. To recover this memory, you must first copy all files from the card, erase the card, and then copy the files back. Future revisions will address this garbage collection problem.

The memory card's software header identifies its electrical capabilities without having to invent new DOS data structures or impose existing ones on other operating systems. The header distinguishes, for instance, between ROM and RAM, and it provides non-operating-system-specific information, such as error correction for card data and battery-installation date. This "meta-format" for header information describes both the card's logical and physical characteristics.

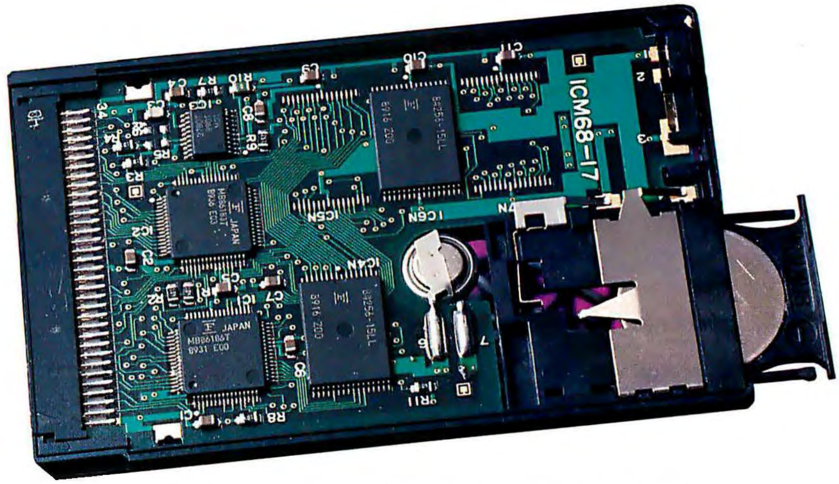
Architecturally, the card can be formatted into two memory spaces: the common memory and the attribute memory. The common memory is conventional storage and is always present, while the attribute memory that contains the header information is optional. A dedicated signal, REG, selects the attribute memory. This allows a system to determine a card's type, even for an unformatted card. The two spaces need not share the same IC memory type. For instance, an SRAM card may use SRAM for common memory and an on-board electrically erasable programmable read-only memory (EEPROM) for nonvolatile attribute memory.

To ensure a future growth path, the memory card's meta-format supports several different file formats, both DOS-compatible and other file systems (e.g., Xenix). It also supports applications, such as data storage for VCRs or musical instruments, which might not use a traditional file system to record their data. Any computer system can query the card and determine its overall size, type, and other basic information.

The ability to read non-DOS cards on DOS-based systems will be significant. The ability to detect that a card is formatted (even if the computer it's plugged into can't read it) is particularly valuable. It lets system designers protect you against some mistakes. For instance, the system could prompt you during the format routine that the card is already formatted as a data-storage card for a VCR.

XIP is still under investigation. Its purpose is to execute the program directly (and quickly) on the card without first loading it into main memory. The program must execute equally well on both portable and desktop machines. The problem is that the card's memory space exceeds what the microprocessor can address in real mode.

PCMCIA is addressing the XIP problem by providing EMS-like functionality to map portions of the card into the computer's address space. A program loader, tailored for the application, pages the program in and out of RAM. PCMCIA's memory map requires that three windows of 64K bytes each be available in the card's address space for mapping and that one of those windows be divisible into 16K-byte pages.



PCMCIA-compatible SRAM cards are now being used in a variety of applications, including pocket-size personal computers. SRAM is a volatile memory; note the button cell used for memory retention.

Memory Types

Memory cards are really a packaging technique, and as such, they let you use any kind of semiconductor memory. Types of memory include ROM (and PROM), EPROM, RAM, EEPROM, and flash (see the photo).

• *ROM:* Programmed once and only mask-programmed during the chip-manufacturing process by etching the programming lines into the IC. When you buy a video game cartridge or a font card for a laser printer, ROMs are used.

PROMs are somewhat similar. Once they are programmed, they are read-only; however, they are supplied unprogrammed and are one-time-programmable (OTP), using a PROM programmer, so you can make your own program cards.

Mask ROMs are dense and yield the lowest cost per byte. Currently available mask ROM cards start at 512K bytes and get as dense as 16 MB. However, with future-density silicon chips, these cards are capable of holding up to 64 MB of

SRAM cards are the first memory cards to be used for both program and data storage.

memory. The first major application of memory cards for pocket-size PCs will employ ROMs.

• *EPROM:* Similar to ROMs and OTPs except that exposing the surface of the IC die to a powerful UV light source will erase them. Then EPROMs can be reprogrammed.

They cannot, therefore, be reprogrammed on the fly. On a memory card, EPROMs present a unique problem: The card must contain a UV window so that it can be erased. Thus, a slightly thicker card must be used.

• *RAM:* You can write to and read from RAMs on the fly; thus, they typically are used for main system memory. They come in two main varieties: SRAMs and DRAMs. Both types are volatile (i.e., they lose data if they lose power). In addition, DRAM requires a frequent data refresh, since data is stored in minute capacitors that lose charge with time. For main-memory expansion, DRAM cards will replace the single in-line mount packages in vogue in desktop computers.

SRAMs are fast, with read/write times in the tens of nanoseconds or less. DRAMs are becoming extremely dense with 4-megabit chips about to ship and 16-Mb chips on the drawing board. However, they are not quite as fast as SRAMs; they have memory-access times below 100 ns. If you use either of them for removable mass storage, you will need some form of battery backup on the memory card, usually in the form of a button cell.

Battery-backed SRAM cards are the first memory cards to be used for both program and data storage. Although they are relatively expensive on a cost-per-byte basis, a single 2-MB SRAM card can typically contain, for instance, a word processing program, a spreadsheet program, and a database program, and still have room for data.

The reasons SRAMs are costly are that the data-storage cell is larger than it is on DRAM cells, production yields are lower, and SRAMs have not been produced in the same quantities as DRAMs. Still, using an SRAM card eliminates the expense of having a floppy or hard disk drive and associated controllers.

While an SRAM card can cost hundreds of dollars, you'll only need one or two if you're a typical user. You'll be able to download the programs and data from your desktop PC onto an SRAM card for your laptop and take it on the road with you.

• *EEPROM:* The ability to electrically erase an EPROM on the fly makes the EEPROM a seemingly ideal replacement for magnetic disk drives. An EEPROM is nonvolatile memory (no battery backup needed), and you can erase it byte by byte and reprogram it. There are, however, several shortcomings.

While almost all ICs operate on a 5-volt power source, EEPROMs need a 12-V power supply to erase. Some chips, such as those from Texas Instruments, use an on-chip charge pump to produce the needed erase potential, but this greatly adds to the price of the chip.

EEPROMs have not yet achieved the density of DRAMs since their cells are larger and more complex. And there may be a problem with the longevity of the cells if they perform more than 10,000 read/write cycles.

The biggest obstacle, however, is cost. EEPROMs are about eight to 12 times more expensive than DRAMs on a cost-per-byte basis. They are often used in military applications where cost is less of an issue.

• *Flash:* Flash memory is a new nonvolatile memory technology that replaces EEPROMs in many diskless applications. Flash read/access times are on a par with DRAM's and represent a 100-fold improvement over magnetic media; write times are more on a par with those of disk drives. Although presently flash memory costs three times as much as volatile memory, it can theoretically achieve the same density as DRAM (or greater) at a comparable cost.

Flash memory's use in electronic still photography will also drive down its cost. For instance, with a charge-coupled device (CCD) of 540,000 pixels and a compression ratio of 5 to 1, a 2-MB flash card can store up to 20 pictures.

As CCD technology develops, so will the storage technology. With higher-resolution CCD, images made on a printer will resemble photographic-quality

pictures. However, even if flash cards are more expensive than ROM cards, you can update a program at minimal cost by reprogramming the flash memory, but you have to throw the ROM card away.

Flash memory does have one often-discussed (and misunderstood) limitation compared to EEPROM: You can't erase it on a byte-by-byte basis. It must be erased completely or, in some versions, on a sector-by-sector basis. One way you can deal with the sector-erase problem is with hardware that treats any block device as if it were a tape or disk drive. Another way is with software where the file structure anticipates a block device. Since magnetic drives are formatted sector by sector, applying sector erase to flash memory seems reasonable.

According to Kurt Robinson, an Intel flash-memory guru, designers think that they have to erase at the sector level, but that's really not true. "You can write in sector-size chunks; you can read back in sector-size chunks. All you have to do is make sure that you have blocks available that are already erased that you can write to. Even if time is required to swap data into and out of sectors, the flash is orders of magnitude faster than a disk drive to start with, so the user actually sees a significant increase in performance." With the availability of 1- and 2-Mb flash devices in TSOP packages, both Intel and Fujitsu now offer flash memory cards in 1- and 4-MB densities.

Flash-memory cards will greatly extend battery life in portables. The most clever power management schemes combine screen shutdown, CPU idle mode, and shutting off the hard disk drive when no reads or writes have occurred for a particular period of time. But it takes a lot of power to spin the drives back up.

The MC400 laptop computer from Psion already uses flash-memory modules to replace disk drives. It has four module slots, and each module contains four Intel 128K-byte flash ICs for a total of 2 MB of memory. Psion also makes an accessory that lets you plug the MC400's modules into any MS-DOS computer.

Standardizing flash-memory specifications is a particularly challenging task. PCMCIA has come to the conclusion that there are several technology variants. More specifically, a flash card informs a system of its particular erase/voltage level through the meta format.

Future Trends

Data storage has moved through an evolutionary cycle from paper to magnetic media to optical to silicon. Beyond this, you can expect to see an increase in modularity as all kinds of peripheral functions become easy to implement in a standard card format.

The card socket will look much the same as an expansion bus, so you can plug cards into any vacant socket regardless of card or computer manufacturer. Do you want to expand main memory? How about adding a modem, a video board, a coprocessor, a fax card, or a scanner? Just plug in the right card. ■

ACKNOWLEDGMENT

I wish to thank Michael Bloom, president of Technology Communications Group (West Linn, OR), for his help in preparing this article.

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Resource Guide: Portable Sources

Classifying portable computers is a difficult task. New classes appear and old ones change as the technology improves. Hand-held computers are those you can fit in your pocket, notebooks are generally AT machines from 4 to 8 pounds (1.8 to 3.6 kilograms), laptops are more powerful machines in the 8- to 17-pound (3.6- to 7.7-kilogram) range, and transportables are full-featured, mobile machines over 17 pounds. Below is a list of portable computer suppliers.

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San Jose, CA 95131
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AEG Olympia
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Somerville, NJ 08876
(201) 722-7000
Inquiry 1231.

Airis Computer Corp.
1824 North Besly Court
Chicago, IL 60622
(312) 384-5608
Inquiry 1232.

Altima Systems, Inc.
1390 Willow Pass Rd.,
Suite 1050
Concord, CA 94520
(800) 356-9990
(415) 356-5600
Inquiry 1233.

American Research Corp.
1101 Monterey Pass Rd.
Monterey Park, CA 91754
(213) 265-0835
Inquiry 1234.

Apple Computer Corp.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry 1235.

Arima Computer Corp.
4/F, No. 1, Nankang Rd., Sec. 3, Lane 50
Taipei, Taiwan, R.O.C
886-2-785-9712
Inquiry 1236.

ArtDex Computers Corp.
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No. 3, Chung Hsin Rd.,
Shi Chin Cheng
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Astarte Computer Systems, Inc.
1035 Pearl St.,
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Boulder, CO 80302
(303) 449-9970
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AST Research, Inc.
16215 Alton Pkwy.
Irvine, CA 92713
(714) 727-4141
Inquiry 1238.

Atari Computer Corp.
1196 Borregas Ave.
Sunnyvale, CA 94089
(408) 745-2000
Inquiry 1240.

Austin Computer Systems
10300 Metric Blvd.
Austin, TX 78758
(512) 339-7932
Inquiry 1241.

Autonomy Computer Corp.
1674 Broadway,
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New York, NY 10019
(212) 265-7836
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Bi-Link Computer, Inc.
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Whittier, CA 90606
(213) 692-5345
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Bitwise Designs, Inc.
701 River St.
Troy, NY 12180
(518) 274-0755
Inquiry 1244.

Bondwell Industrial Co., Inc.
47485 Seabridge Dr.
Fremont, CA 94538
(415) 490-4300
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BSI
9440 Telstar Ave.,
Suite 4
El Monte, CA 91731
(818) 442-0020
Inquiry 1246.

Bus Computer Systems, Inc.
135 West 26th St.,
Eighth Floor
New York, NY 10001
(212) 627-4485
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Cache Computers, Inc.
46714 Fremont Blvd.
Fremont, CA 94538
(415) 226-9922
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CAF Technology, Inc.
600 South Date Ave.
Alhambra, CA 91803
(818) 289-8299
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Cari Computer Corp.
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886-2-508-4793
Inquiry 1250.

Chaplet Systems U.S.A., Inc.
252 North Wolf Rd.
Sunnyvale, CA 94086
(408) 732-7950
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1641 West Collins Ave.
Orange, CA 92667
(714) 771-6151
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Crete Systems, Inc.
12F-7, No. 391, Sec. 4,
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Taipei, Taiwan, R.O.C.
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(415) 683-8888
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Inquiry 1265.

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Westborough, MA
01580
(508) 366-8911
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St. Charles Rd.
Lombard, IL 60148
(708) 627-4004
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Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(512) 338-4400
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El Toro, CA 92630
(714) 768-6842
Inquiry 1269.

Digitech, Inc.
969 Route de l'Eglise,
Suite 200
Sainte-foy, Quebec,
Canada G1V 3V4
(418) 653-1662
Inquiry 1270.

Dolch Computer Systems
372 Turquoise St.
Milpitas, CA 95035
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Epson
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Fremont, CA 94537
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HCI
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IBM Corp.
P.O. Box 1328
Boca Raton, FL 33428
(407) 982-1975
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Burlington, MA 01803
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Ville St. Laurent, Quebec, Canada H4T 1A3
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Samsung Information Systems America, Inc.
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San Jose, CA 95134
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Mahwah, NJ 07430
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Inquiry 1012.

Tandon Corp.
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Moorpark, CA 93021
(800) 800-8850
Inquiry 1013.

Tandy Corp.
1700 One Tandy Center
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(817) 878-4969
Inquiry 1014.

Tatung Company of America, Inc.
2850 El Presidio St.
Long Beach, CA 90810
(800) 827-2850
(213) 979-7055
Inquiry 1015.

Texas Instruments
P.O. Box 2022230
Austin, TX 78720
(512) 250-7984
Inquiry 1016.

Top-Link Computer Co., Ltd.
No. 6, Lane 333, Hsin Hsu Rd., Hsin Chuan
Taipei, Taiwan 242, R.O.C.
886-2-901-3576
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TOPPCs International
648 North Eckhoff St.
Orange, CA 92668
(714) 939-1416
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Toshiba America Information Systems, Inc.
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Irvine, CA 92718
(714) 583-3000
Inquiry 1019.

Trans PC Systems, Inc.
11849 East Firestone Blvd.
Norwalk, CA 90650
(213) 868-6930
Inquiry 1020.

TriGem
2388 Walsh Ave., Building B
Santa Clara, CA 95051
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Inquiry 1021.

Twinhead Corp.
1537 Centre Pointe Dr.
Milpitas, CA 95035
(408) 945-0808
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Uniq Technology, Inc.
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Fremont, CA 94538
(415) 226-9988
Inquiry 1023.

USIT
3023 Research Dr.
Richmond, CA 94806
(800) 543-2294
Inquiry 1024.

Veridata Electronics, Inc.
Fifth Floor, 19, Nanking East Rd., Sec. 3
Taipei, Taiwan, R.O.C.
886-2-506-9755
Inquiry 1025.

Zenith Data Systems Corp.
1501 Feehanville Dr.
Mt. Prospect, IL 60056
(708) 699-4800
Inquiry 1026.

Zeos International, Ltd.
530 Fifth Ave. NW
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(612) 633-4591
Inquiry 1027.

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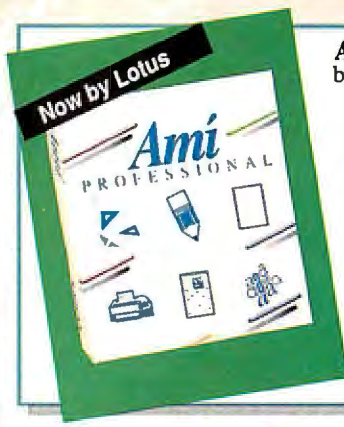

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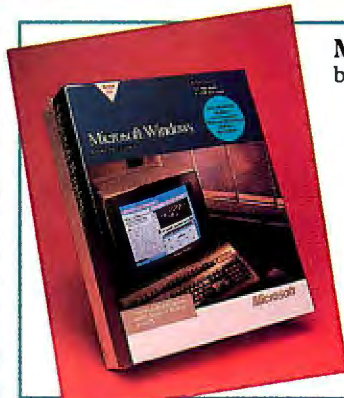

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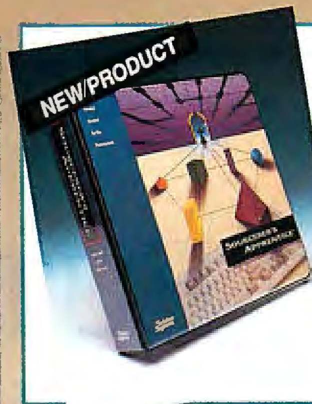

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Networks are undergoing evolution, not revolution, say the experts

THE FUTURE OF NETWORK OPERATING SYSTEMS

Barry Nance

You turn to your computer and load the past month's figures into your spreadsheet program. A network file-server task awakens on one of your company's mainframes; it begins sending the pieces of the file to your computer. Knowing it will take a few minutes to load the figures, you open another window and finish editing your weekly status report.

Satisfied, you electronically mail the report to your boss and send electronic carbons to the other project team members. An E-mail server distributes the files to each person's computer, one of which is located in Singapore.

When the spreadsheet figures have loaded, you adjust your schedule data but leave your cost estimates alone—for now. The recalculated result is still acceptable. The recalculation takes place quickly, on a remote 50-MHz 486 slave computer. You save the file and head off to lunch.

Fred, a Macintosh user who sits across the office, is also saving his figures at the same time. The spreadsheet software coordinates the updates to the separate portions of the file, locking each section in turn until the complete file is safely back on the mainframe.

How long will it be before you can use networks this way? According to industry experts, some features will be available in only a year or two. Other features may have to wait as long as five years to reach our desktops—and perhaps longer to become "standards."

Trends You'll See

The first and probably most important trend in networks is the cooling off of the war between the vendors. Instead of "Buy my LAN—I supply everything you need," the vendors will say, "We're open—we coexist with anything and everything." A trend that's already started, this new direction means you will have fewer headaches with multivendor solutions. Naturally, it'll take some time for vendors to be able to point to successes in this area. Proprietary architectures die hard.

Do you hate having to remember that drive G is on SERVER1 but drive H is on SERVER3? Multiple servers that coordinate with each other are on their way. Soon you'll be able to treat the entire network as one large disk drive. And you'll see large files that span multiple servers. File access technologies such as Structured Query Language (SQL) will be embedded in the network operating system (NOS) itself.

Speaking of file access—it's going to take skull sweat and late hours from the LAN designers, but you will see transparent data access across mainframes, minicomputers, and personal computers become a reality. Mainframe "virtual disks" will

Barry Nance is the author of Network Programming in C *and is the exchange editor for the IBM Exchange on BIX. He can be reached on BIX as "barryn."*

be replaced by mainframe file-server technology. And it will be possible for both personal computer and mainframe applications to share the same data.

Network management is barely past the Lewis and Clark exploration stage now compared to where it will be in a few years. You'll have better interfaces and underlying expert systems that monitor, diagnose, and care for your network. New facilities within the NOS will be paired with administrative software tools; the result will be a network that advises you of corrective actions for problems and suggests improvements when performance degrades.

One software technology already emerging within some NOSes is the remote procedure call. RPC is a process in which an application subroutine on one computer calls another subroutine on a different computer to do some work. Vendors promoting RPC realize that "transport independence" is necessary for this technology to take hold. Some subroutines may execute on a VAX, some on a PC. Token Ring may carry some passed function-call parameters; Ethernet may carry others. Transport independence (i.e., plug-and-play network protocols) lets these pieces process the data without regard for CPU architectures, calling conventions, or data representations.

Up to now, NOS technology has existed at the departmental level, where proprietary protocols could work in isolation. In the future, you'll see enterprise-wide LANs and wide-area networks. This migration is perhaps the rockiest road that NOS technology faces. Gursharan Sidhu of Apple Computer coined the term *polyglot hypothesis* to describe the need for NOS interpreters that translate, United Nations style, the different languages spoken by each vendor. I hope we get simultaneous translations.

Impact of the New Technology

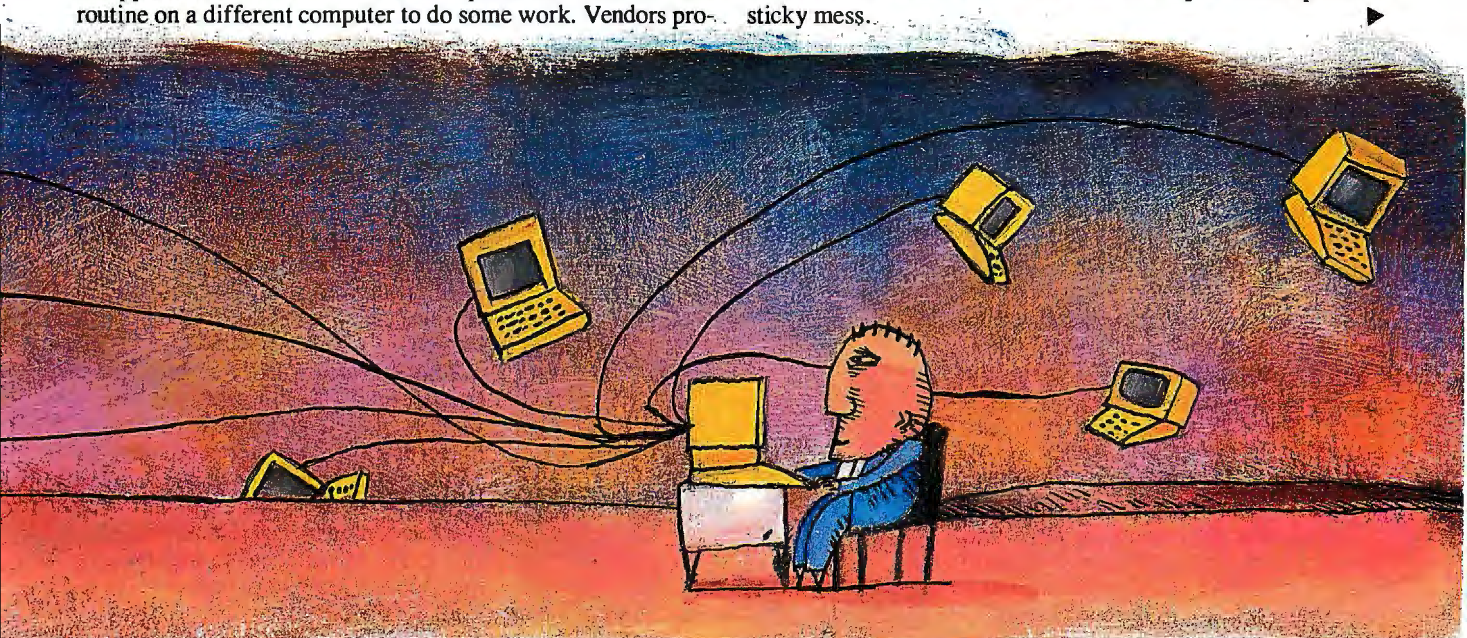
The picture I drew at the outset hints at the impact that new NOS technology will have on us. You may someday see NetWare or LAN Manager running on a mainframe. Excuse me, I mean you *won't* see it. The catchphrase "information at your fingertips" implies you don't need to know (or care) exactly where data resides.

Personal computers will be used to shoulder more and more of the computing workload. The new generation of NOSes will cause yet another explosion in desktop computing. And the computers won't necessarily have to be all the same brand.

Of course, this evolution will cause developers to rethink their designs and interfaces. One of these days, you may very well see a Macintosh front end to a SQL server application in which most of the processing is performed, unattended, by OS/2 database engines.

Companywide E-mail systems will become as pervasive as desk telephones; interoffice mail will never be the same. The NOS will help network administrators keep track of software versions and help distribute updates. Connectivity will improve to the point that you will even see mainframe applications that "reach down" to access records and tables that are located on a PC file server.

In a sense, NOSes are just glue to help us hold things together. Until now, we've had to read the label carefully to know what sticks to what, what combinations to avoid, and how to wash our hands when we accidentally get glue on them. The glue of the future will let us connect more things, but we'll still have to read labels to make sure we won't just wind up with a sticky mess. ▶



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DOWN THE LAN ROAD

Just what is a network operating system? What kinds of developments will take place in the months and years to come? How do you plan for those developments? For answers to those questions, BYTE asked a diverse group of LAN experts to predict the future of NOSes. These folks, representing some of the major players in the LAN industry, are the people working to create the next generation of LANs. As such, they're in a unique position to predict what lies ahead.

Gursharan Sidhu
Technical Director,
Collaborative Network Systems,
Apple Computer

In some sense, the term *NOS* has been an attempt to identify a set of networking services, servers, and support software and give it the same kind of visibility and status that operating systems have.

I think we're going to move beyond isolated single servers. If you look at most systems today, you have one or more file or other type of servers installed on the network and each is sort of an independent entity. I think if people want group productivity with network systems, they will want to have these servers cooperate with each other. Also, I think that the tremendous emphasis that people have been placing on file servers might change. File services are an important sharing facility, but messaging, directory, and security services will probably play more multiple roles.

It's going to be important that the focus go beyond real-time interaction between two programs to interaction in nonreal time—things like the counterpart of answering machines. A program sends a message to another program, and the other program may or may not be running then. The other program wakes up at a later time, picks up the message and handles it. I refer to that as "interprogram messaging."

For about 15 years or so, there's been this great emphasis on discovering a single network standard or protocol. There is not going to be just one single standard. There is a tremendous need to stop banking on the emergence of a single standard and start focusing on how to make the operation of networks harmonious even in the face of all these different standards that have to coexist and collaborate.

Craig Burton
CEO, Clarke Burton Corp.

A NOS is an operating system that controls a given network computing environment (i.e., all the software, including the protocols, architectures, services, and so forth). There are two schools of thought regarding the direction in which NOSes will go. It is pretty clear that they will go toward the latter school.

One school of thought believes that network operating systems will begin to align themselves on a single medium. What's more likely to happen, though, is that multiple versions and multiple types will remain in place. Operating-system designers will come up with some architectures that will evolve to these various versions and types as opposed to a single version.

This scenario will, of course, lead to fundamental file and print services, as well as store and forward messaging, name and directory services, and network management services. A lot of growth will be in development tools (such as compilers and remote procedure call tools) and application and management tools to allow developers to take advantage of these services.

Russ Siegelman (right)
Product Manager, LAN Manager;
Eric Rudder (below)
Program Manager,
Network Business Unit,
Microsoft

The real trend in network computing is "information at your fingertips." That's the big theme for NOSes in the 1990s. It means that customers who are asking for something to fill a need can use a network to put information at their disposal.

What will the market require in the future? Well, enterprise computing is a year or two away. But the base technology that a NOS needs to provide includes security, distribution, and replication. The basic building blocks are there, and we can focus on the higher-level things today—such as scaling.

We do need standards. But just because they arrive doesn't mean we can do enterprise computing. Within the next couple of years, we will have the technology that will make it possible for a large part of the Fortune 500 companies to hook up a large part of their computers—not all, but we're headed in that direction.

A lot is going to happen in the next 10 years. We should see more than just improvements to the existing technology. We should see more ease of use, installation, network management, and software distribution.

One key thing that will have to happen with larger networks is that things will have to become more distributed and less central. The network will have to be well behaved to replicate [the adding of more nodes and servers]. The single biggest difference will be that it will be easier to use and easier to access. The NOS is only a piece of the puzzle. We see the client/servers, communication servers, and E-mail servers coming together.

David Rosenlund
Senior Product Manager,
Distributed Computing,
Sun Microsystems

In the PC LAN world, the term *NOS* has come into being because that's exactly what you have. I'd say nine times out of 10 nowadays, people use that term generically to refer to the network itself.

If you look at the typical company today anywhere in the world, you'll find that it doesn't have all one computer platform—just PCs, or just Macs, or just VAXes. Networking should follow that computing model where people really want to network their VMS systems and their DOS systems and their Unix systems all together in one heterogeneous network.

Contrast that to NetWare, which is an operating system unto itself, explicitly and exclusively designed originally to be nothing more than an operating system that would act as a file and printer server to a bunch of PCs in a network. I'm just using Novell as an example. What NetWare was not designed to do was to be a great operating system on which you would run a CAD or a database application. That's why you see a lot of slow growth in the NetWare marketplace relative to applications running on NetWare servers, because it is a separate operating system.

Sun's approach is what we call a distributed computing platform. It is software technology that you can add to any operating system in existence today—from DOS PCs to Cray supercomputers, including IBM mainframes and DEC systems. The systems of many vendors can all be networked together and can run various applications and implementations. Basically, we follow the ISO model because it's a seven-layered architecture.

Most, if not all, of the implementations of ONC/NFS [Open Network Computing/Network File System] today are built on top of TCP/IP, so IP is the network protocol. And it just so happens that TCP/IP is also the standard for networking dissimilar systems from dissimilar vendors together at the protocol level. On top of that, you have several different session-level interfaces—many different choices.

Over the next year, "transport independence" will become a strong and clear direction. You need a transport-independent RPC so that people can develop applications to the RPC-level interface, and also so that, at run time, the application can determine what transport is being used on that system and run over that transport protocol.

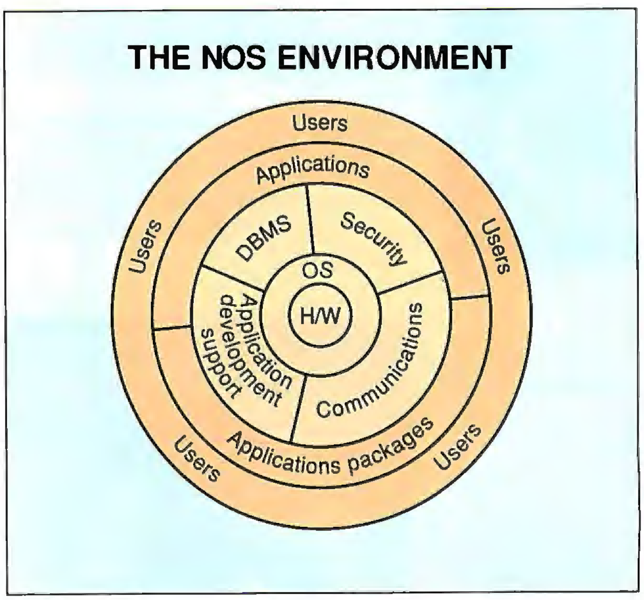
continued

Brad Friedlander
Senior Consultant,
Arthur D. Little

The real NOS already exists to some extent in the larger machines, and we're seeing it going down into the smaller computers—the PC-based arena. In the future, a piece of the NOS will actually be running on each intelligent node, on every PC, on every Mac, on every server that's in the network.

The PC as a piece of iron can do it. The "platform" becomes the hardware plus all the environmental software (see the figure). Low-level protocols exist. You can connect almost anything to almost anything today. But it will be five to 10 years before we get any universal high-level protocols. Sooner than that, companies will develop their own proprietary protocols. That's what we will see first. Once those are successful, people will begin to put on the pressure to make it a heterogeneous environment rather than a homogeneous environment.

In the next year, I don't expect any revolutionary changes. I expect just continued evolution. In five to 10 years, we'll have some standards so that we can really have a true heterogeneous environment. Before five years, we'll definitely have many proprietary-based NOSes.



A way of looking at a NOS environment. The core is the hardware (PC) controlled by the next layer, the operating system. The operating system working with the next layer of software forms the environmental software, *a general term meaning all the software running on a piece of hardware that is not application specific. The layer closest to the user consists of applications and applications packages. Thus, the hardware and all the environmental software make up a NOS platform.*

John Edwards
Product Line Manager,
Novell

A NOS is an integration platform that provides network services, such as database, communication, messaging, file, and print, to all popular desktops, such as DOS, Windows, OS/2, the Macintosh, and Unix, within their native environments.

In the past, many users relied on central control of information processing through a host mainframe or minicomputer. Today, that computing model continues to make sense for many companies, especially for such corporatewide functions as finance and accounting.

These same companies, however, now find that the need for responsiveness within individual departments has resulted in a proliferation of decentralized computing resources, usually in the form of LANs that connect desktop systems. In the future, users will need help in bridging across these computing environments so that everyone in a company can work within the computing environment that he or she is used to, as well as share information with one another.

Typically, you might find an IBM mainframe in the MIS department, a Unix workgroup or minicomputer in the engineering department, a Macintosh workgroup in the marketing department, and a DEC or Hewlett-Packard system in manufacturing. Users need an integration platform that provides services that these dissimilar computing "cultures" can share, as well as interconnectivity between these environments.

Through such an integration platform, desktop clients that are based on DOS, Windows, OS/2, the Macintosh, or Unix share services such as file and print, database, messaging, and communication with remote resources and extended environments such as IBM's SAA, DEC's NAS, Hewlett-Packard's NewWave, and OSI. In addition, users need tools to manage their networks at the enterprisewide level.

Users need fundamental services and transparent connectivity. Developers need an open integration platform to provide them with the tools that they can use to create new applications that take advantage of the enterprisewide network resources.

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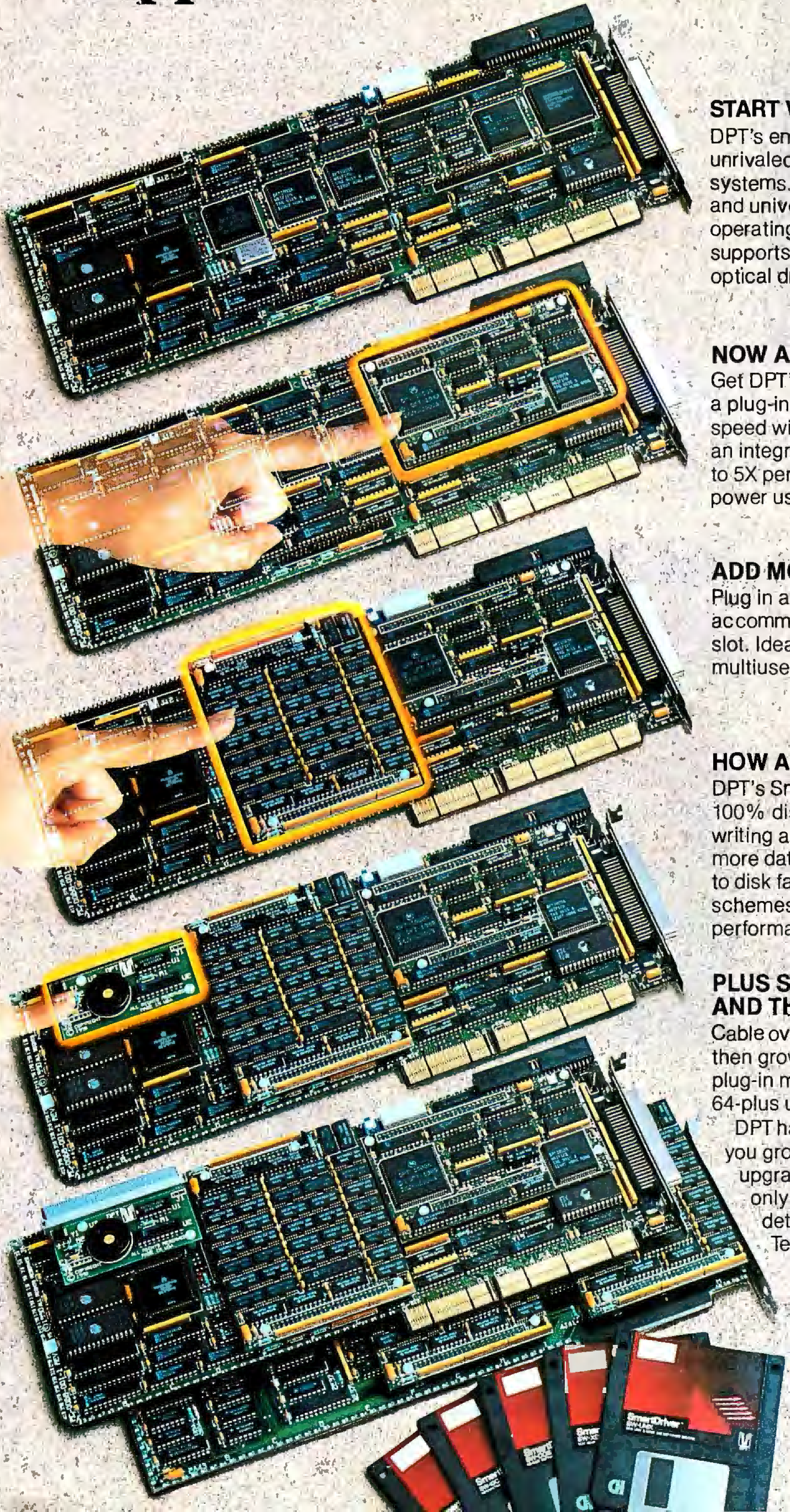

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James E. Allchin
Senior Vice President,
Banyan Systems

A NOS is an independent operating system combined with a layer of distributed processing software that gives the user the illusion of a single combined system even though it is composed of several different machines and, in fact, several different operating systems.

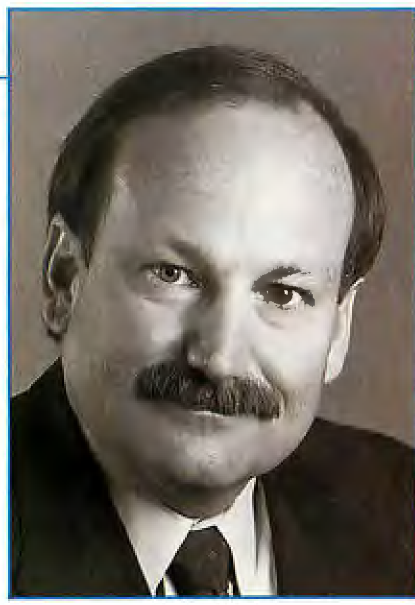
People want information at their fingertips—access to it no matter where it is—whether it's on a server that they're connected to or on a VMS machine or wherever it is in the network. Administrators want a network that runs itself.

In my opinion, there's only one standard in the industry and that's POSIX, which is sort of a superset of Unix. That is the basis for the future of most applications. (OSF, X-Open, and Unix 5.4 all are driving to POSIX, and I believe that both Microsoft and Novell have committed to eventually going to POSIX.)

You will see transparent access to the same piece of data, the same file, whether it's sitting on DOS, OS/2, the Mac, Unix, NetWare, or LAN Manager—while, at the same time, the NOS is running the application on the server going after that same piece of data. That same statement goes for print systems. These capabilities are all within our grasp within the next year and are significant steps along the way to interoperability.

We're also going to see more easily managed networks. A bunch of stuff will happen in network management—more and more tools, perhaps expert systems to help control these networks. And you will see new tools for network administration and new platforms for building distributed applications.

But in a year's time, we still won't have realized the total goal. Applications to take advantage of these application-computing platforms still will not be around (i.e., multimedia and moving of documents). Translation between the systems is still literally five years away. This is still a very young industry.



Ralph Ungermann
President and CEO,
Ungermann-Bass

My personal definition of NOSes is that they are extensions of the operating system provided for PCs, network stations. We are a system supplier that focuses on giving people choices (operating systems, applications, platforms in underlying technology, and so on) in building enterprise networks. Our focus is on the future of integration more than any particular operating system. We don't champion any particular NOS. Our customers are very interested in two things: IBM compatibility and porting client/server architectures across many platforms.

"Enterprise" means a company, a university, a government—a business unit in general—some kind of organization, which may include their customers and even their vendors. An enterprise network is one that extends throughout an entire organization into all aspects of the business—generally across wide geographies. And that's different from what networking has been over the last 10 years, which is more what you might call "departmental networking."

We're still a long way from having enough standards so that people developing distributed computing applications will be able to build products that can interconnect across Novell and Microsoft, LAN Manager and IBM. But that's the direction the industry is going in. In general, we will see more and more convergence on standards. But there are still not enough higher-level standards. Remote procedure calls, for example, need to be agreed on before we're going to get real interoperability. That will come about over the next year or two.

There are two new standards called NDIS and ODLI [Network Driver Interface Specification and Open Data Link Interface]. They make it a lot easier for workstations from different vendors using different adapter cards and different protocol stacks to connect into Novell or LAN Manager. NDIS is supported by IBM and Microsoft; ODLI is supported by Novell. In the future, you'll see those two standards combine into one standard so that it'll be even easier to write applications from different vendors that connect into Novell and Microsoft. Coexistence will be more and more common.

Customers have made it very clear that they're going to buy open systems (and they have to be truly open). I predict that the 1990s will bring the melting of the cold wars between vendors and there will be much more cooperation and openness. That's what this Houston 30 is all about. They don't want proprietary extensions to keep going, and they're making a lot of racket. They're threatening to make examples of some companies that are speaking standards and offering all their applications running on proprietary extensions.

NOSes have to become compatible. In my opinion, there are two operating systems in the world—the IBM/ Microsoft operating system and Unix. Novell will have to add value on top of those systems and become totally compatible with them, and not offer proprietary extensions. Anybody that plays in that industry in terms of operating systems, be it Banyan or Sun or Novell, must offer value on top of those standards. ■

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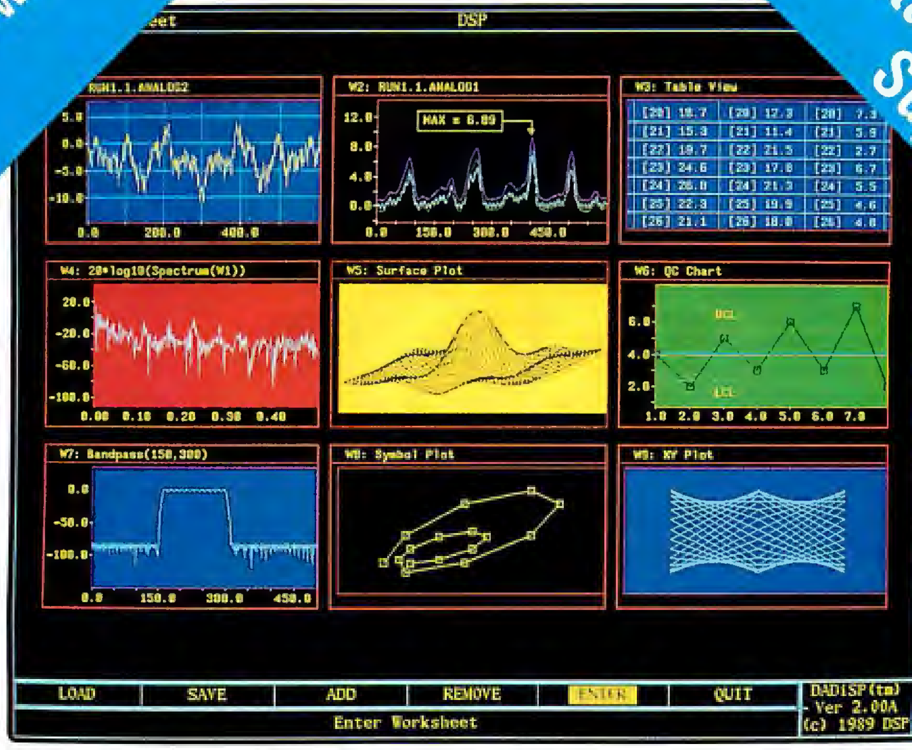

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AN EASIER INTERFACE

Xerox PARC, originator of the computer desktop, unveils a vision for the future of user interfaces

Mark A. Clarkson

In the beginning was the command-line interface, that taciturn A> prompt that offered little assistance and even less encouragement to users of the first microcomputers. Then along came Xerox's Palo Alto Research Center (PARC), seeding the personal computer world with the now-ubiquitous windows/icon/mouse/pull-down menu user interface.

A decade later, the PARC System Sciences Lab has unveiled a new user interface, one that incorporates color and real-time, three-dimensional, interactive animation. PARC calls this new interface the *Information Visualizer*.

The Information Visualizer

Developed as part of the Interactive Information Access project, the Information Visualizer is an experimental user interface. Its aim is to help users better manage jobs that entail vast amounts of information. It uses 3-D real-time animation to present information as 3-D interactive objects.

The Information Visualizer was designed with the business user in mind. Unlike 3-D visualizations that involve wearing special goggles and gloves to enter into an artificial world, the Information Visualizer uses the familiar mouse. This interactive interface relies on perceptual cues, such as light and shadow, to draw you into an artificial reality that has been created on your screen.

Within the Information Visualizer, work is distributed throughout a collection of 3-D (and 2-D) rooms furnished with interactive objects such as walls and floating trees (see photo 1). To better understand the structure of the information that these objects represent, you can access embedded data and examine its structure from different angles by "flying" around or through it. The interface also features other objects, such as 3-D directory trees, which you can rotate, examine, prune, and rearrange (see the figure).

These animated visualizations are designed to shift work to your perceptual system, freeing the conscious mind to work on larger problems. Information Visualizer architects George Robertson, Stuart Card, and Jock Mackinlay quote Walt Disney: "Animation can explain whatever the mind can conceive."

A fast, compact experimental database system, called Text Database, underlies the Information Visualizer. This database system manages the storage, indexing, and search and retrieval of the information that the Information Visualizer displays. Text Database is being developed by the System Sciences Lab's Natural Language Theory and Technology group.

continued

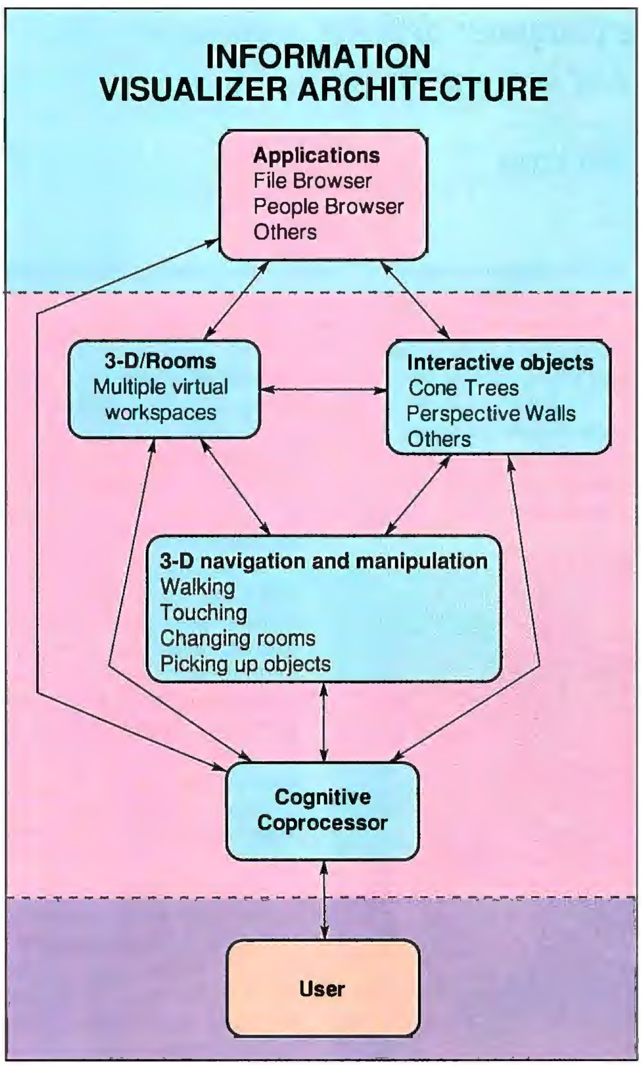
ILLUSTRATION: PAUL SCHULENBERG © 1991

How Much Is That Data in the Window?

PARC scientists believe that information retrieval and use will be to the 1990s what text editing was to the 1980s. Information retrieval is not an end in itself but part of some larger activity.

To ease the management of large amounts of information and projects, the Information Visualizer goes beyond the usual notion of an information retrieval system. It seeks to significantly reduce the total cost of using information—from its storage and retrieval to its management and use. The total cost of information depends not only on the cost of finding and retrieving it, but also on the cost of managing and assimilating it once it is at hand. Thus, a collection of information has a cost structure based largely on how you store and access that information.

In the context of the Information Visualizer, the words *inexpensive storage* and *expensive storage* do not have their usual meanings. Information readily at hand (e.g., on the screen or on your desk) is relatively inexpensive to use, whereas information that is harder to retrieve (e.g., on a floppy disk, in your file cabinet, or in the downtown library) is more expensive. The difference in cost between inexpensive and expensive information can be several orders of magnitude.



Applications run in 3-D/Rooms populated with interactive objects. The Information Visualizer provides tools for navigating within and among these rooms and for manipulating objects. The Cognitive Coprocessor ties all aspects of the system together and handles interaction with the user.

In everyday dollars-per-byte terms, floppy disks are a less expensive medium of information storage than high-speed RAM. In terms of the cost to retrieve and use that information, though, just the opposite is true. Floppy disks are slower, more cumbersome, and more difficult to access than RAM is.

The Problem with Small Screens

The more information you can keep readily available in inexpensive storage, the better. Unfortunately, the most inexpensive storage place turns out to be your computer's screen. The screen is one of the few computer resources that you can access directly. As a result, in overlapping window systems, electronic messy desks are common. You strive to keep as many tools as possible where they are easy to get at and manipulate—on the screen.

In an interactive setting, almost all information passing from the computer to you does so via the screen. To reduce your cost of using this information, the computer has to pass large quantities of information through the screen to you as efficiently as possible.

Unfortunately, the screen is also the computer's most constrained resource. The average computer screen is about the same size as a piece of typing paper. Processing speed, RAM, and mass-storage size can all increase by vast amounts. But current technology cannot produce displays larger than a few million pixels, and such large displays are extremely expensive. In addition, applications that require small, portable displays (e.g., notebook or wristwatch computers) will continue to proliferate.

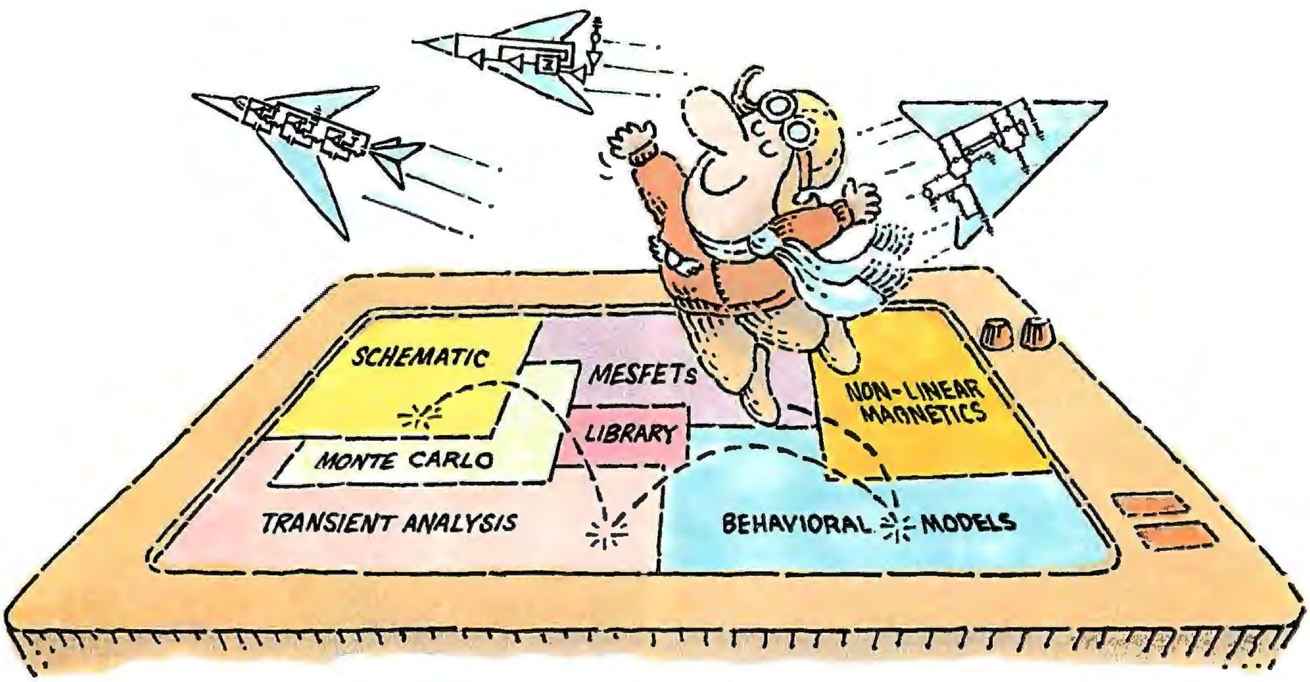
Since the dimensions of the screen are unlikely to increase, PARC decided to increase the effective size of the workspace it represents (i.e., the inexpensive information storage area). Today's sophisticated user interfaces already exploit the existing workspace by alternating screen usage (e.g., swapping the screen between two applications) and providing distorted views (e.g., with icons and overlapping windows).

In an experimental window management system called BigScreen, PARC explored a third method of increasing effective screen size—large virtual workspaces. BigScreen distributes windows over the surface of a large virtual workspace, and the computer screen acts as a sliding viewport onto that larger space. Analysis of BigScreen revealed that users tend to form clusters of windows related to particular tasks (e.g., one group of windows for reading mail and another for Lisp programming). Rather than sliding the viewport over the workspace, users would jump directly from one cluster of windows to another as they performed various tasks. These little clusters are called *locality sets* or *working sets*.

Far from being unique to BigScreen, this clustering of information turns out to be a common phenomenon. The elements in such working sets do not change gradually over time; rather, users tend to work with one distinct working set for a time and then shift abruptly to another. For example, you might open all the windows required for the task of reading the mail, read the mail, and then open the windows required to write a Lisp program. Also, each task employs a specific set of disk files, programs, and memory locations.

Rooms to Move Around In

Concentrating on this clustering of information, PARC developed a window management system called Rooms. Rooms is



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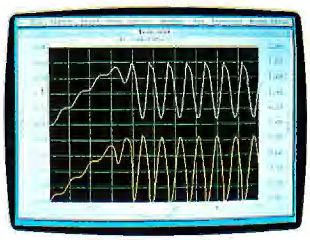
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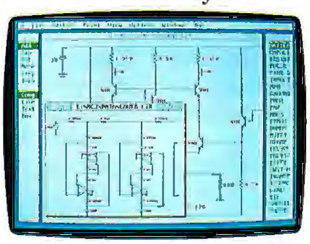
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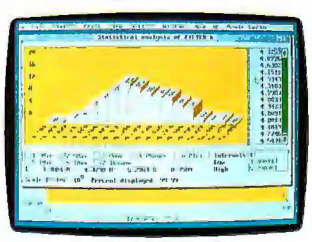
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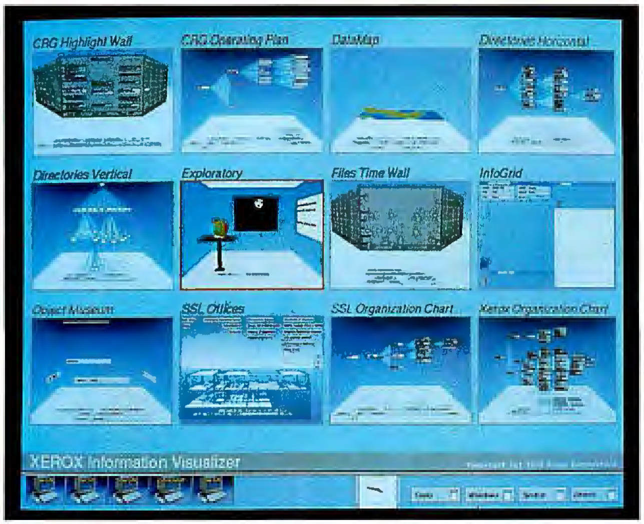

Photo 1: *In the Information Visualizer system, an Overview provides a high-level look at a collection of virtual workspaces called* rooms. *This Overview shows eleven 3-D rooms and one 2-D room, each of which represents an active application or object that can be run and manipulated directly from the Overview.*

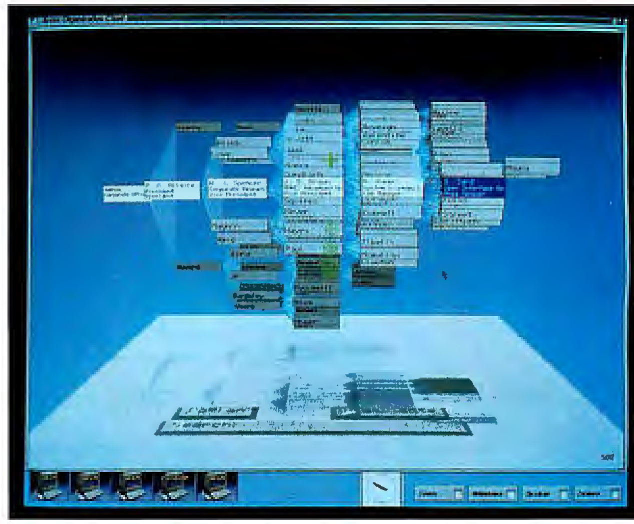

Photo 2: *A Cam Tree is a hierarchy laid out in 3-D. The root node of the hierarchy is on the left, and the hierarchy proceeds to the right rather than from top to bottom. This Cam Tree represents the first 600 nodes of the Xerox organization chart, previously an 80-page document.*

designed around the task-oriented clustering of information and provides multiple virtual workspaces (or *rooms*) that are furnished with windows and objects pertinent to some task.

Rooms helps manage information once it has been retrieved. By making it inexpensive to switch to a new set of windows and objects, Rooms encourages the user to keep less clutter on the screen. Because users switch from task to task, the computer anticipates their needs, more efficiently retrieving items from expensive storage (e.g., the disk or file server). The successor to Rooms, 3-D/Rooms, is a major component of the Information Visualizer.

Rooms are connected to each other by *doors*, through which the user walks. Leaving through the back door returns users to the room from which they came. The user can also jump directly to another room by name or enter a room from an Overview (see photo 1).

The Overview provides miniature versions of a user's rooms and their contents. Using the Overview, the user can look at several rooms at one time. Wiring diagrams display the connections between rooms. In the Information Visualizer, objects in the Overview are active, and a user can manipulate them from there.

In 3-D/Rooms, one object, or a group of objects, can appear in more than one room. Changes to the object in one room affect all copies of that object in all rooms. You can also put things into *pockets* and carry them from room to room.

Visualize This

Another way to increase the effective size of the computer screen is to increase its density (i.e., the amount of information it displays). Obvious limits exist when the information is given in the form of text or numbers, but a picture, as they say, is worth a kiloword.

A common way in which a system, either biological or human-engineered, can improve information processing efficiency is by using methods called *abstraction* and *selective omission*. These terms refer to a way in which the lower levels of an information processing system (e.g., a computer) can simplify and organize information. Without having to deal with so many details, you can process information more easily and in more universal terms.

Pictures are the obvious abstraction for the computer screen, and a 3-D representation can pack more onto a computer screen than a 2-D representation. Even 2-D structures benefit greatly from the added depth of 3-D graphics.

Three-dimensional computer visualization is usually reserved for objects and systems that are inherently 3-D in nature, such as models of molecules and airplanes. The Information Visualizer taps the power of 3-D real-time animation to show structures that are not typically thought of as 3-D objects—structures like organizational charts and calendars. PARC calls these representations *visualizations*.

The prototype Information Visualizer system has visualizations for three classes of information: linear structures, hierarchical structures, and unstructured information.

Hierarchies Hanging in the Air

Hierarchies are everywhere, from business organizations to disk directory structures. The Information Visualizer provides a special visualization called the Cone Tree, with which you can easily deal with large hierarchies.

In Cone Trees, hierarchies are laid out in 3-D. They provide a "fish-eye" view of sorts—the closer nodes are larger and brighter than those farther away. Shadows on the floor provide another perceptual cue. They are, in effect, a 2-D projection of the 3-D structure, providing you with another perspective.

Photo 2 shows a related visualization called the Cam Tree, which resembles a Cone Tree laid on its side. The Cam Tree hierarchy proceeds from left to right rather than from top to bottom.

These animated trees can convey surprising amounts of information. One tree supports a File Browser displaying the host system's entire Unix directory structure at once—about 600 directories holding 10,000 files. Another is an organization chart containing 650 nodes—originally an 80-page document.

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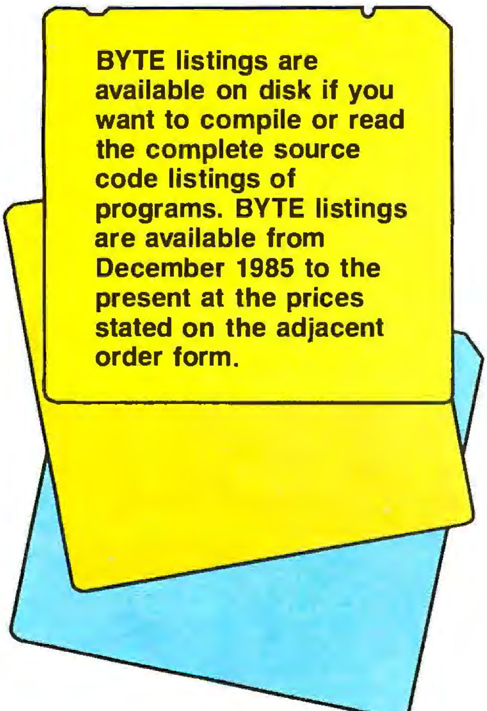

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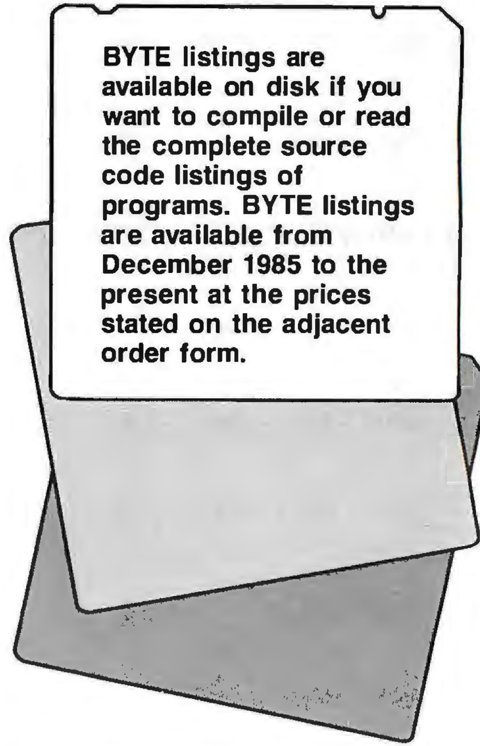

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To help users focus on the interesting parts of these enormous trees, the Cone and Cam Trees also provide a set of gardening operations. Using these tools, you can prune or grow back extraneous branches with a simple gesture and move branches from one node to another.

When users select a node in one of these trees, it rotates so that the selected node and the path from the selected node to the root node are placed front and center and are highlighted. The cones rotate smoothly, like carousels, as fast as the eye can comfortably follow. As the cones turn, the human perceptual system automatically tracks the parts of the tree and their relationships. Users gain added insight into the relationships within the structure by seeing the tree from different angles as it rotates.

The benefits of animation then become clear. A selection can be complex, involving the rotation of as many as 10 levels of cones. With animation, your unconscious perceptual system automatically tracks the rotations as they happen, updating your mental model of the structure. Again, animation can shift some of the work to your unconscious perceptual system, freeing the conscious mind for higher-level cognitive work.

In the same way drivers remain aware of the other cars about them in traffic, needing only to check their mirrors occasionally to update their mental model, users are aware of objects that are "behind" them or occluded by other objects. These objects are effectively present, even though they need not be shown.

A Search as Lovely as a Tree

To search a tree, you can select and examine individual nodes or perform a search on the entire visible structure. (You can perform a search only on the visible nodes of the tree.) When the search begins, all nodes become invisible. Then they reappear, one by one, showing the progress of the search through the tree.

When a node reappears, it is given a score in the form of a red underline—the longer the line, the higher the search score for that node. When the search terminates, the node with the highest score is selected, rotating smoothly to face you.

The Information Visualizer remains active during the search. You can continue to work and then end the search as soon as you have enough information. The catchphrase for it at PARC is "treating the human like a real-time device."

The faster you can perform each step of an iterative search, or the fewer steps there are, the faster you can complete the search. By always keeping you active, letting you move on as soon as you have the information necessary to take the next step, the Information Visualizer speeds the search. The Visualizer presents as much contextual information as possible and provides useful abstractions of the data and its structure. Thus, it shortens the search so that you can more completely understand and more effectively navigate the structure.

Time on a Wall

It is often more convenient to look at information not as a tree, but as a long sequence, such as a collection of documents arrayed over time. The problem with visualizing large linear information structures is the extreme aspect ratio. A chart showing important milestones for a project, for example, can be only a few lines *tall*, but months, or even years, *long*.

If the details are made large enough to see and work with, the entire structure will not fit on the screen. And if the structure is shrunk to fit the screen, the details will be illegible. Yet an effective visualization should provide both detail and context. In the milestone chart example, you must be able to work with weekly or daily milestones while understanding their context within the larger structure.

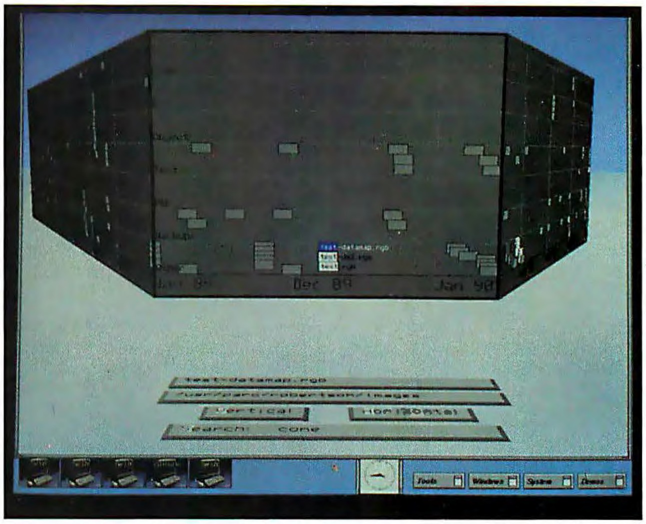

Photo 3: *The Perspective Wall displays information that is essentially linear. Selecting an item slides the wall around the corners like paper in a player piano, bringing the selected item into view.*

The Visualizer designed to display linear information is called the Perspective Wall and resembles a gray slate wall folded into thirds (see photo 3). Like the tree visualizations, the Perspective Wall provides a sort of "fish-eye" view. The center panel provides a detailed view, while the two wings provide a contextual view. As with the trees, the closer objects, which are more likely to provide important contextual information, are larger and brighter than those farther away.

When you select an object, the wall slides around like a sheet of music in a player piano, bringing the selected item to the front. Objects bend as they go around the corner. One of the wings grows shorter, and the other grows longer, depending on the direction of the wall's movement. If the center panel becomes too cluttered, you can stretch it like a sheet of rubber so that fewer items are displayed there. Animation allows your perceptual system to track objects on the wall as it slides.

PARC has designed visualizations of other, less structured information. One system, called the *People Browser*, ties a floor plan to the photos, biographies, and project plans of the scientists who work there (see photo 4).

Navigation and Manipulation in 3-D Space

In addition to simply spinning things from afar, the Information Visualizer lets you move about the room—flying through the nodes of a Cone Tree, for example, or walking around a Perspective Wall. You can pick up, move, examine, and drop objects.

PARC has developed a set of 3-D navigation and manipulation techniques that use the mouse—essentially a 2-D input device—to allow movement through 6 degrees of freedom (up/down, right/left, and forward/backward, plus a couple of rotations).

The Information Visualizer provides you with a virtual body. When you move around within a simulated room, your viewpoint moves as though you were walking within a real room. Virtual joysticks are associated with icons in the center of the screen. For example, selecting the walking joystick and then moving the mouse forward walks you through the room.

continued

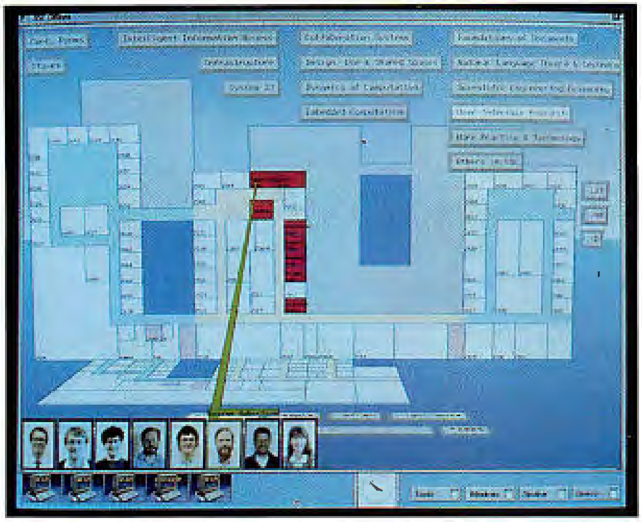

Photo 4: *The People Browser incorporates several databases. It ties a floor plan to the photos, biographies, and project plans of the scientists who work at Xerox PARC. Text searches could, for instance, reveal similarities between the work of various system researchers.*

The other joysticks move the viewpoint up, down, right, and left and rotate your virtual body and head.

To move in to examine details, you can select a point of interest on the surface of some object by clicking there with the mouse. Then, holding down a keyboard key flies you to that point; a second key flies you away.

Movement toward an object is logarithmic. The point of view moves a fixed percentage of the distance to the selected point per unit of time (e.g., half the remaining distance every second). The closer the viewpoint gets to the selected point of interest, the more slowly it advances. You cannot actually collide with an object.

Similarly, you can select an object with the mouse and then pick it up and bring it toward the viewpoint. The mouse moves the object in a plane parallel to the viewpoint. The two keyboard keys move the object toward you and away. The object moves toward the viewpoint, slowly at first and then accelerates rapidly. It finally slows again as it nears the viewpoint, making it impossible for the object to actually collide with the viewpoint.

Many 3-D objects in the Information Visualizer also respond to *gestures*. To gesture, you hold down one mouse button and then move the mouse, flicking it sideways, perhaps, or moving it as if you were drawing a check mark. For example, selecting a node on a Cam Tree and performing the "flick left" gesture prunes all branches below that node; flicking to the right grows them back again.

The Cognitive Coprocessor—A Brain Prosthesis

The more tightly users are coupled with an application, the more effectively information can pass between them. The more effectively information is processed, the less expensive it is to use.

The Cognitive Coprocessor, the heart of the Information Visualizer, provides this tight coupling of user and application by supporting smooth animation and multiple asynchronous agents. Some examples of agents are a database program, a search routine, and the human user.

It is difficult for a system to provide smooth animation and asynchronous agents simultaneously. Multiple asynchronous agents exhibit a wide range of computational requirements, and the overall system load can vary widely from time to time. Smooth animation, however, typically requires a fixed rate of guaranteed computer resources. The Cognitive Coprocessor compensates for the widely varying time constraints of the different agents in the system—including the human—and also translates between their different languages.

For example, animations are designed to run at a fixed rate per unit of time. An animated ball might roll some distance per second (e.g., 3 inches per second), rather than a certain distance per animation cycle. When the system runs more slowly, the ball moves farther on each cycle, and vice versa. The result is smooth animation over a wide range of system loads.

Smooth interactive animation fools your perceptual system. You perceive the on-screen structures as real objects with mass and dimension, reflecting light and casting shadows. These natural perceptual cues draw you in and aid you in assimilating and using the information.

The Information Visualizer user is always active. You never have to wait for the computer to finish a task before it accepts your input. PARC's User Interface Research Group calls this design philosophy "treating the human like a real-time device." You do not have to delay your work for any "Please wait..." prompts or little hourglass icons.

The Cognitive Coprocessor marries 3-D/Rooms, tools for navigating in the 3-D environment, real-time animation, and the interactive objects themselves. Using all these disparate parts, the Cognitive Coprocessor tightly binds you to the application inducing a state of effortless symbiosis—a computational *fahrvergnügen*, if you will.

Goals Reached and Then Some

PARC scientists believe that managing large quantities of information will be the key to computer use in the 1990s. PARC is designing the Information Visualizer interface to let users deal with enormous problems by reducing the cost of using information. By providing highly coupled interaction, the Information Visualizer increases the efficiency of information exchange between the user and the application.

The Rooms system increases the effective size of inexpensive information storage—the workspace on the screen—through multiple virtual workspaces. These workspaces let you spread work out, relieving the clutter of some overlapping window systems. Rooms also allows the computer to anticipate your needs, retrieving items from expensive storage more efficiently.

Animated 3-D visualizations make the screen much denser, increasing the amount of information it can hold and exploiting your perceptual system to convey information subconsciously. With an entire structure visible at once, you can navigate it faster and more easily. And 3-D animation allows the representation and manipulation of objects too large or complex for only 2-D. By exploiting human experience and capabilities, the interface provides familiar, comfortable metaphors for information, navigation, and manipulation.

The Information Visualizer currently runs on a Silicon Graphics Iris graphics computer. But over the next three to five years, the falling prices of the hardware required to run similar interfaces should begin to penetrate the workplace, increasing the demand for other powerful new interfaces. ■

Mark A. Clarkson, formerly a programmer and consultant, is a full-time writer living in Wichita, Kansas. He can be reached on BIX c/o "editors."

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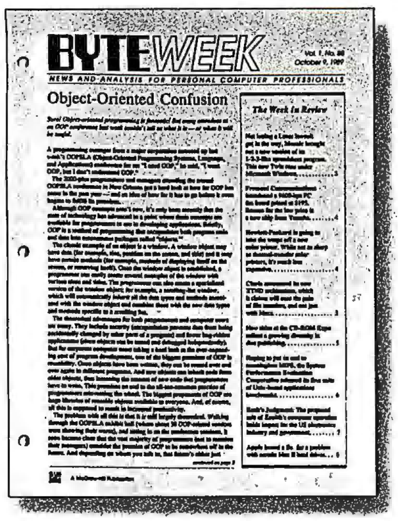

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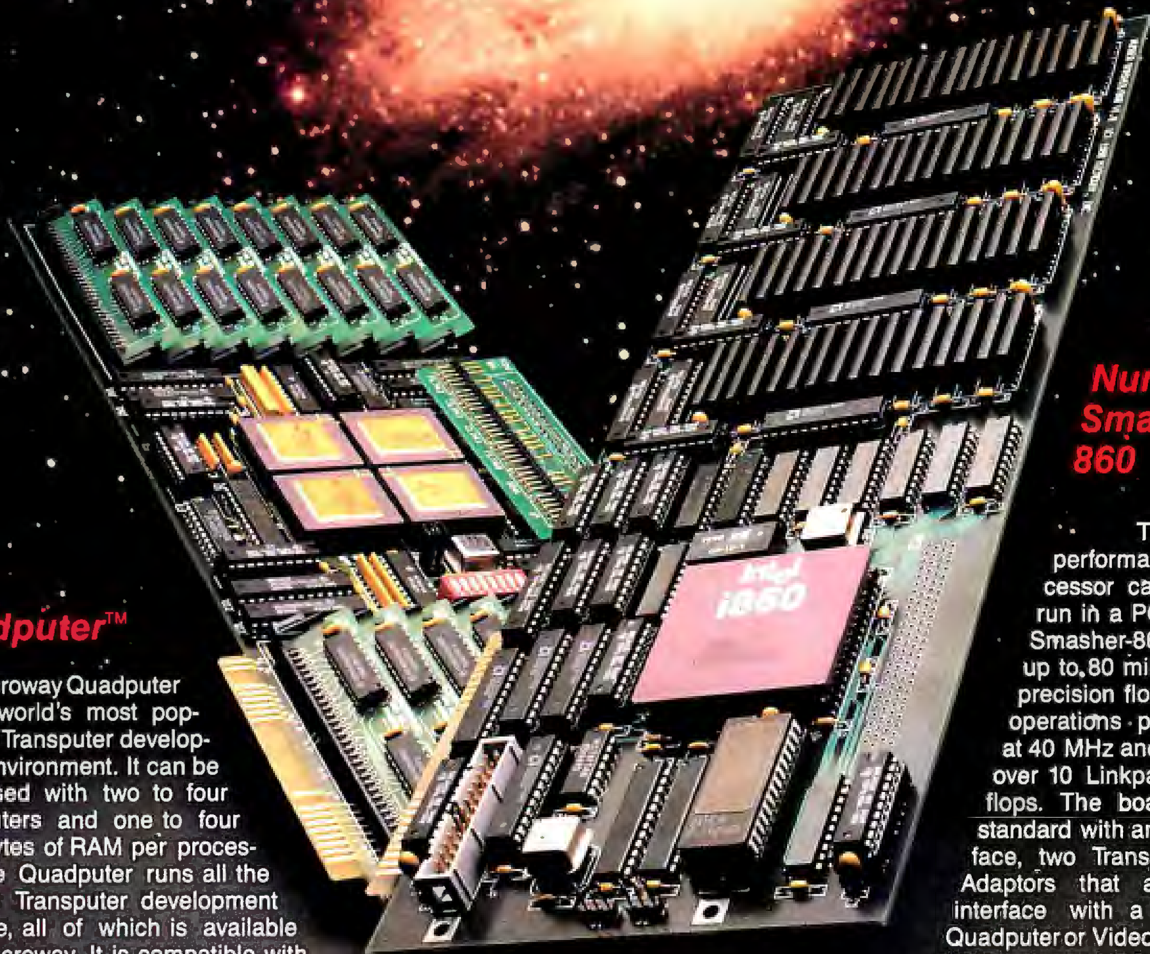

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XGA: A NEW GRAPHICS STANDARD

Combine a fast VGA, a graphics coprocessor, and bus mastering, and you have XGA

Jake Richter

Three and a half years after introducing both the VGA and 8514/A graphics standards, IBM has finally unveiled its next-generation PS/2 graphics hardware—the XGA (Extended Graphics Array).

In 1987, the VGA was shipped standard with the newly announced PS/2 systems. Now the XGA is shipped as the default graphics display platform with IBM's newest PS/2s, the Model 90 XP 486 and the Model 95 XP 486. In the desktop Model 90, the XGA is on the motherboard; in the Model 95 (a tower unit), it is located on a separate Micro Channel architecture add-in board. The XGA Display Adapter/A is also available for other 386- and i486-based PS/2s.

IBM's replacement of the VGA with the XGA as a default graphics platform is remarkable. A couple of years ago, rumors were rampant about IBM's implementing its 8514/A advanced graphics technology on PS/2 motherboards. But the 8514/A lacked one major feature that was necessary for this to occur: backward compatibility. The XGA's full VGA hardware compatibility eliminates this problem; therefore, it is suitable for a motherboard implementation.

In some ways, the XGA is a merger between the VGA and 8514/A graphics platforms. The table shows a feature comparison of several mass-market graphics hardware platforms demonstrating how the XGA has evolved.

The XGA Is Born

The XGA was developed in the U.K. at IBM's Hursley Labs, as were the 8514/A and the niche-oriented Image Adapter/A. Therefore, it is not surprising that in its design the XGA maintains many of the 8514/A's features, although it accesses these features in a different fashion.

Some of the new features, such as bus mastering, are designed to take advantage of the Micro Channel architecture bus, which is standard in most PS/2s. Other features, such as a memory-mapped frame buffer and hardware cursor, provide greater flexibility over existing designs, easing the burden for software developers. Another boon to software developers is that IBM has released full register specifications for the XGA, unlike its tight-lipped approach to the 8514/A. An Adapter Interface comes with the XGA to provide backward compatibility for all those applications that supported the 8514/A via the Adapter Interface.

Multiple Modes

The XGA has three distinct modes: VGA compatibility, 132-column VGA-compatible text, and extended graphics.

continued

ILLUSTRATION: KEN COFFELT © 1991

FEATURE COMPARISON

A comparison of IBM-originated mass-market PC graphics standards features. Resolutions are listed as horizontal by vertical by color(s). The XGA combines the resolutions and capabilities of the original VGA with those of the 8514/A and adds some functionality.

Platform	Resolution	Interlaced at 1024 x 768	Base compatibility	Graphics coprocessor	Memory-mapped	286-/8088-compatible	RAM type	Cost
PS/2 VGA	640 x 480 x 16 320 x 200 x 256	N/A	VGA	No	Yes	Yes	DRAM	N/A
Super VGA	800 x 600 x 16/256 1024 x 768 x 16/256	No[1]	VGA	No	Yes	Yes	DRAM[2]	\$69-\$800[3]
8514/A	640 x 480 x 16/256 1024 x 768 x 16/256	Yes[4]	None[5]	Yes	No	Yes	VRAM	\$900-\$1500[6]
XGA	640 x 480 x 2/4/16/256/65,536 1024 x 768 x 2/4/16/256	Yes	VGA	Yes	Yes	No	VRAM	\$1095-\$1445[7]

1 Some Super VGAs are still only interlaced at 1024 x 768, but with most, you can switch between interlaced and noninterlaced.
2 A few Super VGAs use VRAM instead of DRAM.
3 These prices cover generic ISA-based VGAs all the way to Super VGAs that can do 1280 x 1024 x 16 or 640 x 480 x 32,768.
4 Clone 8514/As offer 1024 x 768 noninterlaced.
5 VGA compatibility is achieved via a pass-through, requiring an actual VGA to exist separately from the 8514/A.
6 Clone 8514/A pricing is included. The top end is an IBM 8514/A with 1 MB of VRAM.
7 \$1095 for an XGA Display Adapter/A with 512K bytes of VRAM; \$1445 for the XGA board with 1 MB of VRAM.
N/A = not applicable.

The extended-graphics mode is the most interesting, since it provides higher resolutions and substantial graphics acceleration.

In addition to maintaining full compatibility with the VGA standard it originally created, IBM learned some lessons from the vast number of VGA clones out there and implemented a larger data path. The VGA mode, while still having only an 8-bit internal data path, supports a 32-bit-wide bus. It also has an internal write cache that allows the chip to break down and write the bus data without holding up the rest of the system with unnecessary wait states.

According to IBM documents, when the XGA is in VGA mode, it is up to 90 percent faster than the original VGA under DOS and up to 50 percent faster under Windows. Except for performance improvements, there is no change in VGA functionality in this mode.

It's important to note, however, that while you can have up to eight XGAs in one system (the configuration software only supports up to six), you can only have one VGA active in the system at any one time. Therefore, if you switch an XGA into VGA mode, you must ensure that no other VGA is active in the system; otherwise, the system might crash due to I/O conflicts.

Using the 132-column text mode (a VGA extension), you can display and manipulate 132 characters per line of text on the screen. The character width is 8 pixels for a virtual horizontal resolution of 1056. Character height depends on the font used, which means that you can have text screen resolutions of 132 by 43, 132 by 50, or 132 by 60 pixels.

Currently, you can access the 132-column text mode only by manually manipulating the XGA registers. Ultimately, however, this mode will be accessible by switching into video mode 14 (hexadecimal). For all practical purposes, note that the 132-column text mode is a VGA mode and the same multiple-VGA caveat applies.

The extended-graphics mode has many exciting features, such as 65,536 colors (i.e., 1024- by 768-pixel resolution), bus mastering, drawing acceleration, and the hardware cursor. While some of this mode's features are available in the other modes, most of the XGA registers and functions are dedicated for use in the extended-graphics mode.

XGA Registers

The XGA design consists of video RAM, a type of dual-ported RAM designed for use in graphics-display systems; glue logic; and two custom chips, the graphics coprocessor and the display controller, which are the core of the XGA (see the photo). The graphics coprocessor controls VGA compatibility, drawing functions, and memory management, and the display controller contains the RAM D/A converter (RAMDAC) with a color lookup table, the CRT controller, hardware cursor support, and a VRAM serializer (a device that extracts data from VRAM for display).

Access to the XGA is accomplished via two sets of registers: The first set is mapped into the system's I/O space, while the other set of registers is mapped into memory. The addresses of these registers vary, due to the configurability of the XGA. This variable addressing allows for multiple XGAs in the same system.

The I/O registers are mapped in at a hexadecimal I/O address of 21X0, where X is the *instance* (or occurrence) of the XGA. According to IBM, in systems with only one XGA, the instance is typically 6, resulting in a base hexadecimal I/O address of 2160.

The memory-mapped registers occupy 128 bytes of memory in the last kilobyte of an 8K-byte chunk. This chunk resides on an 8K-byte boundary anywhere between PC addresses 0C0000h and 0DFFFFh. The purpose of having an 8K-byte chunk is that the first 7K bytes of the chunk contains ROM data, but only on an XGA Display Adapter/A. The motherboard implementation of the XGA does not require its own ROM, as the main motherboard ROMs contain all the necessary information, such as XGA initialization code. The XGA instance number determines the location of the 128 bytes within the 8K-byte chunk.

The I/O registers pertain predominantly to the XGA's display controller. The memory-mapped registers, however, refer primarily to the graphics coprocessor. The XGA's power-on self test routines set the base addresses for both registers, and by examining the PS/2 POST registers for the XGA in question, you can determine the addresses.

Many of the memory-mapped registers are 32 bits in size,

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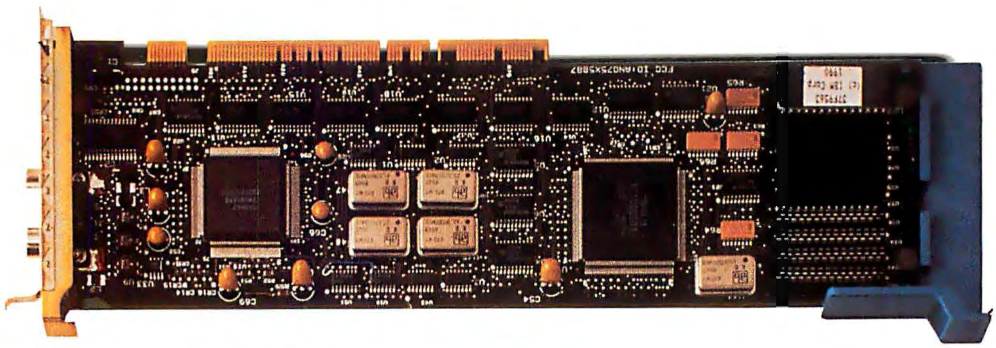

IBM's XGA Display Adapter/A graphics board. The four key areas on this Micro Channel adapter are the VRAM (far left), the graphics coprocessor (large chip on left), the display controller (large chip on right), and the video-out connector.

because the XGA is designed to fit into a 32-bit environment like that of the Intel 386 and i486. Also, due to the software support IBM developed for the XGA, it only works in a 386 or 386-based PS/2 (including 386SX-based PS/2s). The XGA also offers Motorola format addressing (a different byte ordering compared to an Intel format), which allows a Motorola 68000 or similar processor to take advantage of the XGA, assuming the XGA was ported to such hardware environs.

Initialization

Initialization is a necessary step in using any graphics device. In the case of the XGA, initialization mainly involves setting the XGA into extended-graphics mode via the *operating-mode* register. You can then generate the proper CRT control register data for the desired resolution. Selectable resolutions are 640 by 480 and 1024 by 768 pixels. But you can only access the 640- by 480-pixel by 65,536-color and 1024- by 768-pixel by 256-color modes with 1 megabyte of RAM.

The 16-bit-per-pixel (65,536-color) resolution provides almost perfect photo-realistic output. Thus, you can scan or capture a full-color picture and, using this 65,536-color mode, see an almost exact replica on your XGA screen. The 16-bit pixel is laid out as 5 bits of red, 6 bits of green, and 5 bits of blue (5-6-5), or in other words, 32 shades of blue, 64 shades of green, and 32 shades of blue—in each pixel.

This configuration varies from the PC standard TARGA format of 5-5-5 (1 bit is used for overlay) and the i860 format of 6-6-4. According to a technical contact at IBM, the 5-6-5 approach was used because of other similar implementations already in place in various IBM installations.

Apparently, the eye is also more sensitive to variations in green than in red or blue. (The reason for the choice of red, green, and blue is that these are the three color guns found in all color monitors. The beams from the three guns combine to display just about any color, depending on the intensity of each gun.)

The Display Controller

You use the display controller during initialization, but it has other uses as well. Two such uses are the color lookup table and the sprite. The sprite is a 64- by 64-pixel block that overlays the screen.

You use the lookup table to translate the 1-, 2-, 4-, or 8-bit-pixel value into appropriate RGB values. The pixel value is used as an index into the lookup table. The resultant RGB values are then converted from digital levels into analog voltage levels via a built-in DAC.

As with the VGA and 8514/A, the XGA's lookup table supports 64 levels (6 bits) of each primary color, for a total of 262,144 possible color combinations. Thus, in a 256-color mode, you can choose 256 colors from this palette of 262,144.

Each pixel in the sprite has four possible values: sprite color 0, sprite color 1, transparent, and complement. Special registers define the sprite colors, and they let you specify the RGB values for each color. These RGB values are passed directly to the DAC. Their use permits applications to fully modify the local color palette without having to save two entries for the cursor or your having to worry about the cursor changing color as it goes over various portions of the display.

The transparency setting allows cursors that are smaller than 64 by 64 pixels to be defined. Users who want a cursor that is always visible against any background can use the complement setting.

Task Switching

One of the biggest headaches for systems software developers in creating a multitasking environment is saving the current state of the graphics hardware to allow another application to take over the graphics device. This *state save* also has to account for the possibility that the hardware might be in the middle of an operation or a palette update.

The XGA was apparently designed with task switching in mind, because it has extensive facilities for saving and restoring the state of the hardware, including interrupted operations.

Defining Drawing Space

One of the XGA's features that is unique among current PC graphics standards is the use of bit maps, which must be defined to perform any drawing function. These bit maps are linear regions of memory that are defined with a pixel width, height, and depth (or bits per pixel). As such, an 8-bit-per-pixel bit map, with a width of 10 and a height of 6 pixels, would require 60 bytes of memory. The last pixel/byte of a given line of the bit map is directly adjacent in memory to the first pixel/byte in the following line.

The best feature of these bit maps is that they can exist anywhere in the system's address and memory space. Thus, if you define a bit map that resides in your program's data area, the XGA can draw into it or read from it, saving you the effort of manually copying data to and from the XGA (i.e., with your system processor).

The XGA VRAM is mapped into the system's address space so that when you want to specify it for a bit-map definition, you just use its address. The VRAM is usually located in the uppermost addresses of the 386's 4-gigabyte address space. As a result, there should never be a memory conflict.

Bus-Mastering Pitfalls

When the XGA accesses a bit map, it determines whether the access is local (VRAM) or remote (system). For remote access, the XGA arbitrates for the bus and starts accessing system memory. Here is where the XGA's bus-mastering capability comes into play. There is additional overhead in the use of system memory for bit maps, beyond that being used for accessing local VRAM. But there is also the performance benefit of having the XGA processor manipulate memory while the system processor is doing something else.

This bus mastering has some potential pitfalls. The 386 and i486 processors support virtual memory via an internal page-mapping table. The page-mapping table allows control applications, such as expanded-memory managers, DOS extenders, and advanced operating systems, to create virtual PC addresses 4K bytes (or a page) at a time. So, while the software application thinks it is writing data to address WWWWW, the page-mapping table might translate that address to physical address QQQQQ.

In many cases, there is no way for an application to know that the address it is using is not the physical address. And, to properly bus master, the XGA requires a physical address; otherwise, it may copy data to and from an incorrect address, with disastrous results. There is a possible solution to this dilemma, however, with some control software environments.

If an application has access to the control software's page-mapping table, it can pass this information to the XGA, which then makes use of the page-mapping table, and it can do its own virtual-to-physical address translations. Unfortunately, many control programs and operating systems do not provide access to the page-mapping table. In any case, regular DOS applications have the best chance of using bus mastering, because the first 640K bytes of memory are generally the least likely to be virtualized.

In addition to always having the VRAM mapped into high memory, software can map the XGA into a 64K-byte bank at either A0000h or B0000h, the standard PC video-memory addresses. Accessing different 64K-byte banks in the XGA's VRAM via this approach requires only that an index value be written into the *aperture index* register. This banking mechanism is handy for real-mode applications. Alternatively, the whole 1-MB chunk of VRAM can be mapped somewhere in the first 16 MB of the system's memory, assuming there is no memory conflict. This type of mapping is useful only for protected-mode applications.

With respect to the bit maps, the XGA has three generic bit maps available for definition: maps A, B, and C. These maps are referenced when drawing commands are executed.

The drawing commands may require one or more bit maps: source, destination, and pattern. Source bit maps contain the data you want to either copy or use as a tile; destination bit maps are those into which you draw or copy data; and pattern bit maps contain a monochromatic (1-bit-per-pixel) pattern that you can use as an area pattern or a pixel-exclusion pattern.

The XGA also supports an additional map, referred to as the *mask map*. The mask map is a monochromatic bit map that you use to perform *arbitrary clipping* (i.e., a method of clipping to nongeometric shapes). When enabled, each 0 bit in the map indicates a pixel that should not be modified during a drawing operation, while a 1 bit is a signal to draw the applicable pixel. If the dimension of the mask map is smaller than that of the destination map for a given operation, then the outer edges of the mask map also define a clipping rectangle.

The mask map is extremely useful in windowing environments where you have overlapping windows, because you can draw on underlying windows without having to manually preclip all the objects you're drawing. Instead, you just define a mask map that permits drawing only in the exposed area of the desired window. A full-screen 1024- by 768-pixel mask map occupies only 96K bytes of memory. You can also partially enable a mask map so that it acts only as a clipping rectangle and does not perform the arbitrary pixel-by-pixel clip.

All four maps are defined via 5-pixel map registers. The first pixel in the bit map, which is in the upper left corner of a display bit map, has a coordinate of 0,0. The mask-map origin registers define the mask-map position over the destination map. All maps are limited to a height and width of 4096 by 4096 pixels.

The XGA's added features—definable bit maps, bus mastering, memory mapping, and state saving—are well thought out. Software developers who want to get the most out of the XGA should find them quite useful.

Drawing with the XGA

Before you can draw anything with the XGA, you must at least define the destination map for the operation you want to perform. Some operations also require a source map, such as a BitBlt. A BitBlt is an operation that copies bits from one place to another. The available drawing operations on the XGA are lines, short vectors, filled rectangles, BitBlts, and area fills.

Unfortunately, drawing lines is not as simple as just providing an *x,y* coordinate pair. The XGA uses a Bresenham line-drawing algorithm, but you must first calculate the initial Bresenham parameters, a process that creates a bit of overhead when drawing short lines. Coincidentally, the method for calculating these parameters is virtually identical to that used in drawing lines on the 8514/A. A description of this algorithm for optimized line drawing on computer displays can be found in Foley and Van Dam's *Fundamentals of Interactive Computer Graphics* (Addison-Wesley, 1982).

The XGA's short vectors are similar to the 8514/A's short stroke vectors. These vectors can be up to 15 pixels in length, and they can point in any direction that is a multiple of 45 degrees (e.g., horizontal, vertical, and diagonal). The benefit of the XGA's short vectors is that the definition for each one consumes only a byte, and up to 4 bytes can be passed at a time, allowing for a quick data transfer rate and, therefore, a quick drawing rate.

Filled rectangles are quite straightforward. You just specify a width, height, and position, and off you go. BitBlts are similar to a filled rectangle except that you have to specify a source map as well as a destination map. The XGA also has the ability to perform a simple color-expansion BitBlt, one in which the source is monochromatic and each 0 bit is converted to one color and each 1 bit to another color. The destination map can be anything from 1 to 8 bits in depth. Color expansion is useful for displaying rendered fonts on a high-color-content screen or bit map.

Area fills are a modified rectangle fill in which the XGA graphics coprocessor uses the pattern map as a guideline for a scan conversion. This type of fill uses 1-bit flags to toggle the fill state as it scans each line in the pattern bit map. Initially, for each line, the fill state is off. On hitting a 1 bit, each subsequent pixel (or bit) in the pattern map is filled until the next 1 bit is encountered.

Lines, short vectors, and filled rectangles can also use a source map and a pattern map. You can use the pattern map for line patterns and area patterns, while you can use the source map for tiling a region (in the case of a filled rectangle) or for providing a color line pattern for lines and short vectors.

All the drawing functions are also affected by four types of drawing modifiers: drawing colors, mixes, color compare, and the pixel bit mask. Drawing colors are simple to use. The foreground color specifies what color you would normally draw in, while the background color specifies the color you would use in color expansions (for a 0 bit).

Mixes, known as raster operations or raster ops on other graphics platforms, provide a mechanism by which the destination pixel (the one in the destination map at the current drawing position) and the source pixel (the foreground color or source map pixel) are mixed. A typical mix is XOR, the exclusive OR operation, which is used for cursors and highlights.

You can use color compare during normal pixel updates to determine whether a given pixel should be updated, based on its color. The destination pixel value (or color) is compared to the destination color-compare value register by using the compare-operation set in the destination color-compare condition. Therefore, if the result of the comparison is `TRUE`, the pixel is not updated.

There are eight compare conditions: `always TRUE`, `always FALSE`, `greater than`, `less than`, `equal to`, `not equal to`, `less than or equal to`, and `greater than or equal to`. This color comparison can be useful in cases where you need to protect a range of colors from being updated, such as background and foreground objects in graphical scenery.

The pixel bit mask controls which bits in a pixel can be modified. Its biggest use is in protecting binary color ranges and planes of color.

Why XGA?

From a technical standpoint, the XGA is a very elegant piece of work. It fixes just about all the problems that the 8514/A has had, except interlaced displays and simplified line drawing. The added features—definable bit maps, bus mastering, memory mapping, and state saving—are well thought out. Software developers who want to get the most out of the XGA should find them quite useful.

In addition, IBM has finally made the right move in providing full register-level documentation on the XGA. The lack of this type of documentation hurt the acceptance of the 8514/A. The fact that IBM has provided it for the XGA should increase the level of support it receives.

Because of its high-powered nature, the XGA will probably not have a serious effect on Super VGAs or 8514/A clones in the short term. But it is reasonable to expect XGA clones to be announced before the end of this year.

To obtain further technical information on the XGA, you can call IBM's technical books group directly at (800) 426-7282. ■

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FEATURE ■ Jeffrey H. Lubeck and Bruce D. Schatzman

MAKING WINDOWS WORK

Feeling left out by the Windows revolution? Here are some tips that can get you up and running.

Since its announcement last year, Windows 3.0 has broken numerous software sales records. The number of Windows applications that have appeared over the last few months is truly astounding.

But what if you can't get Windows running or can't get it to run correctly? What is the source of these problems? Are there bugs in Windows 3.0? Is the PC environment itself to blame?

After months of working with Windows on a variety of system configurations, we have concluded that the culprit is indeed the PC environment. The primary strength of the DOS environment is also one of its greatest weaknesses. Its strength comes from the wide range of applications, bus cards, and peripherals that are available at low cost. Unfortunately, this array of third-party products introduces a certain amount of chaos into the PC architecture.

The chaos arises when third-party memory boards manage RAM in different ways, applications use different printer drivers, video cards require different system resources, and so on. As a result, system files such as AUTOEXEC .BAT and CONFIG.SYS must be carefully tailored to bring stability to a system. This burden usually falls on users, most of whom prefer not to deal with these matters.

Virtually all problems with Windows 3.0 are related to this third-party chaos. In fact, the most remarkable feature of Windows is that it actually works. But in some cases, Windows will run only after you've done a certain amount of fine-tuning to your system. Here are some pointers on how to get Windows working and how to achieve better performance once your environment is stable.

Setup for SETUP

Windows 3.0 comes with an excellent installation program, SETUP. Microsoft has gone to great lengths to minimize the configuration problems that can arise both during and after installation. SETUP does a thorough job of interrogating the environment for information regarding CPU type, memory, drivers, and other factors. But SETUP may have some problems doing its job if you don't first take care of some potential conflicts between Windows and your applications environment.

Some memory-resident programs, such as TSRs, device drivers, and MS-DOS utilities, are incompatible with Windows. By simplifying your AUTOEXEC.BAT and CONFIG.SYS files before you run SETUP, you can increase the likelihood that the SETUP procedure will complete successfully and produce the correct system files (e.g., removing calls to third-party disk managers from system files). The operation of many nonstandard disk-partitioning schemes causes a direct conflict with Windows' SMARTDRV.SYS disk manager. This conflict has existed with all versions of Windows, but the popularity of Windows 3.0 has brought the problem to the forefront.

This type of problem occurs because SmartDrive allows Windows to bypass the disk services provided by DOS (or a third-party package) and write directly to the disk through the BIOS. Because these nonstandard disk managers modify the way a disk behaves through low-level formatting and interleave selection, there is bound to be conflict. After making copies of your system files, you should

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PREDEFINED WINDOWS SYSTEM TYPES

These are the predefined BIOS versions for Microsoft Windows. Most systems not listed will work using the Phoenix Cascade BIOS definitions (3).

1	IBM AT or 100 percent compatible
2	IBM PS/2
3	Phoenix Cascade BIOS
4	HP Vectra (A and A+)
5	AT&T 6300 Plus
6	Acer 1100
7	Toshiba T1600 and T1200XE
8	Wyse 12.5-MHz 286

delete any references to nonstandard disk managers in your system files. The APPEND, JOIN, and SUBST MS-DOS utilities can cause problems when running in Windows, so they should also be removed. In addition, you should delete all references to TSR programs.

Another way to improve the likelihood of Windows' performing properly is to have the correct version of DOS running on your machine. If you have PC-DOS running on a non-IBM-manufactured machine, you may have problems installing and running Windows. This is because MS-DOS was custom-tailored by IBM specifically for the IBM BIOS. Running Windows on a clone with PC-DOS may yield unpredictable results. In fact, many OEMs modify MS-DOS to take advantage of proprietary aspects of their machines. If you have determined (by using the VER command) that your version of MS-DOS does not match your equipment, install the correct version according to your manufacturer's instructions.

Have Confidence

During installation of Windows, SETUP asks your permission to modify AUTOEXEC.BAT and CONFIG.SYS. In virtually all cases, it is wise to let Windows do this. According to Tim McCaffrey, a Windows program manager at Microsoft, "almost 90 percent of all post-installation problems are a direct result of not giving Windows access to your system files." SETUP does a good job of modifying statements only when necessary, and it makes a backup copy of the original files. However, if Windows cannot complete its SETUP procedure and your system halts (or you experience some other problems), there are a number of steps you can take.

With Windows, Microsoft provides a list of all known supported hardware. You should check to see that your hardware components are on this list. If your particular hardware is on the list, Windows has a compatible driver, and SETUP will display it as an option. If your system appears on the list but has an asterisk (*) next to it, you must choose the specified driver for Windows to work properly. If your hardware is not on the list but can emulate a brand that is, then select the driver for that brand.

If your hardware is not on the list and cannot emulate another device, you can check the Microsoft Windows Supplemental Driver Library, a complete, up-to-date set of supplemental drivers for less common hardware. It is available on many BBSes or can be obtained directly from Microsoft. If the Supplemental Driver Library does not include a driver for your hardware, your only other option is to contact your hardware manufacturer and ask for a Windows device driver for the equipment.

By typing `SETUP /i` at the MS-DOS prompt, you can ensure that the correct SETUP configuration options will be chosen. `SETUP /i` enables you to verify and modify SETUP to match your system configuration at the second SETUP screen.

Other problems with SETUP involve mouse and network options. If SETUP fails on the first try, type `SETUP /i` to run SETUP again, and select "None" for the mouse and network options, even if your computer is on a network and has a mouse. When Windows is properly installed, you can add these options from SETUP within Windows.

Showstoppers

If you have successfully installed Windows but the system halts soon after you enter `win` to invoke Windows, it is probable that some software or hardware component in your system is in conflict. Again, this problem is not with Windows per se, but a result of different manufacturers marching to different drummers. If Windows continues to fail after you follow all the suggestions discussed above, there is still hope.

First, try running Windows in real mode by executing `WIN /r`. Real-mode Windows 3.0 works just like Windows 2.1 and does not make use of the memory above 640K bytes. If your system halts at this point, it is likely that your video display configuration or system-type selections from SETUP are incorrect. If Windows works in real mode but not in standard mode (which you invoke by typing `WIN /s`) or enhanced mode (`WIN /3`), you must isolate each element of your current AUTOEXEC.BAT and CONFIG.SYS files with respect to their compatibility with Windows. Follow the suggestions mentioned earlier in the article about these files before trying the next two options.

In the majority of cases, Windows' HIMEM.SYS extended memory manager will detect what type of system you have so that it can map memory correctly. Sometimes HIMEM is not able to make this identification, and your system may crash. To eliminate this possibility, add the `/M` switch and the number associated with your system type to the HIMEM.SYS entry in CONFIG.SYS. For example, if your system has a Phoenix Cascade BIOS, your HIMEM command line should look like this:

```
DEVICE=C:\HIMEM.SYS /M:3
```

The table lists the system-type numbers you can use. If your PC is not listed, you should use 3, the number for the Phoenix Cascade BIOS.

According to McCaffrey, the single most effective tool to eliminate problems that crash Windows is the EMMEXCLUDE statement. The symptoms exhibited by these "showstoppers" can vary and include a frozen system or a scrambled full-screen display of a DOS application when switching back to Windows. The problem is that Windows is not recognizing that one or more of your hardware components is using additional memory—in this case, within the C000 to D000 address range—to enhance performance. When Windows operates in enhanced mode, it may try to access this memory and cause your system to crash.

Some systems map video memory to the memory-address range of C000 to D000. Many add-in boards also use these addresses. If you have a 386 or 486 machine with at least 2 megabytes of memory, you can resolve some problems by making the memory-address range of C000 to D000 inaccessible to Windows by modifying the SYSTEM.INI file in your Windows directory. You simply open the file with your text editor, find the `[386Enh]` section, and add the following line:

```
EMMEXCLUDE=C000-D000
```

This statement tells Windows not to use the specified range of addresses. You can experiment with this statement; for example, if you are experiencing trouble with a 386 system that has a VGA monitor running in enhanced mode, the statement should read as follows:

```
EMMEXCLUDE=C400-C7FF
```

This provides more memory to Windows than the EMMEXCLUDE statement and can solve the problem equally well.

Some 386 PCs may have trouble running EMM386.SYS when taking advantage of EMS memory, usually because of a conflict with a page-frame address. For example, there is a problem when the computer uses memory for its own hardware purposes, such as video memory. The Everex Step 386/25 and NCR PC925 have this problem. The solution is to change the setting for EMM386.SYS in your CONFIG.SYS file. The correct setting for the Everex Step 386/25 is

```
device=EMM386.SYS E600-C7FF
```

and, for the NCR PC925,

```
device=EMM386.SYS E000-EFFF
```

If you own a pre-1988 low-end 286 clone, you may have difficulty running Windows in standard mode. Microsoft says that almost 50 percent of these machines will experience this problem, because Windows is incompatible with the BIOS versions present in these machines. It was simply not possible to make Windows compatible with all previous versions of the BIOS.

The solution is to upgrade the BIOS ROMs and the keyboard controller. Why the keyboard controller? To operate in standard mode, HIMEM.SYS uses the A20 loader to get to the extended memory, going through the keyboard's 8482 chip to do so. If the system's controller does not match the system's BIOS, Windows will let you know (but not necessarily in a polite manner).

Stabilizing the Environment

Even if you successfully install and run Windows, you can still experience problems once you start working with your applications. Although these problems are rare, they can be difficult to resolve. Most regular DOS applications running in standard or enhanced mode under Windows will run as they do on a normal DOS-only machine after you create a

Program Information File (PIF) for them. If you run a DOS application while in Windows standard mode, the execution of Windows is suspended and the DOS application will run in real (or unprotected) mode. While running a DOS application in Windows enhanced mode, all other tasks continue operation and the DOS application will run in a virtual 8086 window. This simultaneous operation is the primary advantage of having a 386 CPU.

Programs that use the Virtual Control Program Interface will not work with the current version of EMM386.SYS, which emulates expanded memory in extended memory. Such programs include Lotus 1-2-3 release 3.0 and AutoCAD. Other applications, such as Lotus Freelance, simply require too much conventional memory to run in a DOS window.

One solution to this problem is to use a third-party memory manager, such as Quarterdeck's QEMM-386 version 5.1. QEMM-386, which is actually a portion of Desqview 386 version 2.3, is an extended memory manager for 386 machines that can be used by Windows without Desqview. QEMM-386 manages extended and expanded memory for almost all DOS applications by using the 386's paging and mapping hardware. Also, QEMM-386 does something the Windows memory manager, HIMEM .SYS, currently does not do: load device drivers and TSR programs into high memory, the area between 640K bytes and 1 MB.

For a time, the direction that Microsoft took with Windows 3.0 diverged from the directions that some vendors of memory management products were taking. However, Gary Saxer, director of technical services for Quarterdeck, says that his company's relationship with Microsoft is improving. "We've worked closely together to make sure that 386 memory managers, in general, work with Windows," he notes.

Microsoft technical account manager Kai Kaltenbach says that QEMM-386 can offer certain benefits to Windows users. He states, "If you're going to use DOS applications within Windows, QEMM provides more memory for these programs, but if you are not going to use DOS programs within Windows, QEMM provides few benefits." Windows 3.0 applications use extended memory and do not suffer from the 640K-byte limitation.

If you are going to run DOS applications that use EMS memory, such as Qmodem, you may run into trouble because protected mode is violated in these cases. Some DOS applications that use expanded memory don't include checks to see that complete 64K-byte page frames are available. For example, if an application looks to write to memory starting at address C800 and does not verify that the whole 64K-byte page frame is available, the CPU sees a violation of system integrity and terminates the session with an error.

If you run DOS applications that use EMS memory, you may run into trouble.

In this case, Windows is the messenger of bad news. To keep these kinds of applications running in Windows without crashing, you must modify the program's PIF so that EMS memory is set to 0, denying the application the use of EMS memory when it is run in Windows.

Disk Managers

As mentioned earlier, if you are using Windows while operating in enhanced mode and running SMARTDRV.SYS, you may have problems using a third-party disk manager. According to Fred Huett, a computer consultant specializing in disk subsystems for Sunlight Data Systems (Portland, OR), "the conflict with third-party disk managers can vary, from the system not starting (most common) to disk corruption and loss of data (a rare circumstance)."

Windows requires your computer to adhere to the specifications set by the Standard Drive Table and the partitioning of FDISK. The result is that DOS currently invokes a 32-MB limit for disk-partition sizes. Some OEMs, such as Compaq, have followed the SDT specification, which allows them to create partitions larger than 32 MB without causing problems for SmartDrive. But some third-party packages, such as Disk Manager from Ontrack, do not follow the standard and operate in direct conflict with Windows.

In July 1990, Microsoft put out a technical bulletin on the subject of SmartDrive. The company is now working with these developers to come up with a solution, even though the issue is really with SmartDrive, not Windows.

In the meantime, you should check with individual software vendors about compatibility with Windows and SmartDrive. If SmartDrive is not compatible and you want to continue using it in enhanced mode, you must switch the Windows swap-file capabilities from permanent to temporary (a procedure that is described in the Windows 3.0 manual) and modify the `[386Enh]` section of SYSTEM.INI by disabling the `VirtualHDIrq` setting. It should read as follows:

```
VirtualHDIrq=OFF
```

When `VirtualHDIrq` is enabled, Windows, in enhanced mode, can terminate interrupts from the hard disk drive controller, bypassing the ROM routine that handles these interrupts. When `VirtualHDIrq` is disabled, the ROM routine handles the interrupts, eliminating the problem with the conflicting software or hard disk drive. However, when `VirtualHDIrq` is disabled, the system's performance is reduced. You should note that a temporary swap file generally operates slower than a permanent swap file. In addition, a temporary swap file must be created each time Windows loads, which reduces performance even further.

Device Dilemmas

Some DOS applications and certain hard disk drive devices have trouble in enhanced mode because of a conflict with interrupts from the hard disk drive controller; these devices include Borland's Reflex database package, the Plus Hard Card from Plus Development Systems, and all SCSI hard disk drives that use DMA. There are two solutions: The first is to run Windows in standard mode, and the second is to modify the `[386Enh]` section of SYSTEM.INI by disabling the `VirtualHDIrq` setting with the following statement:

```
VirtualHDIrq=OFF
```

However, as mentioned earlier, when `VirtualHDIrq` is disabled, the system's performance is slowed.

Mouse Problems

Mice are rarely a problem with Windows, but setting up a mouse to run with Windows and DOS applications simultaneously can be a little confusing. Windows doesn't need to have a mouse driver loaded from the CONFIG.SYS file; it only needs to have the correct mouse identified in the SETUP file. DOS applications need to have the mouse driver loaded from the CONFIG.SYS file while

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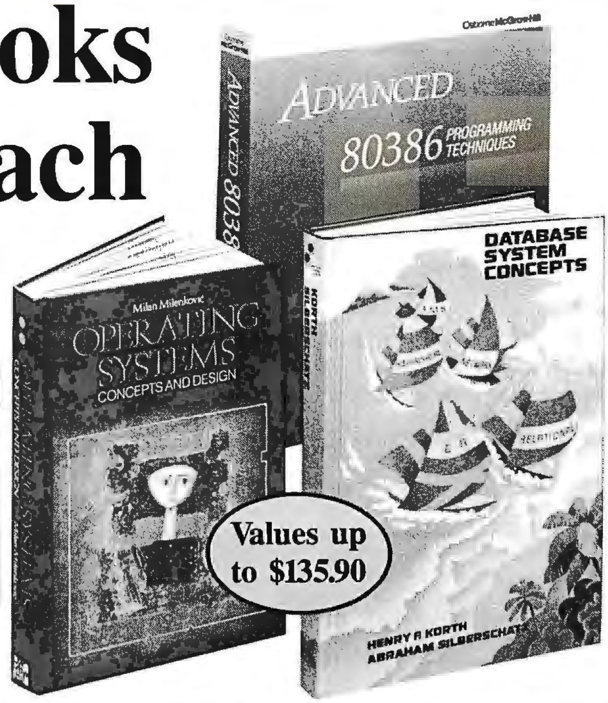

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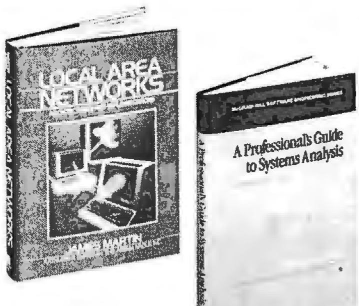

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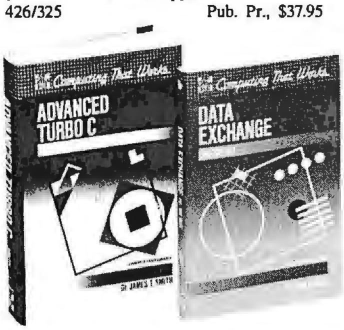

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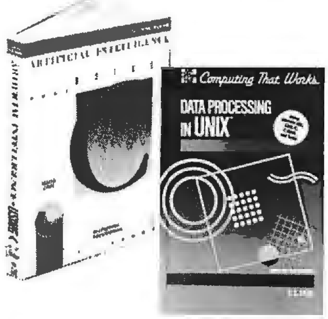

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running in standard mode, and the DOS application controls the mouse directly. In enhanced mode, the DOS application runs in a window, but Windows must maintain control of the mouse. If you want to run DOS applications within Windows, you will need to identify the mouse in the Windows SETUP file and call the proper mouse driver in the CONFIG.SYS file.

The Windows SETUP program will check your CONFIG.SYS file to see if there is a call for a mouse driver and verify that it is the most recent version. Because older versions of mouse drivers do not work properly with DOS applications while running in Windows, SETUP will replace the old driver with the new one. If, however, the driver cannot be located (e.g., it's in a different subdirectory), you must update the driver manually.

If you have a machine with only 1 MB of memory on the motherboard, you must purchase memory add-in cards to take advantage of protected mode. Although the presence of an add-in card does not necessarily mean there will be problems, configuring the card properly and setting up device drivers makes configuring Windows much more cumbersome.

For example, if you have a Compaq Portable III and the Compaq Expanded Memory Module (which uses the LIM 3.2 specification), you can make this memory available to DOS applications in Windows. However, to improve the performance of applications written specifically for Windows, you need extended memory. Adding an Intel AboveBoard with 2 MB of extended memory is a common alternative. (To use the board, you will also need the Compaq Expansion Chassis.) Be sure that the addresses for the boards don't conflict.

Comunications

If you have DOS applications that use a COM port for communications, they could possibly lose characters in data transmission or generate protection violations. To prevent these problems, you specify the XON/XOFF protocol with the following in your SYSTEM.INI file:

```
COMnProtocol=XOFF
```

where *n* is the number for the COM port.

Other problems can arise if you try to take advantage of multiple serial connections, such as a mouse and a modem, that are not utilized in sequential order (i.e., COM1, COM2, COM3, COM4). For example, if you have your mouse connected to the COM1 port, no device connected to the COM2 port, and a modem connected to the COM3 port, you may have transmission failure on the modem because the device is out of order.

Windows requires that the activation of serial ports is performed in logical order and that the mouse resides on COM1 or COM2. If you cannot meet this requirement because of the way your system is configured, you can try this solution from Clifford W. Martin. Martin had an American Megatrends 386/25 Mark III with two serial ports and a mouse on COM1 (IRQ4) and no device accessing COM2 (IRQ3). Due to system configuration limitations, he could not utilize COM3 and had to attach his internal modem to COM4 (also IRQ3).

When running his system in enhanced mode, Martin could not get Windows to recognize COM4. After working with both Microsoft and DCA (makers of Crosstalk) technical support, he added the following lines to his SYSTEM.INI

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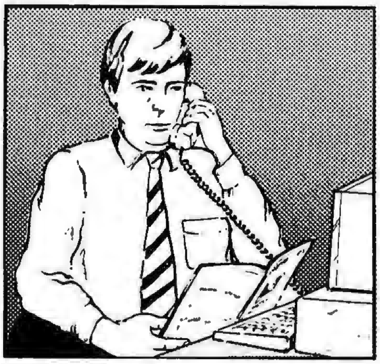

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- *Are manufacturer's warranties handled through the company?*
- *Does the seller have formal return and refund policies?*
- *Is there an additional charge for use of credit cards?*
- *Are credit card charges held until time of shipment?*
- *What are shipping costs for items ordered?*

Reputable computer dealers will answer all these questions to your satisfaction. Don't settle for less when buying your computer hardware, software, peripherals and supplies.

Purchasing Guidelines

- *State as completely and accurately as you can what merchandise you want including brand name, model number, catalog number.*
- *Establish that the item is in stock and confirm shipping date.*
- *Confirm that the price is as advertised.*
- *Obtain an order number and identification of the sales representative.*
- *Make a record of your order, noting exact price including shipping, date of order, promised shipping date and order number.*

If you ever have a problem, remember to deal first with the seller. If you cannot resolve the problem, write to MAIL ORDER ACTION LINE, c/o DMA, 6 E. 43rd St., New York, NY 10017.

This message is brought to you by:

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New York, NY 10017

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of the Direct Marketing Association, Inc.

file at the end of the [386ENH] section:

```
Com3Base=3E8h
Com4Base=2E8h
Com3IRQ=4
Com4IRQ=3
```

He then downloaded a file from CompuServe that contained a program called SetComm, which set his computer's BIOS to the proper base address. Adjusting the base address stopped the Windows error messages but did not give him access to his modem. Then, realizing that COM2 needed to be loaded in some way, Martin got an old XT serial port test plug (the variety that loops pins 2 and 3) and connected it to COM2. The result was successful access to his modem, and everything has run smoothly since.

Printing and Utilities

If you are using Windows with applications that produce large graphics files, printing can be less than satisfying, especially if you have a sluggish PostScript device. One of the keys to faster printing (or, in some cases, printing at all) is the printer driver.

In some cases, you may encounter a problem that is not addressed by even the latest drivers. For example, early versions of the NEC LC890 PostScript printer occasionally stall when printing with the Windows Print Manager. When the Print Manager stalls, Windows will notify you. You can complete the print job by activating the Print Manager and resuming the print operation. For the moment, there is no acceptable technical solution for this problem.

The best action to take is to make sure that there is an existing Windows printer driver associated with the printer that you want to use. Older printer drivers that are not Windows-compliant simply will not work.

With regard to utilities, if you have an Epson computer that takes advantage of the screen-saving utility, you should be aware that the utility will sense that the screen is inactive—even when it is not—and clear the display while you are still in Windows. Technically, Windows is still functioning, but it will not display until you exit Windows and start up again. Epson provides documentation on how to disable the screen-saver driver.

Refinements Take Time

Windows 3.0 is a fine product that does an excellent job of working within the complexities of the DOS environment. Over time, hardware and software manufacturers will deliver products that are better designed to cooperate with Windows, which should help minimize installation and configuration problems.

Once your system is properly configured, Windows should work fine. On most PCs, the SETUP program will take care of everything. On our own systems, we run four or five DOS and Windows applications simultaneously in enhanced mode, along with a variety of add-in boards from different companies. This somewhat hostile environment required tweaking configuration files. Considering what Windows can do, the inconveniences mentioned here are a small price to pay for the improved working environment you will gain. ■

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FAX FACTS

A look inside PC-based and stand-alone fax devices

In the early 1980s, it looked as though E-mail would take off in a big way. E-mail vendors, including CompuServe, MCI, AT&T, and Telenet, spent millions of dollars on advertising intended to draw new users into the fold. But because E-mail wasn't good at sending pictures and required a certain amount of technical prowess to use, it never really caught on. By contrast, the fax revolution took the nation by storm toward the end of the same decade. Today, owning a fax machine or a PC fax board is de rigueur for even the smallest business.

The overwhelming success of the fax industry is due, at least in part, to effective application of digital technology to the problems of scanning, sending, receiving, and printing images of documents. In this installment of Under the Hood, I'll reveal the digital secrets inside fax devices and show you how to exploit them.

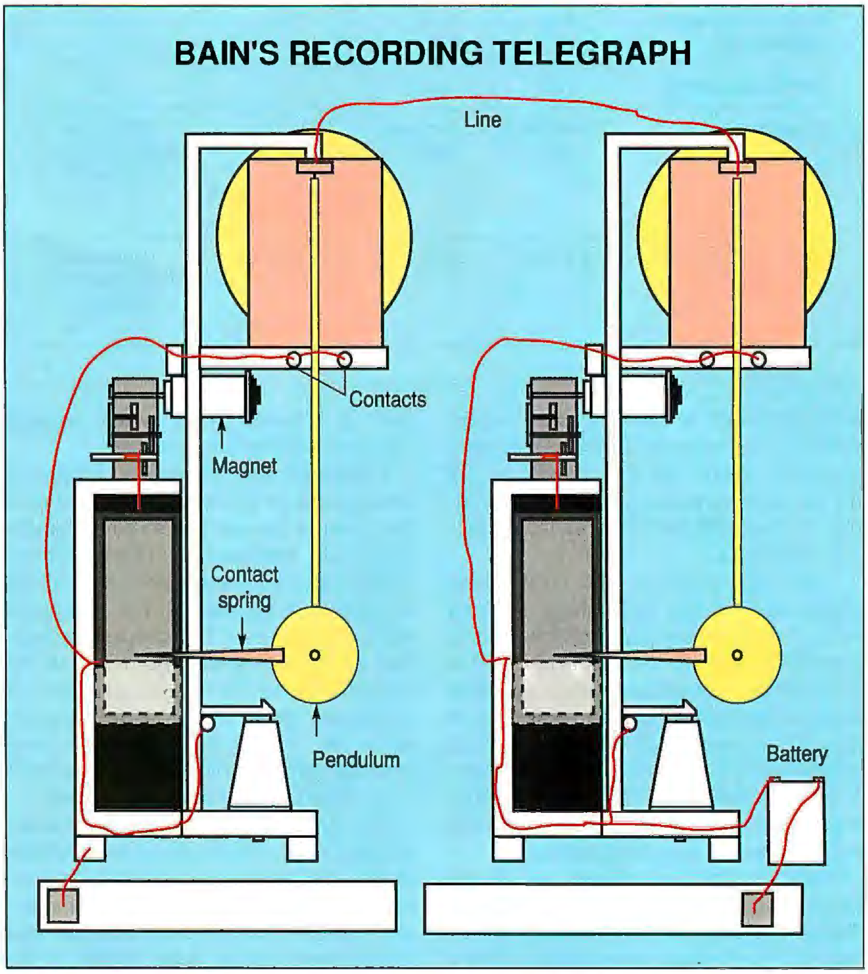


Figure 1: *Synchronized pendulums drove the world's first fax machine. (Courtesy of Artech House, Inc., © 1989)*

The Pen and the Pendulum

The first fax machine bore little resemblance to modern implementations. Scottish inventor Alexander Bain patented it nearly 150 years ago. Bain had developed a system of synchronized clocks, similar to those used in schools and office buildings to this day. The pendulum of each "slave" clock could be caught and held by an electromagnet at the top of its swing to keep it from getting ahead of a "master" clock.

Bain cleverly realized that he could create all sorts of devices that relied on two synchronized pendulums. One, which he patented in 1843, was a simple facsimile system. Bain attached a metal stylus to the pendulum of each of two synchronized clocks (see figure 1). He then rigged the stylus at the sending end so that it swept across a block of metal type, making contact wherever the type stood out from the block. This caused a voltage to be applied to a similar stylus at the receiving end, reproducing an arc of the image on a block holding an electrosensitive recording medium. The blocks at both ends were lowered a fraction of an inch after each sweep of the pendulum until the entire image was reproduced.

Primitive though it was, Bain's invention formed the basis for many later designs. Italian inventor Giovanni Casselli used a improved version of Bain's device to start a commercial fax network in France in 1865. In later decades, other inventors replaced the metal contacts

CCITT FAX STANDARDS

Table 1: *While the Group 4 standard struggles for acceptance, vendors continue to improve already widely accepted Group 3-based products.*

CCITT standards	Group 1	Group 2	Group 3	Group 4
General	T.2	T.3	T.4	T.5—apparatus T.6—coding T.62—control
Modulation standard	T.2 (tones or V.21 for initial handshake)	T.3	V.27ter V.29 V.21 (handshake only)	N/A
Modulation schema	AM or FM	VSB, PM	FSK, PSK, QAM	N/A
Protocol for initial handshake	T.30	T.30	T.30	N/A
Digital encoding	N/A	N/A	T.4	T.6
Image type	Continuous tone	Continuous tone	B&W only (possible extensions for discrete gray scale and color)	B&W, gray scale, and color all possible
Page time (approx.)	4-6 min.	3 min.	12 sec.-1 min.	Varies with line speed and resolution

N/A = Not applicable.

with photoelectric sensors, and the pendulums with rotating drums. Only very recently—within the last 12 years—did the advent of scanners and thermal printing eliminate the need for either a pendulum or a drum.

The 1920s marked the first widespread use of fax technology to send news photos to newspaper offices across continents and around the world. After World War II, newspapers experimented with the idea of faxing entire newspapers directly to subscribers' homes, but the advent of TV torpedoed that notion. From then until the 1980s, fax transmission primarily served journalists, the military, police, and businesses.

More recently, of course, we've entered the age of personal fax machines. Today you can use fax machines to receive the daily news, order lunch, place a personal or classified ad, submit a question to a radio talk show, apply for a job, or enter a contest. This trend is likely to continue as faxing becomes the method of choice for quick point-to-point message exchange. E-mail may catch up one day, but not until it's as simple as pushing a single button on a fax machine.

Getting the Picture

How do fax devices send and receive pictures? Bain's fax machine, like a telegraph key, was binary: It could indicate only black or white, with no shades of gray in between. This system worked fine over telegraph-type wiring.

Later units used photoelectric tubes to measure the brightness of each spot on a document's surface and so could handle gray-scale information. These systems simply varied a voltage according to the brightness of the image. The technique worked only over DC-coupled leased-line circuits, however, because, as the sensor scanned the image, variations in brightness might occur at a frequency below the audio range. To send faxes over the public switched telephone network would require other techniques.

The first solution was amplitude modulation (AM), which solved the problem of low frequencies by using the brightness signal to vary the amplitude of a carrier. Unfortunately, this scheme was highly susceptible to noise. Worse, if the gain of the circuit changed during the transmission, light and dark bands appeared in the image. As a result, AM was used mostly on specially conditioned leased lines. Other modulation schemes followed, including frequency modulation (FM), phase modulation (PM), and vestigial sideband modulation (VSB), a form of AM that compresses the required bandwidth of an AM signal.

At first, analog fax technology wasn't standardized at all—you simply had to buy the sending and receiving units from the same manufacturer. But in 1966, the Electronics Industries Association announced the first fax standard—RS-328; the CCITT followed shortly thereafter with the Group 1 and Group 2 standards.

Digital Fax

Fax didn't really come into its own, however, until the advent of Group 3—a digital fax standard that allowed high-speed, reliable transmission over ordinary telephone lines. All modern fax devices use Group 3. The availability of inexpensive modem modules that implement Group 3 made today's high-quality, under-$1000 desktop units possible. Group 3 is covered in some detail below.

Group 4 is—at least for now—still a twinkle in the eyes of the CCITT fax standards makers. Primarily designed to work with ISDN, switched data networks, or dedicated digital circuits, Group 4 is a layered standard, laid out in terms of the Open Systems Interconnection Reference Model. It offers high-speed transmission, excellent control over errors, and room for advanced features such as gray-scale and color imaging. Alas, like many standards written before any real-life machine was ever built, Group 4 is so complex that only a handful of experts understand how to implement it. Furthermore, its popularity will almost certainly be limited, because there's no universal way (at least right now) to use it over ordinary voice-grade phone lines and because equipment from different manufacturers can't interoperate. Therefore, Group 4—if it succeeds at all—is likely to be used only in applications where high speed and other special features are important. Group 3—together with proposed extensions that may give it gray scale, color, and faster transmission—will be the primary fax standard for the foreseeable future. (See table 1 for a comparison of the CCITT fax standards.)

Anatomy of a Group 3 Fax Call

Here is a close look at how a Group 3 fax device works—from the initial telephone call and handshake sequence through the data encoding, transmission, and decoding. The CCITT T.30 specification divides a telephone call that includes a fax transmission into several phases, as shown in figure 2, beginning with call establishment (phase A) and ending with call release (phase E). (See table 2 for a breakdown of each phase.)

In phase A, the calling device dials a number and begins sending a signal called the Calling Tone (CNG). If you've ever accidentally received a fax call on your ordinary telephone, you've heard this signal: It's an 1100-Hz tone that's on for half a second, then off for 3 seconds. An electronic voice/fax switch can recognize the CNG and automatically put a fax device on the line. It's also easy for a human to recognize the signal and do the same. Finally, two humans can manually switch their machines onto the line after a voice exchange.

When the called device answers, it, too, advertises its presence. As you probably know if you've inadvertently called one, a fax machine picks up the line with a shrill 2100-Hz tone that's known as the

ANATOMY OF A GROUP 3 FAX CALL

Call establishment (phase A)	Pre-message procedure (phase B)	"In-message" procedure and message transmission (phases C1, C2)	Post-message procedure (phase D)	Call release (phase E)

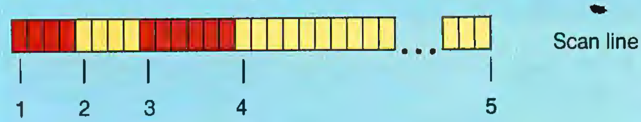
Figure 2: *The CCITT T.30 specification divides a fax call into five phases.*

PROGRESS OF A GROUP 3 FAX CALL

Table 2: *Signals exchanged between caller and answerer during a fax call.*

	Caller sending		Caller receiving	
	Caller (sending)	**Answerer (receiving)**	**Caller (polling)**	**Answerer (sending)**
Call establishment (phase A)				
Units are connected and recognize one another as fax machines.	Calling Tone (CNG)	Called Station Identification (CED)	Calling Tone (CNG)	Called Station Identification (CED)
Premessage procedure (phase B)				
Identification section: Answering machine identifies itself and describes capabilities.		Digital Identification Signal (DIS) Nonstandard Facilities (NSF) Called Subscriber Identification (CSI) Optional Group 2 and Group 1 tone signals		Digital Identification Signal (DIS) Nonstandard Facilities (NSF) Called Subscriber Identification (CSI) Optional Group 2 and Group 1 tone signals
Command section: Caller sends its own identifying information and a command to send or receive a fax. Signaling switches to new modulation scheme (2400 to 9600 bps).	Digital Command Signal (DCS) Transmitting Subscriber Information (TSI) Nonstandard Facilities Setup (NSS)		Digital Transmit Command (DTC) Calling Subscriber Information (CSI) Nonstandard Facilities Command (NSC)	
				Digital Command Signal (DCS)
	Modem phasing and training signals			Modem phasing and training signals
		Confirmation to Receive (CFR)	Confirmation to Receive (CFR)	
In-message procedure (phase C1) **Message transmission (phase C2)**	Fax message			Fax message
		Retransmission requests (only if ECM implemented)	Retransmission requests (only if ECM implemented)	
Postmessage procedure (phase D)	Multipage Signal (MPS) or End of Message (EOM) or End of Procedure (EOP)			Multipage Signal (MPS) or End of Message (EOM) or End of Procedure (EOP)
Transmission is confirmed, and units agree on what to do next.		Message Confirmation (MCF)	Message Confirmation (MCF)	
Call release (phase E)	Disconnect (DCN) (Hangs up)			Disconnect (DCN) (Hangs up)

ONE-DIMENSIONAL CODING (MODIFIED HUFFMAN)



Transition	Code emitted	Meaning
1	00110101	Zero-length run of white pixels
2	011	4 black pixels
3	1011	4 white pixels
4	0010	6 black pixels
...		
5	011000	Makeup code for 1664 white pixels
	01010011	Code for 50 white pixels
	000000000001	End of line

Figure 3: *In one-dimensional coding, the sender looks for transitions from black to white (or vice versa) and reports the number of pixels since the previous transition. To prevent an unsightly blotch from appearing in the event of an error, the line must always start with a "white" run length (which can be zero if the first pixel is black, as shown above). The code for a run of black pixels is not the same as for an equal number of white pixels because they are not as statistically likely.*

Called Station Identification (CED). Then, without waiting for a response, it starts phase B, the premessage procedure. If you're listening to the line at this point, you'll hear the machine that is answering emit a warble, sometimes followed by one or two lower tones. The machine repeats the tones (if any) and the warble until it receives a response or gives up.

What's going on? The distinctive warble is the frequency shift keying (FSK) signal from a 300-bps CCITT V.21 modem. (The standard also makes provisions for use of a 2400-bps V.27ter modem, although this arrangement is less common.) In either case, the burst of digital information tells the caller about the machine that answered the call. The data is packaged as frames that conform to the high-level data-link control (HDLC) standard. It always contains a frame called the Digital Identification Signal (DIS), which describes the standard CCITT features of the machine. It can also contain two other frames: a Nonstandard Facilities (NSF) frame, which tells the caller about vendor-specific features, and, almost always, a Called Subscriber Identification (CSI) frame, which contains the answerer's phone number. The NSF frame, which can be followed by more frames containing information about nonstandard facilities, lends the protocol a great deal of flexibility. It can be used, for instance, to implement features such as encryption and fax store and forward, which weren't contemplated in the original T.30 standard.

The optional tone signals are there for downward compatibility. They are an invitation to a Group 2 or Group 1 fax machine to make a connection using its native protocol. (Since these older machines don't use digital transmission, they can't decipher the digital information, but they will recognize the tones.) In either case, this first one-way message from the answerer to the caller is called the Identification section of phase B.

If the two devices are both Group 3 units, the caller will recognize the digital information and respond. (HDLC frames have check sequences built in, so this part of the transaction is protected against errors.) During the second part of phase B, the Command section, the caller responds—also using a V.21 modem signal—with information about itself and its intentions.

If the caller is transmitting, it will send a Digital Command Signal (DCS), which tells the answerer how to receive the fax. Modem speed, image width, image encoding, and page length are all included in this frame. (The caller knows the capabilities of the answerer because they were transmitted as part of the DIS.) The caller may also send a Transmitting Subscriber Information (TSI) frame with the caller's phone number (this may be used to screen calls). It may also send a Nonstandard Facilities Setup (NSS) command, which is a response to an NSF frame.

If the caller is polling, the process is slightly different. The caller will send a Digital Transmit Command frame, which asks for a page to be sent and gives information about the caller's facilities. It may also send a Calling Subscriber Identification (CIG) frame (which gives the caller's phone number), with or without a Nonstandard Facilities Command (NSC), which is a response to an NSF frame. The machine that is answering will then take over, sending a DCS of its own. (Note that the machine that is sending ultimately has control over which features are used.)

Next, the device that's going to be sending fires up the higher-speed modem it's using to send the fax. Depending on the quality of the line and the capabilities of the machines, it may use either V.27ter (PSK) modulation (4800 or 2400 bps) or V.29 (QAM) modulation (9600 or 7200 bps). A training sequence (a series of signals designed to let the receiver adjust to line conditions) is sent, followed by a Training Check Frame (TCF). If the receiver successfully receives the TCF, it uses its V.21 modem to send a Confirmation to Receive (CFR) frame. Otherwise, it sends a Failure to Train signal. The sender may then send a new DCS frame requesting a lower transmission rate.

The sender transmits the fax during phase C, the in-message procedure and message transmission. Interestingly, in the original CCITT fax standards, this phase—unlike the earlier phases—had no error checking. Why? Because both V.27ter and V.29 are half-duplex protocols. Error checking requires turning the line around, which can take a lot of time and run up transmission costs. However, the CCITT has since added an Error Correction Mode (ECM) that encapsulates the data within HDLC frames, providing the receiver with an opportunity to check for, and request retransmission of, garbled data. (There's also an error-control mode that tries to limit the effects of errors, but it's not used much in practice.)

The CCITT T.30 specification describes two parts of phase C that go on simultaneously. Phase C1 includes synchronization, line monitoring, and detection of problems. Phase C2 includes the transmission of the data. Because the receiver may be anything from a slow thermal-printing unit to a fast computer, the data is paced according to the receiver's ability to process it. (The minimum time between lines has already been agreed to

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during the initial negotiations.)

After the fax is sent, phase D, the postmessage procedure, begins. Both sides revert to using HDLC packets as they did in phase A and phase B. If the sender has more pages to transmit, it sends a frame called the Multipage Signal (MPS). If the receiver confirms with a Message Confirmation (MCF) frame, phase C starts again for the next page. If the sender has no more pages, it sends either an End of Message (EOM) frame to indicate that the message is done or an End of Procedure (EOP) frame to indicate that it wants to end the call, and it then waits for a confirmation. Both sides can also send other kinds of frames that indicate problems or request manual intervention.

When the call is done, phase E, call release, occurs. The station that transmitted last sends a Disconnect (DCN) frame just before hanging up; it doesn't wait for a response.

Image Compression and Encoding

A typical Group 3 fax image might be 1728 pixels across and 1142 pixels from top to bottom—or 1,973,376 pixels in all. If the image were sent uncompressed at 9600 bps, with no delay between lines and no signaling overhead, the image would take roughly 206 seconds to send. If this were the only option, it would have rendered Group 3 uncompetitive with Group 2 (the so-called 3-minute fax). Fortunately, it is possible to reduce the time required to send a Group 3 fax by using one of two compression techniques. The first is a one-dimensional *modified Huffman code;* the second is a two-dimensional *modified READ* (relative addressing) *code.*

The first and most common Group 3 coding scheme is one-dimensional; that is, it takes advantage of similarities between pixels on the same line, but not between pixels on successive lines. It uses a combination of run-length and static (not adaptive) Huffman encoding.

Figure 3 shows a simple example of one-dimensional coding. The modified Huffman scheme allows runs of 0 to 63 pixels of the same color to be represented by a Huffman code up to 8 bits long (for runs of white pixels) or 12 bits long (for runs of black pixels). The codes for runs of white and black pixels are different because the statistical distributions are different (runs of black pixels tend to be shorter than runs of white ones in most printed documents).

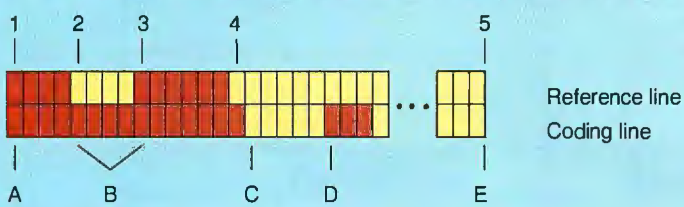
If the run is longer than 63 pixels, a special code called a *makeup code* is prefixed to the code word. Each makeup code adds a multiple of 64 pixels to the run length. Only one makeup code plus one normal run-length code is needed to make a run of up to 2623 pixels long (wider than a normal fax transmission). The makeup codes constitute the modified portion of the Huffman encoding scheme.

The second, more powerful encoding scheme is 2-D, and it does take advantage of similarities between adjacent lines. The first line is sent with ordinary 1-D encoding, but the lines after that are represented by codes that describe the *differences* between the locations of transitions on the line (called the *reference line)* and those on the current one (called the *coding line).* The way these differences are represented is subtle (see figure 4). A pair of transitions on the reference line can be skipped (pass mode), a transition can be shifted a small amount to the left or right (vertical mode), or a new pair of transitions can be added (horizontal mode) to derive the new line from the old one.

One problem with 2-D encoding is that an error in the reference line will propagate to every line that's derived from it. Therefore, Group 3 fax devices typically allow no more than one code line per reference line in a standard-resolution fax and three code lines per reference line in a fine-resolution fax (which has double the number of lines per inch). This safeguard prevents an error from obliterating a feature that's more than two standard lines tall. Still, despite this restriction, 2-D coding can cut transmission time by as much as 50 percent if the receiver is fast enough. And, hopefully, by the time you read this, the CCITT will have eliminated the requirement to send frequent reference lines when ECM is being used.

continued

TWO-DIMENSIONAL CODING (MODIFIED READ)



Feature	Code emitted	Meaning
A	1	Vertical mode, code V(0): Transition is in the same place on both lines.
B	0001	Pass mode: A pair of consecutive transitions in the reference line is absent from the coding line.
C	011	Vertical mode, code $V_R(1)$: A transition on the coding line lies 1 pixel to the right of a corresponding one on the reference line.
D	001	Enter horizontal mode: A pair of transitions appears on the coding line only.
	1100	It starts 5 white pixels from the last transition.
	10	It's a run of 3 black pixels.
E	1	Vertical mode, code V(0): There's an "imaginary" transition at the end of each line. This bit indicates that they line up.
	000000000001	End of line

Figure 4: *In two-dimensional coding (modified READ, or relative addressing), the sender looks for correspondences between the pixels on an earlier line (called the reference line) and the current one (the coding line). In vertical mode, the sender indicates that a transition is shifted up to 3 pixels left or right from one on the reference line. (This scheme is excellent for coding slanted lines.) In pass mode, the sender indicates that a pair of transitions on the reference line doesn't occur on the coding line and must be "passed by." Finally, in horizontal mode, the sender can indicate that there's a new pair of transitions on the coding line that wasn't there on the reference line.*

The Evolution of PC Fax

PC fax boards are now quite common, but few people know how they got their start. Interestingly, the first company to make a PC fax product—a firm called GammaLink—originally implemented it as an extension of a microcomputer-to-mainframe communications link. GammaLink had been using a Rockwell fax modem module in its two-board synchronous data-link control (SDLC) product because that module offered many features for automatic dial-up communications—something that was hard to find in other V.29 modems at the time. When the company began to explore using the fax modem as a fax device, it found a contractor who was interested enough in obtaining a PC fax interface to help fund the project.

GammaLink released its first fax product in December 1985 and followed up with a less expensive single-board unit in the summer of 1986. This was the time of the big office fax boom, and other companies (including Intel and Quadram) also saw the market window and quickly introduced their own products. By 1989, vendors were seeing large enough ecomomies of scale to offer low-end boards for as little as $150.

Most PC fax boards offer roughly the same capabilities. With such a board, you can receive faxes, print them, and store them on your hard disk. You can also create outgoing faxes from text and graphics files, as well as images you've scanned in. Many fax boards can act as fax servers for large networks of computers—sending, receiving, and routing faxes for an entire office.

Fax boards do many things better than ordinary fax machines. Text and graphics created on a PC almost always come out better at the other end than documents fed through a fax machine's scanner. Broadcasts are simple; all you need to do is prepare a list of numbers and let the computer do the calling. You can get clear, nonfading plain paper output from your laser printer, and you can save paper by previewing faxes before you print them out (a must if you get a lot of "junk fax"). Eventually, you may even be able to send binary files to anyone else with a computer and a fax board. (Currently, most manufacturers implement their own proprietary standards; however, the CCITT may soon approve a standard for binary file transfer.)

Still, the PC fax board will never replace the fax machine for many applications. A fax machine can wake up when the phone rings; by contrast, a computer might miss a call by the time it boots up and so must be left on 24 hours a day. The fax machine comes with a built-in scanner and printer; there's no need to plunk down $1000 or more each for good-quality computer peripherals. Certain brands of fax machines use the NSF feature of the T.30 protocol to offer superfine resolution, photo (gray-scale) mode, better data compression, and store and forward—features that are not often found on fax boards. And some vendors, such as Ricoh and Nippon Telephone and Telegraph, now offer encrypted fax machines to combat corporate espionage.

Finally, if you're worried about communications charges, you may find that in some situations the fax machine is faster than a PC fax board. Unlike high-quality fax machines, most PC fax boards don't implement 2-D encoding, because some personal computers they fit into are not fast enough to encode the image on the fly while tending to the fax board's many other needs. (It might be

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possible to do the encoding in advance, but until the connection is made, the board does not know whether the receiving machine is equipped to receive the results.)

There's also one other option worth mentioning. Users who already have high-quality fax machines but want to send computer-generated faxes may opt for another inexpensive solution: a modem with the added ability to send faxes (but not receive them). These modems take advantage of a quirk of the V.29 modem standard: The receiver works much harder than the transmitter to adjust to the characteristics of the line and requires considerably more hardware to implement. Thus, by implementing only V.21 (which the modem's chip set can probably already handle) and a transmit-only V.29 chip, these modems can send faxes just as well as most computer fax boards can. The downside, of course, is that you lose the screening, forwarding, and digitizing capabilities provided by a full-featured fax board. And you can't use a fax machine as a scanner for signatures and letterheads because there's no way to transmit the image to the PC.

Future Fax

While Group 4—the fax standard that relies on all-digital communications—isn't finished yet, many experts say it's already outmoded. Consumers will likely opt instead for the graphics facilities of the X.400 E-mail standard, which provides automatic routing, store and forward, and other desirable features.

Group 3, on the other hand, continues to improve. Work is under way to implement a still-faster modem standard—V.17 (which runs at 14,400 or 12,000 bps)—as well as tighter compression, gray scale, and color. And the installed base of Group 3 fax users is so great that there's a big incentive to provide enhancements—so long as the machines are downward-compatible. Thus, no matter what happens with other standards, we can expect to see better and better Group 3 fax products for a long time to come. ■

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A PRACTICAL GUIDE TO QUEUING ANALYSIS

Simple techniques that you can apply to many problems

In the field of data communications and computer networking, you frequently need to predict the effects of some change in load or design. Perhaps the system's load is increasing, or maybe managers are contemplating a design change.

For example, suppose that an organization supports a number of terminals, personal computers, and workstations on a 4-megabit-per-second token-ring LAN. Another department in the same building is to be cut over onto the network. Can the existing LAN handle the increased workload, or would it be better to provide a second LAN with a bridge between the two?

There are other cases where, based on the expected demand, you may need to design an entirely new system. For example, a department intends to equip all its personnel with a PC and configure these into a LAN with a file server. Based on experience elsewhere in the company, you can estimate the load each PC generates.

In each case, the concern is system performance. In an interactive or real-time application, that usually means response time. In other cases, throughput is the principal issue.

To make performance projections, you need some sort of prediction tool. For networking and communications problems—and, indeed, for many practical real-world problems—analytical models based on queuing theory can often do the job.

Why Queuing Analysis?

Although queuing theory is mathematically complex, its application to the analysis of performance can be remarkably straightforward. All you need is a knowledge of basic statistical concepts (means and standard deviations) and a basic understanding of the applicability of queuing theory. Armed with these, you can often make a queuing analysis on the back of an envelope using readily available queuing tables or simple computer programs that occupy only a few lines of code.

To get a handle on performance, you can do one of the following:

1. Do an after-the-fact analysis based on actual values.
2. Make a simple projection by scaling up from existing experience to the expected future environment.
3. Develop an analytical model based on queuing theory.
4. Program and run a simulation model.

Option 1 is no option at all: You wait and see what happens. This leads to unwise purchases and unhappy users.

Option 2 sounds more promising. You may take the position that it is impossible to project future demand with any degree of certainty and that it is therefore pointless to attempt some exact modeling procedure. In fact, though, a rough-and-ready projection will provide ballpark estimates. The problem with this approach is that the behavior of most communications systems is not what you would intuitively expect. When there is a shared facility (e.g., a network, a transmission line, a bridge, or a server), then that system's performance typically responds in an exponential way to increases in demand.

Figure 1 gives a typical example. The upper line shows what happens to user response time on a shared facility as the load on that facility increases. The load is expressed as a fraction of capacity. Thus, if you are dealing with a bridge that is capable of processing 1000 packets per second, then a load of 0.5 represents an input of 500 packets per second, and the response time is the amount of time it takes to retransmit any incoming packet. The lower line is a simple projection based on a knowledge of the behavior of the system up to a load of 0.5. Note that while things appear rosy with a simple projection, performance on the system will, in fact, collapse beyond a load of about 0.8 to 0.9.

Thus, a more exact prediction tool is needed. Option 3 is to use an analytical model expressed as a set of equations. The solutions to these equations yield the desired parameters (e.g., response time and throughput). Even though models based on queuing theory can provide a good fit to real-world problems, you must make some simplifying assumptions to derive equations for the parameters of interest.

The final approach is a simulation model. Here, given a sufficiently powerful and flexible simulation programming language, you can model reality in great detail and avoid making the many assumptions that are required of queuing theory. However, in most cases a simulation model is not needed, or at least it is not advisable as a first step in the analysis.

For one thing, both existing measurements and projections of future load carry with them a certain margin of error. Thus, no matter how good the simulation model is, the value of the results is limited by the quality of the input. In addition, despite the many assumptions required of queuing theory, the results that are produced usually come quite close to those that would be produced by a more careful simulation analysis. Furthermore, with this approach, you can create a queuing analysis in a matter of minutes for a well-defined problem, whereas simulation exercises can take days, weeks, or even longer to program and run.

continued

Accordingly, it behooves you to master the basics of queuing theory.

The Single-Server Queue

The most basic queuing system is depicted in figure 2. The central element of the system is a server that provides some service to items. Items from some population of items arrive at the system to be served. If the server is idle, it serves an item immediately; otherwise, an arriving item joins a waiting line. When the server has completed serving an item, the item departs, and if there are items waiting in the queue, one is immediately dispatched to the server.

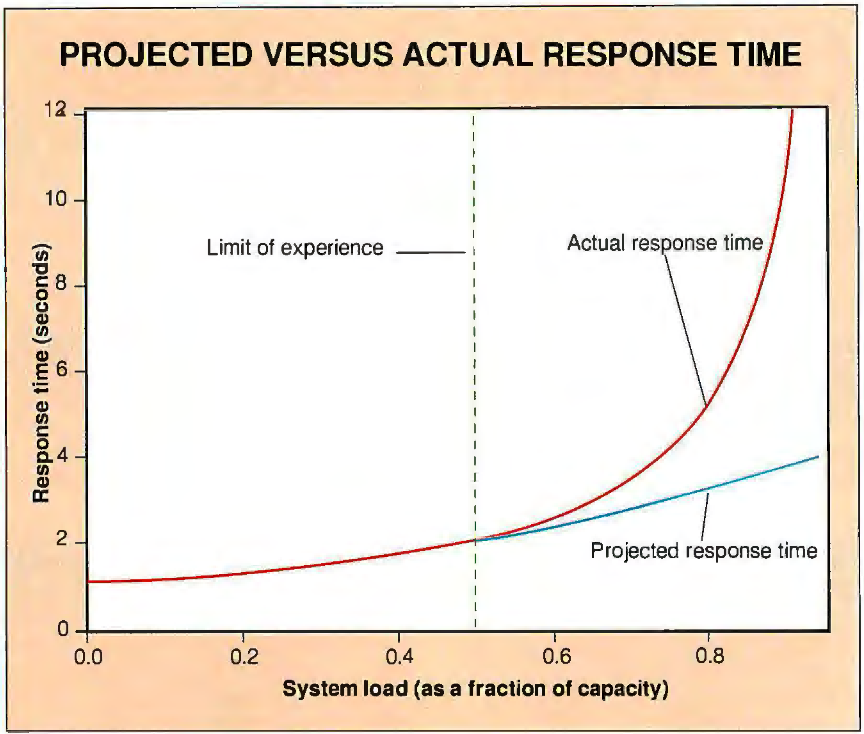

Figure 1: *The upper line shows what happens to user response time on a shared facility as the load on that facility increases. The load is expressed as a fraction of capacity. Limited experience might lead you to project that response time will continue to be adequate when, in fact, performance on the system will collapse beyond a load of about 0.8 to 0.9.*

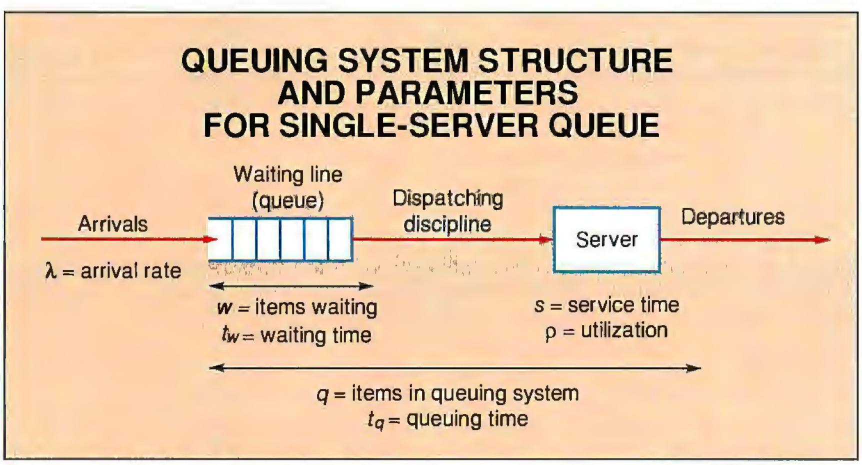

Figure 2: *Shown here are the queuing system structure and parameters for a single-server queue. The central element of the system is a server. If the server is idle, an item is served immediately. Otherwise, the item joins the queue. When the server has completed serving an item, that item departs, and the next item (if there is one in the queue) is immediately dispatched to the server.*

The figure also illustrates the basic parameters associated with a queuing model. Items arrive at the facility at some average rate (items arriving per second), denoted as λ. At any given time, a certain number of items (zero or more) will be waiting in the queue; the average number waiting is w, and the mean time that an item must wait is t_w. Note that t_w is averaged over all incoming items, including those that do not wait at all. The server handles incoming items with an average service time, s; this is the time interval between the dispatching of an item to the server and the departure of that item from the server. Utilization, ρ, is the fraction of time that the server is busy, measured over some interval of time. Finally, two parameters apply to the system as a whole. The average number of items in the system, including the item being served (if any) and the items in the queue (if any), is q; and the average time that an item spends in the system, waiting and being served, is t_q.

As the arrival rate in a system increases, the utilization increases, and with it, congestion. The waiting line becomes longer, increasing waiting time. At $\rho = 1$, the server is saturated, working 100 percent of the time. Thus, the theoretical maximum input rate that the system can handle is

$$\lambda_{max} = \frac{1}{s}$$

However, waiting lines become very large near system saturation, growing without bound when $\rho = 1$. Practical considerations, such as response time requirements or buffer sizes, usually limit the input rate for a single server to from 70 percent to 90 percent of the theoretical maximum.

To proceed, you need to make some assumptions about this model:

- *Item population:* Typically, you assume an infinite population. If the population is finite, then the population available for arrival is reduced by the number of items currently in the system; this would reduce the arrival rate proportionally. Networking and server problems can usually be handled with an infinite-population assumption.
- *Queue size:* Typically, you assume an infinite queue size. Thus, the waiting line can grow without bound. With a finite queue, items can be lost from the system. In practice, any queue is finite, but in many cases, this makes no sub-

stantive difference to the analysis.

• *Dispatching discipline:* When the server becomes free, and if there is more than one item in the queue, a decision must be made as to which item to dispatch next. The simplest approach is first-in, first-out; this discipline is what is normally implied when the term *queue* is used. Another possibility is last-in, first-out. One that you might encounter in practice is a dispatching discipline based on service time. For example, a LAN bridge may decide to dispatch packets on the basis of shortest first (to generate the greatest number of outgoing packets) or longest first (to minimize processing time relative to transmission time). Unfortunately, a discipline based on service time is very difficult to model analytically.

Table 1 summarizes the notation used in figure 2 and introduces some other useful parameters. In particular, people are often interested in the variability of various parameters, and this is neatly captured in the standard deviation.

The Multiserver Queue

Figure 3 shows the model that I have been discussing for multiple servers, all sharing a common waiting line. If an item arrives and at least one server is available, then the item is immediately dispatched to that server. It is assumed that all the servers are identical; therefore, if more than one server is available, it makes no difference which server is chosen for the item. If all servers are busy, a waiting line begins to form. As soon as one server becomes free, an item is dispatched from the waiting line using the dispatching discipline in force.

With the exception of utilization, all the parameters illustrated in figure 2 carry over to the multiserver case with the same interpretation. If you have M identical servers, then ϱ is the utilization of each server, and you can consider $M\varrho$ to be the utilization of the entire system. Thus, the theoretical maximum utilization is $M \times 100$ percent, and the theoretical maximum input rate is as follows:

$$\lambda_{max} = \frac{M}{s}$$

Basic Queuing Relationships

To proceed much further, you'll have to make some simplifying assumptions. These assumptions risk making the models less valid for various real-world situations. Fortunately, in most cases, the results will be sufficiently accurate for planning and design purposes.

There are, however, some relationships that are true in the general case, and these are illustrated in table 2. By themselves, these relationships are not particularly helpful.

Assumptions

The basic task of a queuing analysis is as follows. Given the arrival rate and service time as input, to provide, as output, information concerning the following:

TABLE OF NOTATION

Table 1: *Notation used in this article.*

λ	=	mean number of arrivals per second
s	=	mean service time for each arrival
σ_s	=	standard deviation of s
ϱ	=	utilization; fraction of time that the facility is busy
q	=	mean number of items in system (waiting and being served)
t_q	=	mean time an item spends in system
σ_q	=	standard deviation of q
σ_{tq}	=	standard deviation of t_q
w	=	mean number of items waiting to be served
t_w	=	mean time an item spends waiting for service
t_d	=	mean waiting time for items that have to wait (not including items with waiting time = 0)
σ_w	=	standard deviation of w
M	=	number of servers
$m_x(r)$	=	the rth percentile; that value of r below which x occurs r percent of the time

QUEUING RELATIONSHIPS

Table 2: *Although not particularly helpful by themselves, these basic relationships can be expanded to form the elements of models.*

$\varrho = \lambda s$	for a single server
$\varrho = \dfrac{\lambda s}{M}$	for multiple servers
$q = \lambda t_q$	Little's formula
$w = \lambda t_w$	
$t_q = t_w + s$	
$q = w + \varrho$	for a single server
$q = w + M\varrho$	for multiple servers

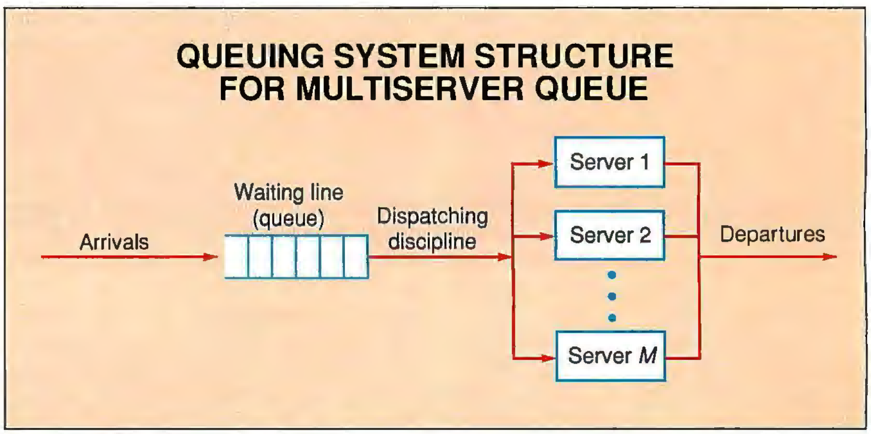

Figure 3: *In this queuing system structure for a multiserver queue, all servers share a common queue. Arriving items are immediately dispatched to the first free server (assuming that all servers are identical). If all servers are busy, items join a waiting line and are dispatched as servers become free.*

SINGLE-SERVER QUEUES

Table 3: *The following assumptions have been made: (1) The arrival rate uses Poisson distribution; (2) the dispatching discipline does not give preference to items based on service times; (3) formulas for standard deviation assume first-in, first-out dispatching; and (4) no items leave the queue; in other words, all items are eventually served.*

(a) General service times (M/G/1)

$$A = \frac{1}{2}\left[1 + \left(\frac{\sigma_s}{s}\right)^2\right] \quad \text{useful parameter}$$

$$q = \varrho + \frac{\varrho^2 A}{1-\varrho}$$

$$w = \frac{\varrho^2 A}{1-\varrho}$$

$$t_q = s + \frac{\varrho s A}{1-\varrho}$$

$$t_w = \frac{\varrho s A}{1-\varrho}$$

(b) Exponential service times (M/M/1)

$$q = \frac{\varrho}{1-\varrho}$$

$$w = \frac{\varrho^2}{1-\varrho}$$

$$t_q = \frac{s}{1-\varrho}$$

$$t_w = \frac{\varrho s}{1-\varrho}$$

$$\sigma_q = \frac{\sqrt{\varrho}}{1-\varrho}$$

$$\sigma_{tq} = \frac{s}{1-\varrho}$$

$$Pr[q=N] = (1-\varrho)\varrho^N$$

$$Pr[q \leq N] = \sum_{i=0}^{N} (1-\varrho)\varrho^i$$

$$Pr[t_q \leq t] = 1 - e^{-(1-\rho)t/s}$$

$$m_{tq}(r) = t_q \times \log_e\left(\frac{100}{100-r}\right)$$

$$m_{tw}(r) = \frac{t_w}{\varrho} \times \log_e\left(\frac{100\varrho}{100-r}\right)$$

(c) Constant service times (M/D/1)

$$q = \frac{\varrho^2}{2(1-\varrho)} + \varrho$$

$$w = \frac{\varrho^2}{2(1-\varrho)}$$

$$t_q = \frac{s(2-\varrho)}{2(1-\varrho)}$$

$$t_w = \frac{\varrho s}{2(1-\varrho)}$$

$$\sigma_q = \frac{1}{1-\varrho} \times R$$

$$R = \sqrt{\varrho - \frac{3\varrho^2}{2} - \frac{5\varrho^3}{6} - \frac{\varrho^4}{12}}$$

$$\sigma_{tq} = \frac{s}{1-\varrho}\sqrt{\frac{\varrho}{3} - \frac{\varrho^2}{12}}$$

- items waiting
- waiting time
- items queued
- queuing time

What specifically do you want to know about these outputs? Certainly you would like to know their average values (q, t_q, w, t_w). In addition, it would be useful to know something about their variability. Thus, the standard deviation of each would be useful (σ_q, σ_{tq}, σ_w, σ_{tw}). Other measures may also be useful. For example, to design a buffer associated with a bridge or a multiplexer, it might be useful to know for what buffer size the probability of overflow is less than 0.001. That is, what is the value of N such that $Pr[q < N] = 0.999$?

You must have complete knowledge of the probability distribution of the arrival rate and service time to answer such questions. And the resulting formulas are exceedingly complex. Thus, to make the problem tractable, you need to make some simplifying assumptions.

The most important of these assumptions is that the arrival rate obeys the Poisson distribution, which is equivalent to saying that the arrivals occur randomly and independently of one another. Another way of expressing the same thing is to say that the interarrival times (times between arrivals) are exponential. This assumption is almost invariably made. Without it, queuing analysis is impractical. With this assumption, it turns out that you can get many useful results if you only know the mean and standard deviation of the arrival rate and service time. You can simplify matters even more and get even more detailed results if you assume that the service time is exponential or constant.

There is a convenient notation for summarizing the principal assumptions made in developing a queuing model. The notation is *X*/*Y*/*N*, where *X* refers to the distribution of the interarrival times, *Y* refers to the distribution of service times, and *N* refers to the number of servers. The most common distributions are denoted as follows:

G = general independent arrivals or service times
M = negative exponential distribution
D = deterministic arrivals or fixed-length service.

Thus, *M*/*M*/1 refers to a single-server queuing model with Poisson arrivals and exponential service times.

Models and Details

Table 3a provides some equations for single-server queues that follow the *M*/*G*/1 model; in other words, the arrival rate is Poisson. If you make use of a scaling factor, *A*, the equations for some of the key output variables are straightforward. Note that the key factor in the scaling parameter is the ratio of the standard deviation of service time to the mean. No other information about the service time is needed.

Two special cases are of some interest. When the standard deviation is equal to the mean, the service time distribution is exponential. This is the simplest case, and the easiest one for calculating results. Table 3b shows the simplified versions of equations for σ_q, σ_{tq}, σ_w, and σ_{tw}, as well as some other parameters of in-

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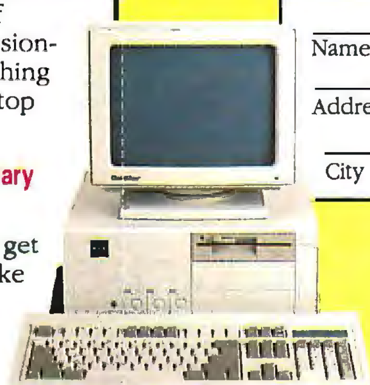

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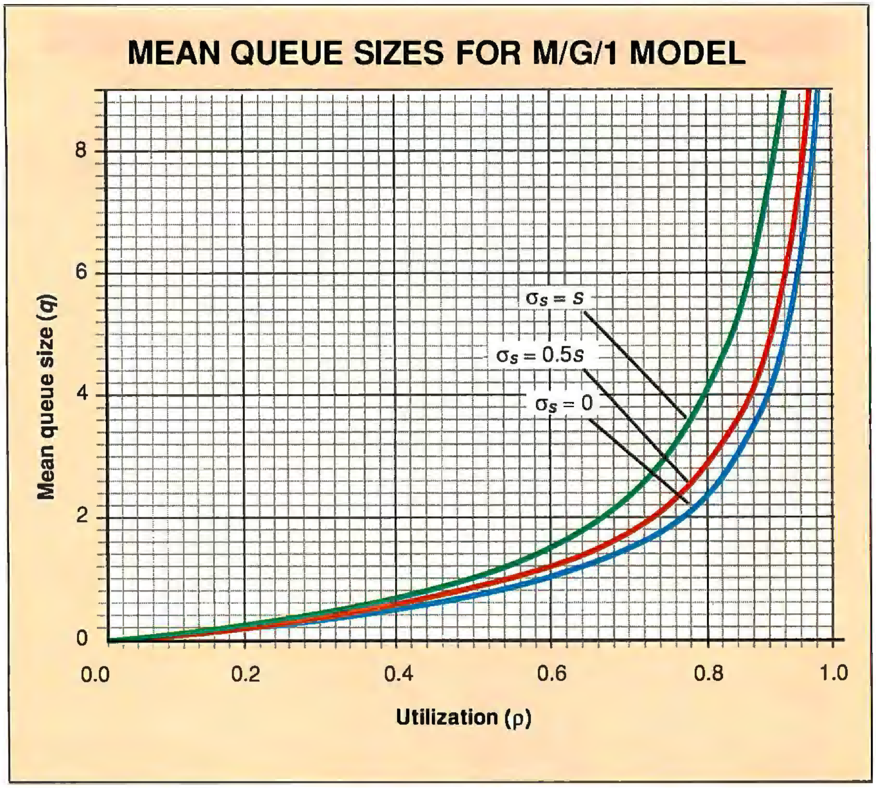
terest. The other interesting case is a standard deviation of service time equal to zero, that is, a constant service time. The corresponding equations are shown in table 3c.

Figures 4a and b plot values of average queue size and queuing time versus utilization of three values of σ_s/s. Note that the poorest performance is exhibited by the exponential service time, and the best by a constant service time. Usually, you can consider the exponential service time to be a worst case; an analysis based on this assumption will give conservative results. This is nice, since tables are available for the *M/M/*1 case, and values can be looked up quickly.

What value of σ_s/s are you likely to encounter? Consider four regions:

1. *Zero:* This is the rare case of constant service time. If all transmitted messages are of the same length, they fit this category.
2. *Ratio less than 1:* Since this ratio is better than that in the exponential case, using *M/M/*1 tables gives you queue sizes and times that are slightly larger than they should be. Using the *M/M/*1 model would provide answers on the safe side. An example of this category might be a data-entry application from a particular form.
3. *Ratio close to 1:* This is the most common occurrence, and it corresponds to the exponential service time—in other words, service times are essentially random. Consider message lengths to a computer terminal: a full screen might be 1920 characters, with message sizes varying the full range. Airline reservations, file lookups on inquiries, a shared LAN, and packet-switching networks are examples of systems that often fit this category.
4. *Ratio greater than 1:* If you observe this, you need to use the *M/G/*1 model instead of relying on the *M/M/*1 model. The most common occurrence of this ratio in a communications system is a bimodal distribution with a wide spread between the peaks. An example is a system that experiences many short messages, many long messages, and few that are in-between.

The same consideration applies to the arrival rate. For a Poisson arrival rate, the interarrival times are exponential, and the ratio of the standard deviation to the mean is 1. If the observed ratio is much less than 1, then arrivals tend to be evenly spaced (i.e., have not much variability), and the Poisson assumption will overestimate queue sizes and delays. On



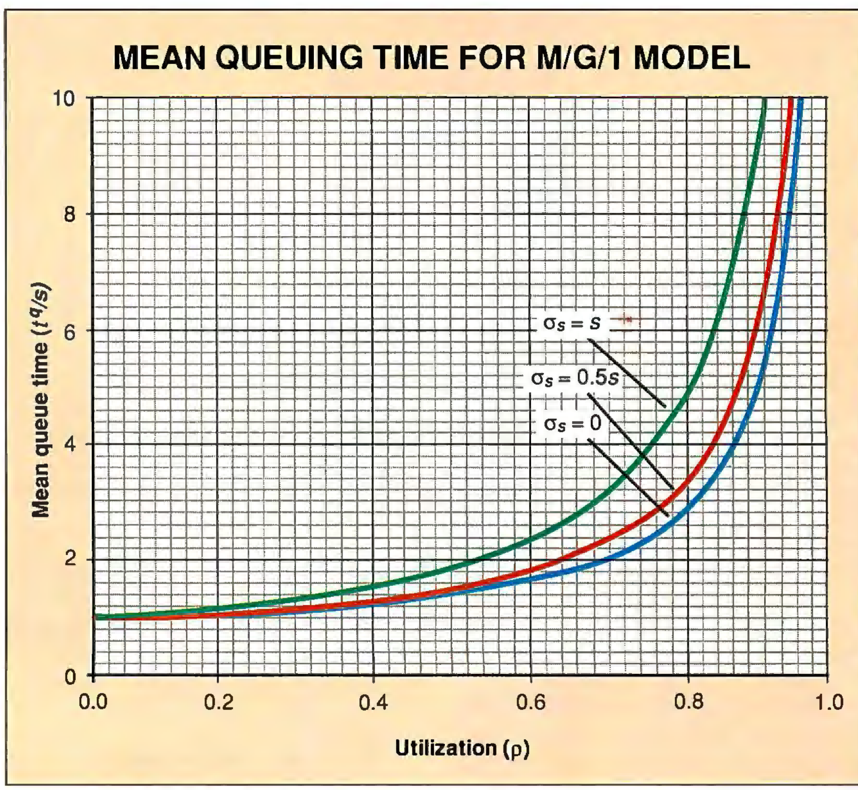


Figure 4: *The change in* **(a)** *queue size and* **(b)** *queuing time for different rates of utilization (the fraction of time that the server is busy), at service times that vary from constant ($\sigma_s = 0$) to exponential (σ_s = s). Note that constant service time (which is rarely seen) provides the best performance, while exponential service time provides the poorest performance.*

MULTISERVER QUEUES

Table 4: *The following assumptions have been made: (1) The arrival rate uses Poisson distribution; (2) services times are exponential; (3) all servers are equally loaded; (4) all servers have the same mean service time; (5) formulas for standard deviation assume first-in, first-out dispatching; and (6) no items leave the queue; in other words, all items are eventually served.*

$$K = \frac{\sum_{N=0}^{M-1} \frac{(M\varrho)^N}{N!}}{\sum_{N=0}^{M} \frac{(M\varrho)^N}{N!}} \quad \text{useful parameter}$$

Probability that all servers are busy =

$$B = \frac{1-K}{1-\varrho K}$$

$$q = B\frac{\varrho}{1-\varrho} + M\varrho$$

$$w = B\frac{\varrho}{1-\varrho}$$

$$t_q = \frac{B}{M}\frac{s}{1-\varrho} + s$$

$$t_w = \frac{B}{M}\frac{s}{1-\varrho}$$

$$\sigma_{tq} = \frac{s}{M(1-\varrho)}\sqrt{B(2-B)+M^2(1-\varrho)^2}$$

$$\sigma_w = \frac{1}{1-\varrho}\sqrt{B\varrho(1+\varrho-B\varrho)}$$

$$Pr[t_w>t] = Be^{-M(1-\rho)t/s}$$

$$t_d = \frac{s}{M(1-\varrho)}$$

the other hand, if the ratio is greater than 1, then arrivals tend to cluster, and congestion becomes more acute.

Table 4 lists formulas for some key parameters for the multiserver case. Note the restrictiveness of the assumptions. Useful congestion statistics for this model have been obtained only for the *M/M/N* case, in which the exponential service times are identical for the *N* servers.

Database Server

Here are a few examples to give you some feel for the use of these equations.

Consider a LAN that has 100 PCs and a server that maintains a common database for a query application. The average time for the server to respond to a query is 0.6 second, and the standard deviation is estimated to equal the mean. At peak usage times, the query rate over the LAN reaches 20 queries per minute. You would like to find the following information:

- What is the average response time, ignoring line overhead?
- If a 1.5-second response time is considered the maximum acceptable, what percent of growth in message load can occur before the maximum is reached?
- If 20 percent more utilization is experienced, will response time increase by more or less than 20 percent?

Assume an M/M/1 model, with the database server as the server in the model. Ignore the effect of the LAN (assume its contribution to the delay is negligible). Facility utilization is calculated as

$$\begin{aligned}\varrho &= \lambda s \\ &= (20 \text{ arrivals per minute}) \\ &\quad \times (0.6 \text{ second per transmission})/(60 \text{ seconds per minute}) \\ &= 0.2\end{aligned}$$

The first value, the average response time, is easily calculated:

$$\begin{aligned}t_q &= \frac{s}{(1-\varrho)} \\ &= \frac{0.6}{(1-0.2)} \\ &= 0.75 \text{ second}\end{aligned}$$

The second value is more difficult to obtain. Indeed, as worded, there is no answer, because there is a nonzero probability that some instances of response time will exceed 1.5 seconds for any value of utilization. Instead, say that you would like 90 percent of all responses to be less than 1.5 seconds. Then, you can use the equation from table 3b:

$$\begin{aligned}m_{tq}(r) &= t_q \times \log_e(100/(100-r)) \\ m_{tq}(90) &= t_q \times \log_e(10) \\ &= \frac{s}{1-\varrho} \times 2.3 \\ &= 1.5 \text{ seconds}\end{aligned}$$

You have $s = 0.6$. Solving for ϱ yields $\varrho = 0.08$. In fact, utilization would have to decline from 20 percent to 8 percent to put 1.5 seconds at the ninetieth percentile.

The third point is to find the relationship between increases in load versus response time. Since a facility utilization of 0.2 is down in the flat part of the curve, response time will increase more slowly than utilization. In this case, if facility utilization increases from 20 percent to 40 percent (a 100 percent increase), the value of t_q goes from 0.75 second to 1.0 second, an increase of only 33 percent.

A Multilink Protocol Problem

The multilink protocol is part of X.25; a similar facility is available in System Network Architecture. With MLP, a set of links exists between two nodes and is used as a pooled resource for transmitting packets, regardless of virtual circuit number.

When a packet is presented to MLP for transmission, any available link can be chosen for the job. For example, if two LANs at different sites are connected by a pair of bridges, there may be multiple point-to-point links between the bridges to increase throughput and reliability.

The MLP approach requires extra processing and frame overhead compared to a simple link protocol. A special MLP header is necessary for the procedure. The alternative would be to assign each of the arriving packets to the queue for an outgoing link in round-robin fashion.

This would simplify processing, but what kind of effect would it have on performance?

Here's a concrete example. Suppose that there are five 9600-bps links connecting two LAN bridges and that the average packet size is 100 octets. Thus, the average service time is (100 octets × 8 bits/octet)/(9600 bps) = 0.0833 second. Assume that the standard deviation of service time is observed to be 0.079 second. Note that this is about 95 percent of the mean; you can thus assume exponential service time. During peak load time, packets arrive at the rate of 48 packets per second.

The Single-Server Approach

If arriving packets are evenly distributed among the outgoing links, then the load for each link is 48/5 = 9.6 packets per second. Thus,

$$\begin{aligned} \varrho &= \lambda s \\ &= 9.6 \times 0.0833 \\ &= 0.8 \end{aligned}$$

The queuing time is then easily calculated:

$$\begin{aligned} t_q &= \frac{s}{1-\varrho} \\ &= \frac{0.0833}{0.2} \\ &= 0.42 \text{ second} \end{aligned}$$

The Multiserver Approach

Using the multilink protocol, you now have an aggregate arrival rate of 48 packets per second. However, the facility utilization is still $0.8(\lambda s/M)$. To calculate the queuing time from the formula in table 4, you first need to calculate B. If you have not programmed the parameter, it can be looked up in a table under a facility utilization of 0.8 for five servers, to yield $B = 0.554$. Substituting,

$$\begin{aligned} t_q &= 0.0833 + \frac{(0.544)(0.0833)}{5(1-0.8)} \\ &= 0.13 \end{aligned}$$

So the use of MLP has reduced average queuing time from 0.42 second down to 0.13 second—a reduction greater than a factor of 3. If you look at just the waiting time, the difference is 0.047 second compared to 0.34 second, which is a factor of 7.

Although you may not be an expert in queuing theory, you now know enough to be annoyed when you have to wait in a line at a facility with single-server queues.

Calculating Percentiles

Consider a router that connects a LAN to a wide-area packet-switching network. Let's look at the traffic from the LAN through the router.

Packets arrive with a mean arrival rate of five per second. The average packet length is 144 octets, and it is assumed that the packet length is exponentially distributed. Line speed from the router to the wide-area network is 9600 bps. The following questions need to be answered:

1. What is the mean queuing time in the router?
2. How many messages are in the router center, including those waiting for transmission and the one currently being transmitted (if any), on the average?
3. Same as (2), for the ninetieth percentile.

continued

4. Same as (2), for the ninety-fifth percentile.

The information available is as follows:

$$\lambda = 5 \text{ messages per second}$$

$$s = \frac{144 \text{ octets} \times 8 \text{ bits/octet}}{9600 \text{ bits per second}} = 0.12 \text{ second}$$

$$\varrho = \lambda s = 5(0.12) = 0.6$$

Mean queuing time is as follows:

$$t_q = \frac{s}{1-\varrho} = 0.3 \text{ second}$$

Mean queue length is as follows:

$$q = \frac{\varrho}{1-\varrho} = 1.5 \text{ packets}$$

To obtain the percentiles, you use the equation from table 3b:

$$Pr[q{=}N] = (1-\varrho)\varrho^N$$

To calculate the rth percentile of the queue size, you write the above equation in cumulative form:

$$\frac{r}{100} = \sum_{k=0}^{m(r)} (1-\varrho)\varrho^k = 1 - \varrho^{1+m(r)}$$

Here, $m(r)$ represents the maximum number of messages in the queue expected r percent of the time. In the form given, you can determine the percentile for any queue size. You want to do the reverse: Given r, find $m(r)$. So, taking the logarithm to the base 10 of both sides:

$$m(r) = \frac{\log(1 - \frac{r}{100})}{\log \varrho} - 1$$

If $m(r)$ is fractional, take the next higher integer; if it is negative, set it to 0.

For the example, $r = 0.6$ and you want to find $m(90)$ and $m(95)$:

$$m(90) = \frac{\log(1-0.90)}{\log(0.6)} - 1 = 3.5$$

$$m(95) = \frac{\log(1-0.95)}{\log(0.6)} - 1 = 4.8$$

Thus, 90 percent of the time there are fewer than four packets in the queue, and 95 percent of the time there are fewer than five packets. If you're designing to a ninety-fifth percentile criterion, a buffer is needed to store at least five packets.

On Your Own

Queuing analyses provide a reasonably good fit to reality. They are therefore valuable for making all kinds of predictions, especially in the area of data communications.

You can address scores of questions with queuing analysis, as it touches on virtually every aspect of data communications. With the information provided in this article, you should now be able to do your own basic queuing analyses.

Recommended Reading

Perhaps the most useful reference that you could acquire is *Systems Analysis for Data Transmission* by J. Martin (Prentice-Hall, Englewood Cliffs, NJ, 1972). Despite this book's age, it is a valuable practical source. It provides a number of graphs and tables that can be used to perform quick queuing analyses. It also provides detailed guidance for the application of queuing analysis, plus a number of worked-out examples.

In addition to Martin's book, there are several obscure but readily available publications of great practical assistance. *Analysis of Some Queuing Models in Real-Time Systems* (IBM Document GF-20-0007, 1971; available from IBM document distribution centers) is an excellent, concise treatment of queuing analysis applied to computer and communications problems, with many examples, plus graphs and tables. *Tables for Traffic Management and Design* by T. Frankel (ABC TeleTraining, P.O. Box 537, Geneva, IL 60134, 1976) is a good collection of tables for various queuing models. *Experimental Statistics* (National Bureau of Standards Handbook 91, Government Printing Office, GPO Stock No. 003-003-00135-0, 1963) is an excellent guide to the practical application of statistics; it has tables, formulas, and examples that aid in determining the proper procedure for estimating values from samples and evaluating the results. ■

William Stallings (Prides Crossing, MA) is an independent consultant and author of 14 books on data communications and computer networking. This article is based on material in the author's latest book, Data and Computer Communications *(Macmillan, 1991). He can be reached on BIX c/o "editors."*

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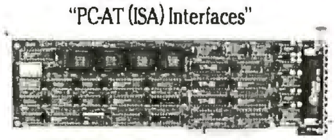

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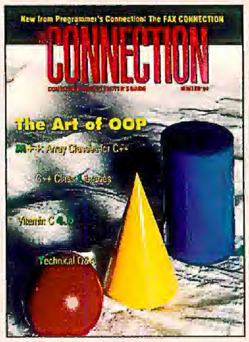

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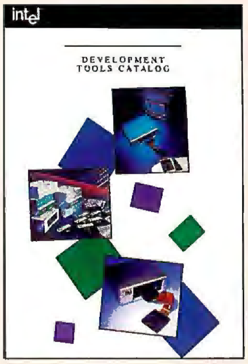

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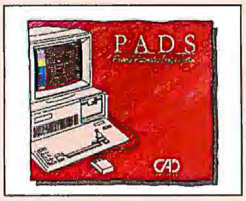

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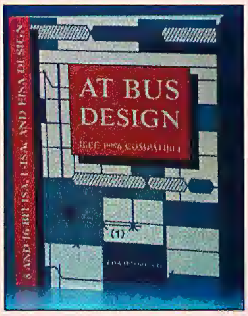

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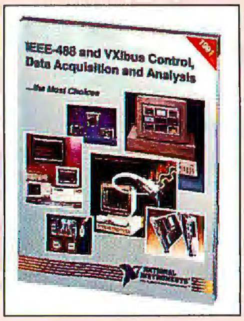

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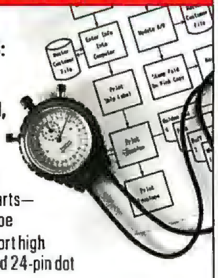

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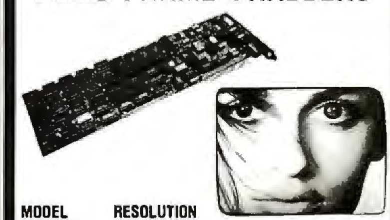

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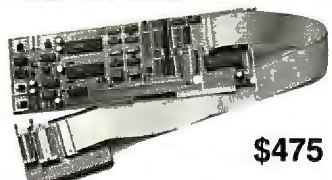

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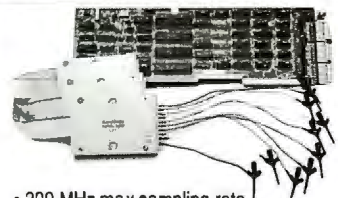

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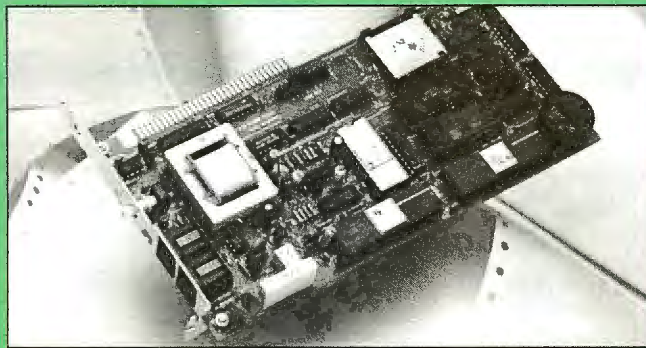

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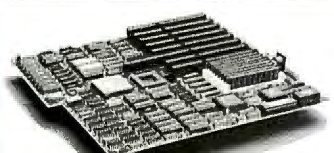

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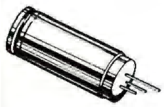

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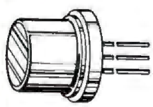

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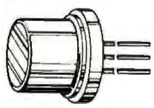

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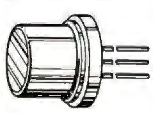

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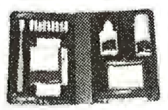

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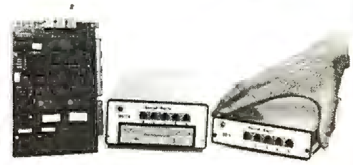

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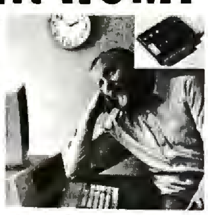

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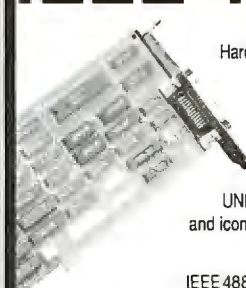

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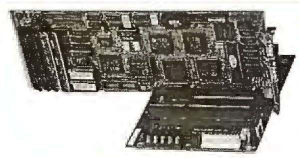

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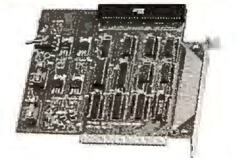

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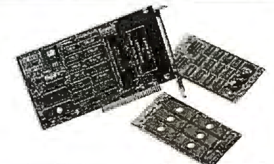

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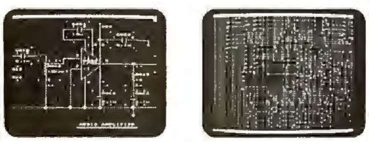

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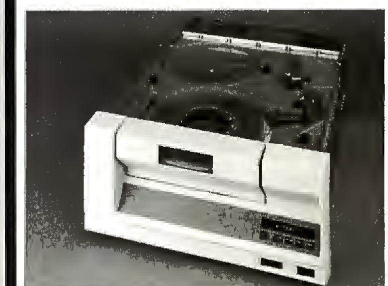

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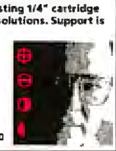

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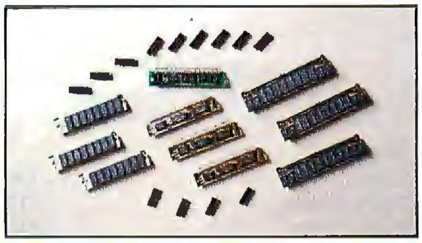

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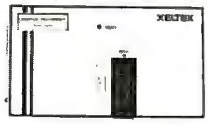

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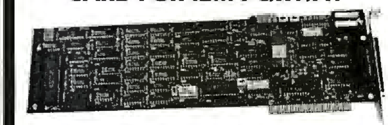

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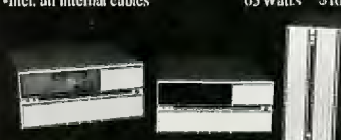

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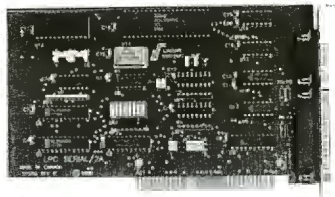

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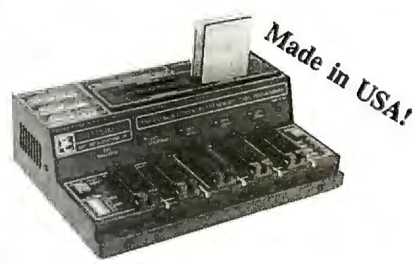

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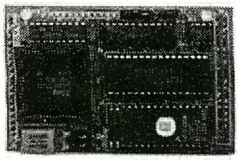

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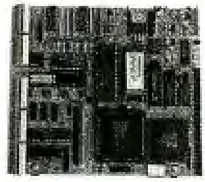

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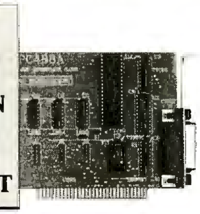

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- Full/Half duplex operation. Supports hardware handshaking (RTS,CTS).
- Dual drivers/receivers;Handles 64 devices;Compatible with most comm. sftwr.
- High speed version available (supports baud rates up to 256KB) - $165

Dual-Port RS-485/422 [PCL743] $175

- Two independent channels / UARTs; 2 or 4 wire operation. Max. Baud 56KB.
- Dipswitch configurable as COM1-4 (IRQ2-7). On board terminator resistor.

IEEE-488 Card [PC488A] $145

- Includes DOS Device Driver and sample Communication program in BASIC.
- Additional sample programs in C, Pascal & Assembly - $50.
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144 Bit Digital I/O [PCL722] $295

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Relay & Isolated D/I [PCL725] $240

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- LED indicators for activated relays. On board signal conditioning.

10 Channel Counter [PCL830] $295

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- 16 bit TTL input and 16 bit TTL output ports. Selectable interrupt channel.

6 Channel 12 bit D/A [PCL726] $495

- Output Ranges: 0 to +5V, 0 to +10V, ±5V, ±10V or sink 4-20mA.
- Settling time: 70µS. Linearity: ±1/2bit. Voltage output driving capacity: ±5mA
- Digital I/O: 16 digital inputs and 16 digital outputs; TTL compatible.

12 Bit A/D & D/A [PCL711s] $295

- **A/D converter:** 8 single-ended channlels; Device: AD574; Conversion time less than 25µsec; Input range: ±5V; Software Trigger Mode only.
- **D/A converter:** 1 channel; 12 bit resolution; 0 to +5V/10V Output Range.
- **Digital I/O:** 16 Input / 16 Output channels; All I/Os TTL compatible.
- **External Wiring Terminal Board** with mounting accessories included.
- Utility Routines and Demo/Sample Programs for BASIC and Quick-BASIC.

12 Bit A/D & D/A [PCL812] $395

- **A/D converter:** 16 single ended inputs; Device : AD574; Conversion time less than 25 µsec; Built-in programmable pacer; **Input ranges:** ±10V, ±5V, ±1V.
- **D/A converter:** 2 channels ; 12 bit resolution.; Output Range 0-5V .
- **Digital I/O:** 16 Input / 16 Output channels; All I/Os TTL compatible.
- **Counter:** 1 channel programmable interval counter/timer; Uses Intel 8254.
- DMA and interrupt capability. Utility software for Basic included.

12 Bit w/ Prgm. Gain [PCL812pg] $450

- **A/D converter:** 16 single ended inputs; Device:HAD574; Conversion time less than 25 µsec; Built-in programmable pacer;
- **Software Programmable Multiple Input Ranges:** ±10V, ±5V, ±2.5V, ±1.25V, ±0.625V, ±0.3125V.
- **D/A converter:** 2 channels ; 12 bit resolution.; Output Range 0-5V .
- **Digital I/O:** 16 Input / 16 Output channels; All I/Os TTL compatible.
- **Counter:** 1 channel programmable interval counter/timer; Uses Intel 8254.
- DMA and interrupt capability. Utility software for Basic included.

Fast 12 Bit A/D/A [PCL718] $745

- **A/D converter:** 16 single ended or 8 differential channels; 12 bit resolution; Programmable scan rate; Built-in Interrupt and DMA control circuitry. Conversion speed 60,000 smpls/sec (standard), 100,000 smpls/sec (optional).
- **Input ranges:** Bipolar ±10V, ±5V, ±2.5V, ±1V, ±0.5V; Unipolar 10,5,2,1V.
- **D/A converter:** 2 channels; Resolution: 12 bits res; Settling time: 5µsec; ±5V
- **Digital I/O:** 16 OUT, 16 IN; TTL compatible; All I/Os TTL compatible.
- **Counter:** 16 bit progr. interval counter/timer; Uses Intel 8254; Pacer clock;
- **Software:** Utility software for BASIC and QuickBASIC included. Supported by LabDAS ($195/495), ASYST, LABTECH, UnkelScope

Fast 12 Bit w/ Pgm Gain [818] $845

- **A/D converter:** 16 single ended or 8 differential channels; 12 bit resolution; Programmable scan rate; Built-in Interrupt and DMA control circuitry. Conversion speed 100,000 samples per second.
- **Software Programmable Input ranges:** Bipolar ±10V, ±5V, ±2.5V, ±1V, ±0.5V; Unipolar 10,5,2,1V.
- **D/A converter:** 2 channels; Resolution: 12 bits res; Settling time: 5µsec; ±5V
- **Digital I/O:** 16 OUT, 16 IN; TTL compatible; All I/Os TTL compatible.
- **Counter:** 16 bit progr. interval counter/timer; Uses Intel 8254; Pacer clock;
- **Software:** Utility software for BASIC and QuickBASIC included. Supported by LabDAS, ASYST, LABTECH, UnkelScope

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- 6 ☐ Other

B. What is your level of management responsibility?
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- 8 ☐ Middle-level
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D. What operating systems are you currently using? (Check all that apply.)
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- 13 ☐ DOS + Windows
- 14 ☐ OS/2
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- 18 ☐ 1-25
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1167	1168	1169	1170	1171	1172	1173	1174	1175	1178	1177
1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188
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1475	1476	1477	1478	1479						

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Title ______________________________

Phone ( ) __________________ Fax ( ) __________

Company ______________________________

Address ______________________________

City __________________ State __________ Zip __________

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1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
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5 ☐ Engineer/Scientist
6 ☐ Other

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7 ☐ Senior-level 9 ☐ Professional
8 ☐ Middle-level

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes 11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS 15 ☐ UNIX
13 ☐ DOS + Windows 16 ☐ MacOS
14 ☐ OS/2 17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?

18 ☐ 1–25 20 ☐ 51–99
19 ☐ 26–50 21 ☐ 100 or more

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FEBRUARY
IRSD002

Inquiry Numbers 1-493

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Inquiry Numbers 494-986

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Inquiry Numbers 987-1479

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1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190
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Title ______________________

( ) Phone ______________ ( ) Fax ______________

Company ______________________

Address ______________________

City ______________ State ______ Zip ______

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2 ☐ Programmer/Systems Analyst
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4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

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8 ☐ Middle-level
9 ☐ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ☐ Yes
11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)
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14 ☐ OS/2
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16 ☐ MacOS
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Inquiry Numbers 1-493

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Inquiry Numbers 494-986

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970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986

Inquiry Numbers 987-1479

987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003
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1463	1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474	1475	1476	1477	1478	1479

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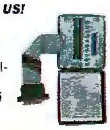

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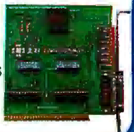

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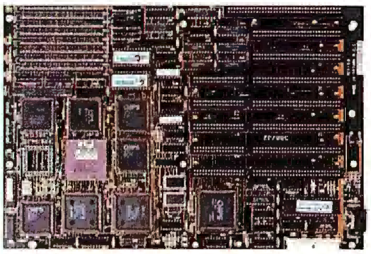

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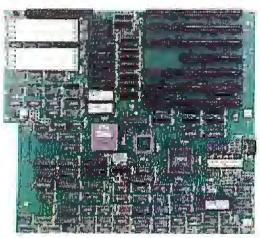

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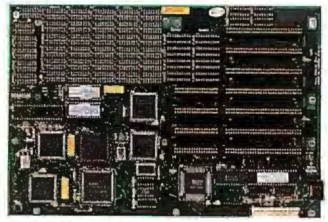

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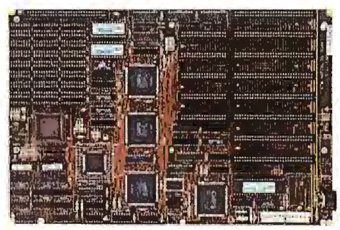

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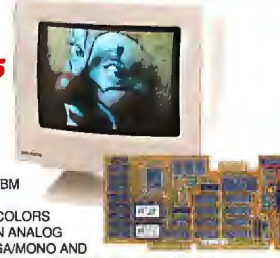

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Read to Me

Dear Jerry,

You've written about CD-ROM text, but I have never seen anyone discuss what I think is the next inevitable step: creating audio output of text on compact discs. I know there is such a thing for the blind, but I am talking about audio output for anyone who likes to be read to. Fairly sophisticated but not unreasonably expensive circuitry could be developed to enable people to put, say, the works of Homer and the Greek tragedians on a disc. You would be able to relax and be read to by the computer in excellent stereo sound. Maybe there could be some hypertext information about the history of the geographic area and maps and such, but the primary function of the disc would be to read to an individual.

I have always thought that, for "creative" reading, the very act of forcing my eyes across the page was detrimental to comprehension. I have always loved to be able to lean back and watch the action take place on the screen of my mind while I am read to, and I think a lot of other people feel the same way.

Sophisticated algorithms could capture inflections—the voice going down at the end of a sentence and up when there is a question mark. In the technology's infancy, you could manually enter inflections, stage directions, and any other necessary information with a joystick. In the future, as the technology matures, end-user software could let users tailor their programs to whatever level they want.

For the plays of Shakespeare, you could assign a particular type of voice to each member of the cast and include sound effects and music. A complete list of archaic terms and puns could appear on the screen beneath the spoken text. This would make certain discs more expensive, but they would be the exception. What I envision is a large body of work on discs with a voice ready to read any work at whatever speed the listener chooses.

People could also scan in documents themselves to make their own talking books. This would certainly change a lot of the copyright laws, since it will be much easier to pirate books.

It would be easy to download E-mail and tape it to play on the stereo on the drive home. People who get volumes of E-mail on BBSes would be able to tape it and "read" their mail any time they could get to a stereo.

Right now, people don't see the point of transferring text to computer screens. This killer application would be a major force in making CD-ROMs an effective and necessary tool for the future.

Richard Hein
New York, NY

Well, I used to like to be read to also; perhaps you're right. I think I have seen some CDs of audio text, though.

However, I see what you're after. I know there are speech synthesizers that work fine reading the screen to people. Hmm.—Jerry

The Visually Impaired

Dear Jerry,

As regards Arni Fredrickson's letter (June 1990) and the choice of a computer for a person who is visually impaired, I suggest that Fredrickson's cousin first select his software and then choose the hardware.

It appears to be an unfortunate fact of life that eyesight problems get worse with age rather than better. Eventually, people with severe visual impairments may need to add speech systems to their machines, and they may find that they cope best with a combination screen reader and large display.

More software for the visually impaired (and associated add-in speech boards) seems available for PCs than for Macs, although a reasonable number of Apple II packages are also around. One popular item is the VERT system (Telesensory Systems, P.O. Box 7455, Mountain View, CA 94039), which reads the screen in an intelligent manner. *Intelligent* is the operative word here; it is no good having a screen reader that reads a row in Lotus 1-2-3 as "Five one one two three point seven four one four point four zero" when the spreadsheet contains the values 112 and 3.7 and a formula that produced a value of 414.40 in cells A5 to C5.

Another factor involved in choosing a system is to remember that the Mac is a graphical user interface-oriented system. The visually impaired user with a screen reader generally prefers to stick with text-based systems, and PCs seem to provide the requisite capabilities at reasonable cost. There's not much need for these people to consider an upgrade next year to OS/2 or Windows. How would a speech system describe such screens? For these people, 8088 or 286 systems do nicely—although I would not recommend an 8088 machine unless money was a severe constraint.

Ironically, a VGA display card might be a better option than, say, a monochrome Hercules card. A Hercules card would be fine except that it doesn't support 40-column mode, which people with very limited vision can sometimes use to good effect with DOS commands. CGA or EGA cards would probably meet resolution requirements for those who need large-text displays, but VGA card prices have come down in recent months to the point where it doesn't make much sense to buy CGA or EGA.

Visually impaired students in my computer science classes at St. Johns River Community College in Florida generally opt for 12-MHz AT clones with 40-MB hard disk drives and VGA cards.

I suggest that Fredrickson's cousin contact local colleges, users groups, and agencies that provide services for the visually impaired so as to meet other people in similar situations. They should provide good practical advice on equipment and programs, because most blind and visually impaired people find computers almost essential in their daily lives.

Also, the National Federation of the Blind (1800 Johnson St., Baltimore, MD 21230), through its Job Opportunities for the Blind program, publishes a document titled *A Review of Speech and Braille*

Software/Hardware Systems Designed to Permit Blind Persons to Access the Video Display of an IBM PC Computer (PC) for those considering screen readers.

James M. Kennedy
St. Augustine, FL

Thanks.—Jerry

Quick/Turbo COBOL

Dear Jerry,

I have been reading and enjoying your columns for many years. I particularly appreciate your perspectives on education and American technological and industrial policies as they relate to our international competitiveness and productivity. Because these sorts of topics seem to be of interest to you, I am writing to share an opinion with you and perhaps get your perspective on my views.

For most of the 1980s, I have been employed as a mainframe programmer/analyst for a major university. During the same time period, I have been a PC enthusiast and have devoted countless hours to using and learning dozens of software packages for the PC. But the one capability on PCs that has consistently eluded me is the ability to readily program sophisticated applications in a high-level language.

This is not for lack of trying. I have bought and/or used dBASE III Plus, Turbo Basic, QuickBASIC, Turbo C, and Turbo Pascal. I have written quite a few minor programs for my own use in these languages, and they've worked fine. Indeed, they are wonderful languages and programming environments. But I have never been able to convince myself that these languages were what I wanted or needed to develop a large PC-based database system.

I've only recently admitted to myself the real reason for my reluctance to get deeply involved in any of these languages, although it's obvious. The reason is that my "native language"—the high-level language I use all day, every day, five days a week, 49 weeks a year—is COBOL. And I like it.

All these years, I've accepted as unfortunate but inevitable that COBOL is somehow too old-fashioned, too stodgy, or too something to be available for the PC. I know that Microsoft, MicroFocus, and Realia have COBOL products, but they are way too expensive and seem to be totally oriented toward giving mainframe shops the tools to offload mainframe development work onto PCs.

At the same time, I've wondered why companies such as Microsoft and Borland haven't done for COBOL what they have done for BASIC, C, and Pascal. ANSI COBOL '85 certainly lacks nothing in features or power, having adopted many of the more "modern" features of Pascal and C, and it always had a more robust file- and record-handling capability than any of these other languages. Not to mention its portability, self-documenting qualities, and all the other features that have made it the number-one high-level programming language in the world for over 30 years.

Either I'm missing something, or the powers that be in the PC world have deliberately chosen to ignore a vast resource pool of trained, experienced programming talent in developing these other languages. I think it's wonderful that Quick and Turbo Pascal, C, and BASIC have been developed, but it does elude me why BASIC is considered "rehabilitable" and COBOL apparently is not, given the far larger and generally more highly trained group of people who program primarily in COBOL, as opposed to those who program in BASIC.

I guess the assumption is that professional programmers are good at learning symbolic languages, so if you know COBOL, you can learn another language, too. And that's what we COBOL programmers have been doing for the past 10 years. But what a waste of the years of training and experience we've already accrued! For there is no way that one's skill at a language learned haphazardly on evenings and weekends can compare to the skill one develops using a language 40 hours a week.

The oddest thing is that I believe that if a Quick or Turbo version of COBOL were developed by Microsoft or Borland and a comparable amount of advertising were devoted to pitching the product, along with a certain amount of high-level enthusiasm for the notion that programming in COBOL is a respectable activity, the product would likely be a smash hit in the marketplace. I may be wrong, but I'll bet there are many tens of thousands of professional COBOL programmers who would throw all their other Quick/Turbo PC languages in the trash and leap to buy COBOL, if a decent one were available. I know I would.

When a language like BASIC can be provided in a package with an integrated development environment, high-speed optimizing compiler, links to other languages, on-line help, space-age graphics, and all the other gee-whiz stuff that has come out in the past few years, there is no longer a reason why the millions of us from the mainframe world need to continue to be disenfranchised from being able to apply our skills in our native language in the realm of desktop computing. As the distinctions between the two computing realms continue to blur and overlap, this will become more true.

I would appreciate your thoughts on this subject. Thanks for your attention.

R. Wayne Parker
Seattle, WA

You know, I often wonder why there isn't a "quick" COBOL, too. Although I'm not so sure it would be as beneficial as you think, it is an opportunity.

I suppose my thinking is colored by Alex's phrase, Completely Obsolete Bad Old Language...

And, of course, I never learned it.

We are getting some of the tools you want for BASIC and Modula-2 and Pascal, though.—Jerry

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

PRINT QUEUE

Hugh Kenner

Never-Never Land

Computer simulations of bees? Frozen heads? What will those transhumanists think of next?

In Samuel Butler's *Erewhon* (1872), disease is equated with crime; also, machines are taboo. Victorian machines, of course, competed with humans: They spun, wove, set type. But today's machines do much that humans can't, such as whooshing folk to Paris as they page through the latest BYTE. Humans merely restricted by their bodies, it grows easy to think, are nowadays plain incompetent, not to say underprivileged.

Human minds, though, working in ways that gave Butler pause—well, Ed Regis has a history of fascination with those. In *Who Got Einstein's Office?* (1987), he took readers on a lighthearted if somewhat skewed tour of the Institute for Advanced Study at Princeton. Now, in *Great Mambo Chicken & the Transhuman Condition* (Addison-Wesley, 1990, $18.95) he's dealing with "the never-never land where science and lunacy collide." That wording is from a blurb by James (*Chaos*) Gleick, who goes on about "a place where building bacteria-size robots, tinkering with antigravity, and freezing human heads is all in a day's work." Also, Harvard's Nobel Laureate Sheldon Glashow calls *Great Mambo Chicken* "the first true 'unification' of science fact and fiction," and Timothy Leary, as often, can't contain himself: "I love it!"

Such enthusiasms, arrayed around a photo of the author looking askance at a fat white hen, may well arouse misgivings. But misgivings are unlikely to survive 10 minutes with the lively Regis prose. As a spectator of unlikely goings-on, he's Butler's worthy successor. Here's his opening paragraph:

"When Saul Kent had the suspension team at the Alcor Life Extension Foundation in Riverside, California, surgically remove the head of Dora Kent, Saul's mother, from her body, his hope was that she could eventually be restored to life and health, probably even youth. The *last* thing on his mind was that they'd all wind up being investigated for murder."

The italicized word—that's a Regis mannerism; it denotes someone speaking under stress, also someone a little out of touch. Lopped heads, in the usual world, lead straight to murder charges, no question of that. But not in Saul Kent's expectations. And—"surgically remove the head": Has such a phrase ever appeared in print before? "Surgically!" Are normal surgeons head-removers? Regis has invented, and in this book is perfecting, a tone in which to discuss bizarre goings-on indeed. They have, yes, their rationale; though, no, it's not a rationale we're used to.

Let's draw back from surgical decapitations (elsewhere called "a rapid conversion to neuropreservation...using a high-speed electric chain saw") to enter the world of this book a bit more gently. About 1985, Dave Criswell had an idea for dismantling the sun to obtain a resource. And was that, asks Regis, "anything more than a large-scale extension of the schemes that had been proposed for the natural features of the earth?" He adduces things that people have wanted to do with icebergs: Make them into unsinkable aircraft carriers (*that* idea got as far as a prototype during World War II), or "tow them to Africa and melt them down for water" (that held allure as late as 1974).

As for Africa, couldn't the discharge of the Rhône be carried across the Mediterranean in a huge plastic pipe? Nothing came, either, of that 1975 proposal; but by 1983, "an enormous tube from the Amazon River, in South America, to the Sahara Desert, in Africa" was being proposed. It could be "150 feet in diameter, made of rubber or rubber-like plastic, held in place on the sea bottom by a cement ballast." Nothing came of that, either. But, heck, hadn't a transatlantic cable been laid as far back as the 1860s? So

ILLUSTRATION: DON BAKER © 1991

what's the *matter* with everybody?

Also, how about damming the Straits of Gibraltar, and then draining enough of that puddle east of the dam (aka the Mediterranean) to give Europeans more living space? Crazy? Well, at this moment, half the population of Holland lives on land reclaimed from the North Sea. An odd experience Holland can offer is the sight of an ocean-size ship passing way above your head. For the Dutch it's commonplace.

So deciding—a priori—what's feasible, what isn't, is far from foolproof. Pointless to call a scheme "crazy." Those Dutch dams were "crazy." Now what was it Criswell had proposed? Saving lost solar stuff? Well, "All those high-quality photons and valuable solar element abundances, all of them winging their way off to nowhere and being lost forever"—what are those but raw material, like, say, Antarctic ice? Conserving them, though, means higher tech than simply building dikes. So—surround the sun with a gigantic circle of linked particle accelerators! Beams fired through those could tighten and loosen the belt in pulsating waves—like "a rubber band squeezing the sun at its equator and pushing solar plasma off toward the sun's poles, where it would fly off in spurts, as if through a rocket nozzle." That way, you'd be seeing celestial objects "for what they really were... gobs of brute matter awaiting intelligent transformation." Wow.

(You'd also be conserving the sun; a smaller sun could have a longer life span. So think of that as *stellar husbandry*. Wow.)

We're talking of a weighing of accident against design. "Should we humans be satisfied with what we'd been handed as the result of accidental circumstances, or should we go out and apply some critical intelligence, some engineering skill, some good old-fashioned hubristic science?" That buys, you'll notice, the paradigm that what's given at present is accident. God, who governed Western thought before—say—Darwin, has ceded place to a random-number generator. ("I believe," said Woody Allen, "in an intelligence pervading the universe, except for certain parts of New Jersey." The protagonists of *Great Mambo Chicken* believe in no intelligence save their own.)

Great Mambo Chicken, by the way? Well, a man named Milt Smith at the University of California, Davis, wondered about prolonged greater-than-normal gravitational forces, and, noting that chickens (like humans) walk on two legs, he placed hundreds of chickens in huge centrifuges, where they lived in 2½ g's for months at a time. And lo, great mambo chickens strutted forth, low-fat, high heart-efficient, with three times the ability to do the work chickens do (beat wings, tromp treadmills). Good for what on 1-g earth? No one is saying. They do demonstrate that our technology can tamper with chickens.

And our 1-g earth seems not very smartly designed. Gravity holds the atmosphere to Earth's surface, yes; but the atmosphere of Mars has leaked away. Earth is simply lucky. Even so, earthlings are "gravitationally disadvantaged" once they essay space travel, which means "blasting out of our gravity well," a hole the depth of 600 Everests. You're thinking God could have been a tad more foresighted? Well, no; best think how much smarter are We than is Chance. For in the world of Chance, ours is the privilege of picking nits, dreaming up fixes. The amoeba is not so situated, nor is even the dolphin.

But back to the head of Dora Kent, since the classic misdesign is death, which was what the Alcor Life Extension Foundation hoped to exempt her from. She was 83 and "legally dead" when those surgeons removed her head. Maybe "a fresh, new body could be cloned from one of her old cells." Maybe her revived brain could be placed in that body; maybe she'd live a new life, perhaps hundreds, thousands, of years. Meanwhile, her head would rest in a tank of liquid nitrogen at −186 °C, while science toiled away at the specifics.

> **M***eanwhile, beware of hype. Everything, it seems, is possible, as long as you don't demand to see and handle results. At an artificial life conference held last year, results were scanty.*

Maybe... well—it's a long story—her head seems to have gotten lost. Scratch one resurrection.

Decades ago, Arthur C. Clarke inscribed Clarke's Law: "When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong." That would seem to imply that nothing is impossible. (Someone's counterexample: "Everest on roller skates.")

Meanwhile, beware of hype. Everything, it seems, is possible, as long as you don't demand to see and handle results. At an artificial life conference held last year in Santa Fe, results were scanty. Someone showed a videotape of a metal arm "juggling" a balloon. The balloon was attached to the arm by a piece of string. Discarding the string: That was said to be next on the research agenda. Thrillsville.

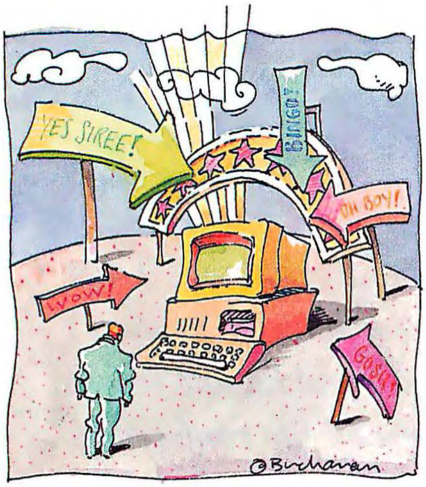
To the very first conference on artificial life, held three years earlier at Los Alamos, a lady from Holland had brought along "bioinformatic bumblebees." I do wish Regis had told us more about those, although from his wording one can guess that they were very likely computer simulations. The only hands-on working entities at that show seem to have been two little cars that sought light, moth-like. They seem trivial, not to say a long remove from a squeezing of hot solar matter out of the sun. But give the transhumanists a little time.

"Oh God! Oh Montreal!" was a phrase Sam Butler contributed to the rhetoric of bemused dismay. It popped into his head on finding a famous Greek statue stowed away in a Montreal attic as "indecent," and it's a useful phrase on occasions when plainer words fail. "O God! O Montreal!" Ed Regis's myriad-minded protagonists murmur, amazed that fellow humans put up with the lot that's dealt them. (Einstein, even, put up with that, and he's *dead*; cryonics subjects, more fortunate, are merely frozen). "O God! O Montreal!" may a reader well think, chin-deep in this broth of schemes and speculations.

Science Slightly Over the Edge is the book's apt subtitle. What saves it, end to end, is its scrupulous way of expounding every proposal, however bizarre. Ed Regis dismisses nothing as incomprehensible, never assumes we'll choose not to understand. And, given the subject matter, that's a rare compliment he's paying us. ■

Hugh Kenner is a professor of English at Johns Hopkins University. He writes for publications ranging from the New York Times *to* Art & Antiques. *His recent books include* Mazes *and* Historical Fictions. *He can be contacted on BIX as "hkenner."*

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



GREAT EXPECTATIONS

Don't set yourself up for disappointment when buying a computer system

If you're like many buyers of information systems, you're probably dissatisfied with a previous purchase that didn't meet your expectations. You may still have the same problems an expensive system was supposed to solve. Why? It may be because buyers and sellers often set up unrealistic expectations, and that you, the buyer, were inadvertently programmed to fail.

Here's how it happened. The salespeople made promises that they couldn't keep: lower inventory levels, improved cash flow, and improved profitability. They meant well. But they didn't see that neither they nor their systems could solve your problems. Only executives making good business decisions can do that. What the information systems companies *could* provide was information to help you better make those decisions.

But you can't just blame the vendor for your unhappiness with the system you bought. After all, you believed them and abdicated responsibility for solving your business problems.

Here are some tips on how to approach your next system purchase so you don't end up a dissatisfied customer again.

Don't let an information systems company take responsibility for solving your problems. Many companies are faced with difficult problems they don't know how to solve. Profits are down, market share is declining. Even if vendors promise you a solution, resist the temptation to believe it. Running your business is your responsibility. Envision yourself solving the problem. What information and tools will you need to do this? These are what you want to ask the vendor for.

Don't be distracted or dazzled by technology. Technology is marvelous, but it isn't what you're buying. You're buying capabilities and information. Be sure that the system can deliver these capabilities. Try to separate the information, tools, and capabilities you need to solve your problem from how the system will provide them. Visit a company similar to yours that is using the system. While you're there, stay focused on capabilities when evaluating the system, not on the solution. The fact that another company was able to solve its problems doesn't necessarily mean that it needed, or got, the same capabilities you need.

Don't expect miracles. One of the reasons companies still have the problems that their system was supposed to solve is because they believed a miracle would happen. If you hear a vendor salesperson saying, "No problem; we can take care of that for you," recognize the statement for what it is: a promise of a miracle.

Ask for proof. Once you have envisioned yourself solving your own problem and determined what capabilities and tools you'll need to do it, you know exactly what to ask the vendor for. Don't let the vendor take you down the boring trail of a full product demonstration with hundreds of product features. You know what you need. Just make the vendor prove that the system can deliver it. Also, make sure that your potential vendor takes care of customers *after* they buy.

Agree on written business objectives. Don't spend money on a system until you're absolutely sure that it will pay for itself in spades. The problem you're trying to solve affects a number of managers and departments, and so will the system you install to deal with that problem. All managers should identify the business objectives that they are having difficulty achieving, why they are having these difficulties, and the specific capabilities they will need to achieve them. Once you have decided to purchase a system, document productivity and payback areas and monitor progress regularly.

Don't program your internal "buyers" to fail. You may have to sell your system purchases to other departments in your organization. If so, do not promise to solve their problems. Help your internal buyers envision themselves solving their own problems. Help them articulate the capabilities and information that they'll need to do this. Then prove that the system you're proposing can deliver those capabilities.

Don't let your expertise be your enemy. As you're helping your internal buyers define their problems, you must stay in tune with their needs. Armed with your technical knowledge, you might tend to jump quickly to your idea of the solution while your buyer is still painting the problem picture. You see the solution; your buyer doesn't. In your enthusiasm, it's easy to offer to solve the problem yourself. Don't take responsibility for problems you can't solve.

You can avoid becoming another dissatisfied customer by making sure you know what you're buying and by making sure your expectations are realistic. As I said earlier, systems cannot solve business problems. Only executives making sound decisions can. Systems provide the information to make those decisions. It's time that we consciously acknowledged this. ■

Stop Bit is an open forum for informed opinion on topics related to personal computing. The opinions expressed are those of the author and not necessarily those of BYTE or its staff. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

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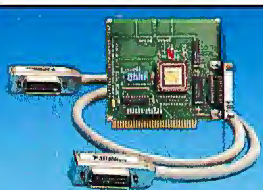

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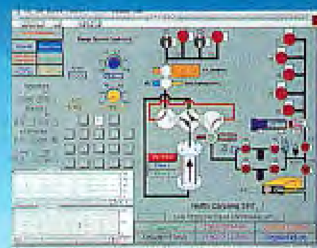

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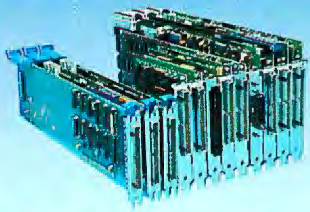

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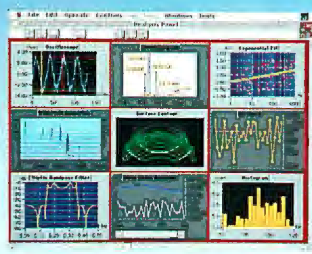

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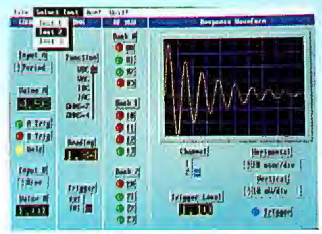

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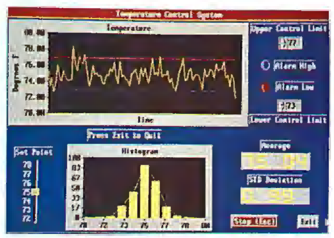

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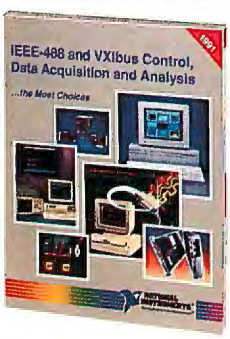

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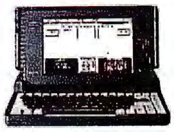

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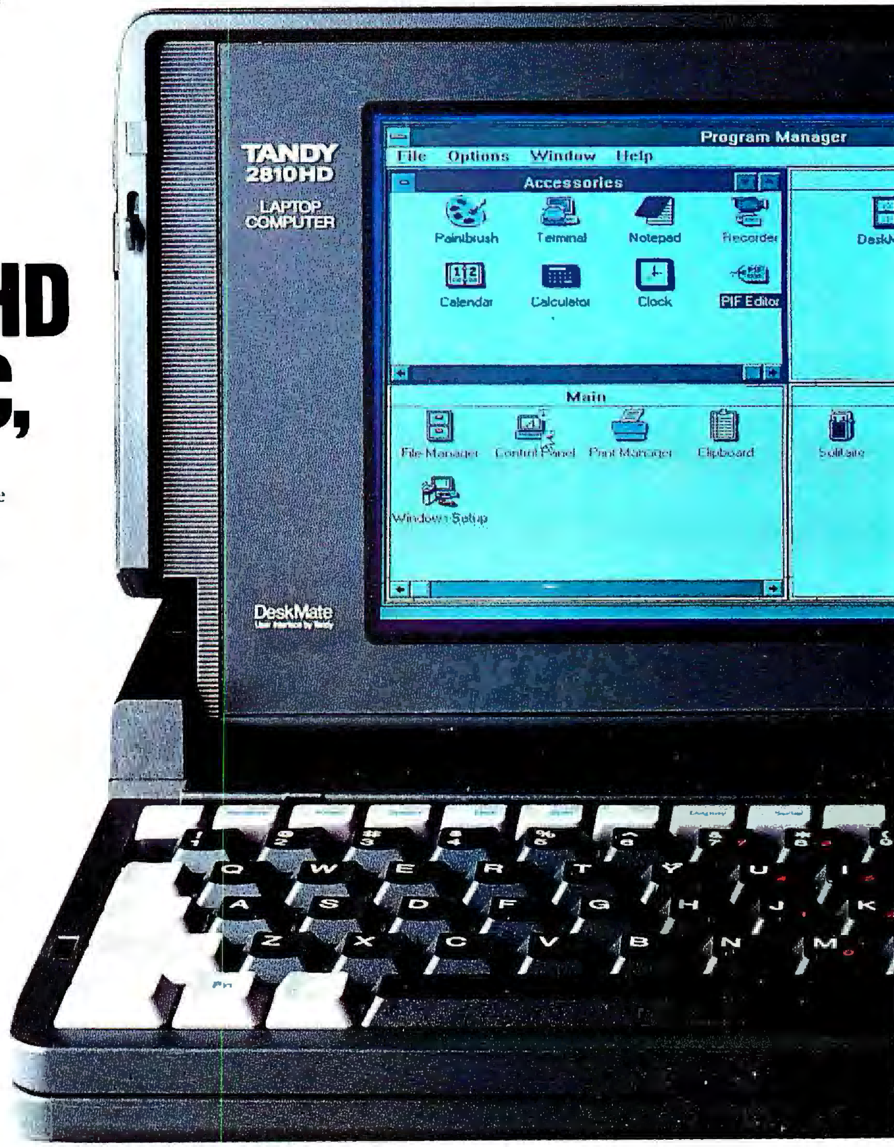

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