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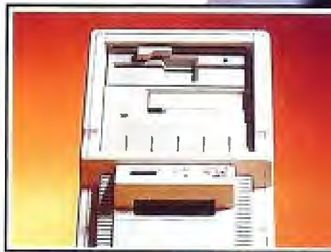
# BYTE

A McGRAW-HILL PUBLICATION

SOLUTIONS FOCUS:
Four network servers take on the Systempro
Page 162



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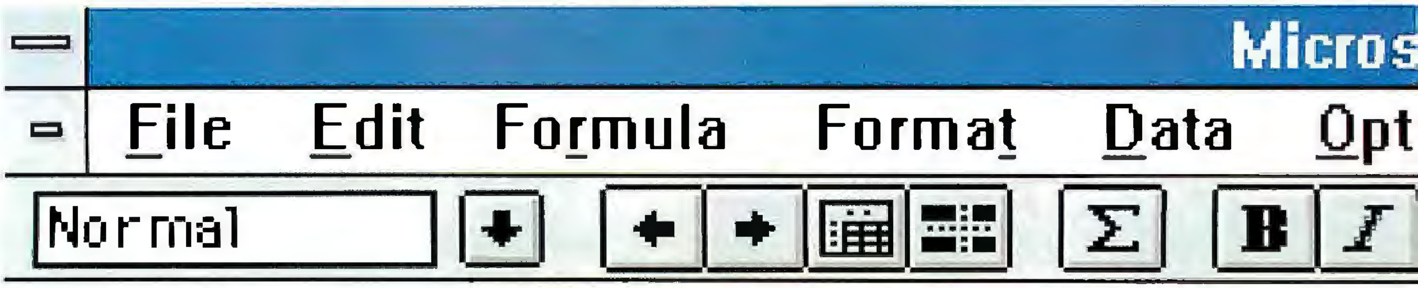


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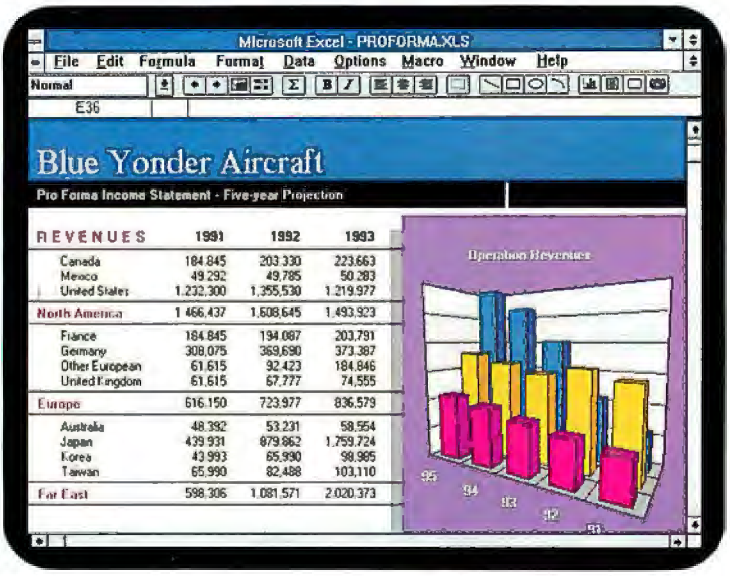


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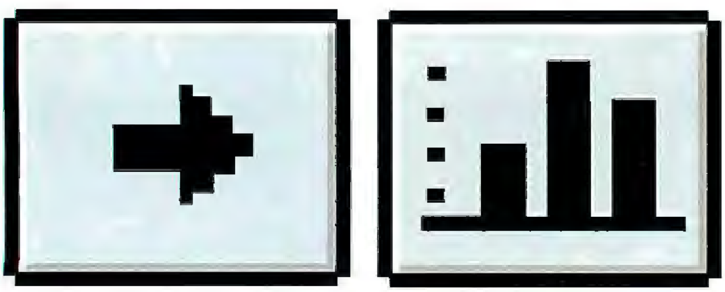

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*February 1992 Volume 17, Number 2*

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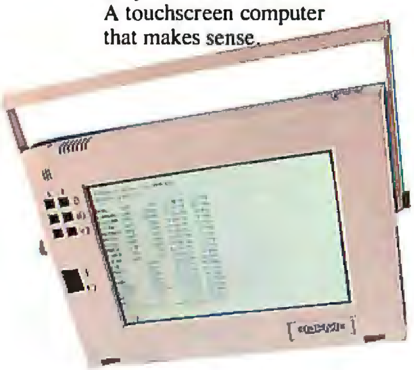



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REGIONAL SECTION begins after page 66


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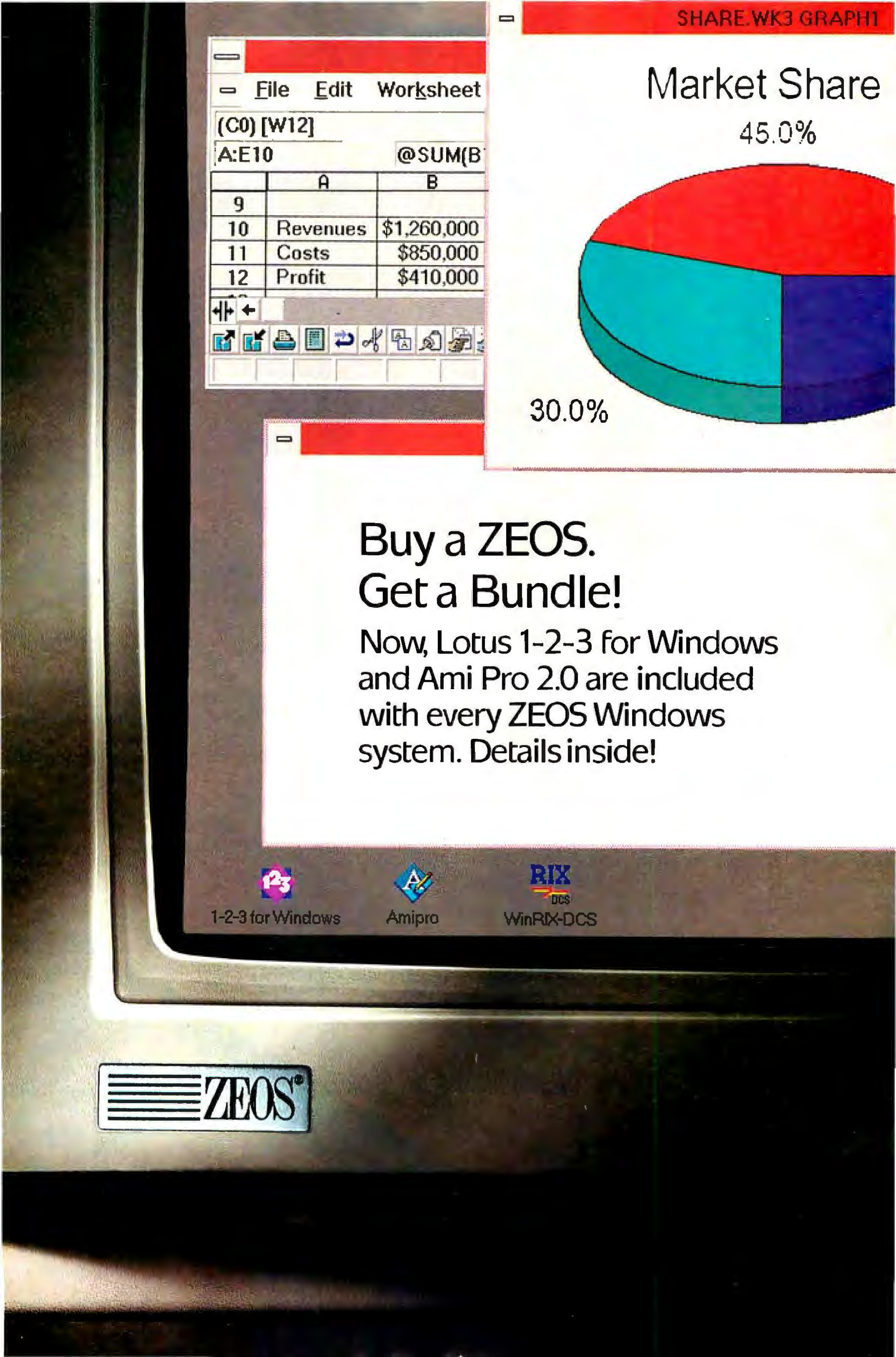
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*This index helps you find articles that contain information on each of the listed topics. (The topic list changes each month.) Combined with the table of contents (page 4) and the Editorial Index by Company (page 340), you can identify articles by type, subject, title, author, or product discussed.*

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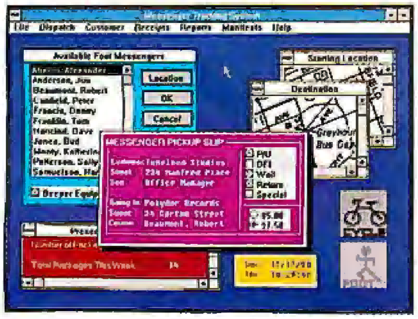

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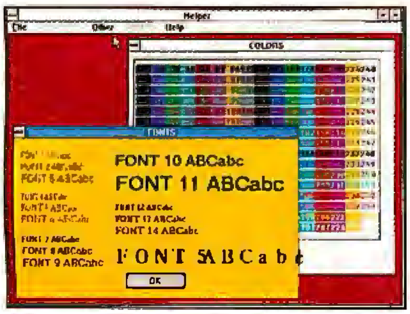


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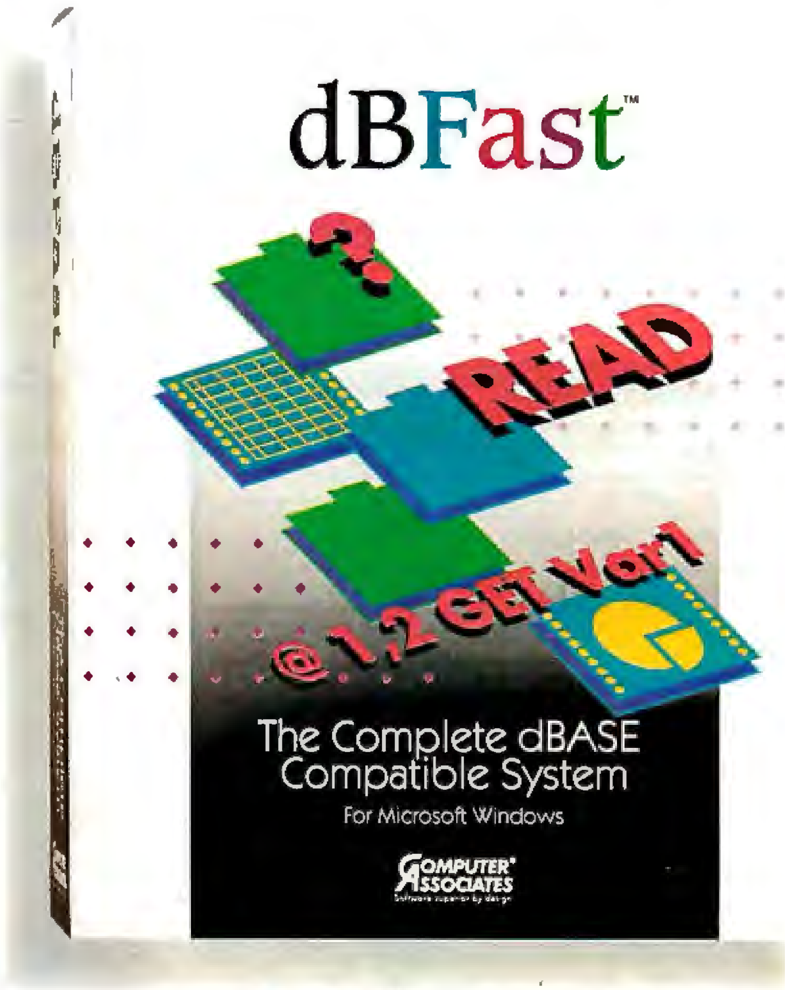


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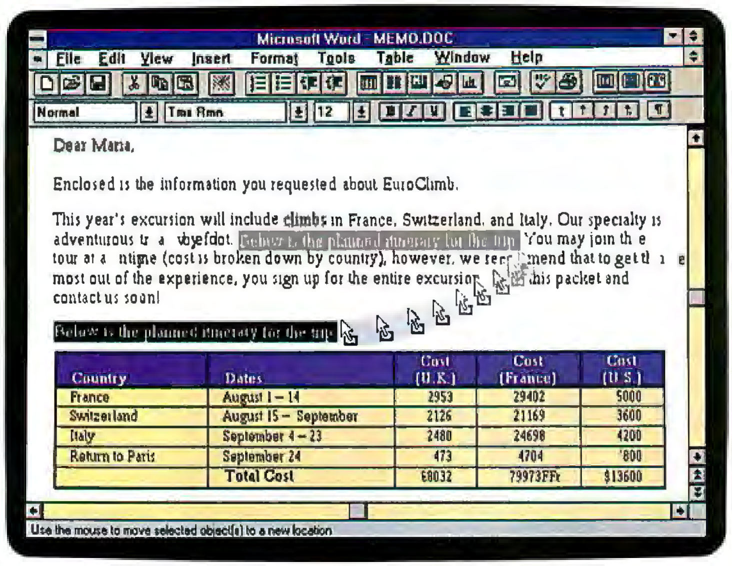


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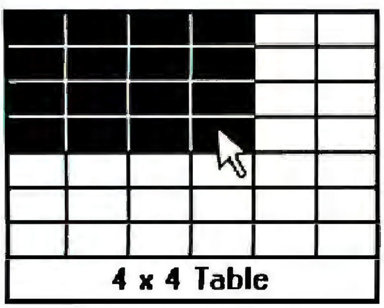


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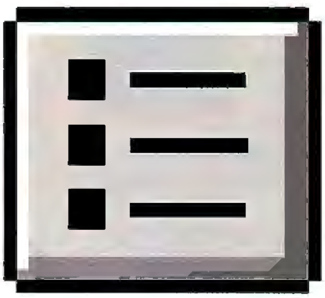

*Click this Toolbar button and get instant bullets.*

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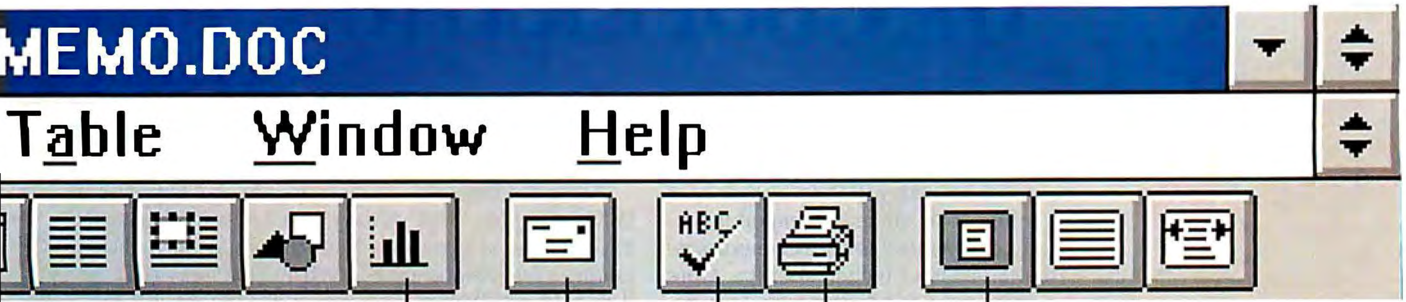


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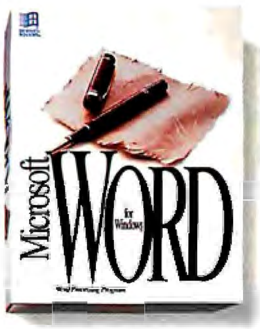


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# EDITORIAL

DENNIS ALLEN

# NEW ERA OF COOPERATION

**The giants IBM and Apple join forces in a milestone alliance in personal computing**

Whether IBM and Apple can succeed with their new venture, the PowerPC, is not nearly as important as the fact that IBM and Apple *have* a joint venture. This alliance is important because it signifies a move toward common systems that can ease the pangs of incompatibility. More than anything else, this joint venture demonstrates a desire by both companies that disparate computers be able to use the same software and information.

For the moment, let's not question if the computer world ought to revolve around IBM and Apple. It does, and IBM and Apple are the hands-down winners for mind-share in this industry. Other alliances between other companies have come before, but none with so much fanfare. No other two companies have heretofore taken such diametric stands in the market. That IBM and Apple found a reason to cooperate on any scale means something.

Consider how corporate America computes today: Most office workers have DOS systems on their desks, the art and creative departments have Macs, the technical and engineering departments have Unix-based workstations, and accounting uses the company's mainframe. The realized promise of "connectivity" has become a large and intricate patchwork that even rocket scientists don't fully understand. Just try to make DOS systems, Macs, Unix-based workstations, and mainframes talk to one another at your company. It isn't easy, and you may go nuts trying.

You don't have to be a rocket scientist, though, to figure out that all those systems could be more useful if only they could share information. This computing synergy is more than just likely—it's inevitable. The divisions and departments of a business must work together to compete in a global market. And that's the driving force behind the IBM and Apple alliance.

Why it took so long for IBM and Apple to do something I'll leave for the Harvard School of Business to answer. For now, what matters is that these two companies have recognized the need, albeit on a relatively small scale, for computers—and computer companies—to cooperate.

What all this means is that we can look forward to networked computers that are truly networked. The power of a single desktop computer will be the sum of all the computers on the network. In short, the network will be the computer.

As for the PowerPC, it pools the diverse expertise of IBM and Apple. IBM's prowess in hardware design and development is legendary. Yet, IBM's success in the operating-systems-and-user-interface arena has been underwhelming. Apple's success, on the other hand, is directly tied to the efficient and friendly Mac operating system and user interface. The first PowerPC may not fully exploit these strengths, but we should expect more if this joint venture continues. Also consider the Motorola factor: That company's CPU ship technology and potential should not be overlooked.

Of course, the IBM and Apple venture is not the final solution, and only time will tell if the PowerPC is even *part* of the solution. The IBM and Apple alliance is, however, a milestone, and it represents a tearing down of a wall that has separated the two largest blocs of personal computers and users. Moreover, the IBM and Apple alliance ushers in a new era of cooperation in the computer industry.

### The State of BYTE

I feel privileged and honored to take the role of BYTE's new editor in chief. BYTE's readers are the most influential and demanding computer users and buyers in the world, and the relationship that BYTE has with its readers is unlike that of any other magazine. You've come to expect a lot from BYTE: fairness in reporting, in-depth and objective product reports and reviews, and clear explanations of the technologies that affect how you use your computer and make purchasing decisions.

In short, you've recognized BYTE as *the* authority of the personal computer industry. That's no wonder, given the considerable expertise of the BYTE editorial staff. Nowhere in the world is there a more experienced group of computer journalists than at BYTE. Their backgrounds vary from writing and editing to designing pen-input systems to developing databases and applications software to programming for the space shuttle, and to more individual experience than can be listed here.

What you can expect in the future is more of BYTE's authoritative voice to separate truth from marketing hype and to put all this computing technology into a usable perspective. Leading BYTE's efforts to meet your expectations will be exciting and, I'm sure, challenging.

*—Dennis Allen*
*Editor in Chief*
*(BIX name "dallen")*

# Introducing Borland's ObjectVision 2.0 Instant Business Software!

New ObjectVision™ 2.0 is the easiest way to create your own Windows software applications. Fast. In fact, if you own Windows, you need ObjectVision to build software that is custom tailored to your specialized job or process. And ready-to-go applications are even included free, making it easy to get started.

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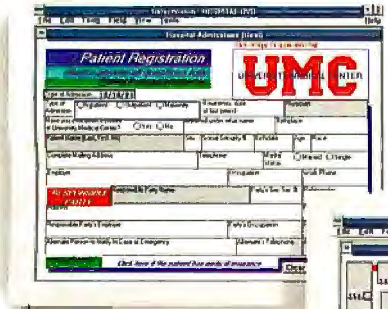


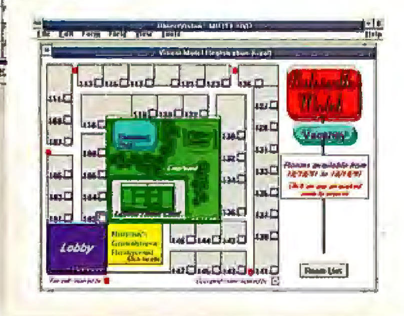


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# Why your next should be a

By now, you're probably aware that an Apple® Macintosh® personal computer was designed from the very first chip to work the same, intuitive way that you do.

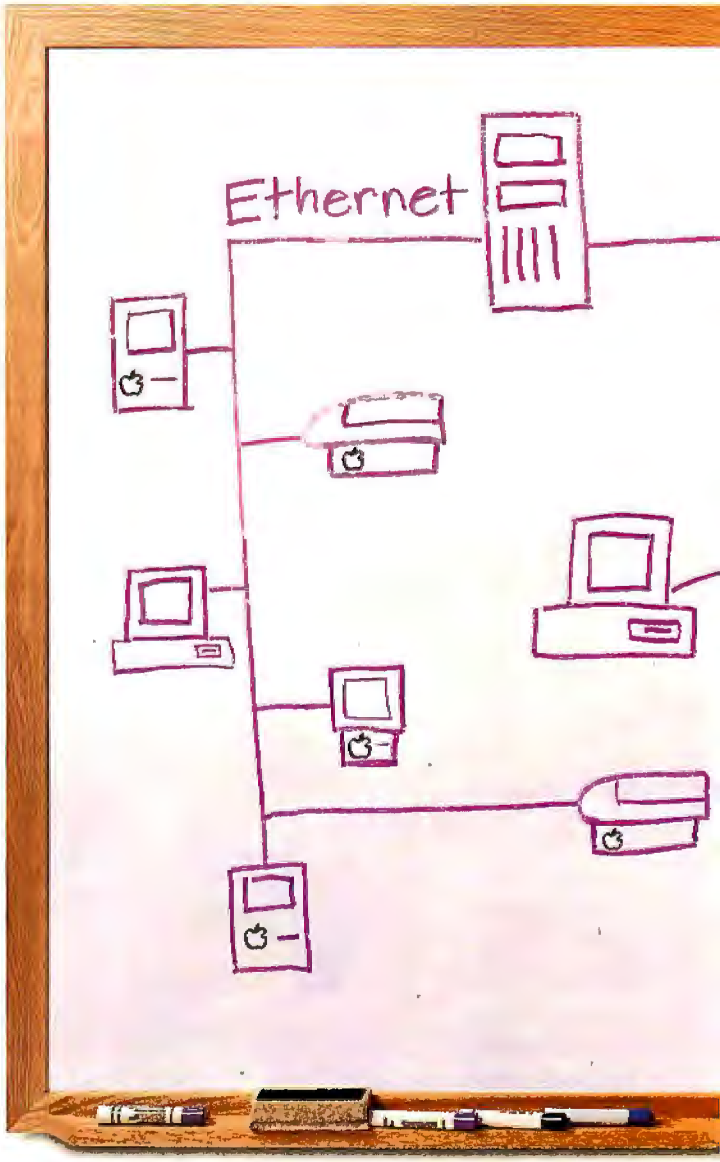
What you may not know, however, is that a Macintosh was also designed to work with other personal computers. Including the MS-DOS PCs you already own.

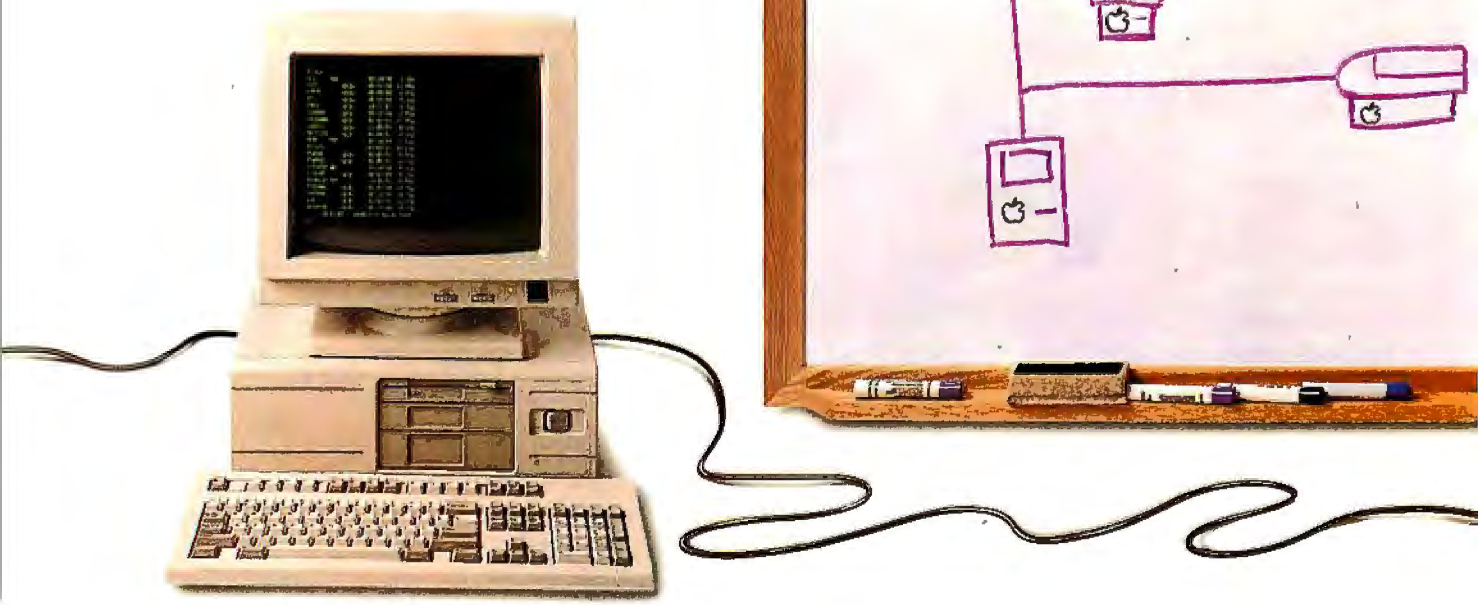
In fact, Macintosh is the only family of personal computers to offer built-in networking and file sharing as standard equipment.

You can use a Macintosh to access almost any mainframe, minicomputer or workstation. Including IBM, DEC, Hewlett-Packard, Prime, Cray and Sun.

You can also access resources such as network file servers and mainframe sessions simultaneously. And then cut, paste and move files between them. (Try doing that on an ordinary DOS computer.)

You can even easily connect a Macintosh with any



# DOS computer Macintosh.


industry-standard Token-Ring or Ethernet network. And share files and printers over Novell NetWare, Banyan VINES, IBM LAN Server or Microsoft LAN Manager networks.

Best of all, only Macintosh offers a single, consistent, intuitive way of accessing and working with information, no matter what computer it's located on.

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# LETTERS

## LAN Champion

Congratulations to Wayne Rash Jr. on his excellent article "Defending Your LAN" (October 1991). I know how much effort it took me to come to practically identical conclusions. His article will save a lot of effort for people who are involved in planning and designing LANs. Other articles by Rash have also been very good, but this one is the best summary of this kind I have seen.

Paul Hofer
*Zurich, Switzerland*


## Looking at *Outlook '92*

I greatly enjoyed *Outlook '92* and would like to add some observations to the discussion of business wish lists and productivity.

We don't need software with more never-needed features. We need software with better information about how it works. Wonderful examples that come to mind include the brief but lucid descriptions of extended and expanded memory that accompany Intel's AboveBoard products and Quarterdeck's memory management software.

Users want to be comfortable with software in the way that they are with Lotus 1-2-3. Although most new spreadsheets outperform 1-2-3, users have remained loyal because they have finally (after years of use) achieved unity with the software. It has become an extension of themselves and no longer requires a conscious, arduous effort to use. Lotus has maintained this gemütlichkeit by retaining its menu-bar interface painstakingly across upgrades, including the new Windows version. This stability has made Lotus 1-2-3 a trustworthy product.

Ernie Leute
*Marlboro, NJ*

In "Are On-Line Services Delivering?" (*Outlook '92*), the considerations relevant to delivering services to customers were well developed. However, the article ignored completely the real question of access, a major consideration for many Americans who live outside urban areas.

Access is merely a matter of on-line costs to those who live where a local phone number allows unlimited access to information services. It is quite another matter for those who live outside those areas. The combined cost for telephone service and on-line service makes personal use prohibitively expensive. Business users in rural areas are also well aware of the added expense they incur, particularly when they might want access during prime time.

I know of no on-line service that has provided equal access to rural customers. If one existed, I would be among the first to subscribe.

Don Messenger
*Beryl, UT*

Your technology forecast (*Outlook '92*) was one of the more interesting issues of the year. It reinforced my opinion that Alan Kay is one of the few people who truly see (and have seen) the future of computing accurately. If his call for the use of "agents" does not come to pass, we may become inundated with information. At times, too much information is worse than too little, as it can lead to indecision when a decision is time critical.

Len Gaska
*Pasadena, CA*

## Give OS/2 a Chance

I want to thank Jerry Pournelle for bringing so many interesting facets of personal computer technology to light. I cannot tell you how pleased I am to see that he and others at BYTE have recently begun to focus more attention on reliability and quality in software. Over the past several years, I have seen many PC users increasingly plagued by problems.

Here at JPL, rebooting a DOS-based system several times daily is typical. Most of those in the area where I work are engineers who use compilers, word processors, graphics programs, and network software to connect with a mainframe computer. I am certain that there is a serious loss of productivity due to the inadequacies of DOS.

Last year, I became so annoyed with the situation that I set about the task of finding a solution. What I found was OS/2. Having used the system for over a year, I can tell you that it is rock solid. True, OS/2 has had problems. The print drivers didn't always work properly, and there has been precious little applications software. However, these problems are not fundamental—they are solvable problems. In fact, practically all the problems with the current 16-bit version of the system have already been fixed.

More significant is the fact that the current version is only a 16-bit system and does not fully utilize the 386 hardware. It appears that this problem will be redressed shortly. The upcoming 32-bit OS/2 promises to be everything that Windows should have been.

I urge Jerry to try OS/2 on some programs, such as Aldus PageMaker, that put multithreaded programming techniques to good use. It's really quite impressive. Fair warning, though. The current version (1.3) is not entirely satisfactory in that applications software is still a mite scarce and the DOS box, while good, can be taken hostage by network drivers.

*continued*

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."*

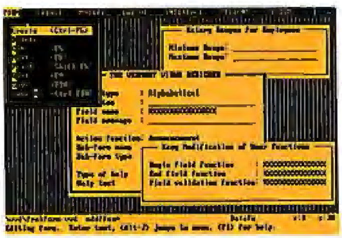
*Your letter will be read, but because of the large volume of mail we receive, we cannot guarantee publication. We also reserve the right to edit letters. It takes about four months from the time we receive a letter until we publish it.*

# We slash interface development time across DOS, UNIX, XENIX, VMS...
## (and we can prove it!)

### *C-Programmers:* See for yourself how Vermont Views™ can help you create powerful user interfaces—whatever your environment!

If you want to create sophisticated user interfaces—and save *tremendous* time and effort doing it—Vermont Views is exactly what you need.

Vermont Views isn't just a common interface package. It's a deep, flexible, menu-driven screen designer supported by a C library of over 550 functions. It lets you create the ultimate user interfaces for complex database applications—in a fraction of the time it would take to code them yourself!



With Vermont Views, you create screens *interactively*. Designing is fast, and creative. And changes—both tiny adjustments and huge reworks—are incredibly easy.

Pull-down menus, window-based data-entry forms with tickertape or memo fields, scrollable form regions, choice lists, context-sensitive help... All these interface objects (and more) are immediately accessible. And with Vermont Views, even terminal-based applications can have the elegant features usually found only on micros.

### Fast prototypes, faster applications.

With most systems, you have to throw away your prototypes when coding begins. But with Vermont Views, *prototypes become the actual applications!*

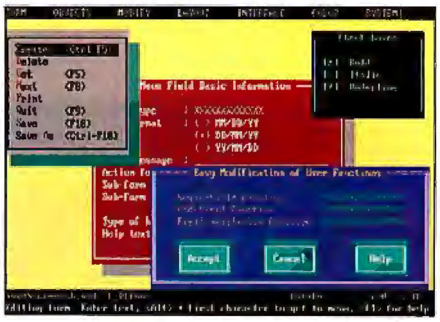
Menus, data-entry forms, and all screen features are usable in the final applications without change. So not only do you avoid creating code from scratch once, you don't have to do it twice!

### It's the universal solution.

Vermont Views operates completely independent of hardware, operating system, and database. Any interface you create can be ported easily among DOS, UNIX, OS/2, XENIX, and VMS.

You can use Vermont Views with any database that has a C-language interface (including Oracle, Informix, db_Vista, and C-Tree). You can run it on PCs, DEC, NCR, HP, AT&T, and other systems. You don't have to pay runtime fees or royalties. And full library source is available, too.

What's more, your DOS applications can have full mouse control, and work in



graphics as well as text modes!

Don't take our word for it—put Vermont Views to the test. Call or fax now for your personal, free demonstration kit. It includes a DOS demo diskette and complete instructions for trying Vermont Views on your terminal, via modem. Or order Vermont Views with our 60-day, money-back guarantee.

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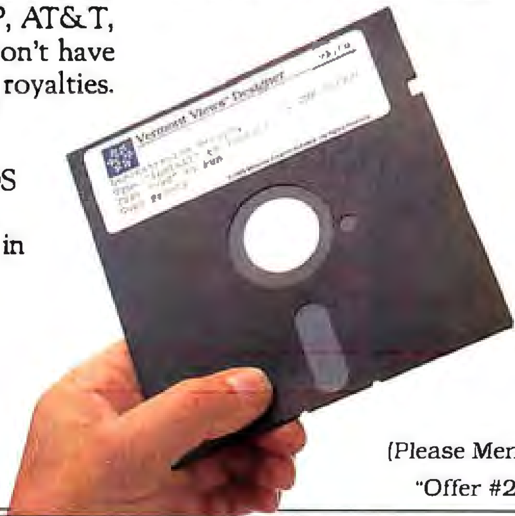


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Thanks to the low-voltage Am386 microprocessors, laptop, palmtop and notebook computer designs will become smaller, lighter, and more powerful than ever before.

With battery life of up to eight hours or more. That's a full day's worth of 386 performance—the per-

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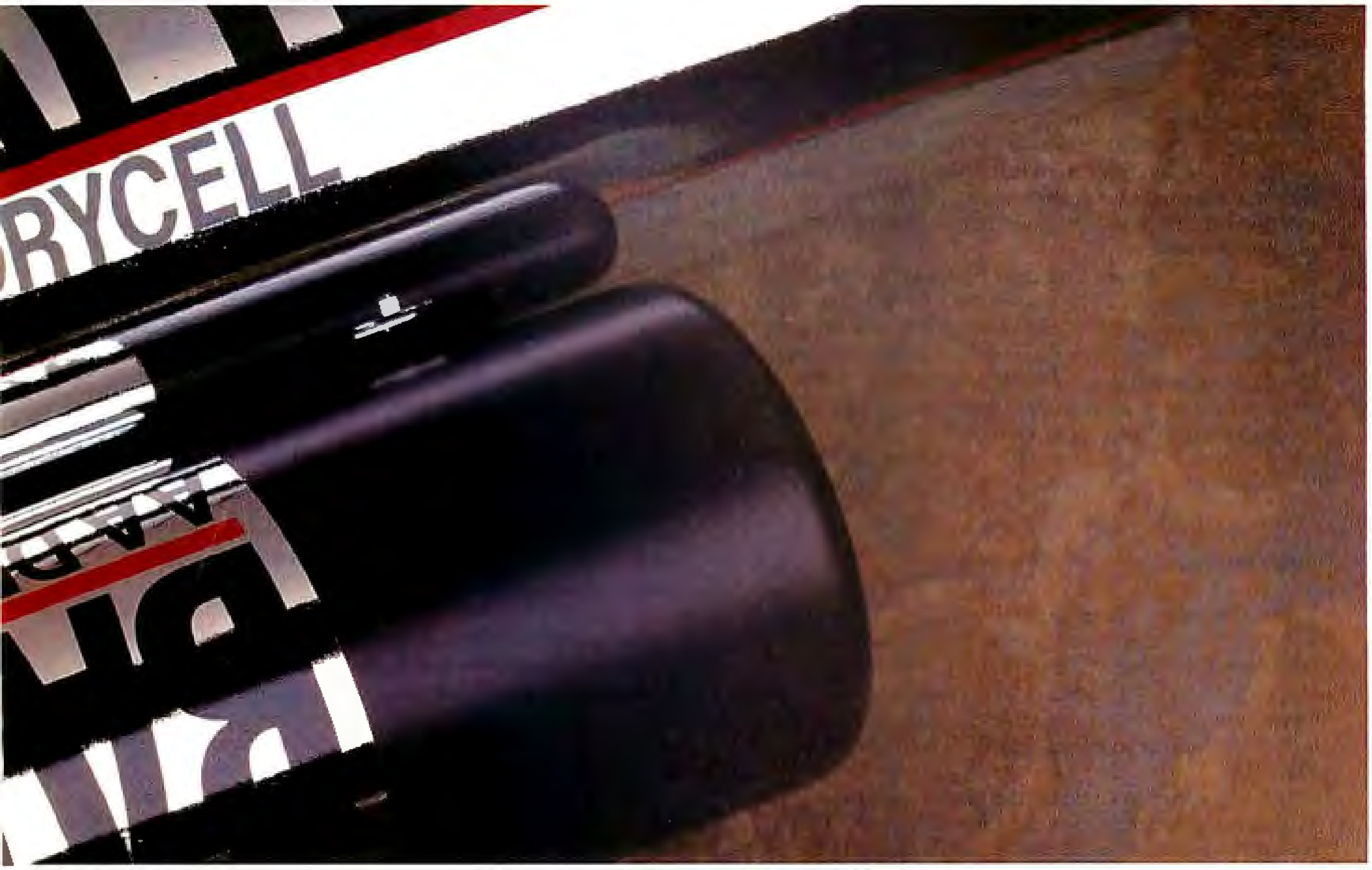

formance you need to run sophisticated applications like Windows™ 3.0.

And rest assured, the low-voltage Am386 microprocessors are proven compatible and comply fully with JEDEC standards for low-power, 3-volt computing. We can even supply you with the 3-volt EPROMs your systems will need. Other 3-volt system logic is also readily available.

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Nevertheless, I can keep the system running almost indefinitely while compiling and debugging computer programs, connecting to a network, communicating over a modem, running a word processor, and using a spreadsheet. And I never hang the computer.

Richard E. Hodges
Jet Propulsion Laboratory
*Pasadena, CA*

### Computer Conferences

I was pleased to read "Getting Groups on Schedule" (September 1991). However, you didn't take aim at the real problem: Where is the computing power in the meeting room?

Directly linked to corporate needs today is the requirement to connect computer technology with meeting management. With a firm grasp on tradition, corporations tend to create an effective "bottleneck" of information prior to a meeting. High technology prepares materials and organizes conference logistics. But once the meeting is under way, it is guided by traditional tools such as the flipchart.

I recently witnessed a meeting that was completely aided by a computer. The excitement I felt at the meeting was curbed only by the present lack of information on this subject. In keeping with BYTE's ability to maintain a sharp eye on new ideas, a follow-up article on the involvement of computers in meetings would, in my opinion, benefit many of your readers.

Christine A. Sudore
*Rochester, NY*

### More on OSI

Barry Nance's "Interoperability Today" (November 1991), while presenting some very good information, contained some technical errors. After his discussion of the Clarkson packet driver, Nance got some of the Open Systems Interconnection levels confused, particularly when he was comparing TCP/IP with Novell's SPX/IPX.

IPX and IP serve virtually the same function and exist at the network layer of the ISO-OSI model. They both provide internetwork routing and a global internetwork address space.

Nance seemed to indicate that IP is a session-layer protocol, which is incorrect. TCP and SPX are both transport-layer protocols. SPX is a sequenced packet protocol while TCP is a reliable byte stream protocol. The difference has more to do with how data is presented to the application. Both are reliable end-to-end protocols that work on top of an unreliable internetwork protocol.

Nance also got RPC confused and placed it at the transport layer. RPC is an application-layer protocol. It provides a machine-independent way of looking at data objects and translates from one machine architecture to another. RPC uses XDR, which is a presentation-layer protocol that Sun RPC (one implementation of RPC) runs over either TCP or UDP transport. There is nothing inherent in the design of Sun RPC that would keep it from running on top of any other transport protocol.

Nance also confused SPX and put it at the session layer. SPX is a transport-layer protocol. The interface to SPX is at the session layer.

Smoot Carl-Mitchell
*Austin, TX*

*You're absolutely right: I should have been a bit clearer about IP, TCP, IPX, SPX, and NetBIOS. IP is somewhat like IPX, and SPX is somewhat like NetBIOS. RPCs fell into the transport-layer discussion just because I wanted to talk about transport-layer independence, which RPCs depend on heavily.*

*Comparing existing protocol stacks to the OSI model is something like comparing apples and oranges. Some people will see the similarity in the geometries of the objects while others will focus on the differences in the textures and the colors.*

*Until companies actually start using OSI, though, comparisons like the one I made are going to be fuzzy around the edges. And that was my main point: We are quite a distance away from the level of interoperability that vendors are claiming for their products.*

—Barry Nance

### Good Viruses?

A small controversy has arisen over so-called beneficial computer viruses. This class of software consists of reproducing programs (REPs) that perform useful functions, such as clearing your system of destructive viruses or updating versions of spreadsheets.

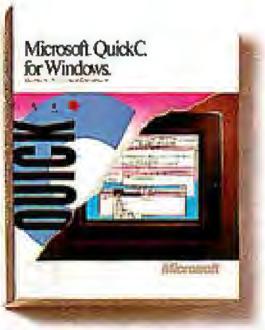
Unfortunately, even when the intentions of the REP's creator are honorable, many things can go wrong with viruses of any sort. I would like to suggest that the following procedures be adopted by anyone who creates self-promulgating algorithms.

1. In addition to the standard DOS or system directories, a REP directory should also be kept. All REPs should be programmed to copy themselves into this directory. For convenience, the REP directory could also be divided into subdirectories such as mail, updates, and miscellaneous.
2. Because REPs are limited to one spot on the hard disk, they can, at installation, check to see if a copy already exists. That way, people won't end up with a thousand copies of a program, which potentially can happen with viruses.
3. Before any copying can be done, the REP must explain what type of program it is, its purpose, who programmed it, its origins, its size, and other important details. It should then ask permission of the user before copying itself into the system.

Because REPs reproduce themselves openly, it might be wise to remove program reproduction control entirely from REPs and give the job to an outside receiving program. Then viruses wouldn't be able to move directly onto your hard disk except through this receiver.

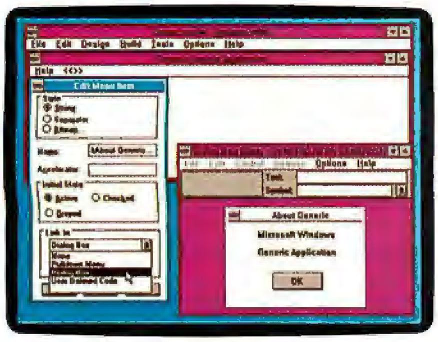
If you are a programmer who wants to experiment with "beneficial viruses," I urge you to do so. Just be very careful in your undertaking. ■

Nathaniel I. Schiffman
*East Brunswick, NJ*

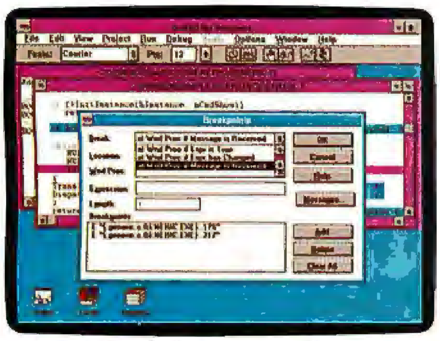



MICROSOFT SOFTWARE DEVELOPMENT TOOLS

# Graphic proof that developing Windows apps is now easier.



*Use QuickCase:W to draw the graphical elements of your Windows program, from menus and dialog boxes to cursors and icons. Then, let QuickCase:W generate commented expert-level C source code for the design that you've created.*



*QuickC for Windows supports a wide range of breakpoint types, from breaking at a location to breaking on a Windows procedure when a message is received.*

Take a look at Microsoft® QuickC® for Windows™.

It's Windows-hosted, so you can edit, compile, and debug inside a single environment. Click on the Toolbar™ to choose frequently-used functions, from changing fonts to setting break-points. Workspace templates let you save your screen layouts, so you can reload them quickly from another session.

Plus, a remarkable tool known as QuickCase:W lets you create every element in your user interface with a few strokes of a mouse. Then it automatically generates the C source code you need.

All of which lets you create more applications. And more kinds of applications: C programs that call Windows APIs, graphical front-end programs for FORTRAN and COBOL, and C DLLs for other programs.

We suggest a visit to your Microsoft dealer. Because with QuickC for Windows, seeing is believing.



## Key Features

- Windows-hosted integrated development environment including an editor, compiler, and debugger.
- All you need to write a Windows-based program.
- QuickCase:W generates source code from your program design and regenerates the code if you change the design.
- Wide range of breakpoint support, including breaking at a location, breaking when an expression has changed, and breaking at a Windows procedure when a message is received.
- Complete printed and online documentation on the Windows API.
- Toolbar for quick access to frequently used editing and debugging functions.
- Save Workspace and Load Workspace for saving and restoring window positions and breakpoints.
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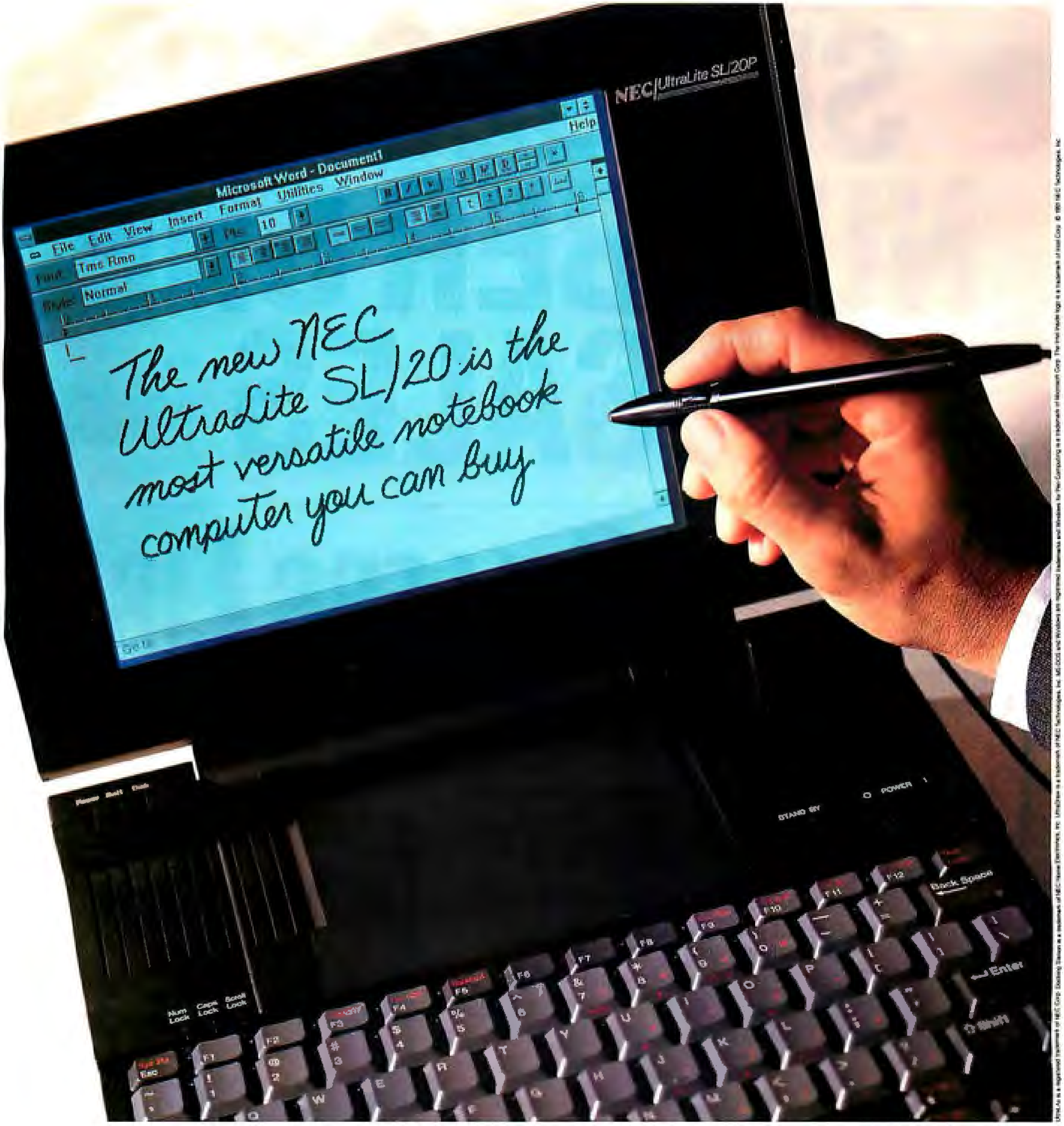
- QuickWin library for converting well-behaved C programs for DOS to Windows programs.
- Generates Windows Executables, Windows Dynamic Link Libraries, QuickWin Executables for the Windows environment, and MS-DOS® Executables.

## PROGRAMMER'S TIPS

- *To rebuild your character-based DOS applications to run under the Windows environment, select the "QuickWin EXE" Project type in the Options menu.*
- *Use the new and improved Dialog Editor to quickly and easily design dialog boxes for your programs.*

**Microsoft**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# NEWS

MICROBYTES

## Apple's QuickTime to Make Its Mark This Year

QuickTime, the Apple protocol for the handling of time-variant data such as animation and video, is conceptually interesting, but not much has been available for users to evaluate what all the excitement is about. With Apple gearing up to make QuickTime generally available at January's MacWorld Expo in San Francisco, the mainstream of users should get a firsthand look at what was reportedly one of the technologies that most intrigued IBM executives when the two companies began talking last summer about their historic partnership.

Apple developers have had alpha and beta versions of QuickTime available to them since last May. WordPerfect and Acius announced last August that their products will be revised to support QuickTime *movies* (as QuickTime data is called) embedded in documents. But those revised programs haven't been released yet.

The QuickTime architecture, which requires a 68020 or higher to run, is a scalable one that includes features that are not immediately obvious. Currently optimized for 16-bit color (which is ample for most of the colors in the NTSC video spectrum), the architecture allows data to be displayed with a standard window size of 160 by 120 pixels, or roughly a fifth the size of a Mac screen. The window size can vary, but current Apple-supported compressors/decompressors are optimized for this window size. Smaller windows make the data transfer rates more manageable, which means faster window refreshing.

One of the more flexible features of QuickTime is that movies can contain multiple video and audio tracks so that versions of video data can be optimized for and played back on different hardware platforms. QuickTime's Component Manager checks to see what hardware resources are available and can alter display parameters to best fit the system. The Component Manager also supports multiple audio tracks for different languages in the same movie.

The first QuickTime applications expected to be available are editors that let you create QuickTime movies. Apple has distributed demonstrations of some of these programs with the developer-only beta version of the QuickTime CD. Indeed, Apple distributed HyperCard XCMDs on the QuickTime CD, letting HyperCard serve as a record/playback vehicle for QuickTime.

Most editors (e.g., SuperMac's ReelTime, which was bought by Adobe and renamed Premiere) record and play back data that is compressed/decompressed on the fly. An exception to this is the DIVA Videoshop program, which records directly to a hard disk without compression for postproduction choice of compression. The $595 program can also use image filters from Adobe's Photoshop, as well as its own preset transition libraries, to manipulate video. Other editors are more specialized (e.g., Light Source's VideoSequencerQT, a $595 editor/control program made for recording QuickTime movies on NEC's PC-VCR). VideoSequencerQT is based on MovieTime, a QuickTime editor from Light Source that was present on the developer beta CDs.

Within the next six months, multifunction boards for QuickTime will appear that will probably have a video digitizer/capture function, a compression accelerator, and possibly a VCR controller (à la Sony's V-Box, which serves as an interface between computers and Sony consumer products, or Light Source's application for NEC's PC-VCR). Such a board would allow for larger movie displays without the performance hits. You can also expect "content providers," such as Disney, Warren New Media, and ABC Interactive, to make waves in the QuickTime field.

QuickTime is an exciting technology for those who have the required hardware to support it, especially memory and hard disk space. Apple hopes that QuickTime will "raise the bar" on what is expected of personal computing.

—**Larry Loeb**

### NANOBYTES

Following an investigation into the acts, policies, and practices of China with respect to the protection and enforcement of intellectual property rights, the Bush administration made public a list of **Chinese products** that may be subject to punitive **tariffs**. A spokesperson for the U.S. Trade Representative said that the administration picked products that would least affect U.S. consumers and manufacturers. The full list of products is extensive and includes petroleum products, textiles, and electronic instruments. China was negotiating with the U.S. to solve the problems, but the talks stalled. China can still negotiate a settlement before the 30-day public comment period expires. □

A **U.S. District Court in Texas** has denied **Intel's** preliminary injunction to enjoin **Cyrix** from selling its family of high-performance math coprocessors. Judge Paul Brown of the District Court for the Eastern District of Texas in Sherman ruled that—at the preliminary injunction stage—Intel has not met its burden of establishing that parts manufactured for Cyrix by SGS-Thomson violate a cross-licensing agreement between SGS-Thomson and Intel, nor that the parts infringe on an Intel patent. (Intel filed the federal-court injunction seeking to prevent Cyrix from selling its FasMath coprocessors last May.) □

**ParcPlace Systems** and **Servio** say that they will cooperatively integrate and market their products by joining ParcPlace's Objectworks\C++ and Servio's GemStone object database management system. Applications created with Objectworks\C++ can now store and manage persistent C++ objects within GemStone. □


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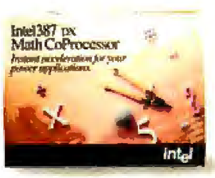


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## Microsoft Gets Closer to DEC

Microsoft needs a big three-initial company to help put Windows on the corporate desktop, and now that the software giant has broken up with IBM, DEC seems to be the replacement. Two weeks after DEC announced support for Windows, saying that the Microsoft environment would be integrated into DEC's enterprise systems, Microsoft returned the favor.

At DEC's introduction of new Mips processor-based RISC products, Microsoft demonstrated the forthcoming Windows NT operating system running on DEC's new Personal DECstation machines. In an understatement, Paul Maritz, vice president for advanced operating systems, said, "We have been working to adapt NT to the DEC workstation line." Maritz went on to list the milestones in what he called "the Digital/Microsoft partnership": their common membership in the Advanced Computing Environment (ACE) Initiative; DEC as the largest OEM (via Pathworks) for Microsoft's LAN Manager; DEC's TeamLinks for Windows; and now, the implementation of Windows NT on DECstations.

Microsoft says that it expects to have a "broad" developer's release of NT for RISC in the first half of this year, with a general customer release to follow in the second half. A developer's release of NT for Intel platforms is already shipping.

Significantly, The Santa Cruz Operation's Open Desktop was not part of the formal program at the DEC event. SCO's Scott McGregor, vice president of general-business units, was mentioned as a participant, but his name was not listed on any of the presentation slides, and he did not appear on stage. When asked afterward why SCO's ODT was not featured, McGregor said that "Microsoft is better-pressed." (In other words, Microsoft gets more attention from the press.) McGregor also said that "Digital has a coup in getting NT running on its platform."

DEC has previously touted the advantages of SCO's ODT as the ACE Initiative operating system of choice. DEC is working on the ODT kernel and also has a financial stake in the ODT operating system. When asked about a possible shift in DEC's emphasis from ODT to Windows NT, McGregor made an apparent reference to Apple and IBM, saying that any shift "may have more to do with other large companies than [with DEC's] relationship with Microsoft."

A DEC official said that the company has an excellent relationship with SCO but added, "Clearly, there are two markets we're looking at."

**—Ellen Ullman**

## IBM Details Reorg, Makes Units Autonomous

After weeks of rumor and speculation, IBM announced that it will reduce its worldwide work force by about 20,000 employees and will reorganize to offer more independence and autonomy to its operating divisions. Part of the reorganization involves the creation of a new Entry Systems Technology organization that is intended to speed up the development of personal computers.

The sweeping changes will involve creating new business units from some of IBM's existing product lines. The company's high-end printers and printing services will now be handled by a wholly owned $2 billion subsidiary called Pennant Systems (Norwalk, CT). IBM's $11 billion in storage products, including disk, tape, and optical subsystems, will become a "line of business" based in San Jose, California. The company's hiring and recruiting needs will be fulfilled by a subsidiary called Employment Solutions.

Wherever possible, IBM will allow its new units to operate like stand-alone entities. Employment Solutions will be able to market its services to other companies, while IBM marketing and services companies will be encouraged to "provide integrated offerings from among the best products, services, and technologies from across the industry, including non-IBM products if required."

The financial results of individual units will be disclosed to the public, and each unit will be permitted to implement management and measurement systems that are appropriate to its line of business, rather than those dictated by the central IBM organization. To keep all these disparate organizations working together, IBM will establish an executive steering committee to coordinate the efforts of the enterprise systems, storage products, networking products, programming systems, and technology products of all the individual units.

**—Andy Reinhardt**

### NANOBYTES

In a move to enlarge its user base of professional tax preparers, **ChipSoft**, publisher of **tax preparation software** for the Mac, Windows, and DOS, purchased the assets of **Park Technologies**, including TaxEase for DOS. According to a ChipSoft spokesperson, current customers of Park Technologies (Clifton Park, NY) will be transferred to ChipSoft products. □

**Phoenix Technologies** says that it is working on a **PostScript Level 2**–compatible version of its PhoenixPage PostScript interpreter. It also says that the interpreter will be a fully compatible emulation of the interpreter in the current Apple LaserWriter IIg printer. Phoenix says that it is on its way to achieving Level 2 compatibility and has integrated extensions for composite fonts, the CMYK (cyan, magenta, yellow, black) color model, advanced color halftoning, compatibility with the Adobe Type Manager font system, and better disk management. □

**GenRad** and **Tokyo Electron, Ltd.** have combined forces to create a new test and measurement system for LCD substrates that the two companies say could reduce the overall cost of color portable computers. According to a GenRad spokesperson, GenRad and TEL jointly developed the GTS-1 system to solve the problem of extremely low yields and consequent high-production costs of LCDs. With the GTS-1 LCD Test and Measurement System, thin-film-transistor LCD manufacturers will be able to detect, locate, and diagnose faults on TFT glass substrates, or foundations, he said. □

**Borland International** has had discussions with Apple and is "trying to work out a **coherent database strategy** on the desktop," Borland CEO Philippe Kahn said. However, he also said that discussions were in the preliminary stage. □

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## McCaw Cellular and Oracle Announce Data-Broadcasting Venture

McCaw Cellular Communications and Oracle have announced that they will develop and test a new form of high-speed data-broadcasting technology that promises cost and performance improvements over existing data distribution methods, such as ISDN or modems. The technology will also allow the point-to-multipoint transmission of any digitized data to approach speeds today offered only by expensive satellite transmission and high-speed leased-line configurations.

The service is intended for use by businesses and individuals. McCaw and Oracle are looking to provide a more economical way of distributing news, stock quotes, financial data, and weather maps. The companies claim that the technology will also make applications such as the electronic distribution of documentation, the inexpensive delivery of computer software, and the communication of fax and E-mail traffic in laser-print quality economically viable. Other potential applications include the distribution of music, photos, directories, reference books, and marketing information.

Given McCaw's participation in the venture, it's not surprising that testing will initially be on the company's cellular frequency. However, the partners will apply for an experimental license from the FCC to test data broadcast technologies in the 1.85- to 1.99-GHz bandwidth. The companies claim that they will be able to deploy the service without disrupting the operations of other spectrum users or existing customers.

For Oracle, already a leader in the data storage and retrieval business, the venture represents a new opportunity in data delivery and distribution. Both firms indicated that it will be several months before the tests are completed and a decision to proceed is reached.

**—D. L. Andrews**

## Network Wires Can Really Sing over Copper

The appetite for network bandwidth is insatiable, especially in image- and digital-video applications. But the cost of buying and installing fiber-optic cable to implement a Fiber Distributed Data Interface (FDDI) network is so high that several LAN hardware companies are now exploring ways to boost data rates over conventional wiring.

The latest player to join the race is Microdyne (Alexandria, VA), which announced late last year a network-interface card that the company says will let conventional IBM Token Ring LANs operate at the FDDI data rate of 100 Mbps. The Microdyne EXOS 505S controller, with a suggested retail price of $1495, is available now in limited quantities for ISA-bus systems. Volume quantities should be available in the first quarter of this year, with versions for the Micro Channel and EISA bus set to follow later this year, the company says.

The difference between Microdyne's scheme and earlier proposals is that the Microdyne scheme layers on top of existing Token Ring LANs. Instead of having to install a $10,000 FDDI hub concentrator and fiber-optic cable, you can attach workstations to an existing $500 IBM multistation access unit (MAU) using standard shielded twisted-pair (STP) wiring and running TCP/IP and the NetWare operating system.

The advantage of the EXOS 505S, says Microdyne president and CEO Phil Cunningham, is that it goes beyond lower costs. Higher data transfer rates move large files around the network faster, and having a greater amount of available bandwidth lets more nodes coexist on the same physical LAN. Whereas a typical Token Ring might have a feasible upper limit of about 250 nodes, Cunningham says, by using the Microdyne network interface, customers will be able to put 500 nodes on the same network without bridges or routers.

Microdyne is not the only company working on ways to boost data rates over conventional wiring. A method to achieve vastly higher network throughput over copper wire was announced last summer by a group of companies known as the Unshielded Twisted-Pair Development Forum. The UDF scheme, commonly referred to as CDDI (Copper Distributed Digital Interface), uses FDDI network protocols and offers 100-Mbps performance over voice-grade unshielded twisted-pair cable, the type found in offices and used for telephones. UDF member companies include Apple, AT&T, British Telecom, Crescendo Communications, Fibronics, Hewlett-Packard, and Ungermann-Bass.

continued

### NANOBYTES

**DEC** is preparing to manufacture and sell versions of Microsoft's leading Windows applications that have been improved to support DEC networks and the file formats that its integrated office-systems environment calls All-In-1 uses. According to DEC, the **TeamLinks** line of distributed applications will improve the ability of teams and workgroups to share, retrieve, and display data. The TeamLinks environment is built on PathWorks. As one DEC spokesperson said, the announcement signals the company's willingness to move from its terminal-based, VAX-only time-sharing model to that of client/server computing across many platforms. □

In a related announcement, **Lotus Development** said that it will extend its suite of leading Windows applications to support the TeamLinks environment, including Lotus 1-2-3 for Windows, Ami Pro for Windows, and Freelance Graphics for Windows. □

**Light Source** is developing a program for the Mac II and the NEC PC-VCR video-recording system that allows you to perform frame-accurate video editing. The NEC PC-VCR (see "Computers Go Video with NEC's PC-VCR," September 1991 BYTE) is a VHS VCR that can be completely controlled by a personal computer through the VCR's 25-pin RS-232 connector. Light Source's NEC Video Sequencer allows Mac II users to precisely edit video on a frame-by-frame basis using the computer and two of NEC's PC-VCRs. The Video Sequencer allows you to build video-clip footage into video databases. □

**Farallon** has decided to concentrate its focus on networking. The company has sold its **MacRecorder** sound input digitizing technology and rights to its SoundEdit software to MacroMind/Paracomp. □

# NEC introduces a 486 series that has a built-in survival instinct.

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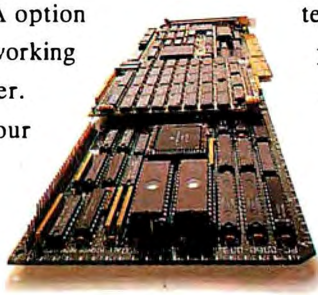

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| | 16 | 4 | 4 | |
| | 64 | 64 | 80 | AST |
| | 112 | 64 | 80 | |
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| | 4GB | 4GB | | Tie |
| | 285W | 240W | 167W | NEC |
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At the time of the announcement, Crescendo vice president of marketing Marleen McDaniel said that CDDI would permit network connections in the price range of $3000 per port, versus the $8000-per-port cost that is typical of fiber-optic FDDI. The key technological breakthrough of CDDI was in its use of an encoding technology called PR-4 that Bell Labs designed into a chip. McDaniel said that PR-4 required less power and operated at a lower frequency than traditional FDDI, which made it possible to run at a blistering 100-Mbps rate over unshielded twisted-pair cabling while still complying with FCC Class B regulations. At about the same time, National Semiconductor and Cabletron proposed a similar standard using data-grade unshielded twisted-pair wiring. This proposal was intended to address concerns about data integrity in voice-grade cabling.

According to Asbjorn Sorhaug, vice president of engineering for Microdyne, all the proposals using unshielded twisted-pair cabling suffer from the potential for unacceptably high levels of electromagnetic emissions. "When you're running at such a high frequency, the cable becomes like an antenna," he said. "In a sense, you're running a radio station, and the FCC doesn't like that." Besides, he adds, it creates potential security problems from electronic eavesdropping.

Another proposal last summer came from a group of companies that includes AMD, ChipCom, DEC, Motorola, and Synoptics. This method also uses 100-Mbps FDDI protocols but specifies shielded twisted-pair to address the RFI problems of unshielded wires. Microdyne says that its new controllers are fully compliant with this proposed specification and even use an AMD FDDI chip; the capability to run through a standard Token Ring MAU is layered on top of the so-called FDDI/STP scheme.

UDF members contend that the problem with using shielded cable is that it isn't nearly as widely installed as unshielded twisted-pair. "If you're going to go to the trouble of installing shielded cable, you might as well put in fiber because it's so much more reliable," says Bill Panepinto, director of marketing for Fibronics. Fibronics has introduced an interim solution, a multiport 10Base-T concentrator that bridges to FDDI, permitting unshielded twisted-pair Ethernet LANs to be inexpensively connected to fiber backbones.

Charlie Robbins, an analyst with the Aberdeen Group in Boston, takes a different view. Noting that STP is widely used in the IBM Token Ring world, Robbins says that he is "intrigued by the simplicity" of the Microdyne product because it requires an existing Token Ring interface card with a new board.

The problem for users is that none of these implementations has yet been standardized. Both the UDF and FDDI/STP groups approached IEEE and ANSI standards bodies last fall, seeking sanction of their proposals, but they were rebuffed. Sorhaug says that he is "fairly sure" that the standards committees will revisit the issue and approve a specification in the future. Notwithstanding resistance from the standards groups, sending data over copper wires will become common.

**—Andy Reinhardt**

## Microsoft to Develop Open Class Libraries

As part of its object-oriented software strategy, Microsoft intends to create and use a group of class libraries that it calls the AFX (Application Frameworx) Class Libraries. The libraries will be part of a total software environment resting on top of the operating system and GUI that will work both as part of Microsoft Windows and as an extension to Windows, the company has disclosed.

Microsoft says that the AFX Class Libraries are not a "closed system," and it intends for other software vendors to use them and their architecture to extend Microsoft Windows. The company calls its current Windows programming tools, which lie directly above DOS and Windows, the "Microsoft Windows Framework and Foundation." The AFX Class Libraries will be the next layer up: Programmers will be able to call them to simplify the work of creating Windows applications. Extensions to Windows, such as those already developed for multimedia and pens, will fit into the same model at the level of AFX Class Libraries. Because this will be an open architecture, Microsoft expects that third-party class libraries will also be added to the Windows environment.

The class libraries will be programmed in future object-oriented languages from Microsoft, such as its forthcoming C++, and perhaps an object-oriented version of BASIC or Visual Basic. ■

**—Owen Linderholm**

### NANOBYTES

**John Landry**, formerly the executive vice president and chief technology officer for Dun & Bradstreet Software Services, has been named senior vice president of software development and **chief technology officer** at Lotus Development. Landry replaces Frank King, who has resigned, and will report to Lotus's president and CEO Jim Manzi. The company has also announced a series of cost-saving initiatives, including an approximate 10 percent reduction of full-time employees, tighter controls over discretionary expenses, and efforts to reduce facilities costs. □

**Solbourne Computer** (Longmont, CO) has reduced prices for its desktop workstations and servers, including a markdown of the **S4000 Desktop Server** to **$2995**. The company says that the S4000 is now the lowest-priced SPARC system on the market, offering $117-per-MIPS price/performance. □

**Nantucket** said at its developers conference in Miami that it is working on two separate projects for Clipper. The company is working on a new version of its DOS-based Clipper development system for mission-critical business applications. The company hopes to eventually release a product based on its Nantucket Future Technology project that will let developers create applications on one platform and then compile and link under several others. Products originating from the new technology will likely be incompatible with today's Clipper and unable to offer acceptable performance running under GUIs. □

While **Borland** gets press on its new Windows-hosted C++ environment, **Microsoft** continues to work on its own C++ compiler for Windows. Stewart Chapin, group product manager for languages at Microsoft, confirmed that the company is working on such a project. ■



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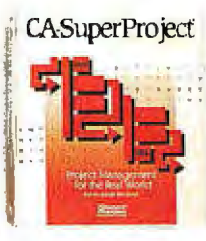


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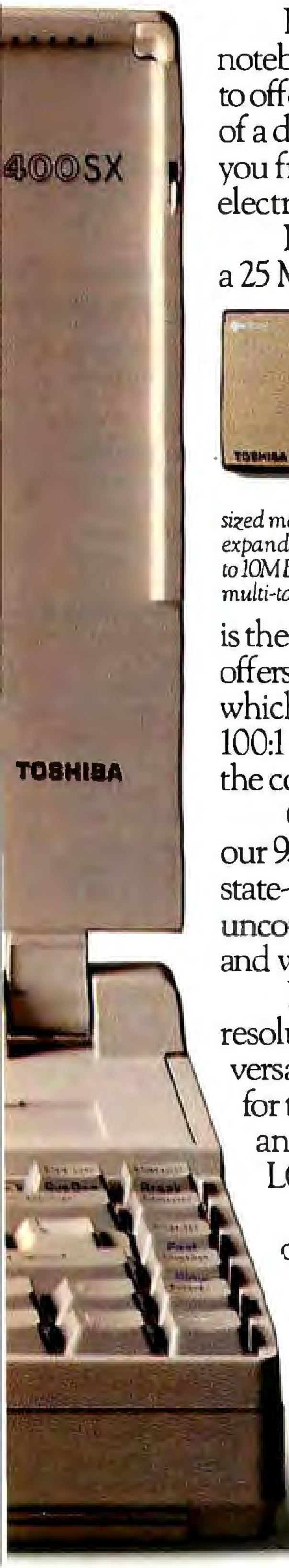


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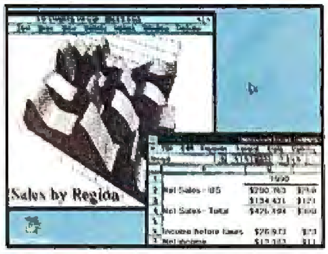


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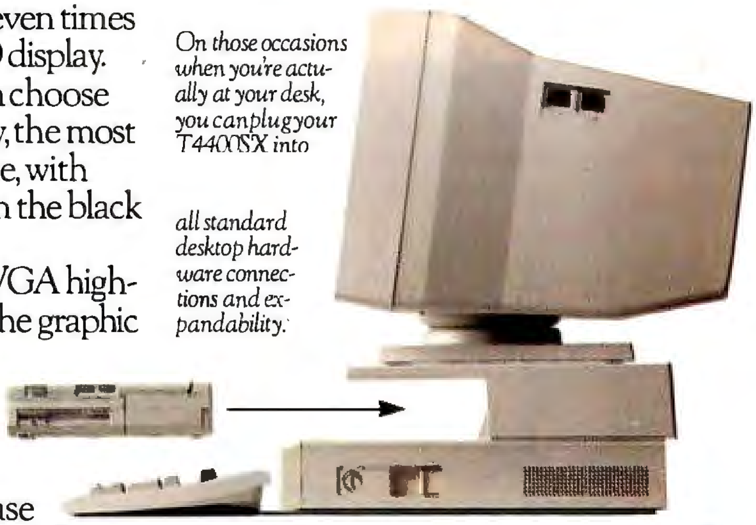

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# Keyboardless Sense

STAN MIASTKOWSKI

**DFM eschews pen-computing fads and makes the TraveLite a practical and cost-effective portable tool**

Is your computing future a keyboardless one? Many companies are betting millions that users will collectively spend multiple millions for pen- or touchscreen-based systems and will relegate their keyboards to the trash heaps of computing history. But hold on a minute. While visions of big bucks dance in the heads of marketing executives, users may have a different idea. Frankly, I'm just not ready to abandon my keyboard for my day-to-day writing and editing chores. What's next? Fred Flintstone's stone tablet along with a hammer and chisel?

Certainly, there is a bright future for keyboardless systems for many vertical markets. (Your UPS driver carries a sophisticated pen-input system right now.) But for many users, systems available now—while interesting glimpses of developing technology—aren't all that useful. They're usually very expensive, and handwriting-recognition software just plain doesn't work reliably yet.

*The DFM TraveLite is designed for on-the-go computing and comes complete with a fitted case.*

## A Unique System

Of all the keyboardless computers that I've seen, a new system from a small company based in West Des Moines, Iowa, is the best example of a truly useful portable computer. The TraveLite from DFM Systems is a unique system whose design and details break away from the conventional wisdom of keyboardless computers. It works, and it costs thousands of dollars less than competing systems.

In the world of computer makers, DFM isn't exactly a household name, but it's not a new company. DFM (originally Dietary Food Management) made a name for itself in the not well-known but large vertical market for dietary management systems in hospitals and institutions. Company officials saw that their clients needed truly portable and easy-to-use systems. The result is the TraveLite, and DFM decided to market it to a larger universe.

The basic TraveLite is a box that measures 5½ by 12½ by 1½ inches and weighs in at 5½ pounds. Inside the box is 2 MB of RAM, a 20-MB hard drive, and (most surprisingly) a 12-MHz 286 processor. In this era where most computer makers make you feel deprived if you have anything less than a 50-MHz 486, why would DFM use what some people feel is a dinosaur of a processor?

There are some very good reasons. A 286 is orders of magnitude less expensive than a 386 or 486, keeping the cost down. Then, too, it draws much less power and requires few support chips. Perhaps most important, a 286 is all that's needed for the kind of application that the TraveLite shines at.

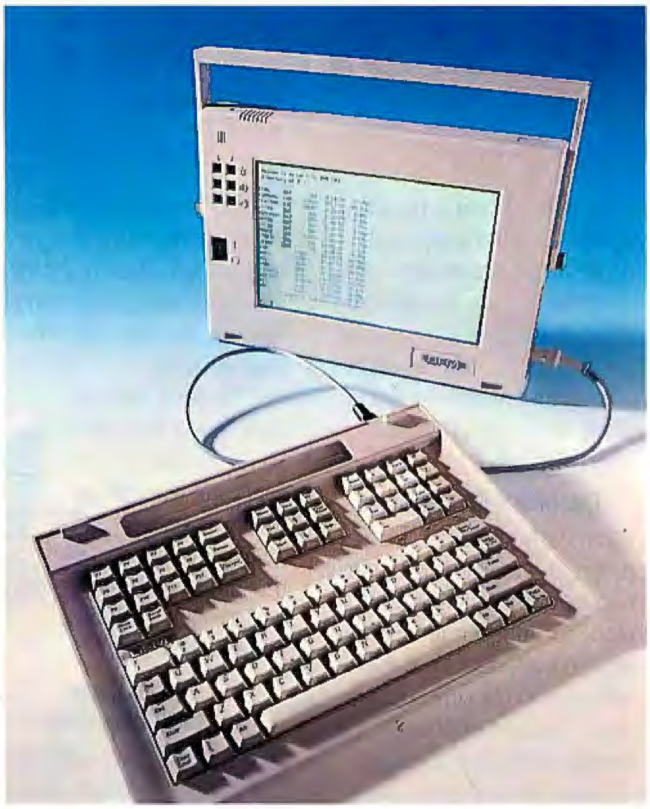
Despite its small size, the TraveLite bristles with ports and connectors. There's a microphone/headset port; serial, parallel, and headset ports; and places to hook up an external keyboard, external monitor, bar code reader, and charger. Also included is a large connector for a future docking unit.

## It's in the Touch

The real heart of the TraveLite's 10-inch diagonal LCD touchscreen. It's your garden-variety cold-cathode fluorescent backlit version, and it's EGA compatible. This is another area where DFM has eschewed conventional wisdom. You simply don't need a VGA-compatible display for the kind of application that the TraveLite is used for. An EGA display system is less expensive to make, and it uses little power.

The touchscreen has 1000- by 1000-pixel resolution. For most applications, a fingertip is all that's needed to do your work. A plastic stylus is included for precision work (e.g., entering characters or drawing).

Perhaps the most surprising and ultimately most useful feature of the touchscreen is that when you touch it, what you might call a "virtual keyboard" appears on the screen. It's a screen image of a standard QWERTY keyboard, which you can type on. Although my initial reaction was skeptical, the more I used it, the more I liked the concept and implementation. It just plain makes a great deal of sense to be able to type what you need on the screen instead of wrestling with a handwriting-recognition program, most of which are finicky.



*The TraveLite's optional keyboard is essential for application development.*

A standard keyboard is available as an option for the TraveLite, but I found that I just didn't need it. Although I wouldn't want to type the Great American Novel on the touchscreen's virtual keyboard, it doesn't take long to get used to it. I used it along with a plain-vanilla ASCII text editor to create a few memos and notes. The on-screen keyboard was all that I needed.

### Doing Some Work

The unit I tested came with a variety of sample programs, including trucker's travel information and paperwork applications and record keeping for doctors and nurses. One fascinating and useful option is voice annotation. For example, a nurse can record voice notes about a patient. A microphone is built into the front of the TraveLite, and comments are digitized and stored on the hard disk.

Most purchasers of a unit like the TraveLite are likely to develop their own custom applications. The unit comes with EazyTouch, a custom development environment. What I found fascinating about it is its range. Even if you're a nonprogrammer, you can easily develop a simple application. For more advanced developers, a library of Microsoft C–compatible library routines access the TraveLite's touchscreen and voice capacities. Even more impressive, you can incorporate a group of BIOS-resident programs that can pop up over the top of any commercial DOS program, letting you use the TraveLite's special capabilities with off-the-shelf software.

The TraveLite doesn't come with a floppy drive, but once again, it's not needed for typical applications. Of course, you do need to get your applications loaded onto the unit's hard disk. You can use the TraveLite's optional built-in modem, but that's a slow way to do it.

DFM has another accessory—TLRemote—that makes the job considerably more painless. TLRemote is a LapLink-like file transfer program that's fine-tuned for the TraveLite. With its serial cable, TLRemote lets you take control of the drives on a remote computer, easily transferring files to the TraveLite.

### Loading Up with Options

Although the basic TraveLite is configured with almost everything you'll need for day-to-day work, DFM will be making a number of options available, including higher-capacity hard drives and faster processors. These will add to the price and will shorten battery life. (The unit I tested ran about 3 hours on a charge.) Also on the horizon is a wireless Ethernet connection and, eventually, true handwriting-recognition software.

With a price tag of $3250 in its base configuration, the TraveLite is less than half the cost of competing units, which seem to be forever aiming at those elusive "power executives" and "early adopters." At that price, it has an excellent shot at being purchased in quantity for a wide range of users. Right now, it's quite a conversation piece, drawing puzzled looks and a small crowd in an airport lounge. But that will change as systems like it become more common.

By integrating tried, true, and reasonably priced technology into an eminently useful package, DFM has done it right. I'm still not ready to toss my keyboard, but I found that the TraveLite grew on me the more I used it. It just could be that this is a harbinger of the next generation of portable computing. ■

*Stan Miastkowski is BYTE's senior editor for new products. He can be reached on BIX as "stanm."*

**THE FACTS**

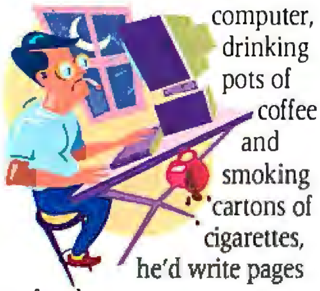
**TraveLite**
$3250; accessory prices not available at press time

DFM Systems, Inc.
1601 48th St.
West Des Moines, IA 50265
(800) 336-5483
(515) 225-6744
fax: (515) 225-0388
**Circle 1210 on Inquiry Card.**

# Why do they call it a dongle?

He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.



It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

### The Most Powerful Program in the World

Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program.

So he sold a few. Only a few.

Back in Boston he waited. After a long year with only 13 orders he set out to see what happened. As he drove across the country and flew around the world he discovered everyone knew about his program. Everyone had it too.

### The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.

Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

### Call It What You Like

He developed a hardware key. His peers applauded his efforts. Finally, a solid solution for revenue protection.

But he didn't know what to call it. He thought of naming it after an exotic place he visited in his travels. Madagascar was a bit too long, though.

"Name it after you, Don!", urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall — the lonely software developer who did what he had to do.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# Macs and PCs: Together at Last

TOM THOMPSON

**The latest version of Farallon's Timbuktu provides remote access and viewing capabilities that span dissimilar computers**

For several years, Farallon Computing's Timbuktu software let Mac users connect to other networked Macs to transfer files and to view their screens. If you had the appropriate access rights, you could even control the remote Mac's mouse pointer and keyboard. In the hands of a network manager who must occasionally guide novice users through basic operations or the corporate network, Timbuktu's remote-control capabilities can be a lifesaver. If you're on the road with a PowerBook or an Outbound Systems notebook, a special version called Timbuktu/Remote lets you control your office Mac via modem.

## Controlling PCs

Unfortunately, for the computing world at large, Timbuktu worked only with Macs. This is no longer the case. An early glimpse of Timbuktu 5.0 shows that it can view or control PCs that are connected to an AppleTalk network and running Windows 3.0. Nor is this capability one-way, because the Windows version of Timbuktu 5.0 lets a PC user view and control Macs.

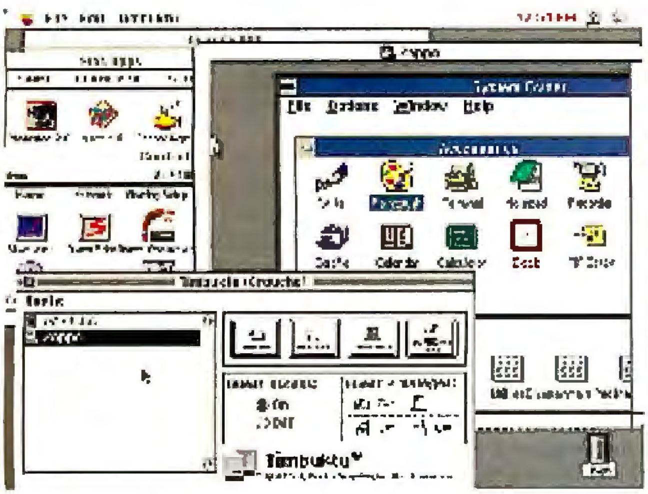
Installation is simple for the Mac. Insert the Timbuktu floppy disk and launch the Apple Installer application. It first lets you choose the target computer's operating system (System 6.0.x or System 7.0), and it then copies the appropriate Timbuktu desk accessory (DA), Timbuktu INIT, and satellite files (e.g., a help file) to the Mac's System Folder.

The Timbuktu INIT allocates memory for Timbuktu's off-screen buffer at boot time and installs patches that intercept QuickDraw's screen graphics operations and relay them to a remote computer. The DA handles access and user preferences. Also, it is what you use to start or stop a remote screen session. The Mac must be connected to an AppleTalk network, either LocalTalk or Ethernet. You reboot the Mac, personalize your software, and are ready to go.

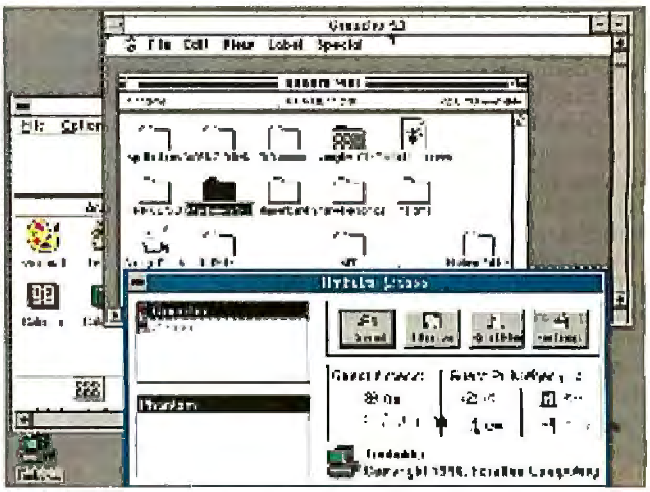
For the PC, you first install a network card that supports AppleTalk. You have a number of cards to pick from: Farallon's own PhoneNet Card PC (ISA bus), DayStar Digital's LT2000 PC Card (ISA or Micro Channel architecture bus), or Dayna's DL/2 LocalTalk Card (Micro Channel bus). For Ethernet, there's 3Com's EtherLink cards (ISA and Micro Channel bus), and there's IBM's Token Ring Network PC adapter (ISA and Micro Channel bus) for use with Token Ring networks. You then install PhoneNet Talk, Farallon's software that implements AppleTalk protocols for PCs.

The PhoneNet Talk software is actually a set of TSR programs that must be run to install the low-level AppleTalk protocols.

*continued*



**Screen 1:** *The Mac version of Timbuktu being used to control Windows. You can operate Mac software and then click on the background window to regain control of the PC when required. The white pointer belongs to the remote PC; the black pointer is the Mac's.*



**Screen 2:** *Not to be outdone, the Windows machine can also control the Mac. Note the similarity of the Timbuktu interface between the two machines. The four buttons, when clicked on, connect you to a remote computer screen or initiate file transfers.*

PhoneNet Talk provides printing and AppleShare (file-server access) services for DOS—handy even if you're not running Windows. If you so choose, you let the installation program modify your AUTOEXEC.BAT file with a set of commands that automatically sets up the AppleTalk connection when the PC boots. Farallon hopes at a future date to closely integrate PhoneNet Talk with the Windows environment as a driver.

Finally, you run Farallon's INSTALL .EXE program inside Windows 3.0 and answer some basic questions, such as to what directory to copy the Timbuktu software, and whether or not you want Timbuktu to load automatically when the PC boots. As with the Mac, once you start the TB2.EXE program and customize the software, you're ready to start.

### My Experience

I loaded a beta copy of Timbuktu 5.0 (Mac version) on a Mac Quadra 900 with 4 MB of RAM, a 160-MB hard drive, a SuperMac Technology Thunder/24 display board, and an AppleColor 13-inch monitor. I also tried it on a Mac IIci with 8 MB of RAM, an 80-MB hard drive, a SuperMac Spectrum/24 PDQ, and a SuperMac 19-inch monitor.

The PC version of Timbuktu 5.0 was installed on a Compaq Deskpro 386/20 with 6 MB of RAM, a 130-MB hard drive, a VGA display, and an ancient Apple LocalTalk PC card, the predecessor to Farallon's PhoneNet Card PC.

As you can see in both screens, Farallon's designers made the Windows interface match the Mac's as much as possible, which makes life a lot easier for those people whose work bounces them between the two platforms. Setting access rights for controlling, observing, or transferring files is simply a matter of clicking on icons in the Timbuktu window.

These four icons set access rights for controlling the computer running Timbuktu. You can arrange passwords that let a guest (remote) user control your computer or only view what's going on. Other passwords let users send files one-way to you or exchange files (two-way transfers). This lets you set up groups or individuals that can perhaps only transfer files, while others can only view your screen, depending on the password you give them.

A master password prevents a remote user from accessing Timbuktu itself and modifying your preference settings or access rights. Once you've selected the zone and target computer (either Mac or PC), clicking on one of the buttons connects you to that computer, to control it, to view its screen (termed *observing* in Farallon's parlance), or to transfer files to or from it.

If you have the memory, a Mac connecting to a Mac (or a PC connecting to a PC) will observe the remote computer's screen in color. A Mac can view Windows screens in color, but as screen 2 shows, PCs observing color Mac screens get only a black-and-white image. Work is being done to correct this limitation, but that's how the early beta software behaves.

If you're controlling the remote computer, you have two pointers present on the screen: your own and the remote's, which dwells in the Timbuktu window. Moving your pointer over the Timbuktu window slaves the remote pointer to the motions of your mouse; moving it outside the window relinquishes control. In situations where the remote's screen is larger than your own (a common occurrence when connecting to a Mac), you can scroll about the remote screen using the Timbuktu's window controls.

Screen updates from one computer to another were sluggish at times, but that's something that can be chalked up to LocalTalk's limited throughput and the overhead incurred translating QuickDraw calls into Windows' graphics device interface and back. Naturally, remote-session operating over Ethernet or Token Ring would perform better.

Interestingly, screen updates from the Deskpro onto the Quadra's display were fast enough to play Solitaire, which is an application that makes intense demands on the mouse and screen drawing. This occurred even though the screen updates had to traverse LocalTalk, a Cayman Systems' GatorBox gateway, and onto BYTE's Ethernet network, where the Quadra hangs out. Apparently, the Quadra's faster processing speed boosts the rate of the screen-translation algorithms.

Trying to control the Quadra from the Deskpro was a tad difficult: The Quadra's pointer tracking lagged the Deskpro's significantly, making clicking and dragging operations tricky. Again, LocalTalk's bandwidth probably is the culprit here. Despite these quirks, the software seems stable enough. There were no system bombs and few Windows unrecoverable applications errors. In the future, Farallon plans to expand Timbuktu 5.0's networking capabilities to work with other PC network cards.

### Is It for You?

Who needs a product like Timbuktu 5.0? Network managers who supervise a network composed of a mix of PCs and Macs will need it. MacFolk in the field who need to do more than print or copy files at the office—the capabilities supplied by AppleTalk Remote Access—will use Timbuktu 5.0 to remotely edit documents and leave messages or run applications that would overwhelm their notebook computers. Because Timbuktu runs over AppleTalk Remote Access, the need for a special Timbuktu/Remote version disappears. Thus, you can now use the same copy of Timbuktu 5.0 for office network control or remote-control access when you're in the field.

Timbuktu 5.0 weaves a new level of interoperability between different computers. Farallon's upgrade lets you sit down in front of one computer—it doesn't matter which one—and simply run another computer's software. Now *that's* cross-platform interoperability. ■

*Tom Thompson is a BYTE senior technical editor at large. He has a B.S.E.E. degree from Memphis State University. He can be reached on BIX as "tom_thompson" or on AppleLink as "T.THOMPSON."*

**THE FACTS**

**Timbuktu 5.0**
Price and availability not set at press time.

*Requirements:*
The Mac version requires a Mac Plus or higher with 1 MB of RAM running System 6.0.5 or with 2 MB of RAM running System 7.0. Color viewing requires more memory. The PC version requires a PC running Windows 3.0 and having a VGA display.

Farallon Computing, Inc.
2000 Powell St., Suite 600
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(415) 596-9100
fax: (415) 596-9020
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FIRST IMPRESSIONS

# Two 600-dpi PostScript Desktop Printers

What's so special about the **QMS-PS 815 MR**? Not much, except its size, its quality, its ease of use, and its PostScript ability. And what's so special about Lexmark's **IBM LaserPrinter 10 Model 30**? Not much again, except its size, its quality, its ease of use, and its PostScript ability.

The Lexmark (an IBM alliance company) printer is a tad smaller at 10½ by 14¼ inches. The 815 MR is a beefier 18 by 25 inches. Both desktop gems come from leaders in the printer field, and both use a proprietary new imaging technology that is similar to the technique used in the Hewlett-Packard LaserJet III. The 815 MR uses a Canon print engine, while the Model 30 uses its own. As for speed, the Model 30 steps ahead with a score of 10 pages per minute compared to 8 ppm for the 815 MR.

If you don't know anything about Lexmark and have never seen its products, it might sound like yet another laser-printer manufacturer producing yet another set of compatible laser printers. But that would be a wrong impression. Lexmark is essentially the printing division of IBM spun off into a separate company. Currently, it makes all the IBM laser printers.

Installing the Model 30 is straightforward. It ships with the toner cartridge in place, and it took less than 10 minutes to set up the basic unit.

Lexmark is justifiably proud of the printer's paper-handling capabilities. It can accept an additional 500-sheet paper tray on top of the 200-sheet tray it comes with. Both can be set to link together. The printer is also designed to print envelopes smoothly without creasing, wrinkling, or bending them.

The 815 MR features a 20-MHz 68020 microprocessor with 6 MB of RAM (expandable to 8 MB), and it comes with 45 Adobe typefaces. The LaserPrinter 10 Model 30, on the other hand, comes with only 1 MB of RAM standard, but it's upgradable to 4 MB when you add a PostScript card. The Model 30 comes with 16 Adobe fonts.

One useful feature of the Model 30 is its ability to accommodate a second paper tray for a total capacity of 700 sheets. The 815 MR comes with only one paper tray; you'd have to upgrade to the 825 MR to use dual trays. Both printers, however, offer plug-and-play ease of use, ease of maintenance, and good print quality. The ability to use plain paper while maintaining near-typeset quality is an added bonus in both printers.

The retail price of the 815 MR is $1800 more than that of the Model 30. This can be justified by features such as switchable resolutions, automatic emulation switching, simultaneous connectivity, and varied paper-handling ability. Resolutions are switchable between 300 and 600 dots per inch, which you can select through software or the front-panel menu. The LaserPrinter 10 Model 30 prints at 300 dpi in its base configuration. When you add the 4 MB of RAM and the PostScript card, it prints at 600 dpi.

A special AI-based sensing technology makes automatic emulation switching possible with the 815 MR, sensing the printer language called for (i.e., PostScript, Printer Control Language, or other emulations). This auto-sensing, when it's coupled with its network capabilities, makes the 815 MR a prime contender for use as a network printer.

The 815 MR has AppleTalk, RS-232, and Centronics parallel interfaces. Its simultaneous interface ability lets you keep all these interfaces active at the same time. The Model 30 can be hooked up to Token Ring and Ethernet networks, or optionally to AppleTalk networks.

Finally, both printers come with a multilingual keypad and an LCD on the front panel that gives you the status of your print job in an easy-to-read format.

These two printers were designed to serve two different needs, and their costs are an indication of this. The QMS-PS 815 MR is a first-class PostScript printer in a small configuration designed to meet the needs of anyone from the lone desktop publisher to individuals in small networked workgroups. For $1800 less, you get business-class PostScript in the IBM LaserPrinter 10 Model 30, which is an example of IBM quality. The printer's add-on PostScript capability offers business users the opportunity to take advantage of basic PostScript quality.

*—Anne Fischer Lent and Owen Linderholm*

## THE FACTS

**QMS-PS 815 MR**
$5495

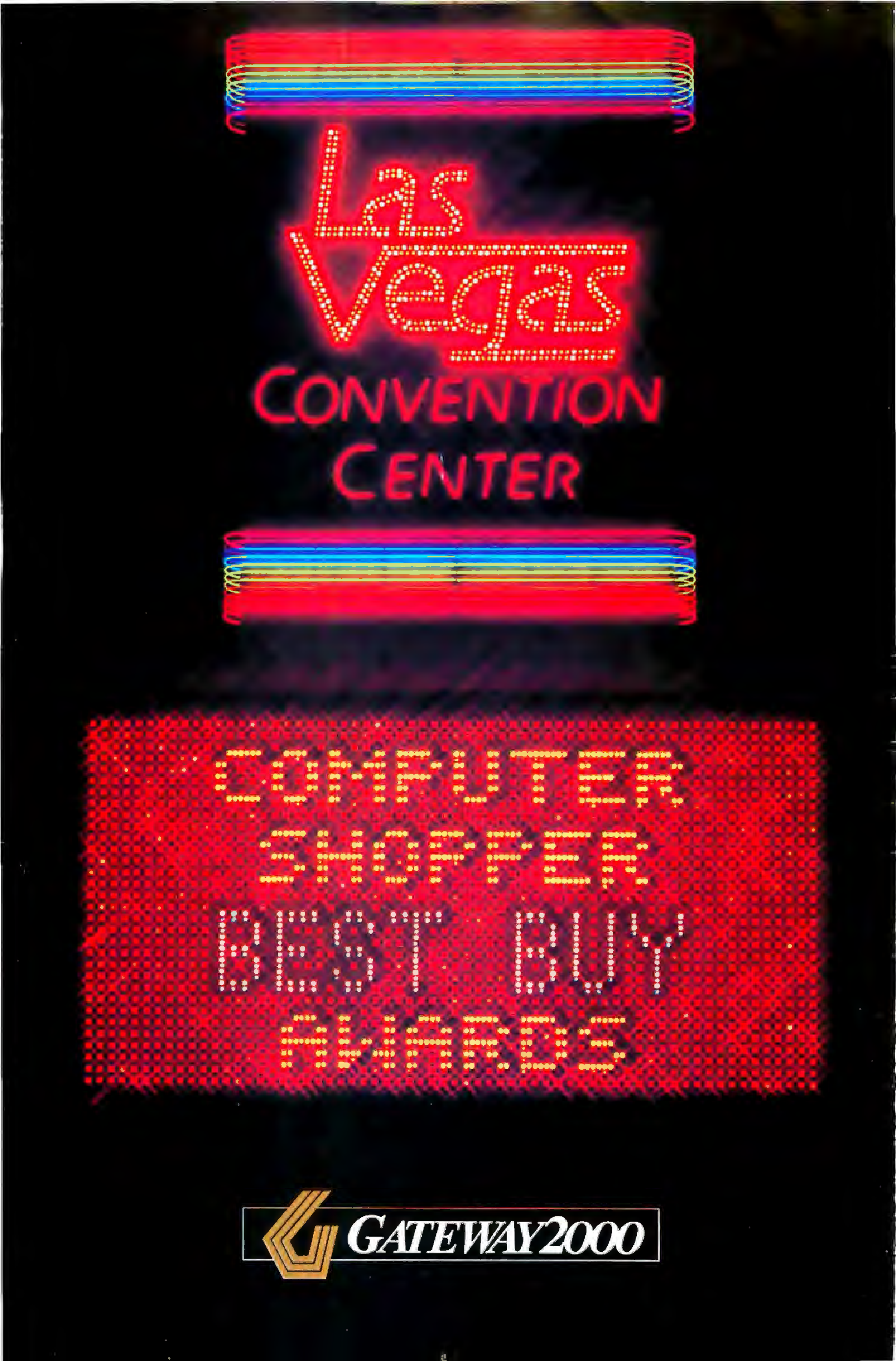
*Basic configuration:*
20-MHz 68020 processor; 6 MB of RAM; AppleTalk, RS-232, and Centronics ports; 45 resident fonts; and a Canon SX print engine.

QMS, Inc.
P.O. Box 81250
Mobile, AL 36689
(205) 633-4300
fax: (205) 633-0013
international fax: (205) 633-0020
**Circle 1204 on Inquiry Card.**

**IBM LaserPrinter 10 Model 30**
$2395; with 4 MB of RAM and PostScript emulation board, $3693

*Basic configuration:*
20-MHz 68020 processor, 1 MB of RAM, RS-232 or Centronics parallel interface, 26 resident fonts, Lexmark print engine, a resolution of 300 dpi, and a printing speed of 10 ppm. Expandable to 4 MB of RAM, Adobe PostScript, and a resolution of 600 dpi.

Lexmark International, Inc.
740 New Circle Rd.
Lexington, KY 40511
(800) 315-2468
(606) 232-3000
**Circle 1205 on Inquiry Card.**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# GATEWAY 2000 – IT'


For the first time in the six-year history of *Computer Shopper* magazine's Best Buy competition, one company swept all of the awards in the desktop PC categories. At COMDEX/Fall '91 in Las Vegas, Gateway 2000 was awarded Best Buy honors for 286, 386SX, 386 and 486 systems.

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"What's most meaningful about these awards," said Gateway 2000 President Ted Waitt, "is they are given by the readers of *Computer Shopper*, people who are buying and using PCs in the real world."

*Shopper* readers voted in record numbers: 15,000 people cast over 100,000 votes for products in 27 hardware and software categories. The vote on desktop PCs was a decisive victory for the Midwestern firm customers call the "cow company."

According to *Computer Shopper*, the Best Buy Awards have come to symbolize the best in service, quality, performance, support and product selection. This combination gives you the best value on the market.

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Our thanks to Gateway's own Semi-Gold Dancers played by employees from departments throughout the company.

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GATEWAY2000

*"You've got a friend in the business."*

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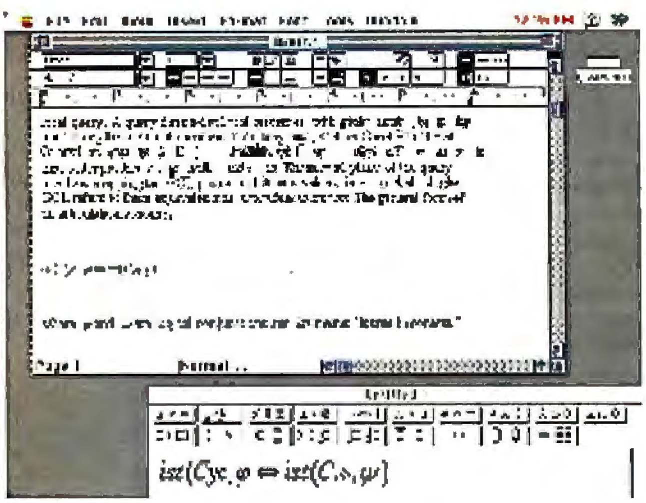
## Word Gathers Steam



**Word for Macintosh 5.0** updates both the look and the guts of the best-selling productivity package for the Mac. The improvements make the package more attractive to novices and experienced users alike.

Word is a full-featured program that includes an integrated spelling checker, a grammar checker, a thesaurus, and a graphics editor. Although it's a large and complex package, installing Word for Macintosh is a breeze. The installation program does all the file copying and decompression. You need only swap disks and indicate your default typeface.

Word 5.0 is a modular program. Many of its features are available through plug-in modules that you can leave out (using an option in the installation program) if you don't have the disk or memory space. You can also upgrade modules or add new ones later. Among the features available as modules are voice annotation, the graphics editor, and a Find File function, which lets you tag and retrieve files by filename, title, subject, author, contacts, version, or keyword. A future module, WordBasic, will implement a programmable macro language for Word.

The entire package takes up about 6½ MB of disk space. You can run Word in a megabyte of memory, but only if you don't install the grammar checker.

Word 5.0 sports a new look. It includes a Ribbon—similar to the one on Word for Windows—that gives you single-click access to commonly used formatting features (e.g., type style, font, type size, justification, line and paragraph spacing, tabs, columns, and the graphics editor). The Ribbon makes Word easier for new users and more convenient for experienced ones.

Although it runs under System 6.0.2 or higher, Word runs best under System 7.0. With this version, you get the benefits of Balloon Help, TrueType fonts, and Publish/Subscribe. You also have access to Microsoft's Object Linking and Embedding technology, which lets you embed objects created with other programs in Word documents. When you access the object to modify it, it calls its parent application to let you do the work. The Equation Editor included with the package uses OLE to let you create and modify equations from within Word. OLE is built on top of System 7.0's Apple events architecture.

Microsoft hopes to establish OLE as a standard for interapplication messaging and processing on the Mac. Given Microsoft's dominance in the Mac applications software market, and Apple's foot-dragging on defining a core suite of Apple events, don't bet against OLE.

Because of its nature, OLE is ideal for automating multiapplication procedures. It also points out the crying need for a standard interapplication scripting language for System 7.0. Word Base may make do for Microsoft applications, but a tool with a wider scope is desperately needed.

Other features in Word 5.0 include Drag and Drop, which lets you move text without cutting and pasting; Print Merge Helper, which guides you through the process of creating and using mail-merge files; import facilities for the more popular DOS and Mac word processing formats; and graphics-conversion utilities.

Word for Macintosh 5.0 is a significant upgrade that broadens its appeal. With its modular design and OLE capability, you can use it as the centerpiece of your applications suite. Even as a stand-alone product, I highly recommend it.

*—Bob Ryan*

### THE FACTS

**Word for Macintosh 5.0**
$495; $129 upgrade from Word 4.0, Microsoft Write, MacWrite, Nisus, WordPerfect, or WriteNow

*Requirements:*
System 6.0.2 or higher and 1 MB of RAM (2 MB is recommended).

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 883-8101
**Circle 1206 on Inquiry Card.**

## A Desktop System in a Briefcase

Numerous manufacturers have claimed that their portable/laptop/notebook systems would bring us the "power of a desktop in a portable package." With the **Toshiba T6400**, this claim has become a reality.

A typical high-performance DOS-based desktop system has a 33-MHz 486DX, 20 MB of RAM, a 210-MB hard drive, a SuperVGA display, a full 101-key detached keyboard, expansion capabilities, and so forth. If you only could fit that into your briefcase, you'd always have your workstation with you. That's exactly what the T6400 provides in a 13-pound package that measures 15½ by 10½ by 4 inches. The only kickers are that you have to plug it in and that it is expensive.

You can have the T6400 with Toshiba's excellent thin-film-transistor (TFT) color display or a monochrome gas-plasma version. You also can opt for permutations of the 25- and 33-MHz DX and SX processors and the 120- and 210-MB (19-millisecond) hard drives, placing the suggested retail price in an area from around $5700 to more than $9700. Some options include memory-expansion cards (the basic system comes with 4 MB of RAM), modems, carrying cases, external floppy drives, external tape backup, and more.

The 10½-inch diagonal color display gives you a choice of 256 colors in 640- by 480-pixel mode, and the color and contrast are excellent. The gas-plasma display operates in VGA mode with 16 shades of gray and, according to Toshiba, provides a contrast ratio at least seven times that of a standard VGA display while operating at 10 times the speed.

The T6400 is loaded with connectors, ports, and little doors to its innards. RAM expansion cards fit in two slots in the main unit covered by the detachable keyboard. The box includes a full-size 16-bit ISA expansion slot, a slot for a Toshiba modem, and a 150-pin expansion port. Interface connectors include those for a 15-pin Super VGA, a 25-pin parallel printer/external floppy drive, a nine-pin serial port, one each for a PS/2-style mouse and keyboard, and an RJ-11.

Toshiba is hoping that you'll make the T6400 your primary machine. It even includes two power cords: one for your desk and one for your briefcase.

This concept of the "universal personal computer" isn't a new one. Visionaries (and marketing vice presidents) have been talking about it for years. It was largely a pipe dream until now, but the technology that makes it possible finally exists and is (relatively) affordable.

There are only two things on my wish list. First, I'd like true portability via battery power. There are those who do need it. Second, lower pricing would make it more competitive (although you can make a good argument that you'd have to buy two machines otherwise).

—Gene Smarte

**THE FACTS**

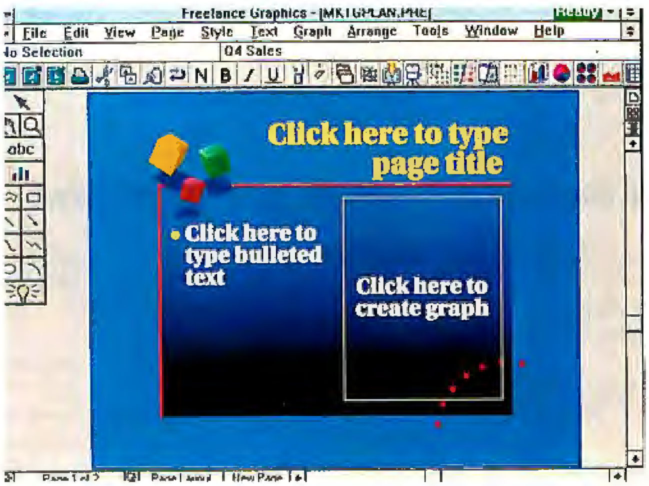
**Toshiba T6400**
with a 33-MHz 486DX, 4 MB of RAM, a 210-MB hard drive, a 1.44-MB floppy drive, TFT color, DOS 5.0, and hypertext documentation, $9749 (with gas-plasma display, $6999)
with a 25-MHz 486SX, a 120-MB hard drive, and TFT color, $8449 (with gas-plasma display, $5699)

*Options:*
RAM cards: 2 MB, $435; 4 MB, $699; 8 MB, $1335
2400-bps MNP level 5 V.42bis modem, $259

Toshiba America Information Systems, Inc.
Computer Systems Division
9740 Irvine Blvd.
Irvine, CA 92718
(800) 334-3445
(714) 583-3000
fax: (714) 587-6034
**Circle 1207 on Inquiry Card.**

## Instant Presentations: Just Add Freelance

Presentations of one sort or another have always been an integral part of the business world. However, the advent of computer technology has upped the ante in the unending competition for the customer's dollar and the boss's eye. A few simple graphs or hand-drawn overheads just don't cut it any more. You now need style with the substance.




Software for creating presentation graphics has evolved with computer technology. I've tried several packages over the years and have always been frustrated by the long learning curves involved—in many cases, they were on a par with learning to use a full-fledged desktop publishing package. With **Freelance Graphics for Windows**, those frustrations have all disappeared. Lotus has designed a revolutionary presentation graphics package that lets you concentrate on generating your presentation instead of on learning how to use the package.

The program includes an on-line tutorial called QuickStart. Its SmartMasters offer fill-in-the-blanks ease of use. And the program offers single-click

*— Full native 32-bit programming power —*

# C++ PLUS.

## ONLY ZORTECH™ C++ OFFERS A TRUE MULTI-PLATFORM COMPILER AND MUCH MORE.

When it comes to building larger, more complex applications, C++ is the language of choice. And now with Zortech C++, Symantec presents the only C++ compiler that provides professional tools for Windows,™ DOS and OS/2 in a single, integrated package.

Zortech C++ goes well beyond the other C++ and C compilers by delivering more of the tools serious programmers demand—plus a collection of exclusive features designed to increase your productivity and reduce your development time.

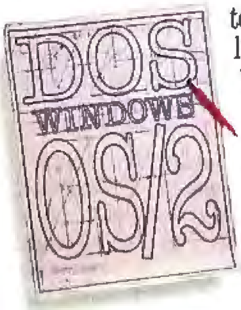
All of which means you'll get your applications to market faster than ever before.

For starters, our unique WINC library automatically converts DOS command line programs to true Windows applications. And you won't need to switch development systems, because you'll have the flexibility of moving to different platforms.

*The security of one compiler across multiple platforms has never been more essential. With Zortech C++ developing applications has never been easier or more efficient.*

Zortech C++ even includes royalty-free 32-bit and 16-bit DOS extenders, for the cost-effective development of programs with advanced memory requirements.

And since Zortech C++ provides absolutely everything you need to edit, compile, link and debug any Windows application, you won't need to buy the Microsoft Windows SDK. We've also added a help compiler and engine, a resource compiler, Windows header files and libraries, and printed SDK documentation.





*Zortech C++ dramatically cuts your multi-platform development time by supporting the complete range of PC architectures.*

For unmatched performance, Zortech C++ offers globally optimizing compilers that boost program speed and significantly reduce program size. So regardless of the platform, Zortech C++ delivers performance and security where it matters... in your finished application.

In fact, as the safest choice you can make, Zortech C++ ensures total C++ and ANSI C compatibility. It's also supported by leading third-party utilities, libraries and other tools.

That's probably why more and more corporations are moving to Zortech C++ for their application development.

## UPGRADE TO ZORTECH C++ FOR JUST $199.

There's never been a better time to take advantage of the world's first multiple-platform C++ compiler.

Because, for just $199, users of Borland C++ and Microsoft C can now upgrade to Zortech C++ For Windows, DOS & OS/2—that's a savings of $500!*

And if your applications require even greater numerics support, pick up the Zortech C++ Science and Engineering Edition (which offers everything from the Windows, DOS and OS/2 version, along with the M++ array language extension, IEEE-754 and NCEG 91-015 numerical support, and much more).

*Zortech's industrial-strength compiler breaks through the DOS 640K barrier, enabling you to develop programs of up to 16MB and beyond.*

Either way, you'll get unmatched Zortech quality backed by Symantec's outstanding service and support. So visit your dealer or call us at **1-800-228-4122, Ext. 804Y** for more information about Zortech C++ and our competitive upgrade offer.



SYMANTEC.

**Promotion ends March 31, 1992. Offer good in the US and Canada only. In Canada, call 1-800-465-2266. For more information in Europe, call 31-71-35-3111. In Australia, call 61-2-879-6577. Everywhere else, call 408-252-3570.*



**Circle 119 on Inquiry Card.**

**THE FACTS**

**Freelance Graphics for Windows**
$495; upgrade from current Freelance or other presentation graphics package, $150

Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
fax: (617) 693-1299
**Circle 1208 on Inquiry Card.**

access to menu commands.

Installing Freelance was easy, albeit time-consuming. That's not surprising, because the package takes up over 10 MB of hard drive space after all the files on the installation floppy disks have been uncompressed. Yes, that's a lot of space. But when I saw how much presentation groundwork Freelance contains, I was surprised that it didn't take up more space.

How do you create a presentation with Freelance for Windows? It couldn't be simpler. First you choose a "look" from Freelance's 60 SmartMaster sets of predesigned presentation formats, each with nine page layouts for titles, bullet charts, graphs, symbols, and combinations. The majority of the SmartMaster sets are in full color, but if you don't have access to a color output device, there is also a generous selection of monochrome sets that look great when printed on your garden-variety laser printer.

Once you choose a look, you merely fill in the blanks. As you can see from the photo, you click your mouse on the area you want to work on. For text, you just type away. For graphics, you can use an on-screen browser to select from hundreds of symbols that are included with the package. But Freelance goes way beyond simple symbols. It includes 96 predefined chart styles, each of which can automatically link to external data (e.g., a Lotus 1-2-3 spreadsheet).

Although Freelance easily imports data from almost any popular application, it's most closely integrated with (surprise!) Lotus's suite of applications. Running Freelance with 1-2-3 for Windows and Ami Pro 2.0 (which feature Lotus's movable, customizable SmartIcons) gives you what amounts to a state-of-the-art desktop. (Freelance is also mail-enabled with cc:Mail 1.1.)

Freelance Graphics for Windows let me put together a moderately complex real-world presentation within half an hour of installing the package. Try that with any competing product. What impressed me most about the program was how Lotus has integrated a true revolution in ease of use with a program that pushes technological and feature barriers. Lotus's programming wizards are finally delivering the long-promised benefits of the Windows environment.

*—Stan Mastkowski*

## Weitek Introduces a New Kind of VGA Card

At last year's spring Comdex, one of the biggest product announcements was Weitek's W5086 user-interface controller chip. The W5086 encodes some of the key functions of the Windows 3.0 graphical device interface, which significantly speeds up Windows and Windows applications.

Weitek has now gone one better and designed a Windows adapter card based on its W5086 chip. While most Super VGA cards on the market today are aimed at graphics applications, **Weitek Power for Windows** targets the business segment. The card speeds up screen performance of typical business applications by speeding up functions such as text scrolling, cutting and pasting, page preview, moving and resizing windows, and line drawing. The card affects text processing, as opposed to graphics processing, because it processes BitBlt and LineDraw functions. These functions are accelerated because they don't have to be processed by the CPU. Instead, they are processed directly by the W5086 chip on the card.

I noticed an appreciable speed increase in my word processing and database applications, but I was immediately impressed by how the card affects Windows alone. Weitek claims a doubling in Windows' performance while maintaining VGA compatibility (i.e., a maximum resolution of 1024 by 768 pixels noninterlaced with 16 colors).

I tested a preproduction version of Weitek Power for Windows. It came with a batch file for installation and a beta monitor setup utility. Weitek promises a user-friendly Windows drivers installation routine with its production cards. The monitor setup utility in its final form will include a user interface and presettings for popular monitors, according to Weitek.

Weitek Power for Windows is an ISA card that plugs into a 16-bit AT-type expansion slot. The card comes with a ModeSet utility that lets you tune it for your particular monitor. A custom setup lets you set vertical refresh rates, screen centering, and screen size for each of the graphics and extended-text modes available.

With all the graphics accelerators out there, why would anyone need the Weitek card? The answer is that Weitek Power for Windows may be all you need. It offers a high-quality, low-cost alternative for those who run primarily word processors, spreadsheets, and other text-oriented applications under Windows 3.0. There's no need to spend extra money on higher-priced graphics chips when your applications are mostly text processing. But there are other reasons to purchase this card. It's a high-quality VGA card that can replace your current graphics card, and you get the added bonus of a speed increase under Windows. ■

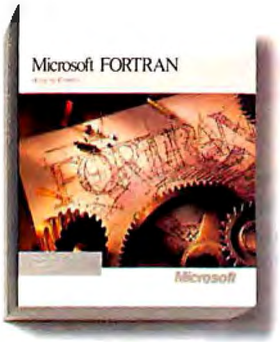
*—Anne Fischer Lent*

**THE FACTS**

**Weitek Power for Windows**
$299

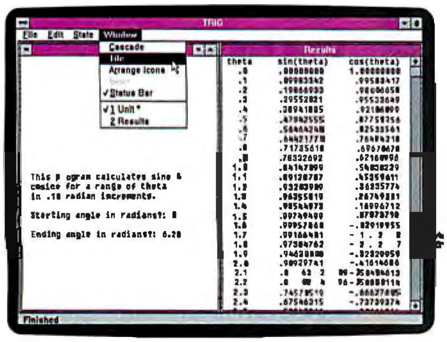
*Requirements:*
A 286, 386, or 486 with an ISA or EISA bus, 640 KB of RAM, a 40-MB hard drive, a VGA interlaced or noninterlaced monitor, and Windows 3.0.

Weitek Corp.
1060 East Arques Ave.
Sunnyvale, CA 94086
(408) 738-8400
fax: (408) 739-4374
**Circle 1209 on Inquiry Card.**

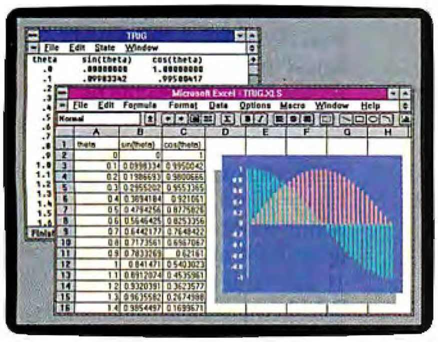



MICROSOFT
SOFTWARE
DEVELOPMENT
TOOLS

# Windows helps FORTRAN users create bigger apps.



*The Microsoft Windows graphical environment lets you have multiple windows in your FORTRAN applications. This means that you can resize and scroll input and output displays to view data...*



*...and to analyze data, simply cut and paste your FORTRAN output into programs such as Microsoft Excel for Windows and you can view it instantly in graphical form.*

With the new Microsoft® FORTRAN Professional Development System version 5.1, your existing code taps into the power of the Microsoft Windows™ graphical environment. FORTRAN 5.1's new QuickWin library lets you develop 16-bit apps that access greater memory than ever before – breaking the 640K barrier on 286 and 386 machines.

You can use the FORTRAN QuickWin library to take advantage of multiple I/O windows, multitasking, and cut and paste. Or write FORTRAN routines called from mixed-language Windows apps. And FORTRAN 5.1 has Programmer's WorkBench, with a new CodeView® debugger and Source Browser.

To see the advantages of bigger, multi-windowed 16-bit applications, give us a call at (800) 541-1261, Department R34 and order your FORTRAN update today.



## Key Features

- Create Windows .DLLs in FORTRAN using new or existing code.
- QuickWin Features:
  - QuickWin child windows are easily created using the OPEN statement.
  - User-defined positioning and titles for child windows.
  - Automatically generated scroll bars for output that extends past a single screen.
- CodeView debugger supports DOS*, Windows-based and OS/2® applications.
- Extended CodeView debugger for large DOS programs.
- Complete online documentation for the FORTRAN language and all compile and link switches.
- DOS and OS/2 run-time libraries are compatible with other Microsoft languages.
- Floating-point support includes co-processor, emulation, and alternate math libraries.
- 100% ANSI 77 compatibility and numerous IBM®, VAX® and ANSI 8X extensions.
- New BYTE keyword emulates VAX data types.
- Language Extensions include DOUBLE COMPLEX variables, precision and maxexponent inquiries.

## PROGRAMMER'S TIPS

- *Use the new /MW option with the FL command to invoke the QuickWin library. For example: "FL/MW MYAPP.FOR" is all it takes to make MYAPP a Windows-based program.*
- *Use the ALLOCATE statement to dynamically size arrays and to access more than 16MB of memory on a 386.™*

Microsoft

## Notebook Networking

Designed as a networking notebook computer, the Sparcbook 1 SPARC-based workstation includes SunSoft's Solaris 2.0 and DOS emulation. The unit integrates scalable RISC technology, Unix System V release 4.0, and portability with networking and communications.

The Sparcbook uses the CY7C-601A-25UC SPARC integer unit running at 25 MHz. With 64 KB of zero-wait-state cache RAM, the computer includes 32 KB of track cache and an average access time of less than 22 ms. You get 85- or 120-MB capacity on the hard drive, with the choice of a second hard drive of either capacity in place of the standard 3½-inch floppy drive.

The sidelit paper-white 640 by 480-pixel resolution screen has a monochrome LCD and simulates up to 64 gray scales. A 2400-bps modem with SendFax capability at 9600 bps is standard. The keyboard allocates one key position as the mouse key.

**Price:** Starts at $4950.

**Contact:** Tadpole Technologies, Inc., 8310 Capital of Texas Hwy. N, Suite 375, Austin, TX 78731, (512) 338-4221; fax (512) 338-4462.

**Circle 1271 on Inquiry Card.**

*A notebook workstation, the Sparcbook 1 has an Ethernet interface.*

## Gulliver Travels

A dictionary-size tower computer, the 8-pound Gulliver has a network port for linking up to your LAN. The 33-MHz 386's optional Ethernet card works with NetWare and NetWare Lite.

With 1 MB of video RAM, VGA capable of 1280- by 1024-pixel resolution, and a 2400-bps data/9600-bps fax modem on-board, the basic Gulliver includes three 16-bit expansion slots, an I/O controller, and a 1.44-MB floppy drive. Building on the basic system, Standard System I adds 2 MB of RAM (expandable to 32 MB), a 100-MB hard drive, a 101-key keyboard, DOS 5.0, Windows 3.0, a mouse, and a Super VGA monitor. Standard System II gives you 4 MB of RAM (expandable to 32 MB) and has a 210-MB hard drive.

**Price:** $1695 to $3375.

**Contact:** Newmarket Computers, 140 Variel Ave., Woodland Hills, CA 91367, (818) 703-0800.

**Circle 1272 on Inquiry Card.**

*The size of a book, Gulliver easily goes places.*

## A Notebook with an Angle

Featuring a slide-and-tilt mechanism at the base of the LCD to improve angle adjustability, the Professional II notebook computer has an electroluminescent-backlit supertwist display with 640- by 480-pixel resolution. A 20-MHz 386SX machine, the Professional II has 2 MB of RAM (expandable to 4 MB) and includes a math coprocessor socket. Other features are a 1.44-MB floppy drive, a choice of a 40- or 80-MB hard drive, serial and parallel ports, and ports for an external monitor, keyboard, and floppy drive.

**Price:** $2399.

**Contact:** Darius Technology (U.S.), Inc., 22028 26th Ave. SE, Bothell, WA 98021, (206) 483-8889; fax (206) 486-2577.

**Circle 1273 on Inquiry Card.**

## Powerful Images Use New Technology

Based on NEC's Image technology, the PowerMate Image 386/33i computer has the power of a file server. Image Video, a local video bus designed into the PC, eliminates any video bottleneck by operating at the same speed as the processor. ImageSync lets the computer sense when it is connected to an NEC MultiSync FG monitor and adjust to the best frequency for the highest possible refresh rate.

With Super VGA on the motherboard, the PowerMate Image 386/33i supports noninterlaced resolutions of up to 1024 by 768 pixels in 16 colors. It has 4 MB of RAM (expandable to 64 MB via SIMMs), 32 KB of cache, and 128 KB of BIOS-upgradable flash ROM on the motherboard. You have a choice of a 60- or 120-MB 3½-inch IDE hard drive and the option to upgrade to a 5¼-inch floppy drive from the standard 3½-inch drive. Interfaces include serial and parallel ports, a VGA display port, and a PS/2-style mouse port.

**Price:** $2799 to $3499.

**Contact:** NEC Technologies, Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (508) 264-8000.

**Circle 1274 on Inquiry Card.**

## Ink-Jet Plotter Makes CAD Fast and Flexible

The HP DesignJet plotter, a large-format monochrome ink-jet plotter, is based on Hewlett-Packard ink-jet technology. Able to print on most media, the DesignJet plotter features Intel's 32-bit 960 embedded RISC processor, enabling it to produce a 300-dpi E-size plot in less than 6 minutes and a D-size plot in less than 3 minutes.

Geared for small groups that use CAD software on PCs or workstations, the plotter lets you work in draft or final mode. You choose the mode from the front panel, from which you also select your line width, which can be from 0.2 mm to 12 mm. Standard interfaces are Centronics, serial ports, and a modular interface slot that accepts optional HP interface cards for network or HP Interface Bus connections. The plotter uses HP Graphics Language/2 and HP's Raster Transfer Language, which lets you import data in raster format from scanned line drawings or other raster applications.
**Price:** $10,995.
**Contact:** Hewlett-Packard Co. Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.
**Circle 1275 on Inquiry Card.**

*The HP DesignJet plotter features a RISC processor.*

## Laser Printing on LANs

The LaserMatrix 1000 Model 6 continuous-form laser printer features PostScript and Hewlett-Packard LaserJet III emulation. Able to automatically switch between the languages, the printer selects the proper one based on the document to be printed, eliminating the need for different printers on a LAN. The LaserJet III emulation uses the same Intellifont scaling technology and typefaces used in HP's LaserJet III printers.

With its i960 32-bit 16-MHz RISC processor and 82961KA controller-on-a-chip from Intel, the LaserMatrix 1000 Model 6 prints high-resolution graphics for such applications as labels and bar codes at 16 ppm, or 1000 lines per minute. It has automatic linefeed at the end of a job and horizontal and vertical forms positioning in 1- to 3-inch increments.
**Price:** $5495.
**Contact:** Output Technology Corp., 2310 North Fancher Rd., Spokane, WA 99212, (800) 468-8788 or (509) 536-0468; fax (509) 533-1280.
**Circle 1276 on Inquiry Card.**

## Ergonomic Keyboard

The ergonomically designed Alps MDS101 keyboard uses a single sheet of conductive elastomeric rubber instead of individual key switches. The conductive rubber protects the keyboard from dust and spills.

Cable exits on the right, left, and center of the keyboard provide connection flexibility. Variable tilt and cylindrical, step-sculptured keys are standard. An autosensing device lets the keyboard automatically configure to any PC; an optional adapter lets you use the keyboard with a PS/2 computer.
**Price:** $85.
**Contact:** Alps America, 3553 North First St., San Jose, CA 95134, (800) 825-2577.
**Circle 1277 on Inquiry Card.**

## It's Clearly a Mouse

Transparently showing off its electronics, the mouse called Crystal is Microsoft and Mouse Systems compatible. With software-adjustable resolution, the three-button see-through Crystal ships with a 9-pin to 25-pin adapter for serial port compatibility.
**Price:** $69.99.
**Contact:** Suncom Technologies, 6400 West Gross Point Rd., Niles, IL 60648, (708) 647-4040.
**Circle 1278 on Inquiry Card.**

## External Keypad

In addition to the standard 10 number keys and mathematical functions, the external numeric Kensington KeyPad provides function and cursor keys to speed up number entry and access to communications programs. Designed for use with Mac PowerBook computers, the keypad comes in a protective carrying case.
**Price:** $139.95.
**Contact:** Kensington Microware, Ltd., 2855 Campus Dr., San Mateo, CA 94403, (800) 535-4242 or (415) 572-2700; fax (415) 572-9675.
**Circle 1279 on Inquiry Card.**

# NEWS

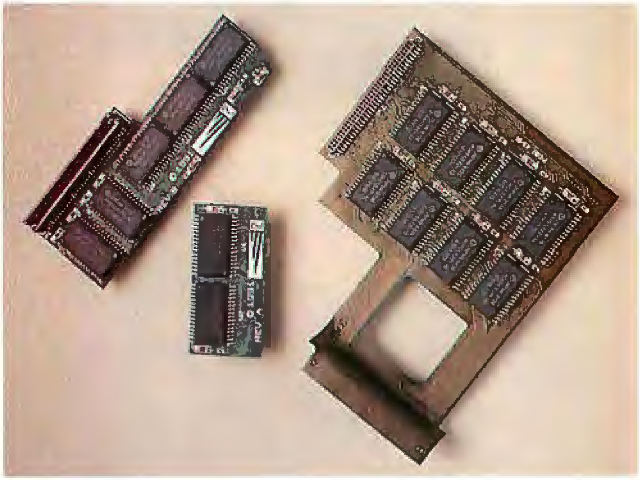
## WHAT'S NEW • ADD-INS

### Incremental RAM Upgrade

Designed for the Mac PowerBook notebook computers, the Power-Memory expandable RAM cards are available in fixed and flexible RAM configurations. The cards let you increase the memory of a PowerBook up to 8 MB.

The fixed RAM card uses standard printed-circuit-board technology to provide 2 MB of additional RAM. The flexible RAM card uses a flexible printed circuit board to provide either 2 or 4 MB of RAM. Both flexible versions include a socket that accepts any 2- or 4-MB fixed RAM card designed for the Power-Books, providing an additional upgrade path.

**Price:** $399 to $999.
**Contact:** PSI Integration, Inc., 851 East Hamilton Ave., Suite 200, Campbell, CA 95008, (408) 559-8544; fax (408) 559-8548.
**Circle 1280 on Inquiry Card.**



*Designed for the Mac PowerBook, PowerMemory h ıs a fixed or flexible configuration.*

### 2-D Acceleration for Sparcstations

The GXtra/W SBus Graphics Subsystem is a single-slot SBus card that provides 2-D acceleration, an 8-bit color frame buffer, a Sun-4-style keyboard, and a mouse. Based on Weitek's 8720 integrated graphics controller, the GXtra/W draws at a rate of 100 million pixels per second for all 2-D applications and runs most Sun software. It is available in resolutions of 1600 by 1280, 1280 by 1024, and 1152 by 900 pixels.

**Price:** $3050.
**Contact:** Tech-Source, Inc., 442 South North Lake Blvd., Suite 1008, Altamonte Springs, FL 32701, (407) 830-8301; fax (407) 339-2554.
**Circle 1281 on Inquiry Card.**

### Multistation Adapter

The VGNA 8514 Multi-Station Adapter has a resolution of 1024 by 768 pixels with 256 colors. The newest product in Advance Micro's UnTerminal line, the VGNA 8514 supports two 8514 users per board and four boards per system.

As do other UnTerminal MultiStation Adapters, the VGNA 8514 connects standard PC displays and AT keyboards to a 386 or 486 machine to create fast text and graphics multiuser stations. You work as if at a stand-alone PC, with complete serial and parallel support. The adapter can be a maximum distance of 250 feet from the PC server.

**Price:** One-user base system, $1595; second user module, $995.
**Contact:** Advance Micro Research, Inc., 2045 Corporate Court, San Jose, CA 95131, (408) 456-9400; fax (408) 456-9430.
**Circle 1282 on Inquiry Card.**

### Super VGA and More

The Quick-VGA Combo adapter from STB is a Super VGA adapter with additional features. Add-ons include one parallel and two serial ports, an IDE hard drive controller, a dual floppy drive controller, and a Microsoft-compatible mouse port. The board takes up a single slot on the motherboard and comes with a three-button mouse.

Resolution provided by the Quick-VGA Combo is as high as 1024 by 768 pixels in 16 colors, and the board supports as much as 512 KB of video memory. Drivers are included for Windows 3.0, Lotus 1-2-3, Ventura, WordPerfect, CADKey, and OS/2. The serial and parallel interfaces have configuration options, and the IDE controller supports AT or XT drives.

**Price:** $199.
**Contact:** STB Systems, Inc., 1651 North Glenville, Suite 210, Richardson, TX 75081, (214) 234-8750.
**Circle 1283 on Inquiry Card.**

### Put Your Mac Quadra in Overdrive

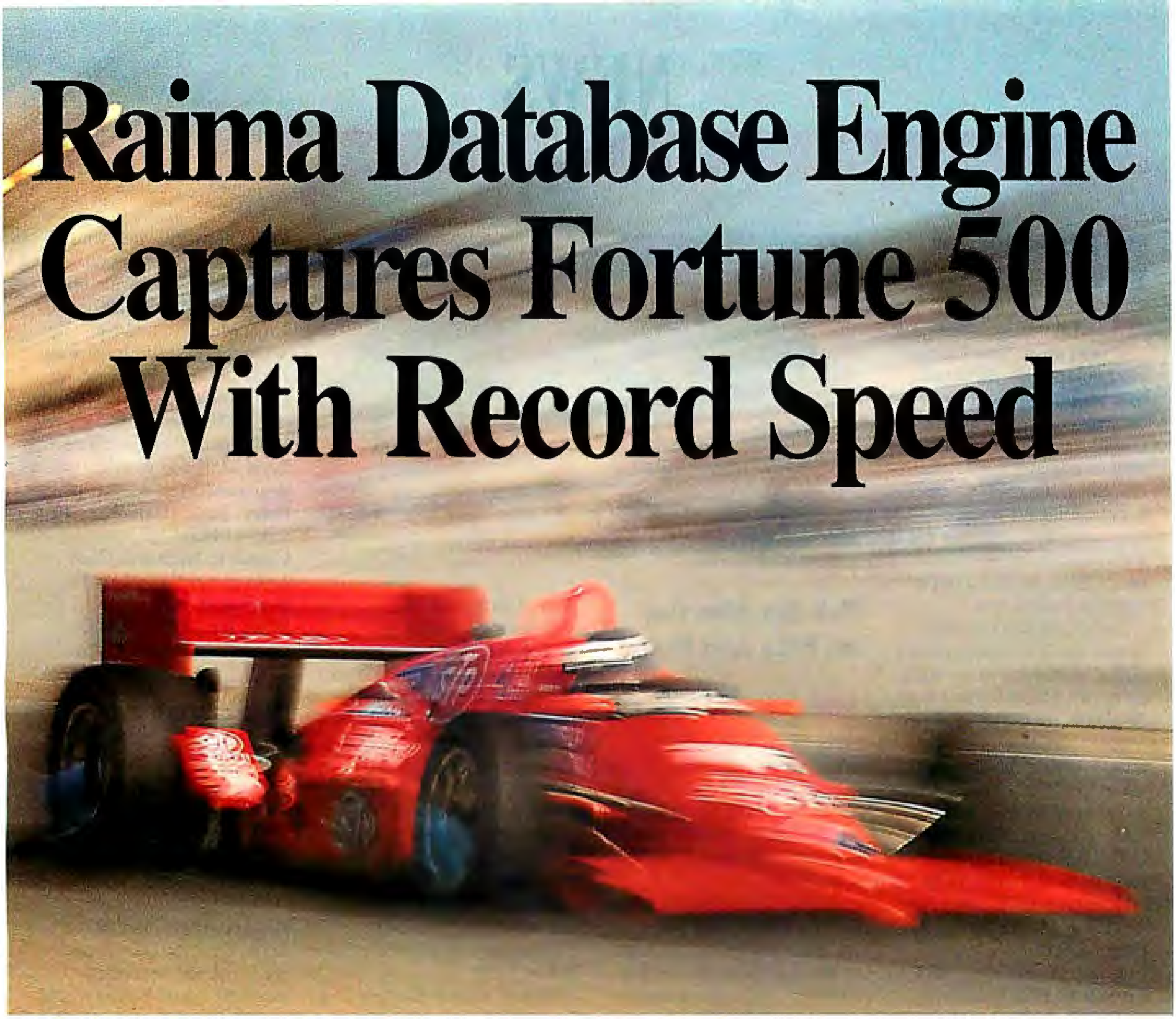
The Quadra/Overdrive, a variable-speed accelerator for Mac Quadra computers, can run at the Quadra 700's and 900's speed of 25 MHz, as well as at 33 MHz. The device plugs onto the motherboard, leaving the Mac's PDS and NuBus slots open. You add the Quadra/Overdrive without soldering or pulling chips.

**Price:** $349.
**Contact:** Newer Technology, 7803 East Osie St., Suite 105, Wichita, KS 67207, (800) 678-3726 or (316) 685-4904.
**Circle 1284 on Inquiry Card.**

### Motion Control on the Mac

The nuStep, a three-axis stepper motor control board for NuBus-based Mac computers, is a general-purpose motion controller compatible with full-step, half-step, and microstepping motor drives. With a programmable step rate of up to 750,000 steps per second for open- or closed-loop motion control, nuStep's command set has more than 40 high-level functions for setup, control, and status readback of motion system parameters. I/O capabilities include end-of-travel limit switch inputs, home switch input, general-purpose digital I/O lines, and optional quadrature encoder feedback inputs.

**Price:** $1595.
**Contact:** nuLogic, Inc., 475 Hillside Ave., Needham Heights, MA 02194, (617) 444-7680; fax (617) 444-2803.
**Circle 1285 on Inquiry Card.**

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## DAT Intelligent Device

The DAT-Link intelligent device lets you use your computer's SCSI bus to communicate with and control a digital audiotape (DAT) recorder or player, as well as connect to CD players. Since the external device is not dedicated to a specific computer, you can use it with most machines that use SCSI or SCSI-2 as a peripheral control bus.

DAT-Link can transfer stereo music or sound from a digital audiotape to the hard drive of a computer and from the computer to the DAT recorder. You control the DAT recorder from the computer via the DAT machine's infrared remote control, using a built-in infrared transceiver. DAT-Link records and plays back digital audio at sample rates of 32, 44.1, or 48 kHz at 16, 20, or 24 bits.
**Price:** $3995.
**Contact:** Ariel Corp., 433 River Rd., Highland Park, NJ 08904, (908) 249-2900; fax (908) 249-2123.
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*DAT-Link lets your computer control stereophonic sound.*

## Peer-to-Peer E-Mail on NetWare Lite

LiteMail, designed for peer-to-peer LANs using NetWare Lite, has E-mail, phone message, and real-time chat features. Futurus's "bumpable" technology lets you add users one by one, bumping up the number of users allowed on the network each time you add someone.
**Price:** $39.95 per workstation.
**Contact:** Futurus Corp., 3131 North I-10 Service Rd., Suite 401, Metairie, LA 70002, (800) 327-8296.
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## Printer Sharing on PCs and Macs

With the JetWay printer sharer, as many as eight PCs can simultaneously access a printer at a speed of 115,200 bps. The unit, which has from 256 KB to 4 MB of buffer memory and turbo speed, works with laser or dot-matrix printers. The JetWay has four or eight serial input ports and one parallel output port.

You configure the JetWay from the keyboard, giving each port its own baud rate, number of copies, and end-of-file time-out values. Velcro fastenings let you mount the JetWay right on the printer. When used with a LAN, the JetWay enables isolated PCs and servers to share a printer.
**Price:** Four-port unit, $345; eight-port unit, $545.
**Contact:** ASP Computer Products, Inc., 160 San Gabriel Dr., Sunnyvale, CA 94086, (408) 746-2965; fax (408) 746-2803.
**Circle 1288 on Inquiry Card.**

The serial QuadLink automatic printer sharer lets you connect as many as four Macs and PCs to a single printer; you can daisy-chain QuadLinks to allow access to additional users. The device's automatic search function scans all four ports for incoming data. When it detects data from a computer, it locks that computer to the printer until the data transmission is complete. After a time during which no data is detected, QuadLink frees the printer for use by the other computers.

QuadLink is also available in a parallel configuration.
**Price:** $179.
**Contact:** Kansai Electric, USA, 2005 Hamilton Ave., Suite 220, San Jose, CA 95125, (800) 733-3374 or (408) 377-7062; fax (408) 377-7085.
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## Access Network Data Transparently

LAN Manager 2.1 facilitates connectivity across diverse clients and servers. Network management capabilities are improved and tight integration with Windows 3.0 lets you transparently access data across NetWare, AppleTalk, Unix, OS/2, and VMS servers.

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**Price:** Basic 10-user Server Pak, $1995.
**Contact:** Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (206) 882-8080; fax (206) 883-8101.
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## Multiport Expander for the Mac

The MP-91 MultiPort Expander, a completely software-controlled multiple serial port switch for Macs equipped with an Apple Desktop Bus, is packaged with the necessary hardware and software to add and control as many as six serial devices, such as printers and modems, eliminating the need to change plugs on the back of the Mac. The System 7.0–compatible MP-91 is controlled by Point-and-Click Accessory software, which instantly selects the serial device you've chosen. You can save port-selection setups so that you needn't reselect ports at each reboot.
**Price:** $169.
**Contact:** Silicon Valley Bus Co., 22546 Summit Rd., Los Gatos, CA 95030, (408) 353-6600; fax (408) 353-1007.
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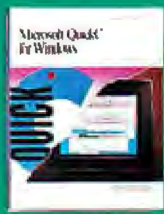


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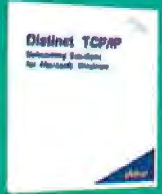


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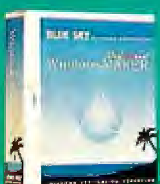


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| PharLap386 Dos Extender | 435 |
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| WATCOM Fortran 77/386 | 579 |
| Zortech C++ Devel. 3.0 | CALL |

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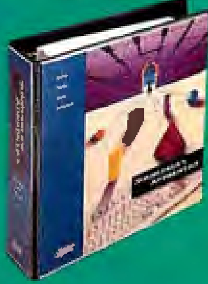

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**WATCOM C8.5/386**
Develop and Debug 32-bit applications for extended DOS and Windows with the most complete 32-bit C development package available. C8.5/386 Professional is packed full of tools you need to unleash 32-bit power on your applications at a low package price. Includes the royalty-free DOS/4GW DOS extender by Rational Systems, components from Microsoft Windows SDK, award-winning compiler, protected mode linker, interactive debugger, execution profiler, run-time compatibility with WATCOM FORTRAN 77/386 V8.5 plus numerous development tools. Supports other industry standard 32-bit DOS extenders. Create ADS Applications for AutoCAD or for embedded systems development.

List: $995 Ours: $579
FAX*cetera*# 1683-0001

**DAN BRICKLIN'S DEMO II**
Experience for yourself why over 30,000 people have made Demo II version 3.0 the leading tool for producing program prototypes, demonstrations, and tutorials. Demonstrate commercial software to potential customers without shipping live software. Produce effective tutorials that interactively teach products. Create Computer Based Training for a fraction of the cost dedicated CBT authoring software. Version 3.0 features include: built-in mouse support, text overlay on bitmapped graphics, memory swapping, VGA support, autosave options and CUA template system.

List: $249 Ours: $215
FAX*cetera* # 0233-0003

A Division of Voyager Software Corp
1163 Shrewsbury Ave., Shrewsbury, NJ 07702

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* All prices subject to change without notice.

**Circle 68 on Inquiry Card.**

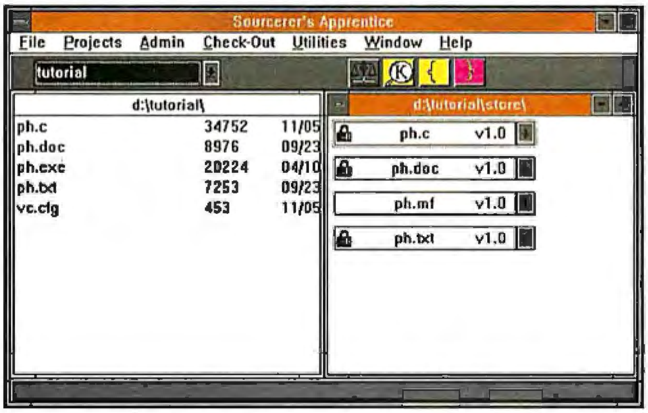
## Apprentice Performs Windows Magic

Support for Windows is included in Solution Systems' upgrade of Sourcerer's Apprentice. Version 2.0 of the configuration management system, which also runs under DOS and OS/2, lets you organize your projects however you choose. You can file your projects by source, object, or headers for immediate module access.

The professional version of the program includes security, compression, archiving, and additional reporting features and also offers automatic support for Novell file servers. The Windows version allows direct access to Brief for file editing and can interface with Microsoft Word for Windows.

Solution Systems also offers a language-independent make facility. MakeKit works with Brief and Sourcerer's Apprentice to perform routine programming chores. Using Sourcerer's Apprentice's time/date stamps, the Unix-style utility can recompile changes since your last build. You can run MakeKit from within the Brief edit buffer, although the company says that the program interfaces with all other editors and make utilities.

**Price:** Sourcerer's Apprentice 2.0: Windows Professional, $599; DOS or OS/2 Professional, $499; DOS or OS/2 Personal, $199; MakeKit: $149; bundled with Sourcerer's Apprentice for DOS or OS/2, $579.
**Contact:** Solution Systems, 372 Washington St., Wellesley, MA 02181, (800) 677-0001 or (617) 431-7445; fax (617) 431-8419.
**Circle 1292 on Inquiry Card.**




*The working window (left) displays files that Sourcerer's Apprentice has checked out for editing, while the window on the right shows the status of the modules.*

## QueryDOS Sees Your Hard Disk as a Database

QueryDOS, described by its developer as the first operating-system query language for the PC, views each file and directory on your hard disk as an individual record. By defining your files as units composed of name, extension, size, date, time, and attribute factors, QueryDOS can perform various processes on them. The program is capable of processing files and directories recursively and will automatically create any needed directories while doing so.

As you process files, QueryDOS lets you set filters for processing only the selected files and also permits processing of system and hidden files. QueryDOS accepts several input syntaxes, including standard DOS, dBase-style English, an abbreviated syntax based on Unix and C, or a combination of all three formats.

Other features offered by QueryDOS include basic statistical compilation; mathematical, string, and logical functions; contiguous command execution; and three levels of file deletion.

**Price:** $149.
**Contact:** Backus-Naur, Inc., 920 Yonge St., Suite 200, Toronto, Ontario, Canada M4W 3C7, (416) 323-0406; fax (416) 323-9684.
**Circle 1293 on Inquiry Card.**

## An X-Based Debugger for Real-Time Unix

The release of Ldb from Lynx brings to market a debugging tool for real-time Unix and Posix that operates in the X Window System environment or ASCII terminal mode. Ldb offers source- and kernel-level debugging of multiple threads and multiple processes. The program's main features include signals debugging; support for break, watch, and trace points; stepping; and stack examination. Ldb can also debug a program on a remote system via an Ethernet link.

According to Lynx, Ldb is the only debugger to offer a true X/Motif interface. The initial release of Ldb supports only LynxOS.

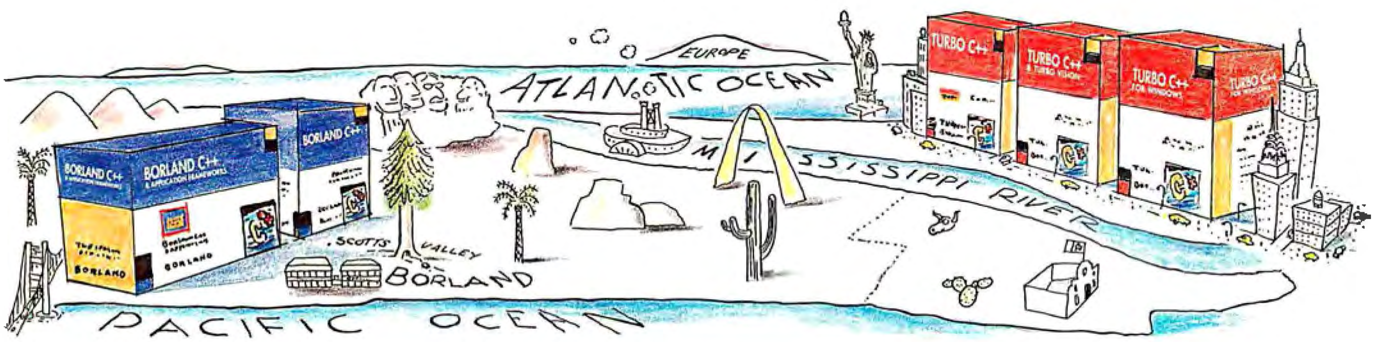
**Price:** $895.
**Contact:** Lynx Real-Time Systems, Inc., 16780 Lark Ave., Los Gatos, CA 95030, (408) 354-7770; fax (408) 354-7085.
**Circle 1294 On Inquiry Card.**

## Check Your OS/2 2.0 Code for Portability

The software development tool CodeCheck/2 now comes in a 32-bit version that runs under OS/2 2.0. The expert system from Abraxas Software evaluates OS/2 2.0–developed C and C++ source code for portability to other environments. You can use CodeCheck/2 to check for compatibility with DOS 5.0, Windows 3.0, OS/2 1.0, and other 16-bit environments.

The program supports all major C and C++ compiler variants, including versions produced by Microsoft, Borland, Zortech, AT&T, and MetaWare. You can use CodeCheck/2 with IBM's WordFrame/2 programmer's workbench to recognize and resolve conflicts between OS/2 2.0 code and the environment to which you intend to port it.

**Price:** $695.
**Contact:** Abraxas Software, Inc., 7033 Southwest Macadam Ave., Portland, OR 97219, (503) 244-5253; fax (503) 244-8375.
**Circle 1295 on Inquiry Card.**




# From C to Shining C++ Borland Covers the Territory

Whether you're programming in C or C++, DOS or Windows, Borland has you covered with the most advanced family of programming tools available.

## New! Borland C++ 3.0 for a new dimension in professional programming

For mission-critical applications in Windows or DOS, you need the power and performance of an advanced language compiler. Borland C++, the development system designed for professionals, lets you reach new vistas of productivity in C and C++ programming. Global optimization and enhanced compiler performance give you fast code fast. The ObjectBrowser™ simplifies class relationships. Resource Workshop lets you create great Windows resources, WinSight™ helps you track windows messages and EasyWin™ converts DOS programs to Windows just by recompiling. Turbo Debugger,® Turbo Assembler® and Turbo Profiler™ are also included. Borland C++ is the solid choice for professional development for $\$495^{00}$.

## New! Borland C++ & Application Frameworks 3.0—a quantum leap forward

If you can't afford to waste time and manpower wrestling with Windows API or constructing a user interface, you need Borland C++ & Application Frameworks. Our application frameworks cut development time by giving you sleek, intuitive user interfaces and high-level objects that you can bolt right onto your applications or customize in anyway you wish. The ObjectWindows™ application framework streamlines Windows development. Turbo Vision™ for DOS gives you similar capabilities for a character-based environment. Borland C++ & Application Frameworks is the powerful choice for C and C++, for an investment of just $\$749^{00}$. Borland C++ included.

## Turbo C++ is the starting point for C and C++

To begin C or C++ programming in DOS, you need a compiler that helps you master both C and object-oriented C++. Turbo C++ gives you a fast start with online context-sensitive help, tutorials and examples that you can paste into your own programs. But Turbo C++ is more than a tutor, it's a great C and C++ compiler. Turbo C++ has won *PC Magazine*'s Technical Excellence Award, *BYTE* magazine's Award of Excellence and many more. For a compiler that's easy enough to start with yet powerful enough to stay with, you need Turbo C++. Only $\$99^{95}$.

## Turbo C++ & Turbo Vision gives you a head start

The combination of Turbo C++ and the Turbo Vision application framework for DOS shortcuts development time by giving you a ready-made user interface with menus, scroll bars, mouse support, and an event-driven architecture that you can plug right into your applications. High-level objects such as an editor, a calculator, a calendar and more are ready for you to add to your applications with just a few lines of code. If you want the fast path for DOS programming, choose Turbo C++ & Turbo Vision. A lot of power for $\$199^{95}$. Turbo C++ included.

## New! Turbo C++ for Windows 3.0 is the fast track for Windows programming

Turbo C++ for Windows makes Windows programming in C or C++ easy—even if you've never programmed for Windows before. Graphical tools simplify development and help speed you along. Resource Workshop lets you create great new Windows resources for your existing applications or for any new program you write. You can visually design your own resources or use Borland's own Custom Controls. The ObjectBrowser graphically shows you class relationships, and ObjectWindows gives you a ready-made graphical user interface that you can use with your own application. EasyWin lets you convert DOS applications to run in a Window just by recompiling. Designed exclusively for Windows to give you the best Windows applications for only $\$149^{95}$.

**See your dealer today or call now 1-800-331-0877, Dept. 5251**

**BORLAND**

*The Leader in Object-Oriented Programming*



**Circle 23 on Inquiry Card (RESELLERS: 24).**

## Business Savvy Without an MBA

The maker of the Business Insight strategic analysis program now offers it in a service-industry version. The DOS program asks you questions about your business plans, forms a model of your business's characteristics, and compares the model to an industry standard. Business Insight analyzes your business by pointing out inconsistencies in your implementation plans, rating key operations factors, and offering improvement ideas.

Business Insight for the Service Industry contains a knowledge base that offers perspectives on businesses of all types, covering everything from the medical industry to the auto service business.

**Price:** $495.

**Contact:** Business Resource Software, Inc., 2013 Wells Branch Pkwy., Suite 305, Austin, TX 78728, (800) 423-1228 or (512) 251-7541; fax (512) 251-4401.

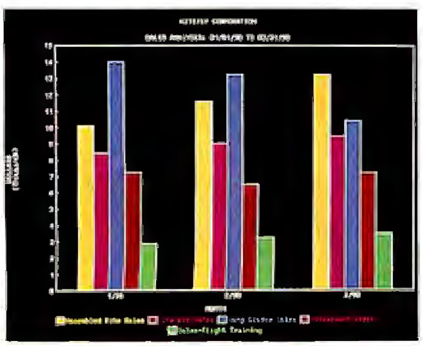
**Circle 1296 on Inquiry Card.**


*Business Insight measures your plans against factors critical to your success.*

## Accounting and More in One Box

The most popular members of Great American Software's One-Write Plus family of small-business software products have been integrated into a single DOS-based program. Accounting Works consists of integrated accounting, payroll, bill collection, vendor correspondence, and backup tools. The program provides linking with Lotus 1-2-3 and other spreadsheets, and it lets you access and share data among modules.

Great American has also developed a point-of-sale accounting system for small businesses. Retail Express manages checkout functions, prints itemized receipts and invoices, and receives and tracks inventory. The program also generates sales and reorder reports, does cost tracking, and performs price checking and correcting.



*Comparative graphing capabilities are included in Accounting Works.*

**Price:** Accounting Works, $299; Retail Express, $199.95.

**Contact:** Great American Software, 615 Amherst St., Nashua, NH 03063, (603) 889-5400; fax (603) 881-9337.

**Circle 1297 on Inquiry Card.**

## GoldMine Adds Sales Forecasting and Faxing

GoldMine 2.0, a new version of the contact manager/groupware program for networked PCs, offers graphing and faxing, sales forecasting analysis and report generation, and other features. The new version has a Common User Access–like interface and supports document management.

The program provides a multiuser system for tracking interactions with customers and prospects. Other improvements are enhanced scheduling, remote-site data transfer, mail and messaging, task delegation and notification, and indexing on an unlimited number of fields.

**Price:** $295; five network users, $695; each five additional users, $695.

**Contact:** Elan Software Corp., 4917 Gerald Ave., Encino, CA 91436, (800) 654-3526 or (818) 999-9872.

**Circle 1298 on Inquiry Card.**

## Evaluate Salespeople Before You Hire

Evaluating a potential salesperson's skills can be a real game of chance. Lousig-Nont has developed a program that takes the guessing out of the hiring process.

Sales Success Profile is designed to measure a salesperson's skills in 12 areas. The questionnaire-style evaluator determines the subject's scores in comparison to the program's statistical scoring database, which is based on a sampling of 11,370 tests. SSP generates a written report of the salesperson's scores and rankings and develops an analysis of his or her strengths, weaknesses, and selling style. SSP also includes a training report module that provides individualized training tips and sales advice.

The program does not test personality, according to Lousig-Nont, because personality-based sales tests identify traits, not skills.

**Price:** $30 per copy in multiples of 20, plus a one-time support fee of $100; quantity discounts available.

**Contact:** Lousig-Nont & Associates, 3740 South Royal Crest St., Las Vegas, NV 89119, (800) 477-3211 or (702) 732-8000; fax (702) 732-1572.

**Circle 1299 on Inquiry Card.**

## Analysis Software from Board Maker

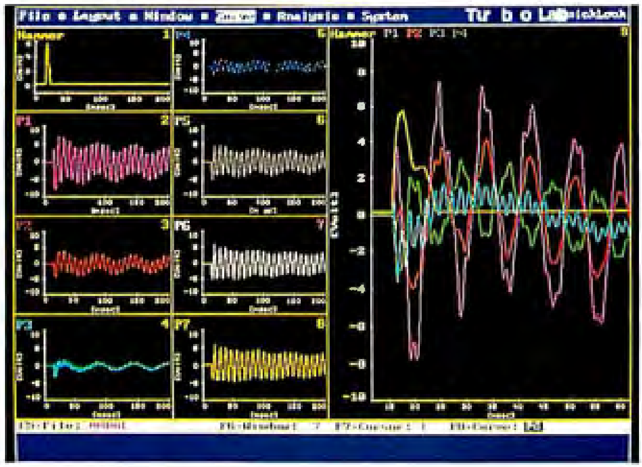
There's a new player in the data acquisition software business. Analogic, known mainly for its data acquisition board business, now offers TurboLab and TurboLab Pro. The post-acquisition DOS-based software lets you analyze data and display it in a graphical format.

TurboLab includes a formula processor that contains over 70 mathematical and analysis tools, including spectral analysis and fast Fourier transform calculations. You can display as many graphs as are viewable on your monitor, and each graph can display multiple signals. With the professional version of the program, you can import and analyze data from a board while you're on-line. You can also output TurboLab graphs to printers or plotters.

**Price:** $1495; professional version, $1995.

**Contact:** Analogic, 360 Audubon Rd., Wakefield, MA 01880, (508) 977-3000; fax (617) 245-1274.

**Circle 1300 on Inquiry Card.**



*The number of graphs you display with TurboLab is limited only by your ability to see them.*

## An Equation for Every Experiment

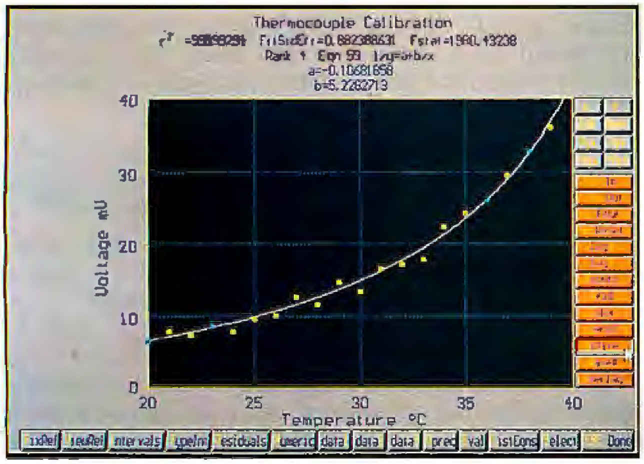
TableCurve helps you determine the best equation to fit your experimental data. Version 3.0 of the Jandel Scientific program automatically fits and ranks 3318 linear and nonlinear equations by a user-defined order of best fit. You can add two of your own equations to the 3304 linear and 14 nonlinear equations included with the program. Other features are zoom, axes scale adjustment, standard error listing, and a full numeric summary for each curve fit.

You can import data to the program from Lotus 1-2-3, SigmaPlot, Quattro Pro, and other file formats, and you can generate code for any of the built-in equations. TableCurve supports PostScript drivers.

**Price:** $495.

**Contact:** Jandel Scientific, 65 Koch Rd., Corte Madera, CA 94925, (800) 874-1888 or (408) 924-8640; fax (408) 924-2850.

**Circle 1301 on Inquiry Card.**




*TableCurve tests 3318 possible equations against your plotted data to find the best fit.*

## dV/dt Draws Diagrams for You

By automating the task of drawing timing diagrams, dV/dt 3.10 and dV/dt Test Vector Generator (TVG) 1.02 let you design and analyze what-if conditions on your Mac or PC. The two new products from Doctor Design provide a link between timing diagram accelerators, documentation, and design synthesis and simulation tools.

dV/dt and TVG tie in to Accel, Data I/O, and other design verification and synthesis tools. They can also import files from documentation packages such as WordPerfect, Microsoft Word, and any Macintosh, DOS, or Windows program that allows graphics to be imported. dV/dt's other new features include graphics exportation via Inset System's Hijaak, multiple font support, seamless integration with TVG, and graphical view simulation from any simulator by means of a link to Source III test vector translation software.

**Price:** dV/dt for DOS or Mac, $695; TVG, $495; both dV/dt and TVG, $995.

**Contact:** Doctor Design, Inc., 5415 Oberlin Dr., San Diego, CA 92121, (619) 457-4545; fax (619) 457-1168.

**Circle 1302 on Inquiry Card.**

## Data Modeling and CASE in One Package

The new tool package from Visible Systems includes the latest release of Arthur D. Little's Information Resource Management Aid, Visible Analyst Workbench (a general-purpose CASE tool). A new interface lets you import Irma-originated associative data models into the Workbench repository for code generation.

The Irma/Workbench combination runs on PC systems and supports Arthur D. Little's Strategic Information Value Analysis and Associative Data Modeling methodologies. You can import ADM data to the Workbench for use with the Workbench's entity relationship modeling, data-flow diagraming, and prototyping features.

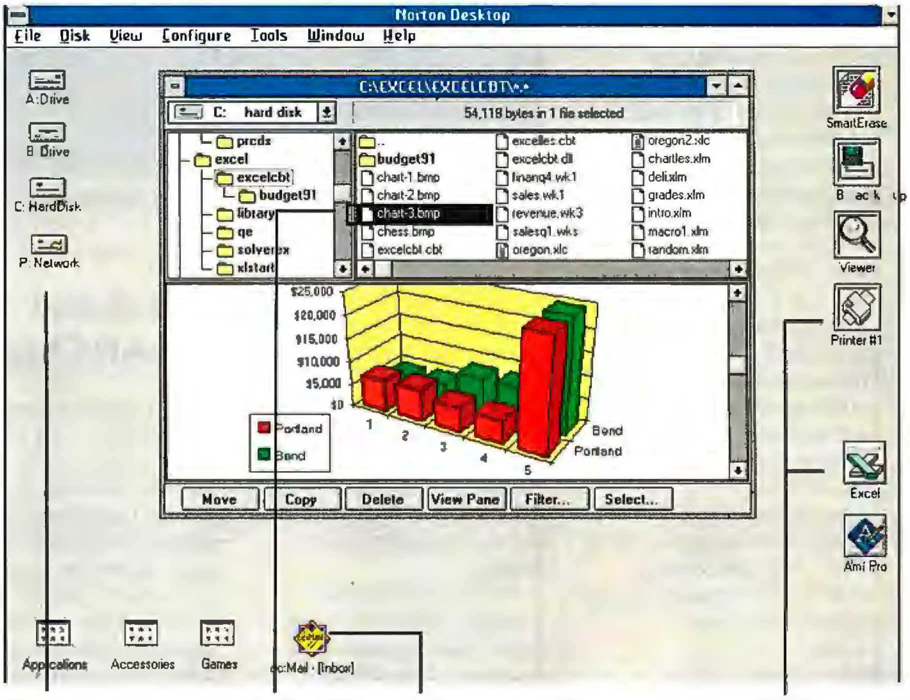
**Price:** $15,000.

**Contact:** Visible Systems Corp., 950 Winter St., Waltham, MA 02154, (617) 890-2273; fax (617) 890-8909.

**Circle 1303 on Inquirv Card.**

# "I Was So Blown Away By Norton Desktop."

*Jim Seymour, PC Week, September, 1991*




*Select drives and directories with a click.*

*Browse and view files without opening applications. More than 4[illegible] (including graphics) are built in.*

*Program management icons can sit right on the desktop.*

*Keep your favorite applications on your desktop. To view, backup, print or delete a file, just drag it to an icon and click.*

"Most Valuable Software Product of the Year."

*PC Computing, COMDEX, October, 1991*

"I can't imagine any Windows user who won't want to own this magnificent, cost-effective collection...the most profound changes in the Windows environment since the introduction of Windows 3.0 itself."

*PC Magazine, September, 1991*

"Norton Desktop for Windows has 'Software Product of the Year' written all over it."

*InfoWorld, September, 1991*

"While upcoming Windows 3.1 will improve the File Manager, it won't surpass Symantec's offering. Norton Desktop adds a new spark to Windows."

*Byte, September, 1991*

"Norton Desktop shines in file management."

*The Wall Street Journal, October, 1991*

"For Windows users... shopping for the best Windows utilities bargain around, this is the answer. Every Windows user should have it."

*PC Computing, December, 1991*

"Run, don't walk, to the nearest store and snap one up."

*Byte, September, 1991*

## NORTON DESKTOP FOR WINDOWS: INTUITIVE FILE MANAGEMENT PLUS A FULL SET OF INTEGRATED UTILITIES. ALL FOR $149.*

No wonder the Norton Desktop™ for Windows is getting unanimous rave reviews. It's the ideal companion for Windows.

It's the seamless, fully integrated interface that makes file and program management as easy as pointing, dragging and clicking. Plus a comprehensive set of built-in utilities – automatic Backup, UnErase,® (restore deleted files), SuperFind,™ (to locate misplaced files), and Disk Doctor,® (recovers crashed files and disks). Plus a gallery of screen savers, an icon editor, and much more. The Norton Desktop for Windows makes working with Windows far easier and more productive.

In short, it's the best thing that ever happened to Windows. Run to your local dealer and see. For the name of the dealer nearest you, call 1-800-[illegible] Ext. 729 or 408-[illegible].


SYMANTEC.



Circle 120 on Inquiry Card.

## Vellum in 3-D

Vellum 3D is Ashlar's entry in the 3-D CAD software market. The wireframe modeling tool is currently available for the Mac, and a Windows version is in the works.

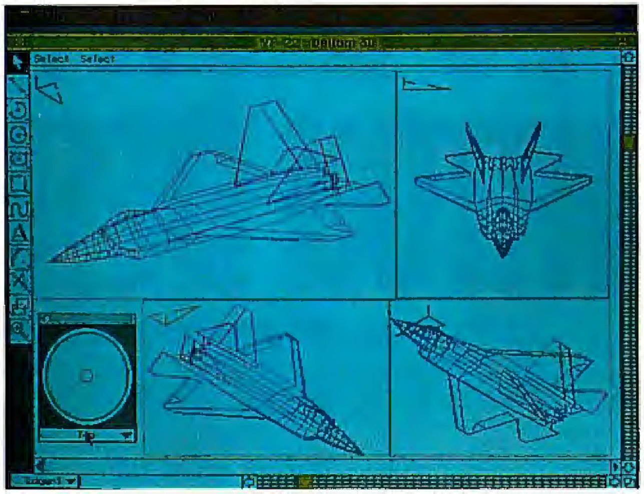
Vellum 3D includes an on-screen trackball that you manipulate to alter the view of your model. The program provides top, side, isometric, and trimetric views of your design, and the trackball lets you rotate the views for unlimited viewing options. The program also provides a 3-D version of the Drafting Assistant. As you draw, the Z-Drafting Assistant automatically aligns geometric design elements, such as center points, intersections, and perpendiculars, in 3-D.

According to Ashlar, you can export drawings through a PICS filter for shading. Vellum 3D lets you calculate surface areas but not volume.

**Price:** $2495.

**Contact:** Ashlar, Inc., 1290 Oakmead Pkwy., Sunnyvale, CA 94086, (408) 746-1800; fax (408) 746-0749.

**Circle 1304 on Inquiry Card.**



*Vellum 3D's on-screen trackball (lower left) lets you rotate your design for alternative views.*

## New Features for Personal Designer

Version 5.0 of Personal Designer incorporates major additions to Computervision's 3-D geometric modeling package. The program still offers 3-D geometric modeling and Bézier surfaces but now features a database capacity of 64,000 entries and alternative on-screen and tablet menus. Further enhancements include a bundling of the Personal Designer Surfaces option, NURB curves and surfaces, alternative menus, drive sweeps along multiple curves, and many more features.

The 2-D version of Personal Designer, MicroDraft, has also undergone revisions. MicroDraft includes the same changes as Personal Designer 5.0 and also supports multiple views.

Both programs are available for DOS systems; Unix versions will be available in February.

**Price:** Personal Designer: PC version, $3995; Unix version, $4495; MicroDraft: PC version, $1995; Unix version, $2495.

**Contact:** Computervision, 100 Crosby Dr., Bedford, MA 01730, (617) 275-1800.

**Circle 1305 on Inquiry Card.**

## Put an End to LAN Chaos

To help you keep track of your LAN components, Nodemap lets you diagram and document all the connections between your networked devices. You can use it to create, modify, and print multilevel diagrams. Nodemap uses standard telecommunications and network planning symbols and provides automatic text formatting and line route generation.

Nodemap runs on PCs and all networks, according to Haventree. You can export Nodemap diagrams to such desktop publishing and graphics packages as PageMaker 3.0 and CorelDraw 2.0.

**Price:** $250.

**Contact:** Haventree Software, Ltd., P.O. Box 1093, Thousand Island Park, NY 13692, (613) 544-6035; fax (613) 544-9632.

**Circle 1306 on Inquiry Card.**

## CAD/CAM File Access Via Your Database

It takes many workers to bring a finished product to market, but, as often happens, few of the people along the production route have access to designs and data while that information is in a CAD or CAM format. Checkmark is designed to improve communication, quality, and productivity in manufacturing settings by providing everyone in the production process access to design information without having to reproduce blueprints or models.

The program uses an IGES format to access data created with CAD or CAM software and also supports DXF and auto-industry file formats. With Checkmark you can call up CAD or CAM files for dynamic 3-D viewing, commentary, or entity checking without making permanent changes to the master data.

Checkmark is available in three versions: Checkmark View, a view-only configuration; Checkmark, for 3-D wireframe viewing, mark-up, and checking; and Checkmark Plus, which lets you view, mark up, and check 3-D sculptured surface data.

The program runs on PCs and Unix workstations.

**Price:** Checkmark View, $995; Checkmark, $1995; Checkmark Plus, $4995.

**Contact:** Micro Engineering Solutions, 26200 Town Center Dr., Novi, MI 48375, (313) 347-9650; fax (313) 347-1893.

**Circle 1307 on Inquiry Card.**

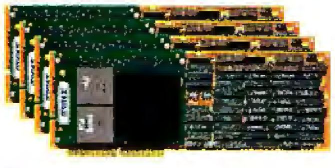
**SPREAD THE WORD**

*Please address new product 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.*

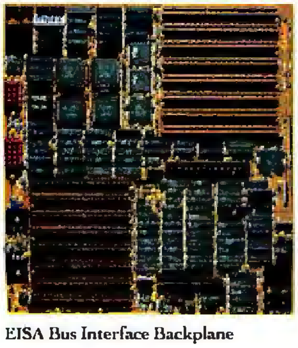
# Multiprocessing System


- 64-bit 267MB/s fully symmetric multiprocessing bus
- Four 486 50MHz CPUs with up to 512KB write-back cache
- EISA bus for high-performance I/O
- Up to 512MB of ECC memory
- Fully scalable and field upgradable
- All EISA peripherals available from Mylex; Mylex BIOS
- UNIX V.4, Novell NetWare 286/386, SCO MPX, MS-DOS, Windows 3.0 and LAN Manager supported

**Available Q1, 1992**

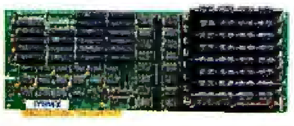


CPU Board



EISA Bus Interface Backplane

Multiprocessor Interrupt Controller

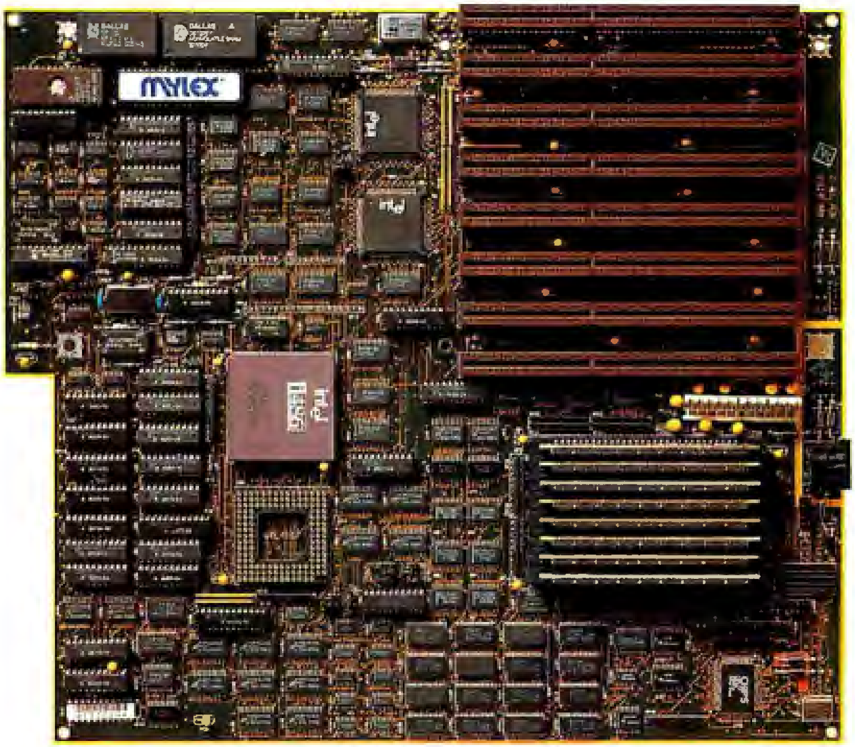


ECC Memory Controller

# System Boards

**EISA 486 System Board**

- 486DX 33MHz*
- 14.5 MIPS performance
- 128KB of external write-back cache
- 8 EISA bus slots
- Integrated I/O– IDE, floppy, parallel, serial and PS2 mouse ports
- Weitek 4167 socket
- Surface mount design
- Mylex BIOS




**MNE486**

**ISA 486 System Board**

- 486DX 33/50MHz*
- 14.9 MIPS performance at 33MHz
- 64 to 256KB of external write-back cache
- 7 ISA bus slots
- On-board I/O– IDE, floppy, serial and parallel ports
- Weitek 4167 socket
- Surface mount design
- Mylex BIOS


**MDI486**

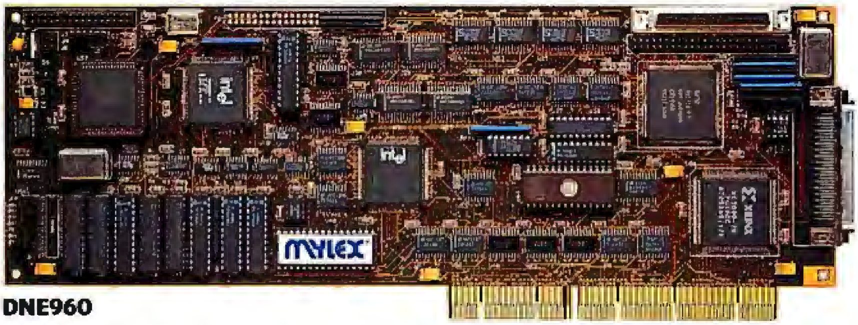
* 50 MHz Available Q1, 1992
** Available Q1, 1992
*** Available Q2, 1992

# SCSI Host Adapters


**DAC960**

**EISA SCSI-2 Host Adapter*****

- Five SCSI-2 (fast and wide) channels– each channel supports up to 20 MB/s peak throughput
- Intel i960CA RISC processor; up to 64MB of write-back cache
- Striping with built-in support for various RAID levels
- Disconnect/reconnect, scatter/gather, command queuing, duplexing, mirroring and spanning
- Fault tolerance features include automatic drive failure detection, hot replacement and transparent rebuild



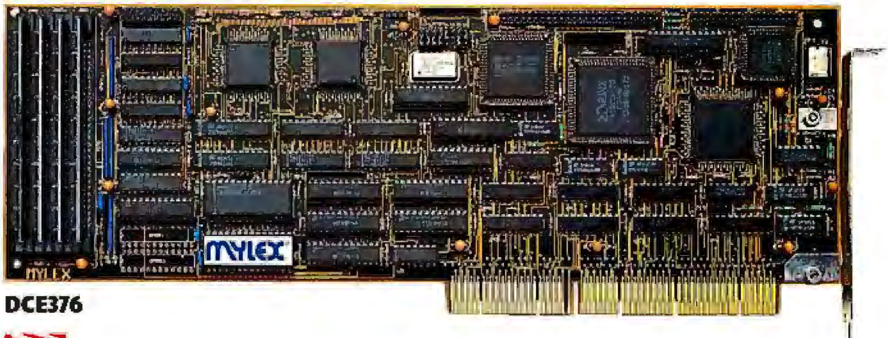

**DNE960**

**EISA SCSI-2 Host Adapter*****

- Fast and wide SCSI-2 providing 20MB/s peak throughput
- EISA bus-master transfer rates up to 33MB/s
- Support for all popular SCSI devices
- Disconnect/reconnect, scatter/gather, synchronous drive support, duplexing and mirroring
- DOS, OS/2, Unix, NetWare

**EISA SCSI Host Adapter**

- Intel 80376; up to 8MB cache
- EISA bus-master transfer rate up to 33MB/s
- Disconnect/reconnect, scatter/gather, mirroring, duplexing and tape backup
- DOS, OS/2, UNIX, SCO UNIX, NetWare, Windows 3.0



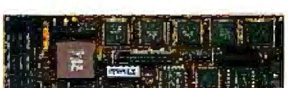

**DCE376**

Novell Labs Tested & Approved

# Disk Array Subsystem

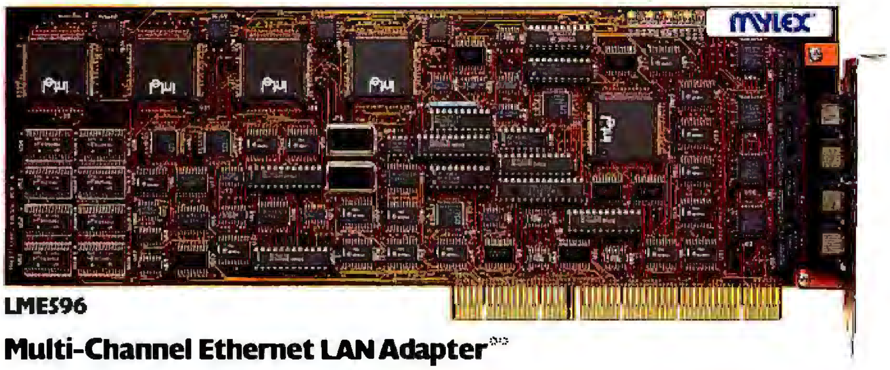

- Fastest disk array subsystem on the market– includes disk array enclosure, controller, host adapter and software
- Five SCSI-2 (fast and wide) channels– each channel supports up to 20MB/s peak throughput
- EISA host adapter uses Intel i960CA 32-bit RISC processor
- Up to 64MB of write-back cache
- Modular support for single-ended or differential SCSI channels
- Flash EPROMs for easy firmware field upgrades
- Striping with built-in support for various RAID levels
- Disconnect/reconnect with full multi-threading, scatter/gather, command queuing, duplexing, mirroring and spanning
- Fault tolerance features include automatic drive failure detection, hot replacement and transparent rebuild

**Available Q1, 1992**



DAC960 Host Adapter

# Ethernet LAN Adapters



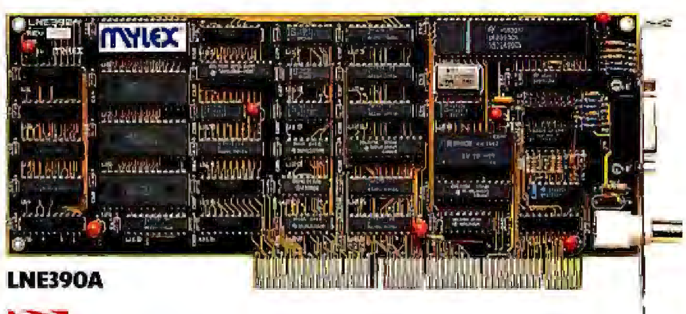

LME596

**Multi-Channel Ethernet LAN Adapter**

- Four 10Base-T Ethernet ports
- Four Intel 82596 32-bit Network Interface Controllers (NIC)
- 256KB dual-ported SRAM (64KB per NIC)
- Intel 82355 EISA bus-master interface controller
- Up to 16 ports per host with four LME596 adapters
- Supports Novell NetWare 3.11, UNIX TCP/IP and NDIS

**EISA Ethernet LAN Adapter**

- DP8390 Network Interface Controller
- EISA shared-memory transfer rates up to 16MB/s
- Support for both thick- and thin-Ethernet interfaces
- Novell certified
- Supports Novell NetWare 2.15, 2.2, 3.0, 3.1 and 3.11, UNIX, and OS/2 LAN Manager

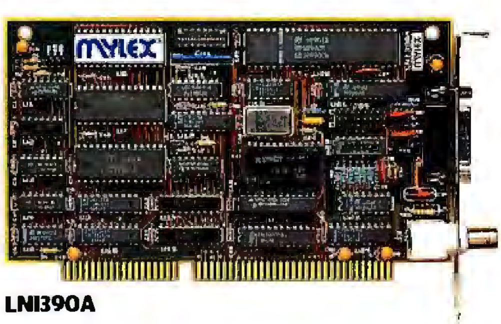



LNE390A

Novell Labs Tested & Approved

**ISA Ethernet LAN Adapter**

- DP8390 Network Interface Controller
- Shared-memory transfer rates up to 2MB/s
- Support for both thick- and thin-Ethernet interfaces
- Supports Novell NetWare 2.15, 3.0, and 3.1 and UNIX

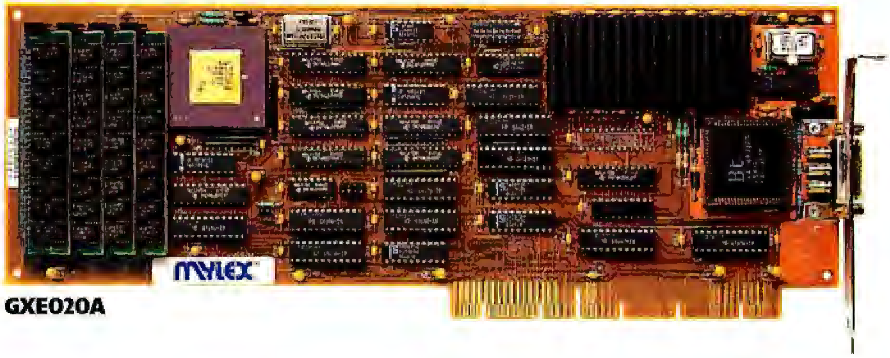



LNI390A

# Graphics Controllers

**EISA Graphics Controller**

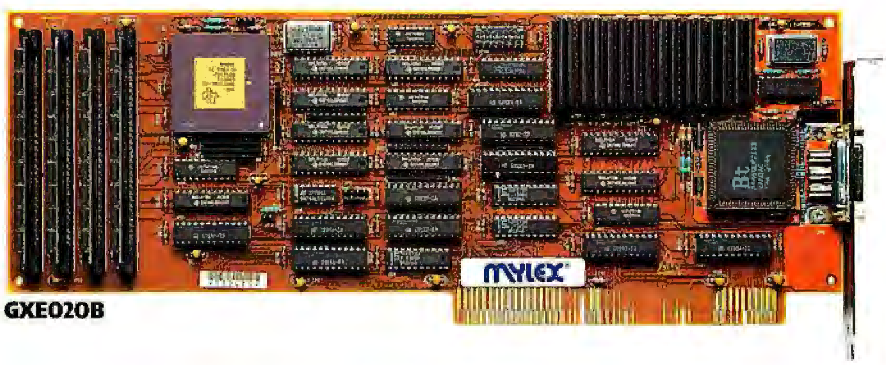
- TI34020 40MHz graphics processor
- 1600 x 1200 non-interlaced resolution
- 8 bit-planes for 256 simultaneous colors
- TIGA 2.05 compatibility
- VGA on-board
- Drivers for Windows 3.0, AutoCAD and X-Window




GXE020A

**EISA Graphics Controller**

- TI34020 32MHz graphics processor
- 1280 x 1024 non-interlaced resolution
- 8 bit-planes for 256 simultaneous colors
- TIGA 2.05 compatibility
- VGA on-board
- Drivers for Windows 3.0, AutoCAD and X-Window

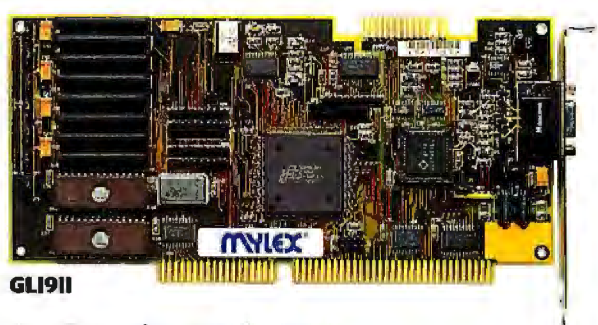



GXE020B


GLE911

**EISA Graphics Accelerator**

- S3 graphics accelerator
- EISA bus data transfers
- 1280 x 960 x 16 or 1024 x 768 x 256 resolution
- 100% VGA compatible
- Drivers for Windows 3.0, AutoCAD, X-Window, GEM 3.1 and many more




GLI911

**ISA Graphics Accelerator**

- S3 graphics accelerator
- ISA bus data transfers
- 1024 x 768 x 256 resolution
- 100% VGA compatible
- Drivers for Windows 3.0, AutoCAD, X-Window, GEM 3.1 and many more

## Save Windows Backups from DOS

Distinct Back-Up for Windows lets you restore backups done under Windows from DOS without having to reinstall Windows. Version 2.4 of Distinct Back-Up features data-compression rates that average 60 percent; password-protection capabilities; and support for PCX, TIF, and other graphics file formats.

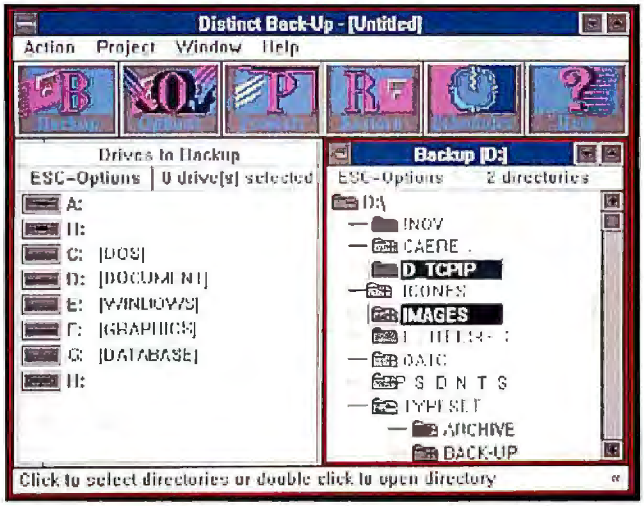
Distinct Back-Up for Windows lets you do background backups of your hard disk while you work with your word processor or other Windows applications. You can do full, incremental, separate incremental, differential, and full-copy backups. You can select files for backup by tagging, using wild cards, or specifying a date range. Using icons, you can back up one project with different methods.

The program includes a user-programmable reminder that prompts you to perform regular backups onto floppy disks or onto your network server. Distinct Back-Up runs over LAN Manager, Novell, Banyan, DecNet, and NFS networks.

**Price:** $129.

**Contact:** Distinct Corp., P.O. Box 3410, Saratoga, CA 95070, (408) 741-0781; fax (408) 741-0795.

**Circle 1002 on Inquiry Card.**




*Distinct Back-Up lets you tag particular directories and files for backup.*

## PC Rx Cures What Ails Your System

By incorporating an intelligent on-line filter, PC Rx constantly searches for viruses without requiring scan pattern updates. The utility from Trend Micro Devices identifies boot-sector viruses in floppy disks and quarantines the infected disks. PC Rx also monitors your hard drive, conventional and extended memory, boot sector, and .EXE and .COM files for viruses. The program can detect more than 700 known viruses, the company says, and can even alert you to the presence of unknown viruses. PC Rx runs under Windows.

**Price:** $69.

**Contact:** Trend Micro Devices, 2421 West 205th St., Suite D-100, Torrance, CA 90501, (213) 782-8190; fax (213) 328-5892.

**Circle 1001 on Inquiry Card.**


*PCRx alerts you to undiscovered viruses, claims Trend Micro Devices.*

## Network Compatibility in a Flexible Tool

By combining security and antivirus tools in a single utility, Dynamic SuperLock provides protection for your PC. Version 3.02 includes virus detection and removal, screen-burn-out protection, automatic user log-off, batch-job lockout, data-file encryption, and password protection. Dynamic SuperLock also lets you disable particular drives or write-protect them for specific users. You can use Dynamic SuperLock over Novell, LANtastic, and other networks.

**Price:** $308.

**Contact:** ElectroDynamics, Inc., 6053 Southwest Atterbury, Lawton, OK 73505, (405) 536-8762; fax (405) 536-4638.

**Circle 1003 on Inquiry Card.**

## Tape Backup for OS/2

Tape backup, data-conversion, and file transfer capabilities are included in NovaWare for OS/2. The utility from NovaStor comes with NovaBack (an archiving, backup, and restoration software package), a tool that transfers data sets between mainframes and PCs, and a data conversion utility that lets you transfer data from an input file to an output file.

The program lets you customize a system for unattended backup, and it supports a variety of backup media. NovaWare is available with an optional C programmer interface that lets you access tape drives with your own code.

**Price:** NovaBack, $295; NovaWare, $1595.

**Contact:** NovaStor Corp., 30961 Agoura Rd., Suite 109, Westlake Village, CA 91361, (818) 707-9900; fax (818) 707-9902.

**Circle 1000 on Inquiry Card.**

## Tame Your Multitasking Environment

By limiting the polling of inactive tasks open in your multitasking environment, Tame speeds up your DOS applications. The 1.6-KB TSR program redirects your CPU's attention from query activities to active tasks. The program works with Windows, Desqview, and other multitasking environments.

**Price:** $79.

**Contact:** PowerSoft, Inc., P.O. Box 956338, Duluth, GA 30136, (800) 437-4128 or (404) 418-0821; fax (404) 623-4503.

**Circle 1035 on Inquiry Card.**

## Automate Your Fax Board

TeleForm turns your fax machine into a remote data terminal by combining forms-design and scanning capabilities with send/receive fax support in a single product.

Running under Windows, TeleForm lets you design forms that can include fills, checkboxes, and artwork. Using your PC and PC fax board, you can distribute forms to selected fax machines. The recipient can fill out the form and fax it back to your PC, where TeleForm, running in background mode, receives and saves the data. The program lets you export the data in an appropriate file format, including dBase, Paradox, and DIF.

Teleform is used in forms-oriented applications (e.g., sales orders, survey compilations, and expense reports).

**Price:** $995.

**Contact:** Cardiff Software, Inc., 531 Stevens Ave., Building B, Solana Beach, CA 92075, (619) 481-2255; fax (619) 481-4198.

**Circle 1004 on Inquiry Card.**

*TeleForm uses your fax machine to send and receive forms and process the gathered information.*

## VideoDirector Turns Videos into Stars

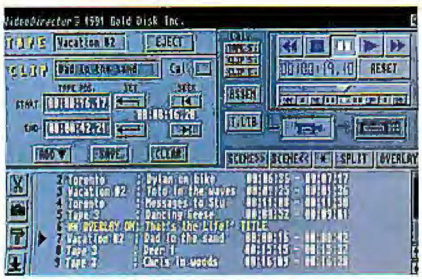
Instead of editing your home videotapes by hand, you can now use VideoDirector and your Amiga to get the job done. The system comprises VideoDirector software, an infrared remote controller, and a serial port interface for your VCR or camcorder.

To use VideoDirector, you need a source machine (either a camcorder or a VCR) with remote, control-L, or LANC inputs; a destination VCR; an Amiga computer; and a TV. The system lets you view your videos on the TV monitor and select clips using the computer to control the camcorder and VCR. VideoDirector's editing features include push-button copying and clip cutting, pasting, and grouping. The system supports Digital Creation's SuperGen genlock for addition of titles or graphics.

**Price:** $199.95.

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

**Circle 1005 on Inquiry Card.**



*VideoDirector keeps a database on each clip of your final video, including its date, content, and location on the tape.*

## Generate Macros with KeyStroke

KeyStroke runs transparently beneath DOS applications and watches for repetitive keystroke patterns. On detecting such a pattern, the program sounds a tone to alert you and automatically generates a macro.

You can use KeyStroke with word processing, database, and other programs. It lets you define your own macros and is compatible with such networks as Novell, 3Com, and Microsoft.

**Price:** $29.95.

**Contact:** Micro Logic Corp., P.O. Box 70, Department P, Hackensack, NJ 07602, (800) 342-5930 or (201) 342-6518; fax (201) 342-0370.

**Circle 1007 on Inquiry Card.**

## Street Maps Available on CD-ROM

Digitized street maps of the U.S. and Puerto Rico are now available on CD-ROM. StreetInfo for DOS incorporates data from the U.S. Census Bureau's 1990 files into a 10-disc set.

StreetInfo presents maps showing streets, address ranges per block, highways, waterways, railroad tracks, municipal boundaries, and bridges. According to MapInfo, you can combine StreetInfo's content with other DOS-based data without further processing or conversion. The program lets you overlay information for territory analysis. You can pinpoint locations on a map or enter an address to find its geographical location.

StreetInfo lets you import data from file formats such as Lotus or dBase. You simultaneously view your data as maps, graphs, or rows and columns.

**Price:** Regional discs, $3995 each; 10-disc set, $30,000.

**Contact:** MapInfo Corp., 200 Broadway, Troy, NY 12180, (800) 327-8627 or (518) 274-8673; fax (518) 274-0510.

**Circle 1006 on Inquiry Card.**


## 486/33 Features

80486 33MHZ 32 bit INTEL CPU
4MB RAM-Expandable to 32MB
AMI BIOS with Extended CMOS Setup
256K Static RAM Cache
8 Expansion Slots (ISA 16 bit)
14" SuperVGA Color Monitor, 1024x768, .28mm dot
1MB VGA Card, resolves 1024x768 at 256 colors
1.2 and 1.44 MB Floppy Disk Drives
120MB IDE Hard Drive, 19ms
Desktop Style Case (Tower Option Available)
220W Switching Power Supply
Serial, Parallel, and Game Ports
MS-DOS 5.0, Serial Mouse included
Full 1 Year Limited Warranty-Parts and Labor

| | | | |
|---|---|---|---|
| EISA System, 32 bit Bus (EISA has 7 32-bit slots, 1 16-bit slot) | add $1000 | 336MB ESDI (16ms) | add $1150 |
| Sony 1304 (non interlaced) | add $450 | 760MB ESDI (14ms) | add $1950 |
| 200MB IDE (15ms) | add $300 | 760MB SCSI (14ms) | add $2250 |
| | | ESDI/EISA 32-bit Controller | add $795 |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## 386/25 Super VGA

**42MB Hard Drive, 1MB RAM, SuperVGA**

80386 25MHZ 32 bit CPU
1MB RAM-Expandable to 16MB
14" SuperVGA Color Monitor
512K Super VGA Card
1.2MB Floppy Disk Drive (add $65 for 2nd Floppy)
42MB IDE Hard Drive, 28ms
Desktop Style Case
220W Switching Power Supply
Serial, Parallel, and Game Ports
Full 1 Year Limited Warranty-Parts and Labor

**$1295.00**

## 286 and 386 SX

**42MB Hard Drive, 1MB RAM, Mono Monitor**

1MB RAM-Exp. to 4MB(286) or 8MB(SX)
12" Monochrome TTL Monitor, 720x348 res.
MonoGraphic Card, Hercules Compatible
1.2MB Floppy Disk Drive
42MB IDE Hard Drive, 28ms
Desktop Style Case, 220W Switching PS
Serial, Parallel, and Game Ports
Full 1 Year Limited Warranty-Parts and Labor

386SX/20 **$845.00** 286/12 **$645.00**

386SX/16 **$795.00**

| | |
|---|---|
| 14" SuperVGA, 512K VRAM | add $350 |
| 80MB Hard Drive, 19ms | add $100 |
| 120MB Hard Drive, 19ms | add $200 |
| Memory Upgrade (per MB) | add $65 |


| | |
|---|---|
| MS-DOS 5.0 (with System Purchase Only) | $65 |
| Logitech Mouseman, Serial | $69 |
| Logitech Mouseman, Bus | $79 |
| Logitech Trackman, Serial | $89 |
| Logitech Grayscale Scanman | $315 |
| TEAC 1.2 Floppy | $65 |
| TEAC 1.44 Floppy w/ bracket | $69 |
| Microscience 8040, 42MB IDE HD, 23ms | $235 |
| Conner 30104, 120MB IDE HD, 19ms | $415 |
| 120MB Tape Backup | $275 |
| CM7 SuperVGA, 14" (Interlaced at 1024, .28 dot) | $345 |
| CM8 SuperVGA, 14" (Non-Interlaced 1024, .28 dot) | $475 |
| AM9 SuperVGA, 14" (Sony Tube, Non-Intl., .25 dot) | $575 |

## 386/33 Power System

**120MB Hard Drive, 4MB RAM, Super VGA**

80386 33MHZ 32 bit CPU
4MB RAM-Expandable to 32MB
64K Cache-Expandable to 128K
14" SuperVGA Color Monitor, 1024x768
512K Super VGA Card, 1024x768, 16 colors
1.2 and 1.44 MB Floppy Disk Drives
120MB IDE Hard Drive, 19ms
Desktop Style Case
220W Switching Power Supply
Serial, Parallel, and Game Ports
MS-DOS 5.0, Serial Mouse included
Full 1 Year Limited Warranty-Parts/Labor

Limited Time At This LOW LOW PRICE!!! **$1695.00**

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| Non-Int SVGA .25mm dot (Sony tube) | add $350 |
| 16" Non-Int SVGA .28mm dot | add $850 |
| 20" Non-Int SVGA ...ced | CALL |

Above Video Upgrades include 1MB VGA Card

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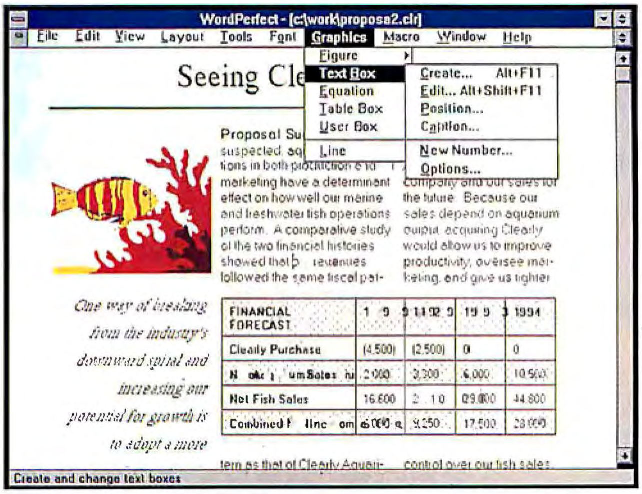
Circle 571 on Inquiry Card (RESELLERS: 572).

## WordPerfect for Windows Is Here at Last

The Windows version of WordPerfect uses typical Windows features, including a button bar that you can customize, Dynamic Data Exchange, and a ruler that you can turn on and off. WordPerfect adds its own functions to the Windows environment with tools such as menu-definable table creation, graphic-image viewing and rotation, and manual kerning. The program lets you do near-desktop-publishing-quality page layout, with ruler-based controls for column width and justification, TIFF and other file format import capabilities, word wrap, and other functions.

WordPerfect 5.1 for Windows files are compatible with WordPerfect 5. For DOS files. The Windows version also supports on-the-fly conversion of many major word processor files, including Ami Pro, Microsoft Word, WordStar, and straight ASCII text.
**Price:** $495.
**Contact:** WordPerfect Corp., 1555 North Technology Way, Orem, UT 84057, (800) 451-5151 or (801) 225-5000; fax (801) 228-5077.
**Circle 1008 on Inquiry Card.**




*You can define text style, design charts, and import graphics without ever leaving your WordPerfect document.*

## Edit Documents in DOS Character Mode

PFS:Write, Spinnaker Software's DOS-based word processor, lets you create and edit documents in DOS graphics mode (i.e., WYSIWYG). You can make changes to your documents (e.g., scaling fonts) and see the results instantly. The current version of the word processor is based on Spinnaker's Word Publisher product.

PFS:Write includes scalable fonts with the ability to view and edit in actual, reduced, or enlarged size. You can create documents with up to four columns of text.
**Price:** $129.
**Contact:** Spinnaker Software Corp., 201 Broadway, Cambridge, MA 02139, (617) 494-1200; fax (617) 494-1219.
**Circle 1010 on Inquiry Card.**

## A Writer's Toolkit for Windows

The Windows 3.0 version of the Complete Writer's Toolkit offers seven tools that integrate with word processing programs, such as Microsoft Word for Windows and Ami Pro. The program includes a new tool called the Dictionary of Common Knowledge, which has been excerpted from Houghton Mifflin's *Dictionary of Cultural Literacy* and quickly puts information regarding geography, history, literature, politics, and science at your fingertips. The Complete Writer's Toolkit also offers reverse searching; for example, to find the word that means the white of an egg, search for any definition with the words *white* and *egg*, and the dictionary will find the word *albumen*.

The seven-tool program supports all Windows word processors, according to Systems Compatibility. You can install any number of the tools.

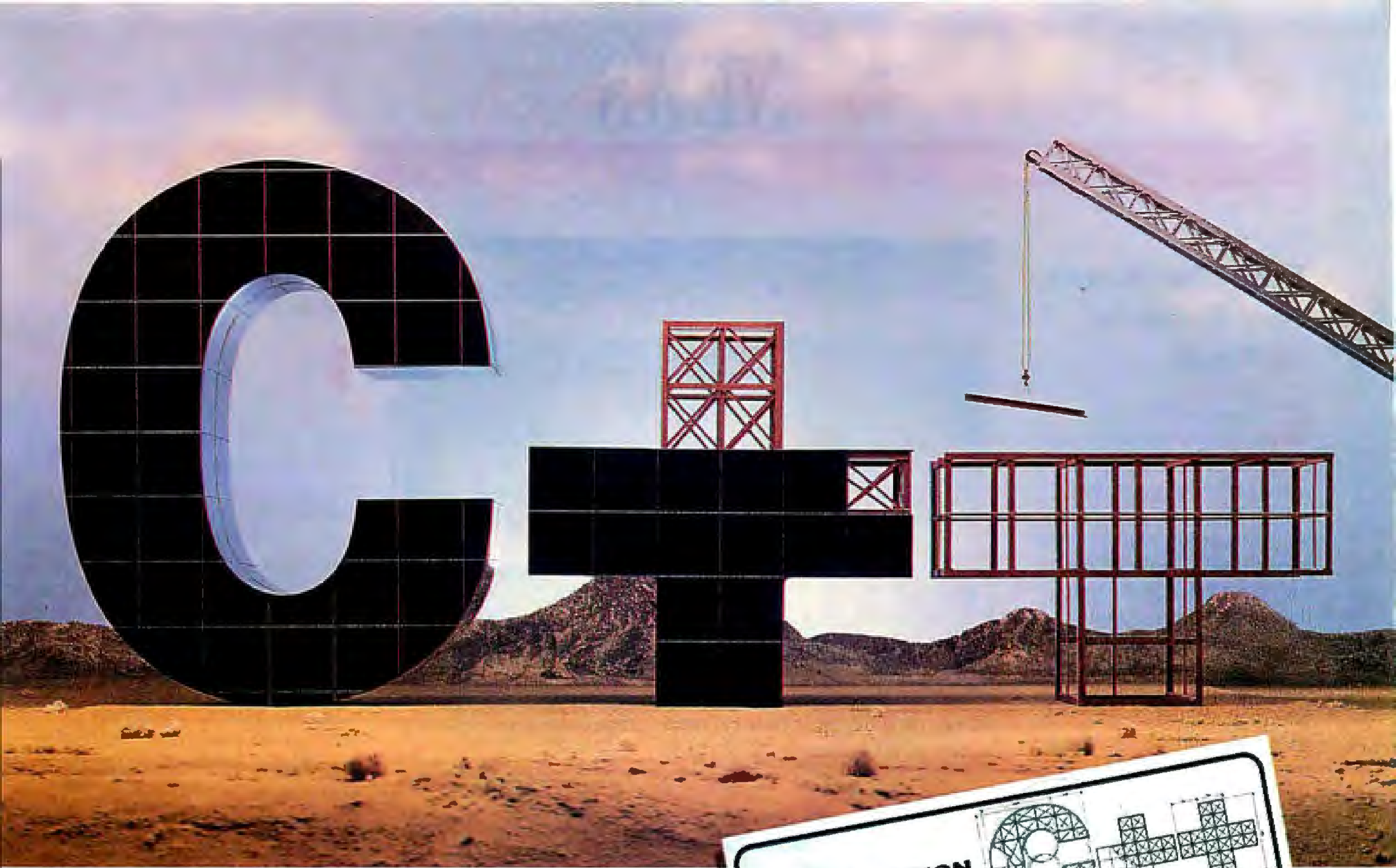
The seven tools include Houghton Mifflin's CorrecText Grammar, Style, Punctuation, and Spelling Checker; The American Heritage Dictionary; Roget's II Thesaurus; The Concise Columbia Dictionary of Quotations; Houghton Mifflin's Abbreviation Program; Written Word III—Principles of Grammar & Style; and the Dictionary of Common Knowledge.
**Price:** $129.
**Contact:** Systems Compatibility Corp., 401 North Wabash, Suite 600, Chicago, IL 60611, (312) 329-0700; fax (312) 670-0820.
**Circle 1009 on Inquiry Card.**

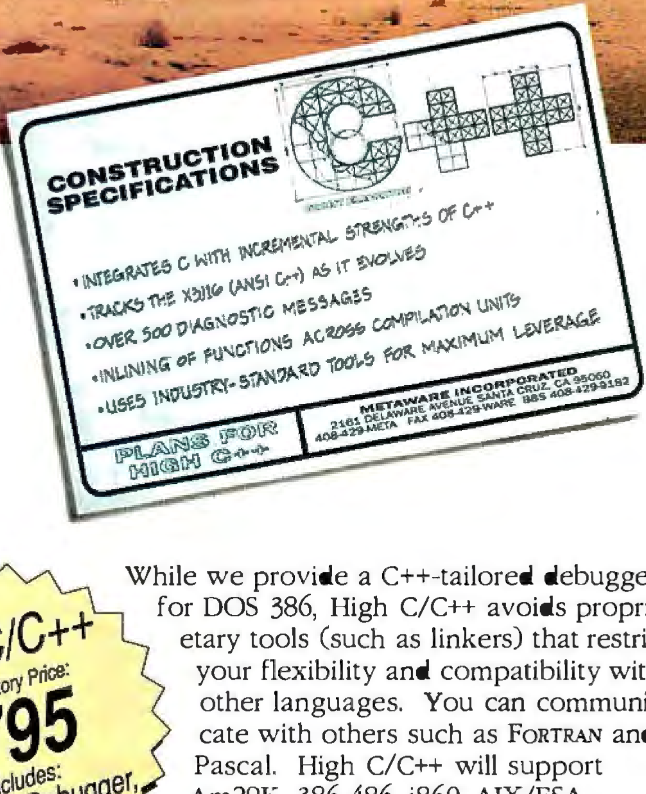
## Start-Up Develops New OCR Technology

The English-language optical character recognition program developed by ExperVision uses a technology called Machine-Learned Fragment Analysis to recognize a variety of typefaces while retaining font size, style, and formatting, including multiple columns and tables. TypeReader for Windows 3.0 is the first program from ExperVision. The company says it plans to release an MLFA-based product later in the year that will fulfill ExperVision's original mission to develop a software-only OCR program that accurately recognizes about 7000 kanji characters.

MLFA focuses on a small number of stable areas of a character that differentiate it from other letters and numbers. In MLFA, the stable fragments of the character image are seen through the eyes of a mathematical model. Character similarities and differences are identified so that the solution is narrowed to one character.

TypeReader is compatible with most scanners, including models produced by Abaton, Hewlett-Packard, and Sharp. The program runs under Windows and supports direct file output from such applications as WordPerfect, Microsoft Word, Lotus 1-2-3, and ASCII.
**Price:** $895.
**Contact:** ExperVision, Inc., 3590 North First St., San Jose, CA 95134, (408) 428-9444; fax (408) 456-0823.
**Circle 1011 on Inquiry Card.**






# *High C/C++ 32 Bits! Under Construction!*

Good News! AMD, IBM, Intel, NCR, and others have long relied on MetaWare's reputation for high-quality, 32-bit development tools. Now, with their OEM support, we're designing and building a better C++ compiler – and including with it our globally optimizing High C ®.

We began this project with our cornerstone: the rock-solid High C compiler, with advanced global optimization and 32-bit code-generation technology. Are you beginning to migrate from C to C++? MetaWare's "Incremental Strengths" feature allows you to build upon C one C++ block at a time.

High C/C++ provides a level of *intuition* and *information* not available in previous tools. Superior error, warning, and information messages help you resolve ambiguous calls. The compiler shows you which function is selected during overload resolution, or presents the choices, if ambiguous. The messages give you line *and column* numbers, and point to multiple occurrences when appropriate.

High C/C++
Introductory Price:
$795
Includes:
Compiler, Debugger, Windows ADK

While we provide a C++-tailored debugger for DOS 386, High C/C++ avoids proprietary tools (such as linkers) that restrict your flexibility and compatibility with other languages. You can communicate with others such as FORTRAN and Pascal. High C/C++ will support Am29K, 386-486, i860, AIX/ESA, 680x0, and SPARC.

High C/C++ will be the intelligent choice for professional developers.

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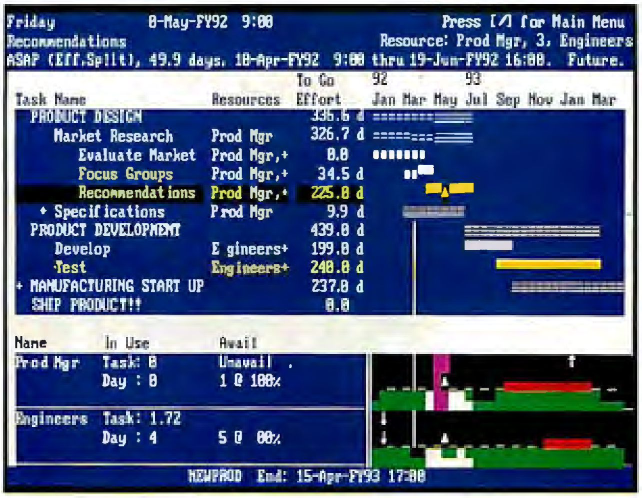
**Circle 573 on Inquiry Card.**

## Time Line Keeps Your Projects on Track

Enhancements to Symantec's project management program provide managers with improved scheduling, data-modeling, and workgroup-connectivity capabilities. Tools such as individual resource calendars, task splitting, and multiple-project resource leveling let you schedule the progress of your projects based on related events, such as employee vacations, resource availability, and staff changes.

The DOS-based program lets you define more than 160 data columns. You can import files directly from Symantec's Windows project planner, On Target, and you can link to On Target schedules. You can share schedules over most networks, including Novell NetWare and IBM Token Ring.
**Price:** $699; network nodes, $599.
**Contact:** Symantec Corp., 10201 Torre Ave., Cupertino, CA 95014, (408) 253-9600; fax (408) 253-4092.
**Circle 1012 on Inquiry Card.**

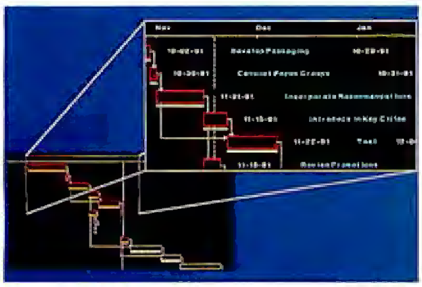



*Time Line illustrates your personnel, time, and other resources to help keep your projects on track.*

## Track 16,000 Resources with One Program

The new version of InstaPlan EMS project management software features enhancements to its preview- and output-device capabilities. InstaPlan EMS 4.0 lets you examine and change your charts and reports before you print them. You can keep track of 16,000 resources per project, and members of your project team can access the program via Novell and 3Com networks.

InstaPlan's other new features include support for a mouse, support for all PostScript output devices, and a zoom tool for closer examination of certain areas of your chart. The cost management function alerts you to overscheduled resources, and the program uses a large question mark to call your attention to conflicts and impending deadlines.
**Price:** $549.
**Contact:** Micro Planning International, Inc., 655 Redwood Hwy., Suite 311, Mill Valley, CA 94941, (415) 389-1420; fax (415) 389-8046.
**Circle 1014 on Inquiry Card.**



*InstaPlan's new zoom feature lets you view PERT-Gantt charts in detail.*

## Project Management for Windows

Executive for Windows 3.0 offers personal and group management under Windows 3.0. It has Message Handling Service-compatible E-mail, a multiuser database, a group scheduler, a word processor, and integrated desktop tools.

Executive for Windows' desktop tools include a deadline monitor, a calendar, a telephone directory, and a message system. The multiuser database is dBase III Plus compatible, and the hypertext word processor can import and export files to Microsoft Word for Windows, WordPerfect, and ASCII. The program's group scheduler can automatically find the best time for a meeting. The program is NetBIOS compatible.
**Price:** $249; six-user LAN license, $445.
**Contact:** FinalSoft Corp., Atrium Office Park, 3900 Northwest 79th Ave., Suite 215, Miami, FL 33166, (800) 232-8228 or (305) 477-2703; fax (305) 477-0680.
**Circle 1013 on Inquiry Card.**

## Negotiate Like A Pro

The Windows version of Negotiator Pro has been introduced by its developer. Negotiator Pro supports Windows' Dynamic Data Exchange, allowing you to merge the program's expert advice with data from such applications as spreadsheets, word processors, and databases.

Negotiator Pro gives you insight into cross-cultural, international, and gender relations. The personality-profile tool anticipates your negotiation style and that of your opponent. To help you keep track of all this information, the program contains a planning feature.
**Price:** $999.
**Contact:** Beacon Expert Systems, Inc., 35 Gardner Rd., Brookline, MA 02146, (617) 738-9300; fax (617) 734-3308.
**Circle 1015 on Inquiry Card.**

## WAN Scheduling Via E-Mail

Calandar provides networked DOS users with appointment- and task-scheduling tools. The program distributes scheduling data via E-mail. Calandar includes support for cc:Mail, Banyan Vines Mail, and other E-mail packages.
**Price:** 10-user license, $395; 50-user license, $695.
**Contact:** Microsystems Software, Inc., 600 Worcester Rd., Framingham, MA 01701 (508) 626-8511; fax (508) 626-8515.
**Circle 1034 on Inquiry Card.**


It has recently become apparent that upgradable, modular computer systems are an excellent approach to preserving a buyer's investment.

SUMEX Corporation is introducing a new, low-cost upgradable computer system line called DATAstation/M. It is upgradable from 386SX to 386DX to 486SX to 486DX by changing a single Processor Module. This upgrade procedure is very simple. It does not require any jumper or switch settings. The system will automatically reconfigure. The system memory will also automatically rescale to match the CPU Module (16-bit or 32-bit) so that no "bottleneck" is created to hinder the CPU performance.

| | Upgradable | | Non-upgradable | |
|---|---|---|---|---|
| | SUMEX | AST | Dell | PCBrand |
| 386SX CPU | 25MHz | 16MHz | 20MHz | 25MHz |
| Memory | 2MB | 2MB | 2MB | 2MB |
| 1.2MB FD | Included | Included | Included | Included |
| 1.44MB FD | Included | Not incl. | Included | Included |
| Hard Disk | 40MB | 40MB | 40MB | 40MB |
| Serial Port | 2 | 2 | 2 | 2 |
| Parallel Port | 1 | 1 | 1 | 1 |
| Mouse Port | 1 | 1 | 1 | 1 |
| Mouse | Included | Not incl. | Included | Included |
| VGA Card | 1MB | Not incl. | 1MB | 1MB |
| VGA Monitor | 1024x768 | Not incl. | 1024x768 | 1024x768 |
| MS DOS 5.0 | Included | Not incl. | Included | Included |
| Windows | Included | Not incl. | Included | Included |
| Price | $1,595 | $2,895 | $2,516 | $1,825 |

SUMEX Corporation, incorporated in 1985, is engaged in the development, manufacture and marketing of "upgradable, modular computers". Following the current introduction, there will be a high-power, 32-bit EISA-MCA based modular computer product line. SUMEX is a company that dares to innovate.

SUMEX Corporation is also poised to grow. The leading-edge technologies, competitive pricing, and commitment to total customer satisfaction are some of the solid building blocks for SUMEX Corporation's growth.

Give us a call today and find out how you can better preserve your computer investment.

## DATAstation/M

Modular, Upgradable Systems

**386DX/33** **$2,395**
*4MB RAM, 64KB Cache, 120MB HD*

**486SX/25** **$2,795**
*4MB RAM, 64KB Cache, 120MB HD*

**486DX/33** **$3,395**
*4MB RAM, 64KB Cache, 200MB HD*

*DATAstation/M includes SVGA, Mouse, Windows 3.0, and DOS 5.0*

## BEST BUY 386SX...$879

- 1MB RAM
- 1.2MB OR 1.44MB FD
- 40MB IDE HD (1:1)
- 2 Serial / 1 Parallel Ports
- 101 Key Keyboard
- 1MB SVGA Card
- SVGA Monitor (1024x768)
- Desktop or Mini Tower Case

## 3 Workstation Network...$2599

- 386SX-16MHz
- 1MB RAM
- 1.2MB OR 1.44MB FD
- 40MB IDE HD (1:1)
- 2 Serial / 1 Parallel Ports
- 101 Key Keyboard
- Monochrome Monitor
- Hardware/Cables/Software

*Other systems and configurations available - call for details.*

## NOTEBOOK PC 386SX-20...$1695

- 2MB RAM exp. to 8MB
- 3.5" 1.44MB FD
- 60MB HD (opt. 120MB)
- 2 Serial / 1 Parallel / VGA Ports
- Dual Batteries (5 hours)
- Built-in AC & Car Adaptors
- Carrying Case / MS-DOS
- 6.38 lbs including batteries

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Prices & specifications subject to change without notice. Call for details of terms & conditions. All trademarks belong to their respective companies. *Refunds do not include shipping & handling charges. Return Authorization Number is required before returning products.

**Circle 576 on Inquiry Card.**

## Take Your Inventory over the LAN

PC Census, a program that scans PCs to identify the applications and add-in cards installed at your business, now collects this information over a LAN. If the program encounters an unknown system or application, you can add brand and model data at the PC, and the program will remember the fingerprint for future reference.

PC Census has two pieces of software: A collector scans the PCs to take an inventory, and the administrator loads the scan results and creates a dBase-compatible database. From that data, the program can generate reports indicating what applications you use in a business and which PC is supposed to have a specific hardware card. PC Census identifies major applications down to their version number, and it can also identify hardware by model and manufacturer.

**Price:** 20-PC starter kit, $295; volume discounts are available.

**Contact:** Tally Systems Corp., Buck Rd., P.O. Box 70, Hanover, NH 03755, (800) 262-3877 or (603) 643-1300; fax(603) 643-9366.

**Circle 1019 on Inquiry Card.**


*PC Census scans your system's hardware and software and provides manufacturer and serial-number data.*

## A Terminal Emulator Plus Two

A new database utility, terminal emulator, and office automation system make up IMS Soft's suite of business programs. DataFlow lets you view, format, search, and sort dBase, Paradox, and ASCII text files. You can customize your data format and create data links between files. The program features pattern-finding and -selection capabilities.

According to IMS Soft, InfoTerm lets you emulate TeleVideo, Wyse, and other terminals on your PC. InfoTerm uses Novell's TCP/IP and can support rates of up to 38,400 bps.

The Linked Electronic Office package for Unix features word processing, E-mail, a calendar, and scheduling tools. You can integrate LEO with other software and have it function as client and server.

**Price:** $89.95 for DataFlow and InfoTerm; pricing for LEO not yet determined.

**Contact:** IMS Soft, 15760 Ventura Blvd., Suite A-5, Encino, CA 91436, (818) 784-6890; fax (818) 784-6552.

**Circle 1017 on Inquiry Card.**

## Meet Your Office Needs with POS

The Personal Office Series offers novice PC users a trio of GUI-based applications at a reasonable price. POS comprises GeoWorks Writer, Designer, and Desktop. Each of the programs includes a run-time version of the company's PC/GEOS graphical-computing environment and features full WYSIWYG.

GeoWorks Writer is a word processor that features mouse-driven desktop publishing tools. Writer lets you select and modify typefaces, format columns, and import graphics. The design program provides extensive graphics tools, clip art, and templates. Desktop features a disk and file manager with a personal information system. The program includes a DOS shell, a file manager, a calendar, and the GeoComm communications program.

**Price:** $69.99 per program.

**Contact:** GeoWorks, 2150 Shattuck Ave., Berkeley, CA 94704, (510) 644-0883; fax (510) 644-0928.

**Circle 1016 on Inquiry Card.**

## Windows Form Designer

WindForm, a program for creating, editing, and managing forms in Windows 3.0, lets you fill forms with data and store the data in ASCII format. A TSR overlay manager lets you overlay fonts or forms on top of any application data, a feature that lets you use the forms' formats in a DOS environment.

WindForm lets you merge data from other applications into a form and can scan and import graphics files. It ships with a Hewlett-Packard ScanJet scanner driver.

**Price:** $179.95.

**Contact:** Ibis Software, Inc., 625 Second St., Suite 308, San Francisco, CA 94107, (415) 546-1917; fax (415) 546-0361.

**Circle 1020 on Inquiry Card.**

## Templates for Your Favorite Spreadsheet

Templates developed and documented by financial experts from *CFO Magazine* are now available in a program for Lotus 1-2-3, Quattro Pro, and Excel. CFO Spreadsheet Applications are available as single modules or as a four-package set.

The four modules are cash management, tax strategies, capital budgeting, and advanced topics, with six templates provided for each topic.

**Price:** Single modules, $99.95; complete set, $299.95.

**Contact:** Intex Solutions, Inc., 35 Highland Cir., Needham, MA 02194, (617) 449-6222.

**Circle 1018 on Inquiry Card.**

## Graphics Tools for the Nonartist

The developer of the high-end paint program PC Paintbrush now offers an entry-level image editor aimed at business users. PhotoFinish lets you enhance scanned photos, drawings, or clip art and import the images into drawing, word processing, presentation, or layout applications.

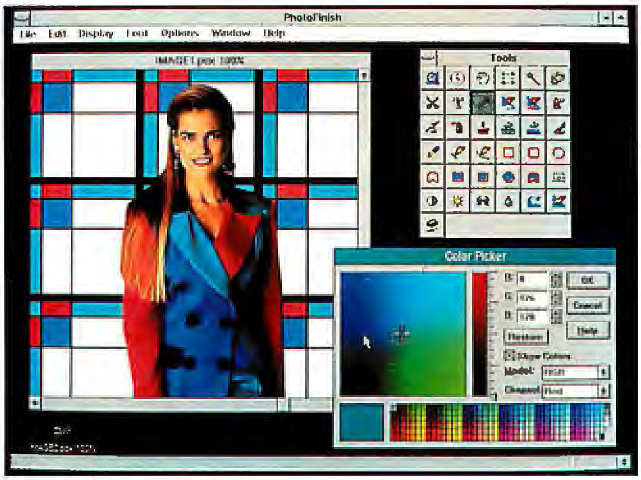
You can use the program to convert images between 256-color or gray scale, 24-bit color, or 16-bit color. Graphics tools include fountain pen, airbrush, and special effects (e.g., motion-blur and cloning).

PhotoFinish runs under Windows and supports practically every image scanner on the market, according to ZSoft. The program supports PCX, BMP, and other file formats, and it is compatible with applications by Aldus, Microsoft, and other vendors.

**Price:** $199.

**Contact:** ZSoft Corp., 450 Franklin Rd., Suite 100, Marietta, GA 30067, (404) 428-0008; fax (404) 427-1150.

**Circle 1023 on Inquiry Card.**




*PhotoFinish's toolbox (upper right) lets you group related tools under a single icon. The program lets you print poster-size output to multiple pages.*

## Merge Graphics with Striking Results

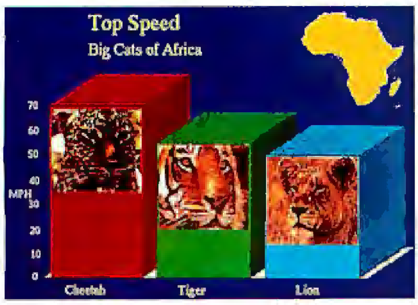
The Juggler incorporates graphics-file conversion and image enhancement with drawing capabilities in a Windows package. This combination lets you use high-quality graphics in word processing, desktop publishing, and presentation applications.

You can use the Juggler to import, combine, and merge multiple images of different formats. The program converts images to the new file format for integration into such applications as WordPerfect, Corel Draw, and PC Paintbrush. The Juggler's image-enhancement features include stretch, flip, rotate, and clip. You can control the colors, gray scales, contrast, and brightness of your graphics.

**Price:** $249.95.

**Contact:** Jewell Technologies, 130 Nickerson St., Suite 105, Seattle, WA 98109, (800) 284-2574 or (206) 285-6860; fax (206) 285-7340.

**Circle 1022 on Inquiry Card.**




*You can use the Juggler to merge and overlay unlimited numbers of images regardless of their formats.*

## Graphicway Leaps from QNX to Windows 3.0

Graphicway, the presentation software for the QNX and DOS operating systems, is now available in a Windows 3.0 version that combines high-end illustration, text, and charting. Graphicway for Windows supports extrusion, 128 predefined charts, and conversion of Type 1 Adobe fonts to Bézier curves. It can also convert text to Bézier curves. The program lets you work in wireframe and preview mode and supports WYSIWYG editing. It comes with a library of clip art and can fit text to any path, Tilcon says.

Graphicway is also available in a version for developers. You can embed Graphicway in an existing application to generate graphical reports from any ASCII source.

**Price:** $495; developer's edition, $695.

**Contact:** Tilcon Software, Ltd., 38 Antares Dr., Suite 300, Nepean, Ontario, Canada K2E 7V2, (800) 665-5928 or (613) 226-3917; fax (613) 226-3631.

**Circle 1021 on Inquiry Card.**

## GIF Provides Extensive Graphics Tools

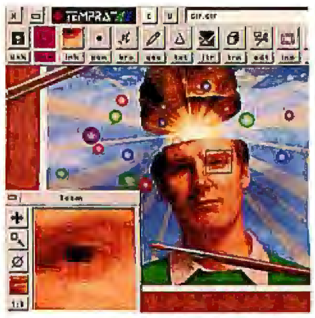
Painting, image processing, and video capture are just a few of the graphics tools that Tempra GIF has to offer. You can use GIF on your Windows, DOS, or OS/2 system to perform such image-editing functions as washing, blending, antialiasing, free-hand drawing, and palette adjustment. The program includes 256 colors, patterns, pens, and geometric tools (e.g., lines and polygons). Image-file formats supported by Tempra GIF include TIFF, WIN, GIF, and PCX.

When used with Digital Vision's ComputerEyes/RT video digitizing board, GIF is capable of real-time video capture. Once you've captured your video images, GIF lets you do frame-by-frame image editing.

**Price:** $149.

**Contact:** Mathematica, Inc., 402 South Kentucky Ave., Lakeland, FL 33801, (800) 852-6284 or (813) 682-1128; fax (813) 686-5969.

**Circle 1024 on Inquiry Card.**



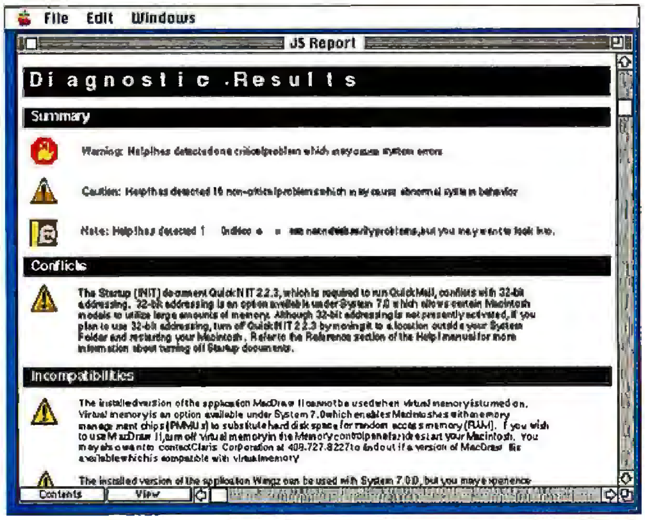

*With a price tag of $149, Tempra GIF will blow your mind.*

Circle 578 on Inquiry Card.

## Help Is on the Way

System compatibility testing is now available for your Macintosh hardware and software. Help identifies problems with start-up documents, system settings, improperly installed files, damaged files, and insufficient memory. The program also tests for incompatibilities between system hardware and software, and applications and system software (including System 7.0).

After determining where the snags in your system are, Help outlines the steps you must take to resolve them. Teknosys offers a subscription service that provides users with quarterly updates of the program's knowledge base and any software upgrades that are released.



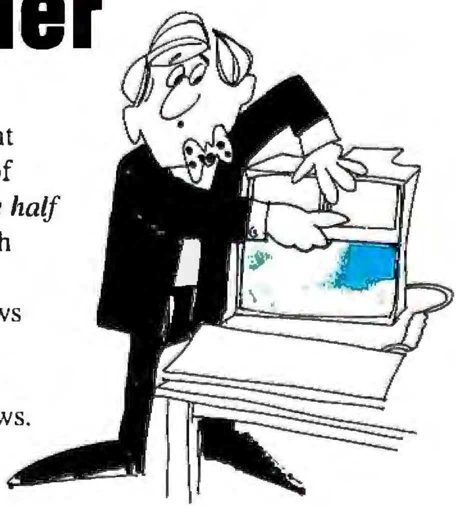

*Help discovered one critical problem for this user: The start-up document conflicts with 32-bit addressing.*

**Price:** $149; annual subscription, $75.
**Contact:** Teknosys, Inc., 3923 Coconut Palm Dr., Suite 111, Tampa, FL 33619, (813) 620-3494; fax (813) 620-4039.
**Circle 1025 on Inquiry Card.**

## Here's Help for Your Help Desk

Support Express offers features that allow you to answer questions quickly, track requests, and report on the activities of the help desk. You can use the customer's description of a problem as text in searching the database for a solution. Support Express delivers acceptable performance on 286 and lower machines, the company says.
**Price:** $1495; five-user LAN version, $2495.
**Contact:** Software Marketing Group, Inc., 108 Third St., Suite 201, Des Moines, IA 50309, (800) 395-0209 or (515) 284-0209; fax (515) 284-5147.
**Circle 1026 on Inquiry Card.**





# EasyCAD 2– the #1 Rated CAD Software


## Number 1 in user satisfaction–PC Week poll.

In competition against other top CAD software for performance, hardware compatibility, ease of use and value, EasyCAD 2 handily won the award that counts most–User Satisfaction (1989, 1990). Now the best is even better.

### You Pay Only $199.00 for the Program CAD Users Rate Number 1.

PC WORLD said it best, "This easy-to-learn program is blindingly fast, and its flexibility, wealth of features and excellent user interface match those of professional programs costing thousands of dollars more."

In fact, because it is written entirely in assembly language experts say EasyCAD 2's speed rivals CAD packages costing up to twenty times more.

So why spend well over $2000 to get what EasyCAD 2 can deliver for just $199.00?

### Expanded, productivity-boosting associative dimensioning.

EasyCAD 2's associative dimensioning feature allows you to rotate, stretch or change the scale factor of a drawing and all dimensions are instantly updated to reflect the change. This includes ordinate, angle, radius and diameter as well as other dimension formats. You never have to erase or re-enter dimensions.

### Whisk through even the largest drawings.

An enhanced memory manager lets you work through the largest drawings faster than ever.


Plot to file means you can store drawings on disk now and send it to the printer later. And it supports PostScript printer fonts and line weight controls.

### More features, less money–guaranteed.

No other CAD software gives you so many features for so little money (and a 30-day money back guarantee): Customizeable pull-down menus, script and macro capabilities that automate complex or repetitive tasks, DXF for exchanging drawings and files with other CAD programs and spread sheets. The list goes on.

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# 1992 BYTE *Readers' C*

*Instructions*: For each of the following categories (where appropriate), please check the product you consider **BEST** for business use. Chec

### Desktop Computer – PC
- A LBRu ss i VnE el 386 ☐1 386SX ☐2 486 ☐3 486SX ☐4
- AST Premium II.... 386 ☐5 386SX ☐6 486 ☐7 486SX ☐8
- Compuadd.......... 386 ☐9 386SX ☐10 486 ☐11 486SX ☐12
- Compaq DeskPro.. 386 ☐13 386SX ☐14 486 ☐15 486SX ☐16
- Dell System......... 386 ☐17 386SX ☐18 486 ☐19 486SX ☐20
- EverexStep ........ 386 ☐21 386SX ☐22 486 ☐23 486SX ☐24
- Gateway 2000.... 386 ☐25 386SX ☐26 486 ☐27 486SX ☐28
- Hewlett-Packard Vectra 386 ☐29 386SX ☐30 486 ☐31 486SX ☐32
- IBM PS/2........... 386 ☐33 386SX ☐34 486 ☐35 486SX ☐36
- NCR.................. 386 ☐37 386SX ☐38 486 ☐39 486SX ☐40
- Northgate. ...... 386 ☐41 386SX ☐42 486 ☐43 486SX ☐44
- Tandon.... 386 ☐45 386SX ☐46 486 ☐47 486SX ☐48
- Tandy. ........ 386 ☐49 386SX ☐50 486 ☐51 486SX ☐52
- Zeos.... ........ 386 ☐53 386SX ☐54 486 ☐55 486SX ☐5 6
- Other PC desktop: ______

### Desktop Computer – Macintosh
- Apple Macintosh Classic or Classic II........ ☐1
- Apple Macintosh IIfx........ ☐2
- Apple Macintosh IIsi........ ☐3
- Apple Macintosh IIci/IIcx........ ☐4
- Apple Macintosh LC........ ☐5
- Apple Macintosh Quadra........ ☐6
- Other Apple Macintosh: ______ ☐7

### Workstation
- DEC, write in model: ______ ☐1-
- Hewlett-Packard 9000........ ☐5
- IBM RS/6000........ ☐6
- MIPS, write in mc ______ ☐7-
- NeXT Dimension........ ☐10
- Silicon Graphics Iris........ ☐11
- Sun SPARCstation ELC........ ☐12
- Sun SPARCstation IPX........ ☐13
- Other workstation: ______ ☐14

### Modem, 9600 bps
- Hayes Optima 96........ ☐1
- Hayes Ultra 96........ ☐2
- Intel 9600EX........ ☐3
- Multi-Tech, write in model: ______ ☐4-
- Practical Peripherals PM9600SA........ ☐8
- Prometheus ProModem Ultima........ ☐9
- Racal Vadic, write in model: ______ ☐10-
- Telebit QBlazer........ ☐13
- UDS FasTalk V.3........ ☐14
- USRobotics, writ ______ ☐15-
- Other modem: ______ ☐18-

### Portable/Notebook Computer
- Apple Macintosh Powerbook........ ☐1
- AST Premium Exec........ ☐2
- AT&T Safari NSX/20........ ☐3
- Compaq LTE 386s/20........ ☐4
- Dell NX20........ ☐5
- Everex Tempo LX........ ☐6
- IBM L40SX........ ☐7
- NEC U ltralite........ ☐8
- Sharp 6200........ ☐9
- Tandy 3810 HD........ ☐10
- Texas Instruments T inSX........ ☐11
- Toshiba T2000SXe........ ☐12
- Toshiba T2200SX........ ☐13
- Zenith MastersPort........ ☐14
- Zeos Notebook 386........ ☐15
- Other portable/notebook ______ ☐16

### Handheld/F
- Atari Portfolio........ ☐1
- Casio Boss........ ☐2
- Hewlett-Pack........ ☐3
- Psion........ ☐4
- Poqet........ ☐5
- Sharp Wizard........ ☐6
- Other handheld/palmtop: ______ ☐7

### Monitor
- Apple Color RGB........ ☐1
- Mitsubishi Diamond Scan 16L........ ☐2
- Nanao T560i........ ☐3
- NEC MultiSync FG........ ☐4
- Panasonic P1395........ ☐5
- Radius, write in model: ______ ☐6
- RasterOps, write model: ______ ☐9-
- Tatung, write in ______ ☐12-
- ViewSonic 7........ ☐15
- Other monitor: ______ ☐16

### Laser Printer
- Apple LaserWriter IIg........ ☐1
- Apple Personal LaserWriter II NT........ ☐2
- Canon LBP-4 Plus........ ☐3
- GCC Technologies B........ ☐4
- Hewlett-Packard IIp F........ ☐5
- Hewlett-Packard IIIp........ ☐6
- Hewlet-Packard IIIsi........ ☐7
- IBM LaserPrinter 10........ ☐8
- Okidata OL830........ ☐9
- NEC Silentwriter........ ☐10
- QMS 410........ ☐11
- QMS 815/825........ ☐12
- Texas Instruments MicroLaser........ ☐13
- Other laser printer: ______ ☐14

### Video Board – MS-DOS/Windows
- ATI 8514 Ultra........ ☐1
- ATI VGA Wonder XL........ ☐2
- Boca SuperVGA........ ☐3
- Cardinal VGA732........ ☐4
- Hercules, write in model: ______ ☐5-
- Orchid ProDesigner IIS........ ☐8
- Paradise (W. Digital), wri ______ ☐9-
- Video Seven VRAM II........ ☐13
- Other video board: ______ ☐14

### Video Board – Macintosh
- Apple 8•24GC........ ☐1
- Radius Precision Col........ ☐2
- RasterOps 24XLTV........ ☐3
- Supermac Thunder/24........ ☐4
- Other video board: ______ ☐5

### Word Processing – MS-DOS/Windows
- Describe........ ☐1
- Lotus Ami Pro 2.0........ ☐2
- Microsoft Word 5.x........ ☐3
- Microsoft Word for W........ ☐4
- NBI Legacy 1.x........ ☐5
- SPC Professional Write 2.x........ ☐6
- SPC Professional Write Plus........ ☐7
- WordPerfect 5.1........ ☐8
- WordStar Professional 6........ ☐9
- WordStar for Windows........ ☐10
- Other word processor: ______ ☐11

### Word Processing – Macintosh
- ClarisMacWrite II 1.x........ ☐1
- Microsoft Word 5.0........ ☐2
- Paragon Concepts N........ ☐3
- T/Maker WriteNow 2........ ☐4
- WordPerfect 2.x........ ☐5
- Other Mac word processor: ______ ☐6

### CAD – MS-DOS/Windows
- American Small Business Computers DesignCAD 3D ☐1
- Ashlar Vellum for Windows........ ☐2
- Autodesk AutoCAD 11........ ☐3
- Autodesk AutoSketch........ ☐4
- Computervision DesignView 2.x........ ☐5
- Evolution Computing EasyCad 2........ ☐6
- Evolution Computing FastCad........ ☐7
- Foresight Drafix CAD Ultra/3E........ ☐8
- Foresight Drafix Windows CA........ ☐9
- Generic CADD 5.x........ ☐10
- Intergraph Microstation........ ☐11
- Other DOS/Windows CAD ______ ☐12

### CAD – Macintosh
- Ashlar Vellum........ ☐1
- Claris CAD........ ☐2
- DesignCAD Macintosh........ ☐3
- Other Macintosh CAD: ______ ☐4

### Contact Managers/PIMs
- askSam........ ☐1
- Chronologic Instant Recall 2.x........ ☐2
- Chronos Software Who What W........ ☐3
- Contact Software ACT 2.x........ ☐4
- Lotus Agenda 2.x........ ☐5
- Micrologic Info Select 2.x........ ☐6
- Polaris PackRat 4.0........ ☐7
- Prisma Software Your Way........ ☐8
- Richmond Technologies Maximizer........ ☐9
- Other contact manager: ______ ☐10

### Database Managers, Programmable – MS-DOS/Windows
- Blyth Omnis V........ ☐1
- Borland dBase IV........ ☐2
- Borland Paradox 3.x........ ☐3
- Clarion Professional Develope........ ☐4
- Computer Associates DBFast........ ☐5
- DataEase........ ☐6
- Fox FoxPro 2.0........ ☐7
- Microrim Rbase........ ☐8
- Nantucket Clipp........ ☐9
- Oracle 6.2........ ☐10
- Software Publishing Superbase 4........ ☐11
- Other DOS/Windows database: ______ ☐12

### Database Managers, Programmable – Macintosh
- Acius 4th Dimension........ ☐1
- Blyth Omnis........ ☐2
- Claris FileMaker........ ☐3
- Other Mac database ______ ☐4

### Database Client/Server
- Microsoft/Sybase SQL Server........ ☐1
- Gupta SQLbase Server........ ☐2
- Novell Netware........ ☐3
- Oracle Server........ ☐4
- Other database client/server: ______ ☐5

# Choice Awards Survey

k only **ONE** item per category. Fold survey and return, no postage necessary, or fax to (603)924-2530.

## Desktop Publishing – MS-DOS/Windows
- Aldus PageMaker 4.0 for Windows ☐ 1
- Logitech Finesse ☐ 2
- Microsoft Publisher 1.x for Windc ☐ 3
- Power Up Express Publisher 2.x ☐ 4
- Spinnaker PFS: First Publisher ☐ 5
- Timeworks Publish It ☐ 6
- Unison World Avagio ☐ 7
- Ventura Publisher 4.x for Windows ☐ 8
- Other DOS/Windows DTP: ________ ☐ 9

## Desktop Publishing – Macintosh
- Aldus PageMaker 4.x ☐ 1
- Letraset Design Studio ☐ 2
- Timeworks Publish It 2. ☐ 3
- QuarkXPress 3.x ☐ 4
- Ventura Publisher ☐ 5
- Other Mac DTP: ________ ☐ 6

## Desktop Publishing – UNIX
- Elan Avalon Publisher ☐ 1
- FrameMaker ☐ 2
- Interleaf TPS/Slim ☐ 3
- Island Write/Paint/Draw ☐ 4
- Other UNIX DTP: ________ ☐ 5

## E-Mail and Workgroup – DOS/Windows
- Action Technologies The Coordinator II ☐ 1
- Access Technology forComment ☐ 2
- DaVinci Email for Windows ☐ 3
- Enable Software Higgins ☐ 4
- Lotus CC:Mail ☐ 5
- Lotus Notes ☐ 6
- Microsoft Mail ☐ 7
- WordPerfect Office ☐ 8
- Other E-mail/workgroup: ________ ☐ 9

## E-Mail and Workgroup – Macintosh
- Lotus CC:Mail ☐ 1
- Microsoft Mail ☐ 2
- Other E-mail/workgroup: ________ ☐ 3

## Graphics – MS-DOS/Windows
- Adobe Illustrator 4.0 ☐ 1
- Aldus Freehand ☐ 2
- Artline 2.x ☐ 3
- Autodesk 3D Studio ☐ 4
- Computer Associates Cricket Graph 1.x ☐ 5
- Computer Support Arts & Letters 3.x ☐ 6
- Corel Draw 2.x for Windows ☐ 7
- Electronic Arts Deluxe Paint II ☐ 8
- Lotus Freelance Graphics for Windows ☐ 9
- Micrografx Designer ☐ 10
- RIX Softworks WinRix ☐ 11
- SPC Harvard Draw for Windows ☐ 12
- ZSoft Publisher's Paintbrush for Windows ☐ 13
- Other DOS/Windows graphics: ________ ☐ 14

## Graphics – Macintosh
- Adobe Illustrator 3.x ☐ 1
- Claris MacDraw Pro ☐ 2
- Deneba Canvas 3.x ☐ 3
- Electronic Arts Studio/32 1.1 ☐ 4
- Other Mac graphics: ________ ☐ 5

## Network Operating Systems – DOS/OS/2
- Artisoft LANtastic ☐ 1
- Banyan VINES 4.x ☐ 2
- Microsoft LAN Manager 2.x ☐ 3
- Novell NetWare 3.11 ☐ 4
- Novell NetWare 286 ☐ 5
- Performance Technology PowerLAN ☐ 6
- Other DOS/OS/2 network OS: ________ ☐ 7

## Network Operating Systems – Macintosh
- Apple AppleShare 3.0 ☐ 1
- Novell NetWare ☐ 2
- Sitka TOPS 3.x ☐ 3
- Other Macnetwork OS: ________ ☐ 4

## Memory Managers
- Helix Software Netroom ☐ 1
- PharLap 386/vmm ☐ 2
- Qualitas 386Max 5.x ☐ 3
- Quarterdeck QEMM 386 ☐ 4
- Other memory mgr: ________ ☐ 5

## Optical Character Recognition
- CaereOmnipage Professional 1.x ☐ 1
- Calera WordScan+ ☐ 2
- OCR Systems Read Right 3.x for Windows ☐ 3
- Other OCR: ________ ☐ 4

## Operating Systems/Environments
- Apple System 7.0 ☐ 1
- Digital Research DR-DO ☐ 2
- Geoworks Ensemble 1.x ☐ 3
- Hewlett-Packard New W ☐ 4
- IBM OS/2 1.x/2.x ☐ 5
- Interactive UNIX ☐ 6
- Microsoft MS-DO ☐ 7
- Microsoft Windows 3.0 ☐ 8
- Quarterdeck DesqView ☐ 9
- SCO Open Desktop ☐ 10
- Sun SunView ☐ 11
- Sunsoft Solaris ☐ 12
- Other OS: ________ ☐ 13

## Programming Language – DOS/Windows
- Asymetrix Tool Book ☐ 1
- Borland ObjectVision 2.x ☐ 2
- Borland Turbo C ++ ☐ 3
- Borland Turbo Pas 6.x ☐ 4
- Microsoft BASIC 7 ☐ 5
- Microsoft C 6.x ☐ 6
- Microsoft QuickBASIC 4.x ☐ 7
- Microsoft QuickC 2.x ☐ 8
- Microsoft Visual BASIC ☐ 9
- Watcom C8.5/386 ☐ 10
- Whitewater Group Actor 3.x ☐ 11
- Within Realizer ☐ 12
- Zortech C ++ 2.x ☐ 13
- Other programming language: ________ ☐ 14

## Programming Language – Macintosh
- Apple MPW ☐ 1
- Claris HyperCard 2.x ☐ 2
- Silicon Beach Supercard 1.x ☐ 3
- Symantec Think Pascal 3.x ☐ 4
- Symantec Think C ☐ 5
- TGS Prograph 2.x ☐ 6
- Zortech C ++ 2.x ☐ 7
- Other programming language ________ ☐ 8

## Project Management
- Computer Associates SuperProject ☐ 1
- Harvard Project Manager ☐ 2
- Instaplan 5000 ☐ 3
- Microman ☐ 4
- Micro Planner International ☐ 5
- Microsoft Project 1.x for Windows ☐ 6
- Primavera SureTrak Project Scheduler ☐ 7
- Symantec On Target ☐ 8
- Symantec TimeLine 5.0 ☐ 9
- Other project mgr: ________ ☐ 10

## Spreadsheet – MS-DOS/Windows
- Borland Quattro Pro 3.0 ☐ 1
- Computer Associates CA-Compete ☐ 2
- Computer Associates Supercalc 5.x ☐ 3
- Informix Wingz 1.x ☐ 4
- Lotus 1-2-3 2.3/3.x ☐ 5
- Lotus 1-2-3 for Win ☐ 6
- Microsoft Excel 3.x ☐ 7
- Microsoft Excel 3.x ☐ 8
- Other spreadsheet: ________ ☐ 9

## Spreadsheet – Macintosh
- Claris Resolve ☐ 1
- Informix Wingz ☐ 2
- Lotus 1-2-3 Mac ☐ 3
- Microsoft Excel ☐ 4
- Other Mac spreadsheet: ________ ☐ 5

## Utilities – MS-DOS/Windows
- Central Point Software PC Tools Deluxe 7.x ☐ 1
- Fifth Generation Direct Access 5.x ☐ 2
- Fifth Generation Fastback Plus 3.x ☐ 3
- Gibson Research Spinrite II 2.x ☐ 4
- hDC FileApps ☐ 5
- Lotus Magellan 2.x ☐ 6
- Mace Utilities 1990 ☐ 7
- Multisoft PC-Kwik Power Pak 2.x ☐ 8
- Norton/Symantec Desktop for Win ☐ 9
- Norton/Symantec Utilities 6.x ☐ 10
- Traveling Software LapLink Pro 4. ☐ 11
- XTree Gold 2.x ☐ 12
- Other DOS/Windows utilities: ________ ☐ 13

## Utilities – Macintosh
- Central Point MacTools Deluxe ☐ 1
- CESoftware QuicKeys ☐ 2
- Fifth Generation Fastback II 2.x ☐ 3
- Norton/Symantec Utilities Mac ☐ 4
- On Technology On Location ☐ 5
- Symantec Utilities (SUM) II 2.x ☐ 6
- XTree Mac ☐ 7
- Other Macintosh utilities: ________ ☐ 8

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3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

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7 ☐ Senior-level
8 ☐ Middle-level
9 ☐ Professional

**C. Are you a reseller (VAR, VAD, Dealer, Consultant)?**
10 ☐ Yes
11 ☐ No

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12 ☐ PC/MSDOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

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| 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | 657 | 658 | 659 | 660 | 661 | 662 | 663 |
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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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9 ☐ Professional

**C. Are you a reseller (VAR, VAD, Dealer, Consultant)?**
10 ☐ Yes
11 ☐ No

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13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

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JERRY POURNELLE

# THE HIGH END

A few readers have written to ask why I spend so much time with high-end equipment, so I'll start by answering that.

My first microcomputer, Ezekial (or Zeke I), cost $12,000 in 1976. About half of that cost was for a Diablo letter-quality printer; the rest was for the computer kits, the cost of having Tony Pietsch and his Caltech crew build them, systems integration, and software. That was a lot of money in those days: what I got was a 64-KB system running at 2 MHz, two 8-inch floppy drives capable of storing 128 KB per disk, Digital Research CP/M and utilities, Microsoft BASIC, and a word processor called Electric Pencil.

I had to borrow the money to buy that machine, and it was worth every cent, because it greatly increased my productivity as a writer. I loved it, and that led to this column.

Within two years after I bought Zeke, you could have bought his like for a quarter of what I paid. It's the same now: the high-end stuff you can't afford today will be affordable in a year or two, and three years from now, you won't know how you lived without it. Meanwhile, you get this advantage: my playing with this stuff not only brings it to your attention but also gets folded back into the system design. Sometimes you see that happen, but often you don't: sometimes I won't write about a system until companies have taken it back and made some design improvements.

If I've drifted just a bit toward high-ticket items recently, it's largely because there are so many of them. I always try to include shareware and tips for making do with older and cheaper equipment; alas, if page count is tight, that's often what's cut. I'll pay more attention to that in the future.

## Setting Up

I've been setting up a new Arche Legacy 486. I recommend 486 systems to anyone who can possibly afford them; and if you can't get a 486, you might think about a temporary stage with a cheap 386SX until you can. My reasoning is this: the 286 was not well designed, and it isn't much good for multiple task-switching operations using Desqview, Windows, or OS/2. The least you ought to have is a 386SX.

Full 386DX machines are very good, and if you install a math chip—there are many available now—they will do just about everything. I'm writing this on Big Cat, an older Cheetah 386/25 with a 387. However, it's about as cheap nowadays to manufacture a 486 system as it is to build a 386 with a math chip; the 486 is more efficient than the 386. As to why you want the math chip, believe me, you do: more and more software takes advantage of it even if you don't know it. From spreadsheets to math programs, a math chip speeds things up.

The new Arche Legacy 486 is a 33-MHz machine with 8 MB of memory on the motherboard and a 200-MB SCSI hard drive. Its first task will be to function as a test-bed for a lot of other stuff: my major precaution against mischief is always to have a good fast system totally isolated from my network and to put everything new on that. The Arche 486 is a bit too good a system to stay in that duty, but just now I don't have another test-bed system, and I do have the Arche system available.

**The latest, most expensive computer technology will eventually trickle down to everyone**

Arche equipment is solid and well designed and comes with a 90-day on-site service warranty. You can extend that to two years of on-site service for only $149. As it happens, my previous Arche 486 was an experimental model, and the contract-service people came out to replace the motherboard. I was quite favorably impressed, and they had no idea who I was. Incidentally, the new motherboard design was, in part, due to problems I'd detected, and I'm pleased to say that the new system has none of them.

## LapLink Pro 4.0

The Arche 486 replaces an experimental 486 that was getting increasingly flaky. No one wants an unreliable machine, but clearly, the one machine that has to work properly is the one used to test other equipment. The first task was to transfer the software from the old machine to the new one.

Neither machine was, nor would be, on a network, so I had to use some kind of port-to-port transfer. Normally, if the machines are close enough together—these were—I use LapLink 3.0 (LL3) in parallel-turbo mode,

ILLUSTRATION: STEVE TURK © 1992

but I just got a copy of the new LapLink Pro 4.0.

LapLink Pro has many features not available in LL3. The most spectacular is that it will send files, and itself, over a modem. Sending itself takes about 15 minutes at 2400 bps. After you are done, LapLink Pro will try to speed things up; once you have LapLink Pro running properly at home, you can set it to answer the phone and do file transfers from anywhere. You can (and should) set things to require a password. The package comes with the new LapLink "designer" serial and parallel cables.

The tower-configuration experimental machine that I was transferring from kept crashing, and I was getting worried. I'd already opened it and taken out every unnecessary board; that kept it running a little longer between crashes, but every few minutes the screen would dissolve into white goo, and there was nothing for it but to turn it off for a while. This made a great opportunity to test LapLink Pro, which is much easier to restart after interruptions.

What I'd done was create on the Arche system a subdirectory called Old486, and under that, I'd created subdirectories called C1, D1...M1, corresponding to the subdirectories on the older machine, which had been set up under DOS 3.3 and thus had no logical drive larger than 32 MB. LapLink Pro then took over and created subdirectories on the target drive as needed. The only problem was the constant interruptions from the machine crashing.

Then inspiration hit. I expect you've already figured it out. I took off the cover, got a large electric fan, and set it on the floor to blow across the motherboard. Voilà! After that, everything went automatically. Because LapLink Pro uses a file-compression system, it's much faster than the old LL3. For example, I recently sent (in parallel mode) 35 MB comprising over 1300 files and requiring creation of about a hundred subdirectories between the Cheetah 486 and the Arche 486; total time, 13 minutes. That's fast.

LapLink Pro has a lot of new smarts about file dates and duplicates. If the times on the two machines differ, LapLink Pro notices and asks if you want to do something about it. The command screens are quite unlike those of the old LapLink we all know and love; fortunately, they're just as intuitive—or almost so. In old LapLink, to "tag" a file for sending, you push the *t* key. That does nothing in LapLink Pro, and it took me a while to figure out that the space bar now does that job. Even so, although the machine kept crashing every few minutes, I got LapLink Pro running without opening the manual.

I since have read that book, and I advise you to do so: LapLink Pro is just crammed with new features worth knowing about. There's even a small text editor so that you can modify a file before sending it. The manual is well written.

There's more, all good. Once again Traveling Software has come up with a

**LapLink Pro's most spectacular feature is that it will send files, and itself, over a modem.**

genuine improvement to a product that was already as good as anything in the field. Highly recommended.

## Tooling Up

Once I had everything off the old machine, it was time to clean off its disk. It's probably paranoid of me, but I always do that before sending anything back. I don't really suppose anyone is going to use Norton Utilities to restore erased files—but I did once get a test machine that had not been erased at all, and it contained the previous evaluator's Quicken files of personal finance, the telephone numbers of her pediatrician and psychiatrist, and even a lot of personal letters as well as evaluation software. She'd wish she used Norton Utilities' WIPEDISK if she knew what she left on there....

Anyway, I set it up to do WIPEDISK on every logical drive, including C. That took a while, but it's thorough.

While that was running, I installed Norton Commander on the new Arche. I no longer routinely install the Norton Editor, but I find I really can't do without Commander. Even though MS-DOS 5.0 has a neat little full-screen editor available at all times, I find I generally use Commander's text editor for little jobs like adjusting CONFIG.SYS and AUTOEXEC.BAT; absolutely nothing beats Commander for copying or moving files from one directory to another. It's also great for managing MCI Mail. I don't like DOS shells much, but I sure do like Commander.

After that it was Norton Utilities 6.01, which is enough of an improvement over versions 4.5 and 5.0 to be worth getting: version 6.01 puts back the neat features of 4.5 that were missing in 5.0 and adds new capabilities. Norton Utilities has file recovery, of course, but it also has directory sorts, a file finder, a batch enhancer that lets you build batch files that do useful work, and other such stuff. Like Norton Commander, it's something I don't like to be without.

I then installed Q&A 4.0, which I've said enough about before. It's the database and word processing program of choice at Chaos Manor. Others may be more powerful, but none are easier to learn—or easier to use once learned. While I was at it, I put in GrandView, Symantec's outline program. I have discovered over the years that although I approve of outline programs, I tend to use them less and less. However, when I'm trying to put together an essay on a new subject, I'm glad to have an outliner, and GrandView is the one I'm used to.

## Minor Problems

Next, I connected the Corel SCSI Controller Board that runs the daisy chain with the Pioneer Dual Optical Disk Drive and the Pioneer 6-Disc CD-ROM Minichanger. These won't stay on a test-bed machine long: they're assets I need on the network, but they're also a fair test for the Arche's compatibility.

I opened up the Arche to insert the Corel SCSI Controller Board. There's only one 8-bit slot in the Arche; for some reason, that slot is up at the top nearest the drive cages. I had three cards to insert: the Corel SCSI, Brown-Waugh Publishing's Sound Blaster, and an Intel Net Satisfaxion fax/modem card. Since the Corel SCSI is an 8-bit board, it seemed reasonable to put it in the 8-bit slot. That meant sliding it under the cables going from the disk drive controller card. There were a couple of other cables running nearby, including the ones that led to the Arche's primary serial and parallel ports.

I inserted the card and turned on the machine. It trundled for a moment and then reported, "CMOS battery low. Press to continue." Oops, thought I: one of those cables was the CMOS battery cable, and I'd knocked the battery connector loose. Nothing for it but to remove the Corel board, reach down under the disk cage, and push the battery connector firmly into place. No problem. It was tedious and took longer than I expected, but it wasn't difficult.

I turned the machine on.

No CMOS at all. No access to the hard drive. Nothing. I would have to set all

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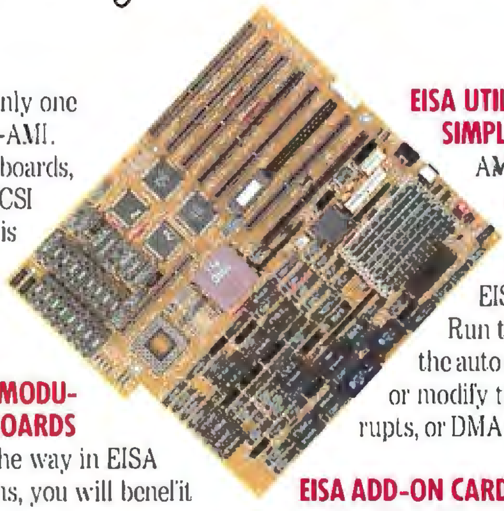

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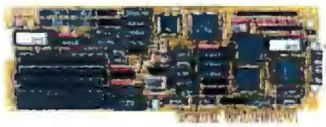

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that information again.

Only one problem. What kind of drive did I have? The Arche comes with quite a good user's manual, but there are several options for hard drives; the Arche manual referred me to the documents furnished by my hard drive manufacturer; and there were no documents from the hard drive maker. I didn't even remember how large the hard drive was, much less how many heads and sectors it had.

Of course this was on a Friday afternoon. The Arche switchboard said everyone had gone home. By pleading, I got them to see if anyone was still there, and, by luck, someone was. That was the good news. The bad news was that the company ships those machines with several different kinds of hard drives, and neither they nor I had the foggiest notion of which kind this was. Moreover, the disk, which is a tiny little half-height affair, is securely caged into the system. Fortunately, with the aid of a strong light, I was able to read off just enough information from the disk to allow the folks at Arche to look it up. Type 47,987 sectors, and so on. I entered the information into Setup, noted that the time and date were still right even though we'd lost battery power, and fired up. All was well. The machine ran just fine.

This leads me to a suggestion: why not put the CMOS information on a sticker on the inside of the machine's cover? Leave space for changes if you update. Then you will always have the information. I'm doing that on all my machines, but I strongly suggest that manufacturers do the same when sending them out. I told the Arche people this, and they said that they liked the notion.

Anyway, it was now time to install the Corel SCSI software. Like many modern machines, the Arche comes with one 5¼-inch A drive and one 3½-inch B drive. The Corel CD-ROM software comes on a 3½-inch disk. Insert it into the B drive and log on. Look at the directory; no problem. Type `Install`.

"Sector Not Found Error."

I figured the drive had gone bad; after all, I'd installed all the Symantec software using that B drive, so it wasn't likely anything had happened to it. Oh well, no real problem: via LapLink Pro, I already had the Corel software on the Arche's hard drive. Go there and type `Install`—and discover to my horror that the installation program works only from a floppy disk. Well, all right, that's easy enough, too: format a floppy disk in the B drive, copy everything to it, and type `Install`. It seemed an odd procedure, but it worked fine, all automatic. Shortly, I had six CD-ROM drives. The Corel installation routine is quite simple to use.

Next was the Pioneer read/write optical disk drive. Corel has an installation program for that, too. When I inserted the disk, I got "Sector Not Found Error." OK, maybe the drive's going flaky. At least it reads disks it has formatted. So, format a disk, copy everything to it—but there wasn't enough room on the disk, at which point I was enlightened. Of course there wasn't enough room, and of course the drive couldn't read normal 3½-inch disks. Go into Setup, and, just as I thought, the default for a floppy drive is 1 2 MB. Tell the machine that's a 1.44-MB floppy drive, and it has no problems. Sigh.

Once that was done, the Corel software for accessing the Pioneer read/write drive installed without difficulty. By way of test, I copied about 10 MB over to the Pioneer and back again. The 10 MB included Wing Commander, so when I got things copied back again, I fired up a game and learned

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two things: it worked fine, which wasn't surprising; and the Arche 486/33 is *much* too fast to play Wing Commander on. I've got to the point where I can play on the Cheetah 486/25, but I don't think I'll ever be able to play on the Arche without using something like the shareware AT-Slow program. That's one speedy machine.

### QEMM-386 6.0

OK, I had the Arche working with both CD-ROM and the Pioneer read/write drive, and I had 500 KB of memory available. Alas, many programs require more than that. Time to try a memory manager.

Last month I had some problems getting Windows to work with QEMM and ended up using 386Max. This upset Quarterdeck something awful. It turns out that QEMM will work fine with Windows, including Windows 3.1; it's just that you have to invoke Windows with the WIN /D:X command. I'm not precisely sure why, but I'm told it's a bug in the Microsoft code. In any event, Quarterdeck says that the next version of QEMM will fix everything; meanwhile, you should do WIN /D:X to invoke Windows.

This all seemed reasonable, so I let QEMM 6.0 install itself. I put it that way because I didn't have to do any work at all; Quarterdeck has done a really good job with their installation software. It automatically runs the Optimize program that mucks around putting TSR programs and drivers into high memory. I ended up with 588 KB of temporary program area (TPA) even with the optical drive and CD-ROM software installed. Quite respectable. Of course, when I REMed out the CD-ROM and optical disk drivers, I had over 620 KB of TPA.

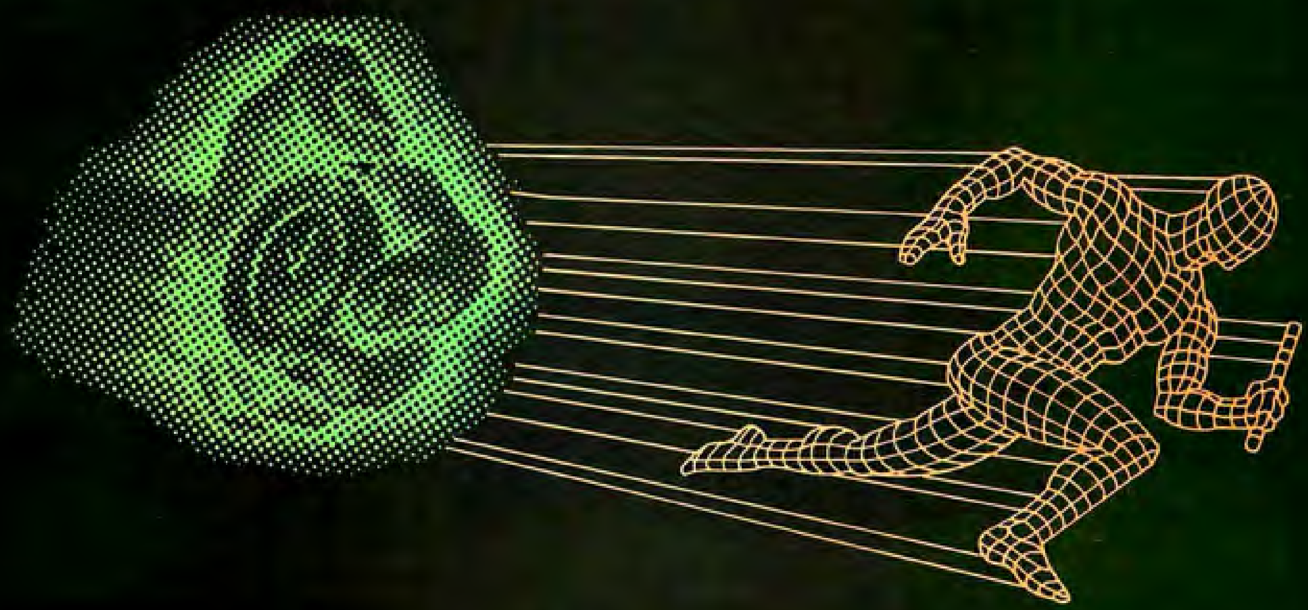
QEMM 6.0 has a new "stealth" technology: this is a fancy name for an ability to recover even more memory by putting certain ROM data out in extended memory. You find out if you can use stealth by invoking Optimize /ST. I'd already tried that on my Cheetah 386/25, and it worked just fine, with the bottom-line result that with DOS 3.3, LANtastic, and a Hitachi CD-ROM implemented, I still have Desqview windows of 577 KB.

When I tried it on the Arche, though, I got the message that you can't use stealth on that machine. At the moment, none of us know why. "Something in the BIOS" is the general consensus. Arche and Quarterdeck are both working on the problem, and they expect to have that taken care of before you read this. Even without stealth, QEMM 6.0 works as well as any other memory manager I've tried, but there's no reason why stealth shouldn't work on the Arche.

Once I had QEMM up, it was time to try Desqview itself. The trick is to REM out the DOS=HIGH statement in your CONFIG.SYS, because Desqview will make much better use of that memory area than DOS can. This was all very well, but I wasn't getting very large Desqview windows no matter what I did. Finally, I went into the System Setup and disabled various features, but it didn't help. One thing I did learn: on an Arche 486, you must *not* disable the shadow RAM. If you do, the machine won't boot. That's surprising, and neither I nor the technical-support people at Quarterdeck know why. It's something else to refer to Arche.

Eventually I got 576-KB Desqview windows without the Corel SCSI drivers; with them it's 528 KB, which is respectable, but it would be higher if the stealth feature could be used. I'll keep working on it. What I really want is Desqview windows

# Faster Runtime



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large enough to let me run Windows 3.1 inside one of them and still have my CD-ROM and optical disk drives.

If I'm not using Desqview, I leave the DOS=HIGH statement in CONFIG.SYS and get a TPA of 628 KB with both CD-ROM and optical disk drive for Windows. That's about as good as I'm going to get, stealth or no stealth.

The result is that I've put QEMM 6.0 into all the machines at Chaos Manor. Recommended.

### Windows 3.1

Microsoft says that by the time you read this they will have released Windows 3.1, and you'll have seen a lot of articles about it, so it's pointless for me to go into details. The important thing is that I installed Windows 3.1 from scratch on the Arche 486. This takes about half an hour, but it sure beats trying to transfer an already-installed Windows from some other machine: *that* will really drive you nuts. For safety's sake, I disabled QEMM and the Corel SCSI chain during installation; when I was done, I reenabled both.

The only disconcerting feature was when the Windows installation program went ranging through the C drive looking for applications. Of course, there were a lot of them, since I'd transferred all those files from the older machines. No harm done, except I now have about a zillion .PIF files.

For Windows you want DOS=HIGH. You also must invoke windows with the WIN /D:X command. Provided you do that, Windows goes just fine with QEMM. If you have Norton Desktop, there is an idiot error message to the effect that "no association exists for X," but ignoring it doesn't do any harm.

### CorelDraw 2.0, CD-ROM Edition

There's not much to say about this program; that is, it's going to be reviewed by nearly everyone, and it will win a bunch of awards, and ought to. It's the best drawing program I've seen. The CD-ROM has thousands of clip-art pictures, some really beautiful. Hundreds of fonts. The tools work. If you're into artwork on a PC, get it. Highly recommended.

### Norton Desktop

This is another one I've mentioned before. If you use Windows, do yourself a favor and get Norton Desktop. It makes Windows easier to use and considerably more fun. It accesses your peripherals, such as CD-ROM and optical drives. It understands what Windows is doing somewhat better than Windows does. The newest version corrects a couple of minor problems when working with Windows 3.0a and 3.1.

One caution: it does use a lot of hard disk space, depending on the options you select. I have a lot of hard disk space and selected all the options. Anyway, when I do Windows, Norton Desktop goes in as well. Recommended.

### Flashdrive

The tendency is toward big, powerful laptop machines. I'm presently carrying the Texas Instruments 3000 WIN SX, which, unsurprisingly, is a 386SX that runs Windows. I do like it. It's as powerful as my old Zenith Supersport SX and weighs about one-third as much; still a bit heavier than I like, but nothing I can't live with.

Roberta, knowing that I'll always carry a big machine, generally opts for the smallest and lightest thing she can use, which turns out to be her old standby, Toshiba-san, the Toshiba T1000. Toshiba-san stopped working briefly last month, but that was fixed by replacing his battery,

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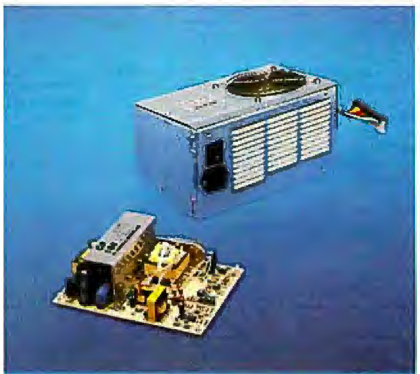

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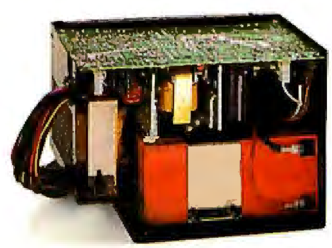

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## USER'S COLUMN

and he's as good as new.

Of course, "good as new" is relative. Toshiba-san came with DOS 2.11 in ROM. There's no hard drive, and the floppy disk is a single-density 3½-inch one holding 730 KB. This means that in addition to the T1000, you carry a word processing floppy disk, a data floppy disk, a communications floppy disk, and so on; and if you are working on several projects, each probably gets a disk. None of this is any great hardship, but it is a minor inconvenience.

The solution would be a hard drive, preferably battery-powered, small enough to tuck into your briefcase or wrap up in an old shirt and stuff into checked luggage. That's Flashdrive. The physical box is about the size of a small modem. It connects to the T1000 through the printer port with a supplied cable; there's an output printer port on the drive box.

You can buy The BSE Company's Flashdrive with a hard disk installed, or you can get its case, electronics, and software and furnish your own. Unless you know what you're doing, I'd advise getting the preassembled version.

Software installation is simple once you've prepared for it; that is, Flashdrive requires that its own device driver (only about 2 KB) be loaded by CONFIG.SYS in the root directory of the boot drive, and you must boot up with DOS 3.0 or higher. Since the T1000 normally boots DOS 2.11 from a ROM drive, there's nothing for it: you need to make up a boot floppy disk with DOS 3.0 or higher (I used 3.3). Alas, you can't boot from Flashdrive itself.

In my case, I made a DOS 3.3 boot (system) disk and copied XCOPY and CHKDSK (which are DOS-version specific) to it. Then I ran Flashdrive's installation program. Everything worked fine, and I found that I have 32 MB on one logical drive and 9 MB on another; they're labeled drives G and H.

That done, it was time to transfer in some software. First I installed LapLink Pro. Then I connected the LapLink parallel cable to the Cheetah 486.

That didn't work: if you connect the T1000 to another machine through the parallel port, the hard drive won't work (although it works if you connect to a printer). The simple solution is to connect through the serial port; that works fine. Of course, it's slow. For that matter, the whole disk operation is fairly slow, but it's much faster than a floppy disk.

I could also have installed the Flashdrive software in one of the other machines—DOS and Windows see Flashdrive as another logical drive on any DOS 3.0 or higher system—and used the drive itself for software transfer.

*Continued*

# PC Magazine caught us speeding.

## *"PacificPage XL beats HP on LaserJet PostScript printing"*

PCMagazine, June 25 1991

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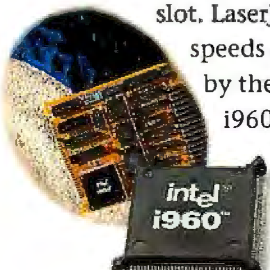


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We can now boot Toshiba-san from ROM, insert the Q&A Write disk, and begin work, exactly as always; later, we can bring out the boot floppy disk and set the hard disk for work back in the hotel room. Flashdrive takes up very little room in checked luggage or will work from nickel-cadmium batteries right on the airplane. All told, a welcome addition to the T1000. Recommended.

### Electronics Workbench

I got interested in electronics when I was about 10 years old. Of course, that was during World War II; electronics experimental kits were hard to come by. The best book I could find in the Memphis library was called *Understanding Radio*, and it was mostly about Model 01A vacuum tubes; indeed, everything electronic used vacuum tubes. After the war, I got some cheap surplus equipment working, but I wasn't able to do a lot of the experiments I'd have liked. My high school physics lab had less equipment than I did.

Electronics Workbench bills itself as "The electronics lab in a computer," and that pretty well describes it. Of course, it *is* in a computer: experiments run with Electronics Workbench get about the same result that you'd get if you did them in hardware, but you won't have many surprises, either. For some, that's all to the good: no shocks, solder burns, cuts and scrapes, or contusions, all of which I got when playing with my surplus equipment.

Electronics Workbench includes transistors, coils, diodes, transformers, and all the other stuff you expect to find on a real workbench. There's a dual-trace oscilloscope as well as voltmeters and ampere meters, a logic analyzer, and systematic lessons. If I had my druthers, I'd take a box of real equipment and a bucket of solder, but if you're trying to learn electronics, you can do 10 times as many experiments with Electronics Workbench than you'd get done with the real stuff.

Electronics Workbench will work on 512-KB systems with a CGA display, but it really wants a full system with VGA. Either way, a mouse is required. I sure wish I'd had something like this back during World War II.

### Chaos and Cells

Autodesk is known for AutoCAD, the program that changed the way architects and design engineers work; however, they also support experimental programs in virtual reality, Ted Nelson's Xanadu hypertext project, and other far-out stuff. Products include Rudy Rucker's Cellular Automata and James Gleick's Chaos: The Software.

Cellular Automata is hard to describe. If you're familiar with Conway's Game of Life, you're on the right track: Rucker's programs include that but let you change the rules. Rucker describes Cellular Automata as "self-generating computer graphic movies." Some people call them *artificial life*. Mostly, Cellular Automata lets you explore the complexities you can get from simple rules and makes pretty pictures in the bargain. It's a lot of fun and can be a real time sink.

About 10 years ago, something called *catastrophe theory* became an intellectual fad. A lot of people talked about it, although it's safe to say that few understood it: the math is pretty hairy. Chaos theory has similarities to catastrophe theory, and it probably would never have become popular had not Gleick written an extraordinary book (it was book of the month here a couple of years ago) on the subject.

Gleick managed to convey the flavor of chaos theory without bogging the reader down in math. Now mathematician and science fiction writer Rudy Rucker has teamed up with Gleick to produce a "chaos laboratory." It includes the mandatory Mandelbrot set, but there's a good bit more, including Toy Universes, which are cellular automata.

Chaos: The Software lets you survey "strange attractors," fool with fractals, mash the Mandelbrot set, and, in general, see for yourself much of what Gleick tried to describe in his book. This is even more of a time sink than Rucker's Cellular Automata. It hasn't quite replaced the original, at least not for me: I can still get very interested in the simple programs (often in BASIC, with source code) in Cellular Automata, but since you're likely to get only one of these games, my recommendation would be for Chaos: The Software. Having said that, I find I spend more time playing with the other one.

They're both fun.

### I Hate Algebra

Peter Roizen and his sister Heidi founded the T/Maker Company. Peter decided he didn't like being chairman of a big company, so he sold it to his sister and went off to write software. His latest product is I Hate Algebra, which is a Windows spreadsheet for people who hate spreadsheets and don't want to become power users. That leaves him with a problem: who's going to review it? For big, powerful spreadsheets, you want Lotus, or Excel, or Quattro Pro, all of which have increasingly steep learning curves.

I Hate Algebra is deceptively simple given its power. It's easy enough to learn, despite some needlessly murky language in the manual. Anyone can start doing fairly useful work with it in a few minutes, and it's another of those programs I wish I'd had when I was in high school. I'm looking forward to Borland's Quattro Pro for Windows: that has some really neat features, and I find Quattro Pro fairly easy to use. For those who don't need so much power and just want to get things going, look into I Hate Algebra. It works.

Meanwhile, the T/Maker Company has become the lead producer of graphical computer art with thousands and thousands of ClickArt images from business to humor to religious to personal. ClickArt works on PC systems with CorelDraw, Aldus PC, PageMaker, Adobe PC Illustrator, and Ventura Publisher. ClickArt images are available in PICT2 and Encapsulated PostScript format for the Mac. If you do a newsletter or want to do fun party invitations or design your own letterhead, you can't afford to be without their catalog. Good stuff.

### Winding Down

The book of the month is Michael J. Mazarr's *Light Forces & the Future of the U.S. Military Strategy* (Pergamon-Brasseys, 1990). The computer book of the month is *Object-Oriented Design with Applications* by Grady Booch (Benjamin-Cummings, 1991). There's been a lot of talk about "objects"; Booch, one of the clearest writers in the computer field, explains it. I've been impressed with his work before.

The game of the month remains The Lost Admiral (see my January column), but two days ago it got a rival: Sim Ant from Maxis (Mac version only so far). If you ever wanted one of those home ant colonies, here's your chance.

Next month, a shoot-out: I'll install the

Distributed Processing Technology and Perceptive Solutions caching disk drive controllers in the Arche 486 and compare them to each other as well as to the controller that came with the machine, under both DOS 5.0 and DR DOS 6.0, with and without software caching. There's also a ton of new Windows software, new stuff for the Atari 030 and the Mac, new CD-ROMs, and two huge boxes from BYTE that I haven't even opened yet. I'll also resume the Shareware of the Month feature. ■

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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. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."*

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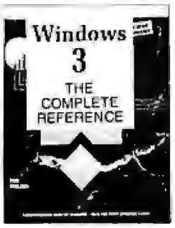


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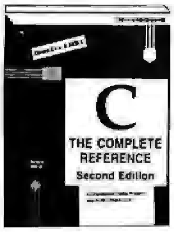


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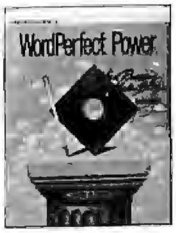


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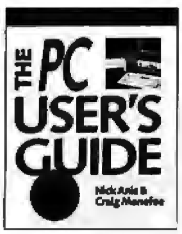


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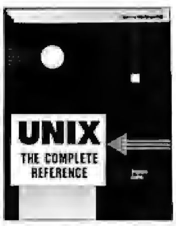


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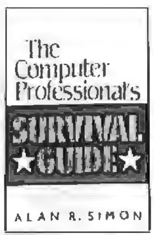


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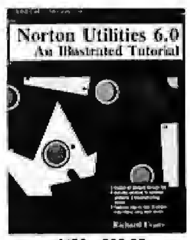


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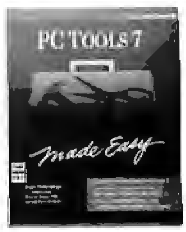


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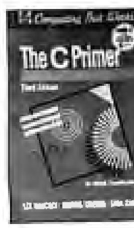


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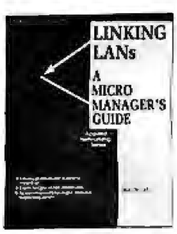


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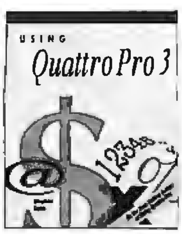


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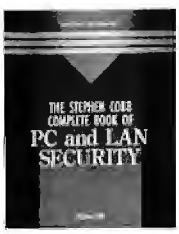


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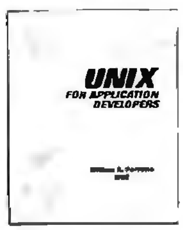


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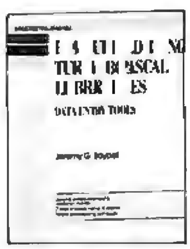

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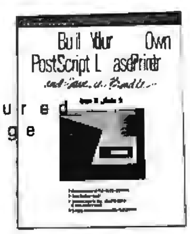


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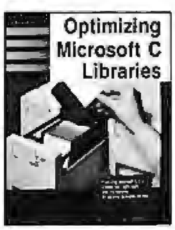


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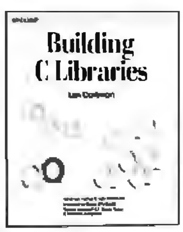


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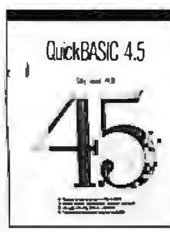


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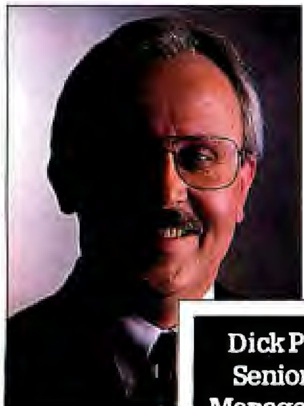

**Dick Patefield, Senior Project Manager for Store Systems Support, JCPenney**

Recently JCPenney Co., Inc. changed its operations from the old POS systems to the new PC-based technology, relying on PC platforms for point-of-sale and in-store support. And they back each one up with help from MINUTEMAN.

*"There was a violent surge in one of our stores,"* says Patefield. *"If we didn't have the MINUTEMAN unit, it probably would have seriously damaged all of our point-of-sale equipment.*

*"The key was the switch-over time from AC to battery,"* says Patefield. *"It really has the best continuity of the UPS systems we evaluated. Also, the price was very favorable. When you're installing them in as many locations as we are, the pricing was very attractive."*


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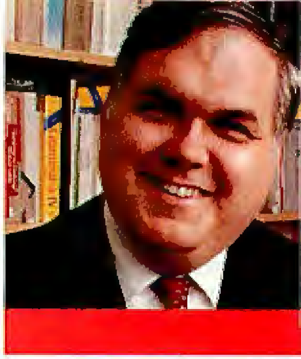

WAYNE RASH JR.

# Multimedia Moves Beyond the Hype

"We have met the enemy, and he is us." You remember the phrase. It was uttered by a character in the *Pogo* comic strip after he had been following footprints of a perceived enemy through the swamps for days. It turned out that the footprints were his own. This situation is a lot like the state of the multimedia industry, at least until recently.

The multimedia industry has been its own worst enemy. Many manufacturers found that they could sell a PC with a CD-ROM drive and call it a multimedia PC. This was a good way to unload old, slow IBM XT and AT clones, but customers began to associate multimedia with slow perfomance, lackluster video, and muddy sound. Actually, multimedia technology implies the ability to produce clear pictures—both moving and still—and high-quality sound, as well as to provide data access and communications. In fact, none of the attributes normally associated with current products, including the CD-ROM drive, are really necessary for multimedia. Given that promise, only users of entertainment software would put up with the previous generation of products; business users considered multimedia a game technology, with some potential uses in training.

Change has come suddenly. First, Commodore's Amiga made it big in broadcasting. Then the Macintosh received hardware upgrades and new software that made quality multimedia work possible. Unfortunately, the majority of business users had IBM PC clones. Multimedia would have to catch up with the PC before succeeding as a business tool. By Fall Comdex last year, many manufacturers were demonstrating PC-based products that met the capabilities they had been promising for years. The key was the emergence of a handful of technologies that have pushed the industry forward.

### Real Products for Real Users

The first hints of change came last fall with a flurry of multimedia product announcements. I decided to investigate. My first stop was Intel and IBM, the joint development team behind ActionMedia II. This PC expansion board supports high-quality, full-motion NTSC video at 30 frames per second, VGA and XGA images, and digital audio. It conforms to a series of de facto multimedia standards that ensure interoperability with multimedia products on other system platforms. Macintosh, Unix, and PC products supporting this standard should be able to share sound and image files transparently.

The Intel/IBM demonstration illustrated how far multimedia has come. Instead of the usual still images seen at trade shows, Intel and IBM used full-motion footage of the Air Force's Thunderbirds, the launch of a space shuttle, and scenes of wildlife. More important, ActionMedia II stores the video images and digital sound on a standard NetWare file server hard drive instead of on a slower CD-ROM drive. ActionMedia II makes multimedia available for the typical PC user, without special system hardware. You simply use the system you have to do the job.

**Products finally arrive that solve real business problems**


Another product, Multimedia Beethoven from Microsoft, provides an intimate look at the power of multimedia technology. The product consists of a CD-ROM containing a digital recording of the complete Ninth Symphony as performed by the Vienna Philharmonic. You can also see the score on-screen, along with the words to the choral portion in German and English and a running commentary on the music.

During a product demonstration I attended, the effect on the audience was electric. Each time that the Microsoft representative tried to change to a new demo, the audience stopped him. I watched as an IBM executive put out a hand to prevent any interruption of the recording. "Please don't," he said quietly, listening to the music as he read the score. A scientist from Jet Propulsion Laboratories found personal joy in the glory of the final movement, tearfully and silently reading the German text. For the first time, I saw a technology that could speak to the mind and the emotions as well as to the intellect.

### More Power to You

A tool with the power to bring an audience to tears is an effective form of communication. The problem lies in finding a way to use the power effectively in a business environment. This is an area in which multimedia has historically had a bad image, and one that will require some effective new products.

*continued*

ILLUSTRATION: COCO MASUDA © 1992

The only real business application for multimedia has been training. Having clear images and quality sound output is useful in some forms of instruction, although there has been surprisingly little activity even in that area. Multimedia technology has been long on promise but short on delivery.

Enabling technology, such as the ActionMedia board, is changing this, as is the growing source of material available for use in multimedia projects, including video images and sound clips. And finally, true business applications are starting to arrive.

One of the first multimedia products for business users is Zuma Group's Curtain Call, available from Brown-Waugh Publishing. This presentation package is designed to work with multimedia hardware to produce presentations that incorporate video, computer-generated images, and sound. Curtain Call can mix the traditional business slide show with pictures, music, and narration.

Curtain Call looks like a Windows-based paint package. You can draw pictures, enter text, and modify images on disk. But it also lets you manage a MIDI device to synthesize music, and it lets you record and replay sound from a variety of sources. Once you've recorded a sound, you can mix it with other sounds and with synthesized music.

Curtain Call's table-based scripting process makes the product even more useful by giving you control over the events that make up your presentation. You can use Curtain Call to record an entire presentation for automated delivery, but most people will use it as a complement to their own presentations. The product will add flexibility and power to any business presentation.

Imagine how powerful your presentation would be at the next meeting if you could mix your slides with photographs and recorded sound. Imagine inserting a musical interlude between segments. Imagine presentation text and drawings that use something other than the usual, boring Times Roman, Helvetica, and black line art that you usually see.

Curtain Call is not perfect. However, it's so easy to use and cheap to implement that it could tempt many businesses into trying multimedia presentations for the first time.

While you can probably use your existing desktop computer for multimedia applications, you'll need a few add-ins. For the presentation itself, you'll want a projection system that's capable of VGA resolution and an audio system that's large enough for the room you'll be using. You will also need a sound board for your PC. I used Creative Labs' Sound Blaster, available through Brown-Waugh Publishing. It supports small speakers directly, or you can connect it to a stereo amplifier. Alternatively, you can plug a microphone into the Sound Blaster to make your own recordings.

Sound expensive? It's not. I use an old Realistic microphone for recording and an inexpensive set of Realistic Minimus speakers. You should be able to buy the whole outfit to add to your existing PC for under $500.

**Business Future**

Curtain Call is an important product in its own right, but it's even more important as an indicator of what the future holds. It's the first useful multimedia presentation software aimed squarely at the business market. With this package and the programs that follow it, business users will learn to use multimedia technology to

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## BYTE

USER'S COLUMN

**Sou n Bl ast**
One of the boards we installed in the Arche 4 8 6 was Sound Blaster. With its associated software, it has quietly (no pun intended, but what the heck) become the standard sound system for advanced PCs. The Roland board has much higher sound quality for a higher price, but for anything short of professional music quality, Sound Blaster is good enough.

There are lots of other accessories you can get for Sound Blaster, including musical instrument software and a voice editor. Sound Blaster has become the standard sound board, if not for the industry, at least here at Chaos Manor. Recommended.

*Jerry Pournelle*

## PC GAMES

### SOUND BLASTER PRO

By Barry Brenesal

The Marines may look for a few good men, but any PC game player will gladly settle for a single good sound card that plays both Sound Blaster and AdLib scores, one that doesn't fry your other boards, one that never draws attention to itself, one that delivers all the sophisticated sound effects and music bundled into the latest batch of game software.

Look no further: Sound Blaster Pro does it all, and more. At $299 it's not cheap, but neither are its features.

#### Testing: One, Two . . .

Installing Sound Blaster Pro is a snap. The 16-bit card slips easily into place. It comes with a test...

Trying out Sound Blaster Pro is a treat. It's got great frequency response — that's the difference between listening to a film score on a tinny, muffled AM radio and hearing it on a stereo movie-theater speaker system. The orchestral soundtrack to Origin's Wing Commander is a good example, because it changes mood and melody to match the success of your current battle. Add Sound Blaster Pro to a good VGA screen and a responsive joystick (which you can plug into Sound Blaster Pro's joystick port), and the illusion of dogfighting aliens in a George Lucas-style film becomes 3-D, symphonic reality.

Another plus is the absence of the annoying background hiss...

In short, Creative Labs' Sound Blaster Pro is a big winner. It's quick to install, easy to use, full-featured, and compatible with Sound Blaster and AdLib files. Signal response is excellent. And don't forget...

## COMPUTE

## SNEAK PEEKS

### SOUND BLASTER PRO

In just two years, the Sound Blaster has become one of the the most widely-supported PC sound cards. It's easy to see why. The Sound Blaster contains an 11-voice FM synthesizer that makes it fully compatible with the popular Ad Lib Music Card. The day it hit store shelves, the Sound Blaster could be used with hundreds of Ad Lib compatible games and educational programs. To add even more value, the original Sound Blaster included a DAC(Digital to Analog Converter) for digitized voice and sound effects, a microphone jack for voice input, a built-in game port, a built-in 4-watt amplifier, and an optional MIDI interface.

The built-in mixer makes the Sound Blaster Pro fully compliant with Microsoft's Multimedia Level 1 Extensions to Windows. Multimedia software will be able to fade-in, fade-out, and pan the various audio sources to create elaborate sound montages.

The Sound Blaster Pro includes a CD-ROM interface for either an internal or external CD-ROM player.

There's also an internal connector for CD-Audio. The MIDI interface is compatible with the original Sound Blaster's MIDI interface, but adds the MIDI time-stamp that's part of Microsoft's new multimedia standard.

All in all, the Sound Blaster Pro is chock-full of new features, yet it's fully compatible with its younger brother.

DAVID ENGLISH

Scheduled Release: September 1991
For IBM PC and compatibles—$299.95

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## PC HOME JOURNAL

### SOUND BLASTER DOES IT ALL

*Review by Harvey Bernstein*

The Sound Blaster has so many audio applications packed into one half-sized board that it almost boggles the mind. First, it has an 11-voice stereo music synthesizer that is fully compatible with the widely used AdLib sound format. Older software that only supports the AdLib board will automatically turn on the AdLib mode - no adjustment by the user is necessary. A separate channel is exclusively for reproducing digitized speech. A microphone jack on the back of the card allows you to digitize your own input voices. With a 4-watt stereo amplifier built in, you can run speakers or headphones directly from the card — no additional amplification is necessary. A standard joystick port also doubles as a MIDI interface, allowing you to connect a synthesizer or any other MIDI instrument. Combine this with an excellent library of software, and it is easy to see why the Sound Blaster has become so popular.

...Is the Sound Blaster worth the investment? Yes, yes, a thousand times yes!!! When you hear how much the Sound Blaster increases the capabilities of your PC, you'll wonder how you ever got along without one.

Now you can get the number one sound card as part of our new Multimedia Upgrade Kit. Which also comes with a MIDI kit, an internal CD-ROM drive and 5 CD-ROM titles, including Microsoft® Bookshelf® and Windows™ with Multimedia Extensions. In all, $2,000 worth of goodies for just under $850.

So before you get into multimedia, call 1-800-544-6146 or see your dealer. You'll like what you hear.

CREATIVE LABS SOUND BLASTER PRO

MPC Multimedia PC

Creative Labs, Inc., 2050 Duane Ave., Santa Clara, CA 95054 Telephone: (408) 986-1461 Fax: (408) 986-1777 For international information, fax Creative Technology at (65) 773 0353. Sound Blaster is a registered trademark of Creative Labs, Inc. Windows and Bookshelf are registered trademarks of Microsoft Corporation.

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enhance the way they make business presentations.

Multimedia isn't the first thing that comes to mind when most users think of business applications software. It's true that some businesses will never use multimedia, just as some businesses don't use spreadsheets or desktop publishing software. Five years ago, only a few business users could figure out why they would want to publish their own material. Times have changed. Now, people question why anyone would want to use multimedia technology to create presentations. Like desktop publishing, multimedia products will soon become general-purpose business tools.

Of course, in the process of entering the business environment, multimedia as a discipline will have some growing pains. For a while, you will see products that make use of every possible multimedia effect, not because they're effective, but simply because they're there. Fortunately, both the users and the developers will mature, and multimedia presentations will become an accepted part of business.

### What's Next?

The capabilities of ActionMedia II are waiting for applications developers to exploit them. With products like Curtain Call, presentation packages have pictures and limited animation. A few pieces are missing. Full-motion animation and video will be coming shortly. Likewise, CD-quality audio will be available as soon as multimedia presentation software capable of processing it becomes available.

Before the various pieces of multimedia can be integrated, a few changes must occur. The industry itself must change. A PC with a CD-ROM drive shouldn't be labeled a multimedia machine. Users aren't buying the hype, they're not buying the promises of an industry that can't define itself, and they're not going to change the way they do business just to take advantage of multimedia technology.

This is one reason that multimedia technology is only being taken seriously now that it's available for PCs. For many years, Brown-Waugh sold a precursor to Curtain Call for the Amiga, but with the exception of the film and broadcast industries, few businesses have this machine.

The same factors hold true in the Macintosh market. Business users tend to view the Mac as a niche machine rather than as a serious piece of business equipment. This view isn't justified, but it is pervasive. For multimedia to be a success, it must be accepted on the platform used by the business mainstream (i.e., PCs), and it must support typical business applications. This is why the introduction of the Intel/IBM ActionMedia II is so important. It's also why applications such as Curtain Call matter so much.

With the advent of multimedia business applications, the Macintosh and the Amiga may find more acceptance in the business mainstream. These machines will be able to exchange audio and video information, making the architectural divisions between machines less important.

The integration of multimedia technology into business is what matters most, regardless of platform. Multimedia is a powerful means of communicating with the mind and emotions at levels never approached before. It benefits businesses because it restores the humanity that has been stripped away by the pressures of the bottom line. Both the business community and the computer industry need this dose of humanity. ■

**ITEMS DISCUSSED**

**ActionMedia II** ....................$1295
Intel Corp.
3065 Bowers Ave.
Santa Clara, CA 95051
(609) 275-8080
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**Curtain Call** ........................$199.95
**Sound Blaster** .....................$169.95
Brown-Waugh Publishing
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Los Gatos, CA 95030
(408) 378-3838
fax: (408) 378-3577
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**Multimedia Beethoven** ........$79.95
Microsoft Corp.
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Redmond, WA 98052
(206) 882-8080
**Circle 1223 on Inquiry Card.**

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*Wayne Rash Jr. is a contributing editor for BYTE and a principal and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He is coauthor of two books for business network users:* The Executive Guide to Local Area Networks *and* The Novell Connection. *You can contact him on BIX as "waynerash," or in the to.wayne conference.*

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

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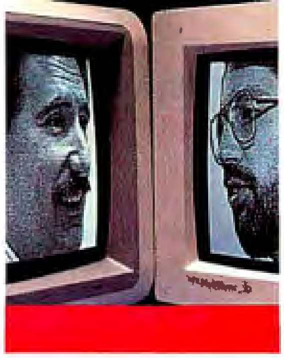

BYTE editors debate the issues with contributors, readers, and industry experts

# NEXT-GENERATION OPERATING SYSTEMS

Roundtable is a forum in which BYTE editors, contributors, readers, and industry experts debate key issues that affect how you purchase and use hardware and software. The "conversations" take place on BIX, where you can participate in the round.table conference.

**Editor's note:** *MS-DOS is showing its age, and the battle for the next major personal computer operating system is well underway. IBM and Apple have teamed up to develop the Taligent and PowerOpen operating systems, IBM has OS/2 2.0, Microsoft is pushing Windows NT (New Technology), Unix System Labs is going with Unix System V release 4.0 and Open Look, and Open Software Foundation advocates OSF/1 with Motif. With all these operating systems and so many promises, how do developers and end users make sense of it all?*

**MARTIN HELLER:** The Apple/IBM alliance, which produced the Taligent and PowerOpen collaborations, doesn't mean anything for developers right now. If they eventually produce a real operating system for real hardware, that's different. But Taligent, a shotgun marriage of Apple's Pink group, Patriot Partners, and Big Blue, isn't likely to attract much support in advance.

Life is too short to bet the company on long shots.

**DON CRABB:** I couldn't disagree more. Pink is close to beta as we go to press. IBM and Apple have redefined computing for many years to come with their joint venture. The failure to see the fundamental shift in the way operating systems are implemented on top of hardware that Apple and IBM will create is a serious mistake.

Many of my fellow Apple developers have been steeling themselves to the day when the Mac would require another paradigm shift. This day is now in sight.

The Apple/IBM joint venture is going to control desktop computing at many levels. Developers who stay behind and don't make the jump to these new object-based systems are going to find themselves just like Apple II or CP/M developers find themselves today.

**ELLEN ULLMAN:** Taligent will include Pink plus something from IBM or Metaphor. The Metaphor Constellation Project was supposed to be a multiplatform-component software environment. IBM itself has already written over a million lines of code for its own object-oriented operating system, or so I've been told by IBM insiders.

Will Taligent turn out to be simply Pink under joint ownership, or will it be the product of some sort of technology sharing between Apple and IBM/Metaphor (assuming, that is, the groups can even *talk* to one another)? We will just have to wait and see.

**TOM THOMPSON:** I don't have very much faith in the Apple/IBM alliance. I would rather have Apple come out with System 8.0, and I suspect that they're going to do that anyway.

I have seen articles that say the Mac's life span is limited: dead when PowerOpen and the PowerPCs arrive. That is not going to happen. Macs will be made for quite some time, and since Apple had the capability in-house to develop Pink, you can bet that it will move the Mac OS to a RISC CPU when necessary. Whether or not the alliance bears fruit is of academic interest.

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**ELLEN ULLMAN**
Consulting Editor

**ULLMAN:** Taligent will have to be much better than anything else available to win converts. Then again, maybe it won't. Like Windows NT, Taligent is being designed to run foreign APIs, although Windows NT is not among them right now. Microsoft and Taligent are hoping to provide platforms that provide both a new operating environment and a migration path from old environments.

**HELLER:** PowerOpen will run only on the RISC-based PowerPC, and not everyone is going to run a RISC machine. Those who are may well care about Pink or Purple or SUN OS or Windows NT or SCO. Those who don't can safely ignore the whole issue.

**CRABB:** PowerOpen could easily run on a CISC machine as well. The important thing about creating object-based operating systems such as these is their quick adaptability to new CPUs. They offer a constant programming base for applications developers.

**FRANK HAYES:** More important is the USL-joins-ACE story. If the alliance holds (a big if), the Unix wars at the vendor level will be over. Solaris's SVR4 and OSF/1 (on which Open Desktop is based) will compete at the engine level, but they will use the same gas and tires and wiper blades. The next step is a Unix box for OS/2 and the Mac that is SVR4/OSF compatible. That sounds a lot like Pink, doesn't it?

Users don't want operating systems; they want applications—and they don't want to change from the applications they've got now. No operating system matters if it can't bring with it what people are currently using.

**ULLMAN:** On the surface, it appears that USL, by joining ACE, has given in to OSF. But the only change in USL's direction, although it's a big one, is the decision to release a version of SVR4 that will support the API to the OSF/1 kernel. (SCO had already announced that its OSF/1-based Open Desktop would support the SVR4 kernel API.) The underlying kernels are not that different, and this mutual kernel API support should be a fairly straightforward task for both USL and SCO.

As for the GUI, USL has not actually given in to the ACE specification for the OSF/Motif interface. USL will "support" Motif through a toolkit that produces *either* Motif or Open Look front ends. USL has not exactly yielded on this score.

But under all this agreement to support each other's kernel is a lot of bickering, nasty commenting, and ill feeling. After talking to DEC, especially, who is writing the SCO Open Desktop kernel, I don't have any sense that the feud has been called off. Quite the contrary. DEC is fuming, waving around the letter of the ACE agreement, saying things like, "If you don't support Open Desktop, you're not complying with the ACE agreement you signed."

There's been movement, but it's been like the Israelis and the Palestinians agreeing to be in the same room. USL and DEC/SCO are in ACE, but that's all they'll admit to.

**JERRY POURNELLE:** Any operating system that will not painlessly run DOS programs, preferably a number of them in a task-switching environment, is doomed.

People are not going to give up their applications or learn a complicated way to use them. They already get a good bit out of their computers, and it is not at all clear what it does for a user to change to Unix or OS/2: I haven't seen any killer applications that run only in those other OS environments, and I have a number of DOS applications I simply do not intend to do without.

Thus, the OS/2 2.0 that's said to be a better DOS than DOS, a better Windows than Windows, has the chance to sweep the world; and the hardware requirements won't matter a lot, since people will go on using DOS (or Windows)—they will run what they have until they decide to upgrade hardware. Meanwhile, people getting new systems will go for the new OS *if* it will run all the applications they want.

This is so obvious that I can't understand why anyone doubts it.

**HELLER:** OS/2 2.0 is big. It needs a lot of disk space and a lot of RAM. It is complicated. New users can easily get lost with all the DOS and OS/2 boxes and with the PM desktop and the Windows desktop. And it has only limited support for the weird and unusual devices we know and love—DAT tape, CD-ROM, WORM, music cards, and so on.

It's also still called OS/2. OS/2 1.0 through 1.2 couldn't even print. There's a dearth of OS/2-specific software. There's even more of a dearth of 32-bit software for OS/2 2.0. And people seem married to DOS. Go figure.

**HAYES:** I suspect the name *OS/2* is less important than the ability to sell it to OEMs. Few people will care whether their 386 clone is running Windows or OS/2.

IBM will do the same thing to Microsoft that Digital Research did with DR DOS: go head-to-head with a superior product. To protect its market share, Microsoft will have to keep sweetening the deal for Windows NT OEMs. Meanwhile, IBM has its own cash cow: all those true-blue accounts that will still buy IBM and only IBM. Result: There will be some *very* attractive deals on both Windows and OS/2 machines.

**The question isn't commitment, but compatibility.**

The question isn't commitment, but capability. Will Windows ever do what Pink promises? I'm not convinced; Windows (even NT) looks a lot like a single-user system with a conventional design. Its heritage is showing.

Will Pink ever do what Pink promises? It's got the right design—but then, so did OS/2 in its day. And how much real risk is there in going with Windows now and Pink in two years? A lot of people are likely to take that path for the moment, especially with budgets tight.

**OWEN LINDERHOLM:** Pink is principally a product of Apple and Patriot Partners. IBM has had little input other than buying Metaphor. IBM is just standing back and letting the ex-Metaphor people work their magic. This means that Pink will be a product of the company that truly pioneered and worked toward the one goal of a united object-oriented OS (Metaphor) and the company that has more successful experience with user interfaces that people obviously like and use than any other (Apple).

This marriage could unite the people who have shown that they can produce real working OSes with the people who have shown that they have the best ideas and technologies around. Pink's biggest problem is that it has lots of other people breathing down its neck.

**ULLMAN:** These days, operating systems are taking on so much work that it doesn't surprise me their release dates keep slipping. Operating systems used to be content to start up programs, manage tasks and memory, and allocate resources at a low level. Suddenly, the OS is expected to provide a user interface and a very complicated set of functionality in the desktop. Now comes multiple-API support—the emulation and toolkit layer that used to come under a separate wrapper.

The Mac has been providing GUI and desktop support for years. Now the Mac is taking on the more extensive low-level work that systems like Unix have been doing all along—like multitasking and Interapplication Communication. There's been a merging of the idea of the operating system, resulting in something like the forthcoming Apple/IBM AIX with a Mac front end, SCO Open Desktop (Unix with a GUI and desktop), Solaris (same as ODT, except Open Look substituted for Motif), Windows (DOS with a Mac front end), and so on.

The battle between systems like Unix and Mac (cryptocomplicated OS versus graphical, friendly system) has become a draw. The best of both worlds will show up in these forthcoming systems. ■

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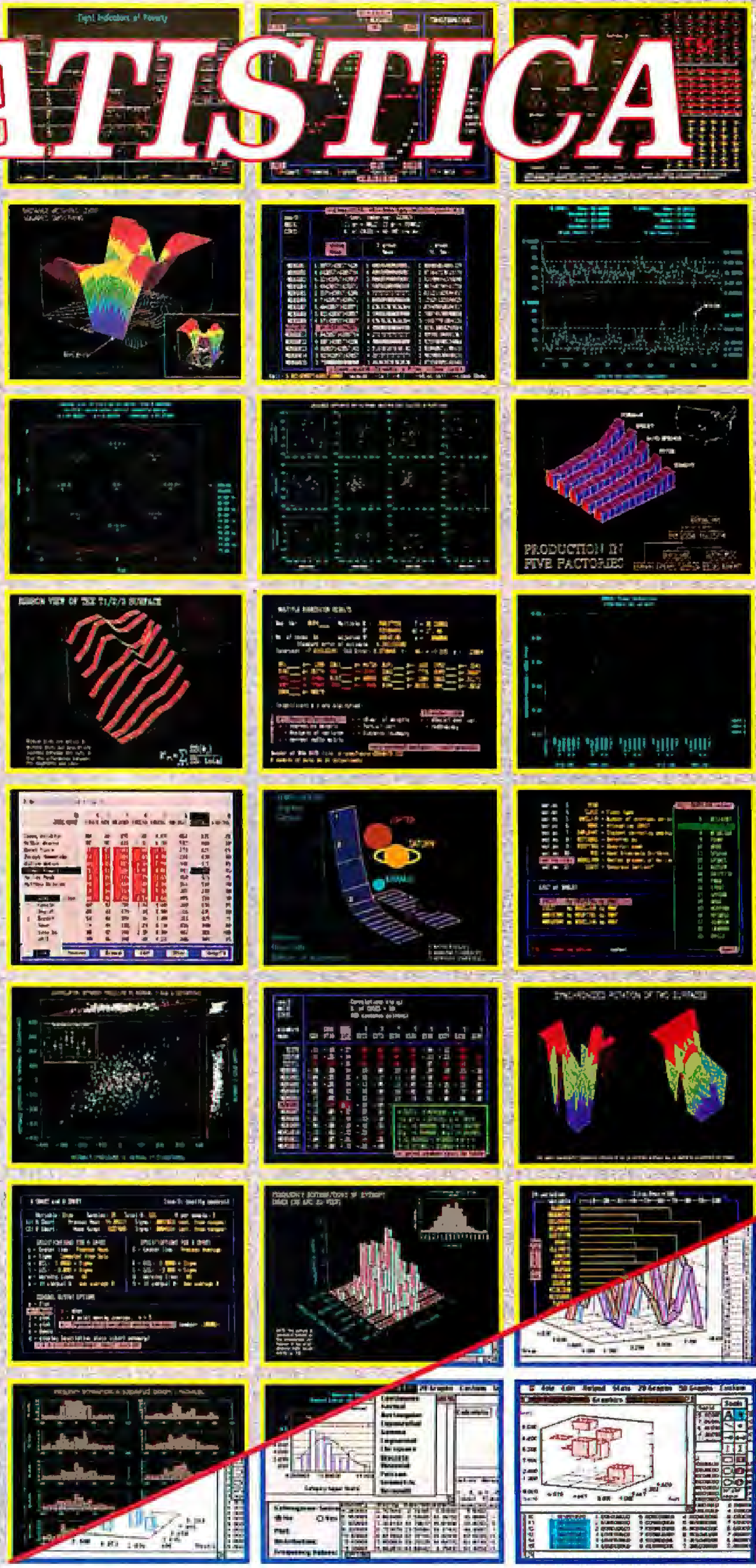

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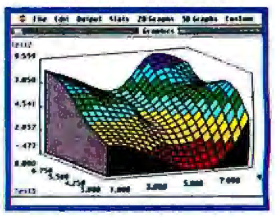

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FEATURE

# The Future of Personal Computing?

## BYTE probes the depths of the IBM/Apple/Motorola PowerPC

KENNETH M. SHELDON, OWEN LINDERHOLM, AND TREVOR MARSHALL

On July 3, 1991, IBM, Apple, and Motorola signed an agreement to develop the PowerPC, a system that will exemplify new hardware and software standards for personal computing. The prospect of Apple and IBM, the industry's two long-time competitors, working together could be the most important computer story of this decade. It is the glasnost of personal computing, the coming together of the leaders of their respective corners of the industry.

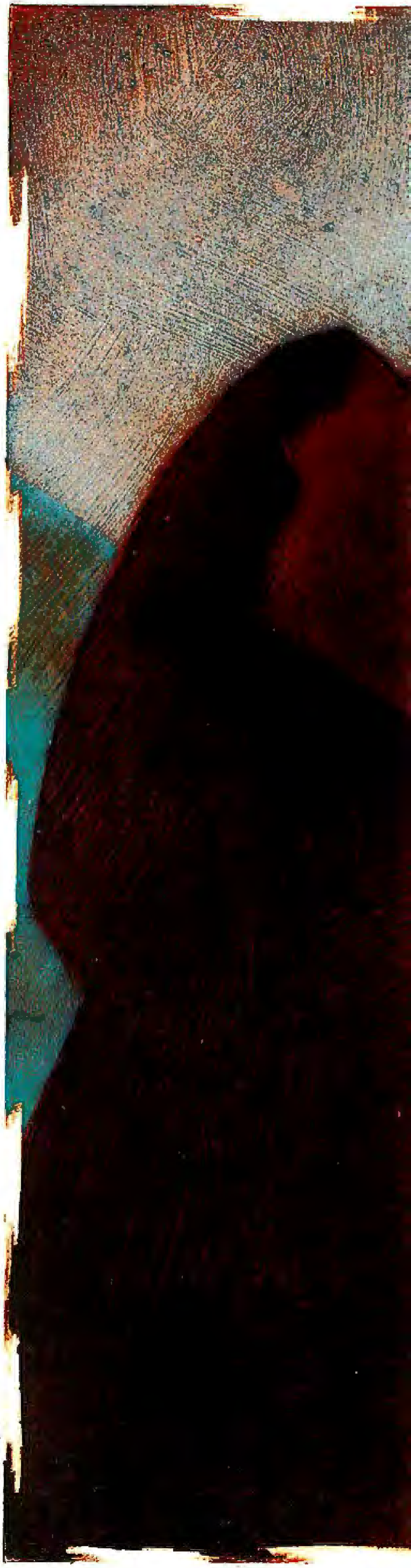
Like many new ventures in this field, the announcement was accompanied by much speculation and few details. Now, however, the participants have revealed some of the particulars of what their future PCs will look like.

### The Power Platform

The PowerPCs from Apple and IBM will be descendants of IBM's RISC System/6000 (RS/6000) systems, a series of high-end Unix-based computers built around IBM's POWER (for Performance Optimization for Enhanced RISC) architecture. (For more on the RS/6000 series, see "Sizzling RISC Systems from IBM," April 1990 BYTE.)

In a relatively short time, the RS/6000 systems have become very popular as engineering workstations, boasting speeds of up to 56 million instructions per second (compared to about 4 MIPS for the average 386-based PC). With that kind of horsepower, the RISC systems will be able to handle compute-intensive tasks that are now beyond the reach of affordable personal computers: high-quality speech recognition and synthesis, three-dimensional graphics, image processing, new user interfaces, and other applications.

IBM's current POWER systems are built around a five-piece chip set. The coming PowerPC systems will use a single-chip version of the architecture, which IBM is developing in cooperation with Motorola (see the text box "In the Power PC Chips" on page 100). At first glance, the choice of Motorola to help develop the chip might seem odd; Motorola already makes a RISC processor, the 88000—not to mention the 680x0 chips inside Apple's current Macintosh lineup. Nevertheless, Motorola's high-volume manufacturing expertise complements IBM's strong design team. The two companies are creating a joint design center in Austin, Texas, where they will produce three versions of the PowerPC chip: a low-end version for laptops, a midrange version for desktop systems, and a high-end version for workstations. In a separate effort, Apple and IBM are developing a fourth chip, aimed at

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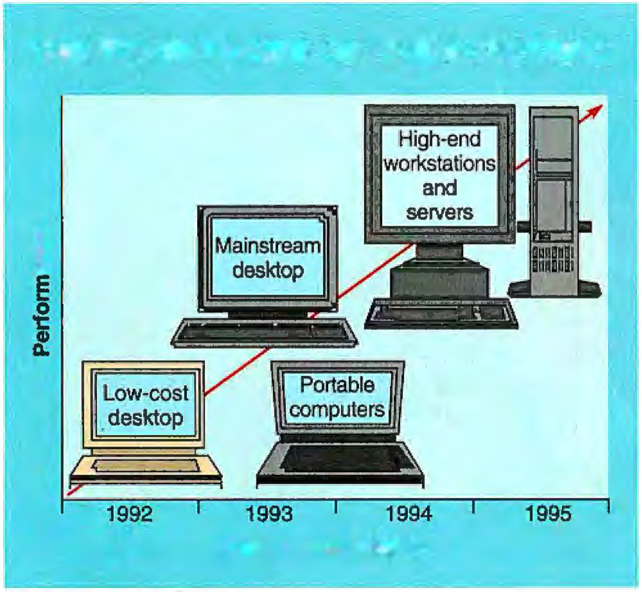


**Figure 1:** *Although based on the same architecture (a single-chip version of IBM's highly successful RS/6000 processor), the PowerPC chip will be available in four different implementations, to be incorporated into four classes of computers. The first systems—low-cost desktop models—will be based on an implementation of the chip that is being developed by Apple and IBM and will be available in late 1992 or early 1993. Three other implementations of the chips, developed jointly by IBM and Motorola at a new design center, will go into portables, desktop systems, and high-end workstations and servers.*

low-cost desktop systems. It will be the first of the four chips to become available—in late 1992 or early 1993. (See figure 1.) With some extensions, the PowerPC could, perhaps, even be used at the supercomputer level; the RS/6000 architecture is scalable, which means that it is designed to scale easily from very small, simple systems to very large, high-powered ones.

**BYTE ACTION SUMMARY**

The announcement of a joint venture between IBM and Apple to develop an entirely new type of computer could be a turning point in the history of personal computing. The PowerPC, combining features of Macintosh and IBM RISC systems, also promises to run current Macintosh, DOS, and Unix applications—a feat that could prove difficult to achieve.

IBM and Apple—and other companies in the future—will incorporate PowerPC chips into their products. The advantage for end users will be that all systems based on this chip will be able to run the same software, regardless of manufacturer. Manufacturers will differentiate their systems by developing designs with different features for different settings—much as makers of 80x86 systems currently develop different systems for desktop use, portability, multiprocessing, and so on.

The PowerPC will use an expansion-bus structure adapted from the one used by Motorola's 88110 RISC chip. What kind of adapter cards will fit in the slots on the bus? At a recent industry forum, representatives from all three companies noted that PowerPC systems could have Micro Channel slots (to retain IBM plug-in compatibility), VME slots, and also NuBus slots. Whether a given system has any or all of these would be up to that system's manufacturer.

## Opening Up the Software

The other half of the PowerPC puzzle is PowerOpen, a new version of Unix based on AIX (IBM's Unix) and A/UX (Apple's Unix). Depending on whether you talk to Apple or IBM, you get a slightly different picture of what the various software layers will look like. From talking to both companies, we've come up with figure 2, which shows how a variety of applications will coexist on PowerPC systems.

PowerOpen will conform to OSF/1, the Unix standard from the Open Software Foundation, with extensions added by Apple, IBM, and other developers. It will therefore support multitasking, multiple users, and other features that vendors of current PC operating systems are struggling to add.

You'll be able to purchase PowerOpen from Apple (in the form of A/UX 4.0) or from IBM (in which case it will be AIX). While the A/UX and AIX versions will share a common kernel, Apple and IBM will add features to differentiate them (just as Microsoft's MS-DOS and Digital Research's DR DOS can run the same programs but have different features).

AIX applications and new applications written specifically for PowerOpen will run in native mode, talking directly to the PowerOpen Application Binary Interface (ABI)—the part of the operating system that talks directly to the hardware. These applications will provide the fastest, most efficient operation of any programs running on the RISC POWER platform. However, you'll also be able to run all your current DOS, Macintosh, and A/UX applications under PowerOpen, thanks to emulation software—software that essentially tricks applications into thinking they're running on their native hardware. (One popular example is SoftPC from Insignia Solutions, which lets you run DOS applications under Unix or the MacOS.)

Just how *fast* current programs will run on the PowerPC is a matter of opinion. Running under an emulator is like talking through an interpreter to someone who speaks a different language—all other things being equal, it takes longer than if you know the native language. However, PowerPC proponents claim that current Mac, A/UX and DOS applications will run just as fast (if not faster) on the PowerPC, thanks to the RISC chip's extra horsepower, in spite of having to run under emulation software. (For more on how emulation software works, see the text box "Mimicking the Mac . . . and DOS" on page 102.)

The ABI will incorporate the Macintosh Applications Programming Interface (API), also known as the Toolbox, which handles file I/O, communications, floating-point math, memory management, and the Macintosh look and feel. At the low end of the PowerPC systems (notebooks and desktops), Apple expects Mac OS applications to predominate. For the workstation and server markets, it expects that most developers will port their applications to the native (RISC) operating system.

## The Look

New programs written for the PowerOpen operating system will have the option of either sporting the Macintosh look and feel or—since PowerOpen will be OSF/1-compliant—following the OSF GUI, Motif.

The Macintosh look and feel is encoded in the Macintosh API ROMs, which contain most of the functionality of the Mac OS, including all the QuickDraw routines used to draw and refresh the

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Talking about room, we have a large 15" flat square monitor with 30% more viewable area than a standard 14" monitor, which makes those large spreadsheets and high resolution documents much easier to read.

The Dell 486D/33 comes with factory-loaded MS-DOS 5.0, Microsoft Windows 3.0 and a Microsoft Mouse.

intel inside


THE DELL 486D/33 33 MHz i486DX SYSTEM.*
SYSTEM INCLUDES 200MB HARD DRIVE, ULTRASCAN (1024x768) 15C MONITOR, 5.25" 1.2 MB and 3.5" 1.44 MB FLOPPY DRIVES AND 8 MB RAM.

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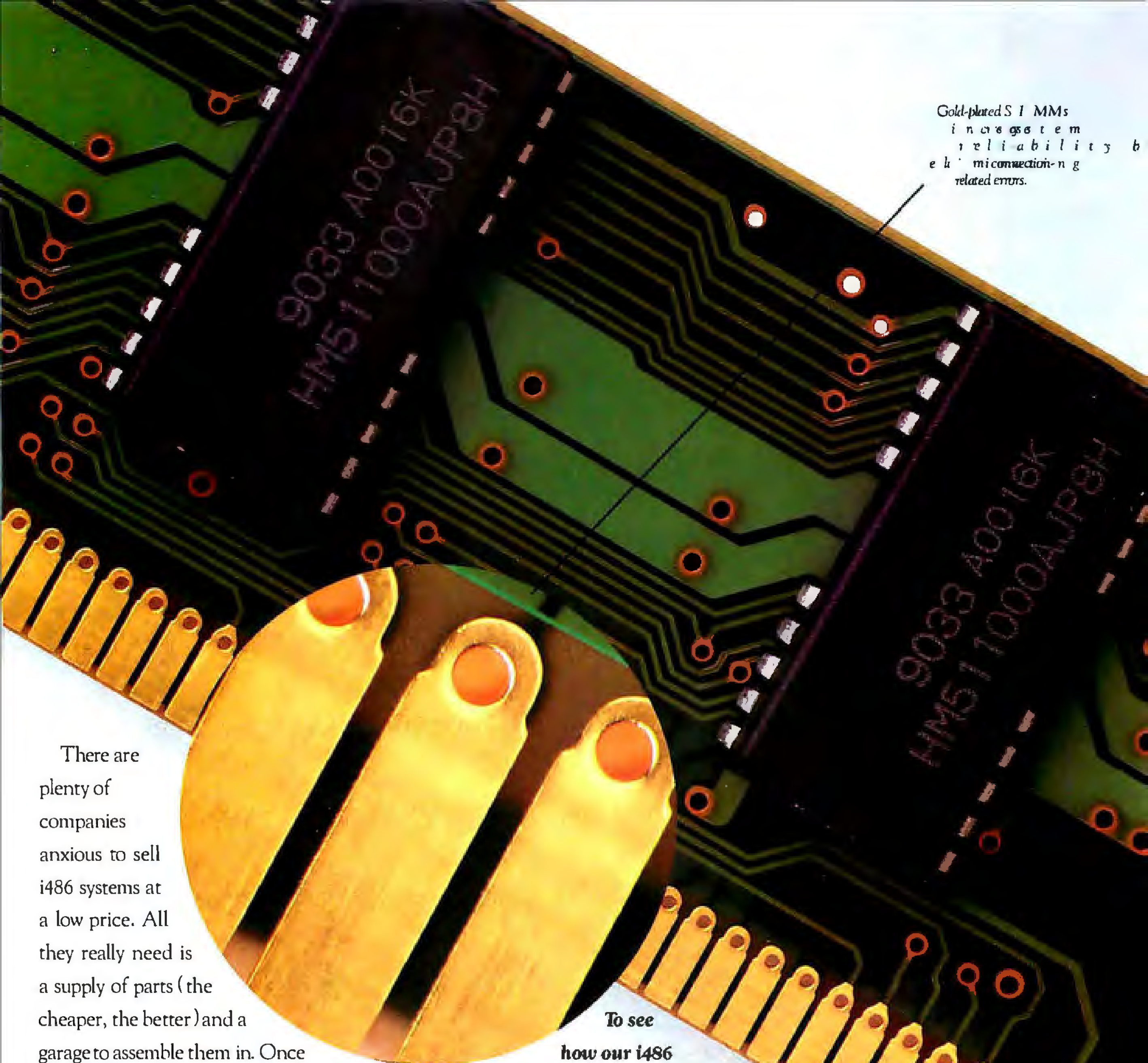


Gold-plated SIMMs increase system reliability by eli[illegible] connection-related errors.

There are plenty of companies anxious to sell i486 systems at a low price. All they really need is a supply of parts (the cheaper, the better) and a garage to assemble them in. Once the "production line" gets going, they place a few ads in the paper. After that, of course, it's anyone's guess as to which will last longer: the computer or the "company" it came from.

*The 486P/[illegible] one of the few computers to feat[illegible] 16 MB SIMMs.*

At Dell, on the other hand, we offer lower prices by cutting down on traditional retailer mark-ups, not quality. In fact, we're almost fanatical about the quality of every machine that leaves our state-of-the-art factory. That attitude is reflected in the way we design, test, manufacture and ship our i486 systems.

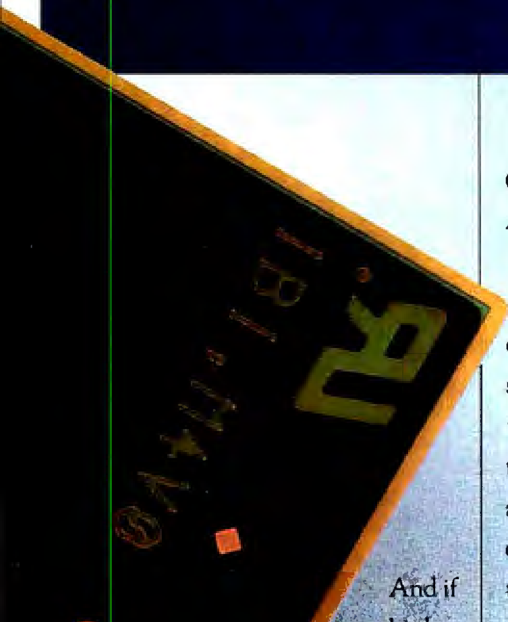
***To see how our i486 systems stand up to air delivery, we use a Black Box.*** Or, in technical parlance, a portable accelerometer/thermometer. This little device is fitted into a test computer which we then send out through regular delivery channels, much as if you had ordered it yourself. When we bring it back, the "Black Box" tells us exactly what the computer went through, in terms of shock, vibration and temperature. This innovative test is part of a series that's been so successful in helping us improve our packaging, we've won an international award for package design.

*Our Black Box test makes sure your Dell [illegible] this way.*

***To make our computers more reliable, we cook them.*** After our computers are fully assembled and configured, randomly selected units are "burned-in" and tested at 104°F.

In perhaps the most grueling temperature test we've ever come up with, pilot Dell systems must survive a storage chamber where temperatures vary rapidly between −40°C and +60°C.

# JUST BECAUSE YOU PAY LESS DOESN'T MEAN YOU GET LESS.



And if you think that's rough, consider our shock test. Sample i486 computers are strapped to a guillotine-like apparatus which repeatedly drops them to the ground. This tells us what we can do to improve their shock tolerance level.

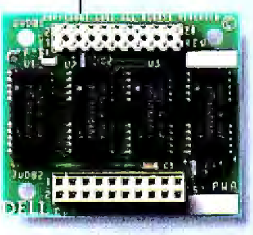
Our power supply units undergo an equally rigorous quality control process. In a test that simulates several years of actual usage, randomly selected test units are switched on and off *1 ,02 times;* only then can they be approved.

While our testing may seem a little extreme, it's based on a rather simple fact: if our machines don't fail with us, they haven't much chance of failing with you, either.

***Our computers have a heart of gold.*** At Dell, we take quality consciousness so seriously, we fit our i486 systems with SIMMs that have gold-plated connectors. If you're wondering what such expensive components are doing in relatively inexpensive computers, the answer is simple: they cost us a bit more, but by eliminating connection-related errors, they're worth their weight in gold.

It's exactly this kind of commitment to quality control that's enabled us to meet CSA, UL ,TUV-GS, FCC and VDE standards, earning worldwide regulatory approvals.

***There are thousands of ways to use a Dell i486 system.*** Dell i486 systems are tested for compatibility with major peripherals, software applications, network topologies and network operating systems, including Banyan and Novell, in several hundred permutations per system. They're even tested for AS-400 connectivity. So you can use our machines in virtually any environment.



*A small e xpa nsi emide memory gi ve you over 3 2000 c o lfsoa near photographic quality display.*

***50% fewer opportunities for things to go wrong.*** After the traditional computer manufacturer builds a system, it goes to the dealer, who then does his own configuring. That's 2 stages of manufacturing, which means twice as many opportunities for things to go wrong.

*R a n dDell c omputers r e " bu rnitm "t 0 4 c le grE aheshe t*

A Dell i486 system, on the other hand, is manufactured only once. We custom-configure memory boards, network cards and advanced video, testing the system as a unit.

We even load select software packages you buy from us, at no cost to you. That includes MS-DOS 5.0, Microsoft Windows 3.0, and many popular applications programs.

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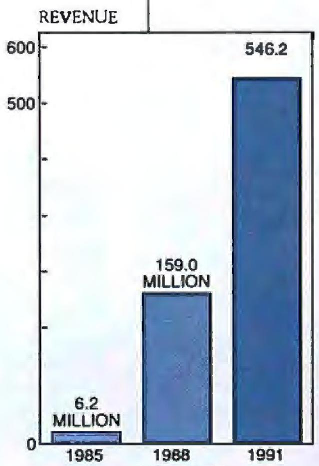
We even have a special section on CompuServe's PC vendor forum. So you can view other users' problems, and, more importantly, our solutions. But what makes our bulletin board speci that we constantly monitor what goes on there. Which means we can keep track of small problems, and stop them before they become big ones.




*Dell has built a $546 million dollar business by building a relationship with every customer.*

But what if you have a problem that just can't be solved over the telephone?

***On-site service is an ambiguous term.***

To some enterprising vendors, it conveniently mea hat the replacement parts, and not the service technician, will arrive on-site. Which isn't as crazy as you may imagine; there are any number of do-it-yourself computer whiz kids in this business.

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Introducing the Dell® 486P/20. A computer that gives you an i486™ SX processor at the price of an i386™ DX machine.

An incredible performance boost of up to 40% at virtually no additional cost.

Generating enough processing power to exploit the full potential of future versions of Microsoft® Windows™ and OS/2®.

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And if that isn't impressive enough, the Dell 486P/20 comes with an upgradeable processor that can go from a 20 MHz i486SX chip all the way up to a high-end 33 MHz i486DX system, and even beyond.

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***A true power user's desktop.*** For its low price, the Dell 486P/20 has a lot of technical innovations you wouldn't expect to find on even higher end machines. Things like programmable Flash EPROMs, for example, that make conventional methods of upgrading system BIOS seem almost obsolete. You won't have to take this computer apart and lose your patience trying to pry out a reluctant chip. Just slip in a diskette — that's all.

Expanding memory is equally convenient. One of the few PCs to support 16 MB SIMMs, the 486P/20 carries 4 memory expansion sockets, on its main board. So as your needs grow, you can keep adding RAM in 1, 4, or 16 MB increments up to a total of 64 MB. That's plenty of room to run your networking software, Microsoft Windows and just about any high-performance graphics application.

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***An i486SX processor with the future built in.*** Because the Dell 486P/20 upgrades via a processor chip instead of traditional processor cards, upgrading takes the form of a single, economical step: Just remove one chip and replace it with a higher performance version.

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THE DELL 486P/20 20 MHz i486SX SYSTEM.*

SYSTEM INCLUDES 50 MB HARD DRIVE, VGA COLOR MONITOR, AND 2 MB RAM.

screen displays. These QuickDraw routines give the Mac much of its coveted look and feel.

Where does the PowerPC RISC CPU fit in this scheme? In the past, one of the major difficulties in porting Macintosh applications to other platforms has been the need to completely rewrite the graphical interface routines, since Apple allowed only its own Macintosh product line to use QuickDraw technology. This has particularly been a problem for applications that are heavily graphics-oriented. That will change, however, with the incorporation of the Mac API into the PowerOpen ABI. With access to Apple's API, developers will be able to port their 680x0 applications to native RISC operation with very few changes to the source code.

### What About Pink?

Much has been made of the new object-oriented operating system (dubbed Pink) and its role in the future market positioning of both Apple and IBM. Both companies have made a significant investment in Taligent, the company that will produce Pink. Unfortunately, details on Pink are scarce. But according to Jim Groff, Apple's director of Enterprise Computing, Pink will be a completely object-oriented operating system, rather than an object-oriented layer added on top of a traditional operating system (e.g., NextStep). Current object orientation is like getting a meal by choosing food "objects" from a menu, according to Groff. "Pink," he says, "will be like going to the grocery store and selecting items, which you will cook at home." As such, Pink will lend itself to custom applications developed for specific tasks.

However, both Apple and IBM have made it clear that the PowerPC, at least initially, will not use the Pink operating environment. According to Phil Hester, director of the Engineering Center for IBM's Advanced Workstation Division, "The Macintosh and Unix operating systems and the application of multimedia to them are the key areas we want to focus on." Eric Harslem, vice president of Apple's Desktop Products Division, emphasizes that point by adding, "It is most important for us on the Apple side to remain focused on the Unix and Macintosh operating systems."

When will Pink be available? The companies say that features and schedules for the Taligent products are less specific than for those of PowerOpen. They say that the Taligent product will start with a clean slate and will be targeted to run on a wide range of platforms, but they have declined to say for certain whether the PowerPC would be one of these.

### Down the Power Road

IBM, Apple, and Motorola have formed an industry organization, modeled after the 88Open group, to promote the PowerPC architecture and allow any interested parties to participate in defining standards. The PowerOpen group will define the instruction set for the PowerPC, the ABI, and software interfaces. Phil Hester says that PowerOpen will actively solicit input from others in the industry. "This is not a three-person club," he says.

In trying to attract new members, the PowerOpen group will be going head-to-head with the Advanced Computing Environment consortium, which includes Compaq, Mips, Microsoft, DEC, and others. To make it easier for other manufacturers to develop PowerPC systems, the PowerOpen group will provide a "reference hardware platform"—a standard implementation that developers can use to design their own systems. According to Hugh Martin, Apple's director of High-Performance Products, that reference standard will not be as strictly defined as the ACE standard. "We want to make the definition as broad as possible to encourage innovation," says Martin, adding that the intent is to encourage vendors to customize and add value to the PowerPC platform.

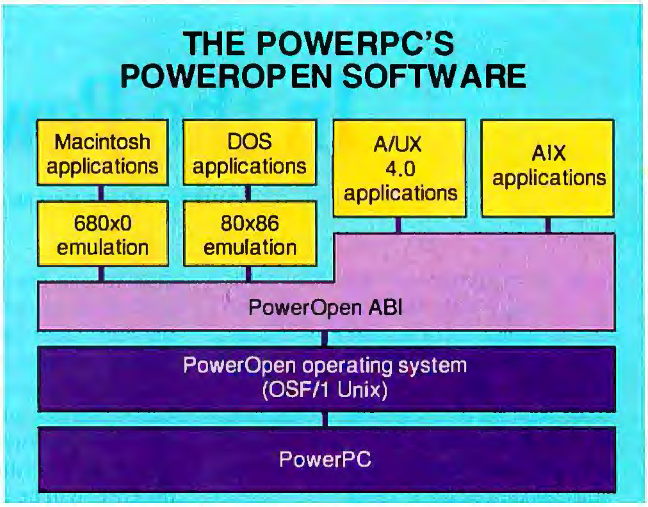


**Figure 2:** *While the system software of the PowerPC is still in flux, the various layers will look something like this: The PowerPC RISC hardware will run PowerOpen, an OSF/1-compliant Unix that will be available from IBM or Apple. Both companies' versions will support the PowerOpen Application Binary Interface, which will allow all current AIX programs to run. They will also include the Macintosh Applications Programming Interface, which provides the Mac look and feel. PowerOpen supporters say the system software will run all current Mac, DOS, A/UX, and X Window System programs. The emulation software will be either a part of the ABI or an extension to it. IBM and Apple plan to continue selling systems based on other CPUs (i.e., the Intel 80x86 and Motorola 680x0 families, respectively), as well as system software other than PowerOpen (e.g., the Mac OS,.Pink, and OS/2).*

The three founding members of the PowerOpen group say that the PowerPC architecture will be fully licensable, in the same manner that the SPARC architecture is licensed from SPARC International. They've said that prices for licenses would be competitive with those of other RISC licenses in the industry. Hester wouldn't provide specific prices in comparison with Sun's, but he said, "There's no such thing as a free lunch; you get what you pay for."

Meanwhile, none of the companies involved has committed its whole future to the PowerOpen architecture. Les Crudele, vice president and general manager of Motorola's RISC Microprocessor Division, says that Motorola intends to continue to produce the 680x0 series of CISC processors, as well as the 88000 line of RISC processors. Crudele says that, while the 88000 might seem to compete with the PowerPC, there are many existing customers for the 88000.

Phil Hester says that IBM will continue to produce RS/6000 machines. They will mostly be based on the PowerPC, but the company will use extensions to the basic PowerPC architecture to produce high-performance RS/6000 systems.

IBM will also undoubtedly continue to develop systems based on Intel's 80x86 family of chips. It recently signed a deal with Intel, under which the two companies will work together on future versions of the 80x86 series—a sure sign that IBM hasn't given up on the CPUs that have been the basis of its PC line for 10 years.

Meanwhile, Apple will continue to produce Macs based on the 680x0 line, in addition to the PowerPC-based Macs. The 680x0 systems will run some future variant of the Mac OS (which

# In the PowerPC Chips

OWEN LINDERHOLM AND TREVOR MARSHALL

Development of the PowerPC chips will take place in two stages, according to Phil Hester, director of IBM's Advanced Workstation Engineering Division. The first stage involves getting a functional chip operating in 1992, but the second and more important development phase is targeted for 1993.

The PowerPC silicon expected to be available before the end of 1992 will be suitable for a low-end workstation. The PowerPC developers will plan to achieve working silicon in that time frame by taking the computing core of the single-chip version of the RISC System/6000 (RS/6000) that IBM has already developed and integrating it with the bus interface and cache technology Motorola is now using in its 88110 RISC microprocessor. The new chip will probably be implemented in either 0.8- or 0.5-micron CMOS, will operate at 50 MHz, and will be able to achieve at least 40 SPECmarks.

Hester says that the chip will use a version of the RS/6000's instruction set that is "tuned" to a low-cost, single-chip implementation. This means that some RS/6000 instructions will be left out and others added. Instructions not implemented in silicon will be trapped and emulated in software or microcode, resulting in a microprocessor that is both forward- and backward-compatible with the current RS/6000 designs.

In addition to certain instructions being cut out, some others that now execute in one cycle will be allowed to execute in two or three cycles, according to Richard Oehler, the RISC architecture manager at IBM's T. J. Watson Research Center. Oehler claims that these changes will not result in a significant performance degradation. However, the silicon area required for the CPU will be greatly reduced, making a single-chip RS/6000 not only feasible but also inexpensive.

Both Apple and IBM say they plan to use the first PowerPC chip in future systems, and IBM says it expects such a product to appear in 1993. Apple representatives have stated that the street price of a system based on the PowerPC chip could be as low as $1000 to $2000 and that the processor itself will cost about $50.

By the mid-1993 time frame, the PowerOpen consortium expects to have scaled up the PowerPC chip, says IBM's Hester. Each level of power will have differing numbers of instructions implemented in hardware or emulated by software. The lower-cost versions will use 32- or 64-bit internal buses, while at the high end, CPUs more powerful than the current RS/6000 chip set will have most of their functions supplied in silicon and will retain the 128-bit internal bus that gives today's RS/6000 much of its performance. Hester expects that by 1993, technology will permit even the low-end chips to include caches the same size as those of the current RS/6000: 8 KB of instruction cache and 32 or 64 KB of data cache.

## Best of Both Worlds

The IBM-Motorola partnership indeed unites the strengths of two semiconductor giants, combining IBM's fast design cycle with Motorola's dense packing techniques. The venture will use Motorola's new 0.8-micron CMOS facility, bolstered with IBM's 0.5-micron technology. Motorola will also gain some of IBM's pad-bonding technology, which lets connections to a chip be made anywhere on the surface, not just around the edges of the die.

The 1993 version of the chip, usable for desktops and notebooks, is expected to offer performance in the range of 30 to 50 SPECmarks; a server processor due in 1994 or 1995 will boast 50 to 150 SPECmarks, Motorola says. By 1995, the top-of-the-line processor could be capable of 500 SPECmarks, according to Les Crudele, vice president and general manager of Motorola's RISC Microprocessor Division.

Future plans are ambitious. Hester says that IBM is examining the technique of using internal CPU bus speeds that are twice as fast as those of the external bus—a technique pioneered by Fairchild Clipper and now used by AMD, Mips, and Intel. The companies may eventually be able to move to a 0.35-micron process, according to Crudele. And the processors' clock speed may reach 100 MHz by 1995.

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is currently at System 7.0), while the PowerPC systems will run A/UX 4.0. Both will run current Macintosh applications, according to Hugh Martin. "All our existing 68000 applications will be able to run in emulation mode under PowerOpen," says Martin. "We will have an absolute, rock-solid emulation on the new RISC environment."

Eventually, Apple will have Mac, Power, and Pink systems. " 'One size fits all' simply isn't a reasonable approach anymore," says Jim Groff.

On one issue, at least, all parties are unanimous: They can make no time schedule whatever regarding the availability of software development tools for the PowerPC. The only environment currently available is that on the RS/6000 workstation line. None of the API or ABI extensions is available in the RS/6000, so no one will be able to begin development of PowerPC applications software at least until those key components are finished. The software tool availability will probably lag behind the hardware by six to 12 months. This means that you can expect to see the first applications running native on the PowerPC platforms in late 1993.

By then, Intel 80x86–based platforms may already have so much force in the market that the PowerOpen venture may have difficulty challenging it. Clearly, however, the IBM-Apple-Motorola triumvirate hopes that the promise of a low-cost RISC PC that will run Mac, DOS, and Unix applications will blunt some of the inertia being gained by the ACE consortium and allow PowerOpen time to finish its product offerings before any potential competitors gain a stranglehold on the RISC PC marketplace.

continue

# LOOK WHAT PC MAGAZINE HAD TO SAY ABOUT A VERY GRAPHIC AND RACY SUBJECT.

# Mimicking the Mac...and DOS

TREVOR MARSHALL

A key feature in the success of the PowerPC will be its ability to run current Mac, DOS, and Unix applications. To do that, PowerOpen will need to incorporate emulation software. In discussions about PowerOpen, Apple has demonstrated a commercial DOS software emulator (SoftPC) running Lotus 1-2-3 as an example of what could be achieved with software emulation technology.

The question that remains unanswered relates to operational speed. While it may be impressive to see the header screen of 1-2-3 on a Macintosh display, a commercially viable computer will need to be able to run the program at an adequate speed. It is still unclear whether this can be achieved using emulation technology.

Nevertheless, Apple has been working on 680x0 emulation technology using RISC CPUs, including the Am29000 and the 88110, for several years now. Sources within Apple indicate that the company has achieved an emulation performance level that approaches that of a Mac IIcx. Although the 680x0 emulator itself is slower than the 68030 in the IIcx, much of the time taken to execute a Macintosh application is spent running code in the Mac Applications Programming Interface ROM routines. In the PowerPC environment, these operating-system calls will execute in native mode, and the speed improvement gained in API functions will offset some of that lost in the 680x0 emulation itself.

The other issue, of course, is compatibility. The compatibility of the DOS emulator in PowerOpen ought to be adequate, since much engineering effort has been spent on PC emulators (for both RISC and CISC machines) in the last few years. Since Apple hasn't made any of the results of its emulation tests publicly available, I can't speculate on what compatibility issues will arise.

### How Do You Emulate a CPU?

A microprocessor is made up of an integer execution unit, a register bank, a bus interface, and, sometimes, floating-point and cache circuits. Each CPU has an instruction set, which ensures that the data flows through each of the functional units in such a way as to execute a program and do useful computing work. Almost every CPU has a different instruction set. Even those that are "compatible" (e.g., the 68020 and 68030 or the 386 and 486) add new instructions with each new generation.

Software running on a microprocessor is dependent only on the *programming model.* As long as the CPU executes at least the instructions being used, the presence of enhanced op codes becomes important only when those enhanced modes are used. There are also a number of registers and op codes that are only available in supervisor or protected mode. Normally, applications software can't use these facilities—they are reserved for operating-system use and are emulated by the operating-system software (Application Binary Interface and AIX).

For one CPU to emulate another (using a different instruction set), you need software to simulate each op code of the original CPU. A block of memory is usually allocated to emulate the registers, and a sequence of (host) instructions is used to simulate the operation of the emulated microprocessor.

Some emulators, called *interpretive,* fetch each instruction individually and emulate it. Other emulators store code that is used frequently (such as that residing in a loop) so that it only has to pass through the interpreter once, making the emulation faster. Emulators that do this are called *compiling* or *mixed-mode emulators.* The aforementioned emulator that achieved Mac IIcx speeds with the Am29000 RISC chip was a mixed-mode emulator. It is reasonable to expect that Apple's semicompilation technology will find its way into the PowerPC platforms.

### Will Emulation Be Fast Enough?

Emulation speed is subjective. Software written for the 68030 may emulate more slowly on a PowerPC than it runs on a Mac IIfx, but the mix of software that a user needs to run will ultimately determine whether the results are satisfactory or not.

How hard will it be for the PowerPC to emulate the 68040 and 486? Very hard indeed. Emulators for the 68040 have to handle the floating-point hardware in addition to the integer unit. They also have to handle 68030/68882 emulation (with a totally different floating-point architecture). Similarly, 486 floating-point is different from that of the 386/387. Both CPUs are very complex. Indeed, the PowerPC core is not significantly faster (maybe just a factor of two to four times) than the CPUs it is expected to emulate.

So, the transition between DOS and Macintosh machines and PowerPC-based systems is likely to be slow and complex. At best, emulation will provide only a partial solution to the problems of interoperability. Unless PowerOpen can make significant technical breakthroughs in emulation technology, both DOS and Macintosh boxes will be needed alongside the PowerPC until all the Mac and DOS applications software base has been ported to native mode, running under PowerOpen.

Both PowerOpen and ACE are trying to prepare for the future without totally cutting off the past. As Apple's Jim Groff says, "To succeed, any new environment will need a smooth migration path and the ability to run existing apps." It remains to be seen whether PowerOpen will be able to provide those features soon enough to be a success. ■

*Kenneth M. Sheldon is West Coast bureau chief and Owen Linderholm is a senior news editor for BYTE. Both are based in San Francisco. Trevor Marshall is a consulting editor for BYTE. They can be contacted on BIX as "ksheldon," "owenl," and "tmarshall," respectively.*


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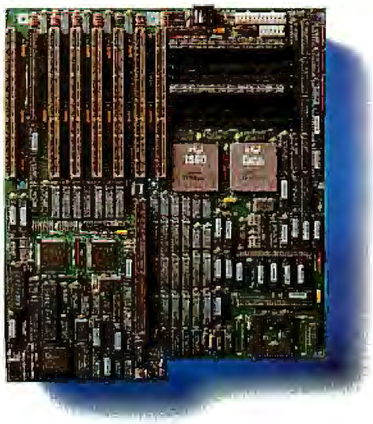

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# Signal Processing for Multimedia

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JOHN F. LYNCH AND NARCISO MERA

When most people talk about multimedia, they focus on the ideal: the seamless integration of text, audio, speech, video, and data communications on a personal computer. But most personal computers don't have the horsepower to handle the demands of multimedia, and that is often overlooked. Many multimedia functions require sophisticated, real-time signal processing, which historically has been too expensive and inflexible for personal computer platforms—and beyond the experience of most applications developers. The Visible Caching Operating System (VCOS) from AT&T is designed to address multimedia's digital-signal-processing gap.

The VCOS consists of operating system routines, AT&T's DSP3210 Digital Signal Processor, and the VCOS Multimedia Module Library. The VCOS is a real-time, multitasking operating system designed to give personal computers access to DSP-based multimedia functions. It is an open operating system that supports the development of third-party multimedia applications and alternative signal-processing algorithms. The DSP3210 is a floating-point DSP designed for low-cost computer systems. It consists of a 33-million-floating-point-operation-per-second engine and a 16.7-million-instruction-per-second RISC ALU. It includes 8 KB of on-chip RAM, a serial port, and an external-memory interface that handles the Intel and Motorola microprocessor-bus protocols. The VCOS Multimedia Module Library consists of a broad range of DSP modules that perform functions (e.g., speech and audio coding, speech recognition, data and fax modem operation, and Joint Photographic Experts Group video compression/decompression) that are designed to run under the VCOS kernel.

The VCOS provides a common engine accessible to different multimedia applications and platforms. It promises to make the power of DSP available to PCs, Macintoshes, and other platforms and to facilitate the development of multimedia applications that support these platforms. The result will be more powerful and widespread multimedia applications.

## What's in a Name

Even though DSP technology is widespread, it has always been considered too expensive to include as part of a general-purpose multimedia platform. AT&T has found a way around the cost issue by using a technique called *visible caching*, which enables a DSP to share existing system memory with its host microprocessor.

The VCOS kernel caches the code and data used by DSP functions on the DSP chip. This caching strategy is termed "visible" because it is the DSP algorithm developer, not the hard-wired logic on the chip, that determines what gets cached. Visible caching lets the DSP chip efficiently share host-system memory and eliminates the need for the expensive, dedicated static RAMs typically found in today's DSP designs. In addition, visible caching provides for a close coupling between the DSP module that runs the signal-processing algorithms and the host CPU/operating system that provides the operating environment and the user interface.

The VCOS kernel provides a flexible operating environment for signal-processing algorithms through its multitasking capability and its support for both real-time and non-real-time execution. Multitasking lets the DSP3210 concurrently support a variety of applications (e.g., high-speed modem data transfers, CD-quality audio coding, and speech recognition). The VCOS kernel supports real-time execution via

**BYTE ACTION SUMMARY**

AT&T's VCOS provides signal-processing functions to personal computer applications. It consists of the VCOS operating system routines, the DSP3210 chip, and the VCOS Multimedia Module Library. Associated development tools let you develop alternative DSP modules.

# Putting It All Together

To see how the VCOS works in the real world, consider the case of a PC-based telephone-answering machine. The figure illustrates the basic logical setup of such a system. It outlines the interconnections between the various digital-signal-processing modules and between the DSP modules and the host application. The modules shown are all included in the VCOS Multimedia Module Library, and their execution and interconnection are controlled and defined by the applications developer.

The visible portion of the host application, the user interface, displays a control panel for the answering machine that may include a list of new message files, a list of old message files that have not been deleted, play and rewind controls, record new message control, and a volume control.

The answering machine has four execution states: idle (waiting for your input or for an incoming call), playback (playing recorded messages), prompt (playing a prerecorded message to urge a caller to leave a message), and record (recording the caller's message). The application control functions of the host determine which of the four states the machine should be in, based on your input.

For example, whenever you request "play back a new message" by clicking on the appropriate control with your mouse, you trigger a call to a host playback function. This function executes a `TaskLoad(playback)` call to load the DSP playback task—consisting of the speech-decoder module and volume-control module—into memory. The speech-decoder algorithm decompresses the outgoing compressed voice samples, and the volume-control module adjusts the amplitude of the outgoing signal, based on the value in the volume-control parameter buffer. The `TaskLoad(playback)` is then followed by a `TaskStart(playback)`, which instructs the VCOS kernel to include the task on the execution list and start its execution, respectively.

At this point, the host application begins reading the compressed data from disk and writing it to the first-in/first-out buffer using the `FifoWrite()` function. The speech decoder in turn reads a block of data out of the FIFO buffer every execution frame and decompresses it. It writes this data to an all-in/all-out buffer, which feeds the volume-control module. This module applies the current volume-control value to the outgoing block and sends its output to the A/D/A device driver via another AIAO. (If at any point during playback you adjust the volume-control slide bar, you cause the host application to update the value in the volume-control parameter buffer.)

When it reaches the end of the message file, the application executes a `TaskStop(playback)` call to inform the VCOS kernel to remove the task from the execution list. This also puts the answering machine into the idle state.

The rest of the answering-machine system mirrors the playback. The additional DSP modules needed are a touch-tone detector (DTMF detector), a telephone-line interface (TLI) status and control module, and a speech coder.

When a call comes into the handset, the A/D/A device driver samples the incoming data and passes it to the DTMF detect module via an AIAO buffer. The application reads the tones detected by the DTMF module from the FIFO buffer (`FifoRead()`) and invokes the TLI status and control module to determine the type of incoming call (e.g., voice, modem, collect, or operator assist). If the call is voice, the application enters the prompt state (`TaskLoad(prompt)`) and plays your prompt message to the caller by passing the compressed prerecorded message from disk to the speech decoder using a `FifoWrite()` function call.

After it plays your prompt, the application enters the record state and starts the speech coder (`TaskLoad(record)`) to record the caller's message. After the caller hangs up, the host application executes a `TaskStop(record)` function call and re-

frame-based block processing. A frame is a unit of DSP processing time; 10-millisecond frames are typical, but other frame intervals can be used. The operating system executes each task on the real-time execution list once every frame. During a frame, each DSP task processes one block of data. The block size varies from task to task, and it is tied to the data rate of the given task. Frame-based block processing has two major advantages: deterministic processing and efficient utilization of DSP bandwidth. The VCOS kernel executes non-real-time tasks during the frame time left over after execution of the real-time tasks.

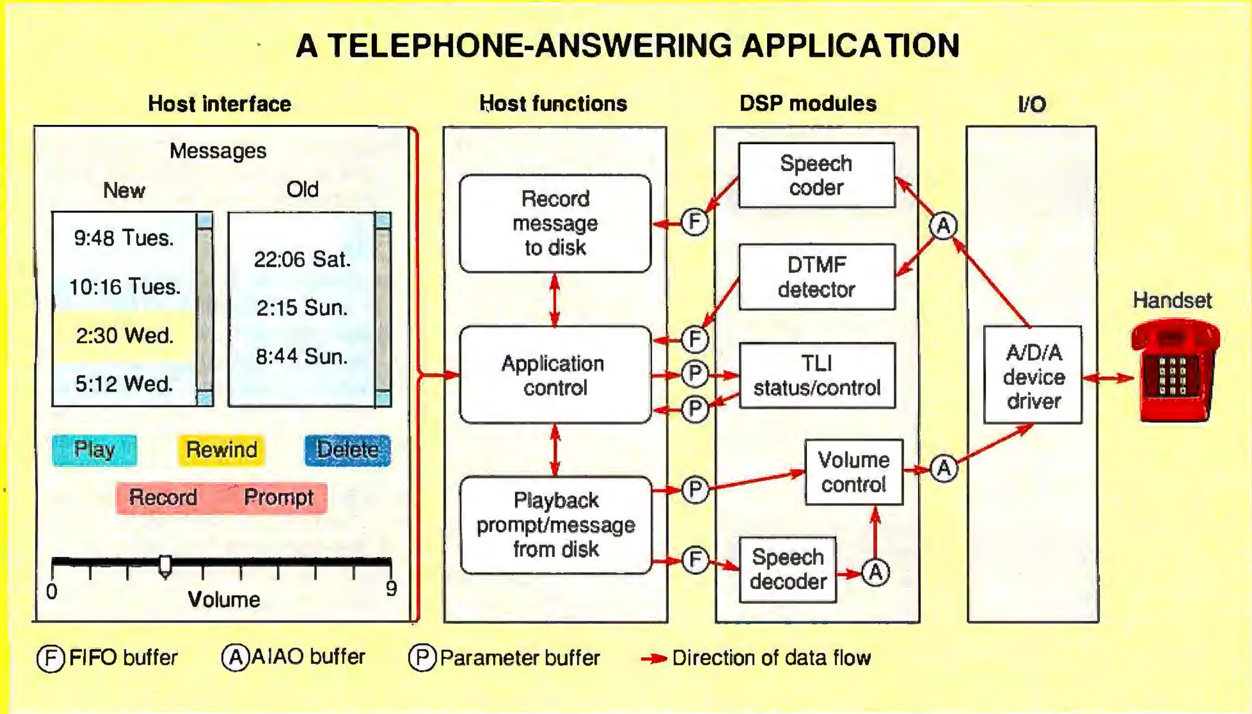
### DSP Programming Under the VCOS

The VCOS-kernel development environment supports DSP algorithm developers and applications developers. Both are important because few software developers are skilled in both areas.

DSP algorithm developers usually specialize in a particular signal-processing discipline (e.g., speech compression/decompression, speech recognition, modems, and image compression/decompression). They use a straightforward DSP programmer's model and real-time debugging tools. The DSP programmer's model incorporates buffers used for communication among DSP tasks and between the DSP chip and the host system. The model supports three basic communication-buffer types: first-in/first-out, all-in/all-out, and parameter.

FIFO buffers are for asynchronous data streams. You would typically use FIFO buffers to play back compressed audio from disk. The host application reads the data from disk and writes it to the FIFO buffer, and the DSP task reads the data out of the end of the FIFO buffer. You use AIAO buffers for synchronous data streams (e.g., passing a block of decompressed audio output from the DSP chip to a D/A converter device driver). Parameter buffers contain symbolically accessed data structures that contain status/control data. For example, you would pass volume and fade control for an audio application from the host application to the DSP task through a parameter buffer.

The DSP programmer's model also lets an algorithm developer direct how the VCOS kernel will cache the modules that make up a particular DSP task. Thus, a developer who has an




*The host application, consisting of a user interface and assorted control functions, accesses the DSP chip by calling various modules from the VCOS Multimedia Module Library. The modules communicate with host functions, with each other, and with the I/O systems through intermediate buffers.*

turns to the idle state. When you close down the answering-machine system, the host uses the `TaskUnload()` function to remove all the tasks associated with the answering machine from memory.

A simple answering machine can be expanded to an automated attendant by adding a text-to-speech DSP module. You could browse through a database of product information via telephone-keypad interaction. When you select a particular item, the host application would invoke the text-to-speech module to read back an ASCII file in the database that describes the product and its price and availability. The possibilities for such a system are numerous, and they demonstrate the flexibility of a system that uses a general-purpose DSP chip as opposed to a dedicated-function chip.

intimate knowledge of a given module's program and data flow can implement a caching strategy optimized for that module.

An important piece of the DSP programmer's environment is the VCOS Debugger, which provides DSP multitasking development support for the VCOS kernel. It lets you develop, execute, and test DSP tasks made of interconnected sets of modules. Once tested, these tasks can be used without modification in multimedia applications. The debugger executes on DSP-3210-based plug-in cards available for PCs and Macs. It supports symbolic referencing, disassembly, breakpoints, single stepping, and reading and writing both registers and memory. The debugger can use disk files to simulate non-real-time I/O while testing and simulating DSP modules and tasks. It is able to operate with A/D and D/A converter signals to simulate real-time I/O.

## Applications Development Under VCOS

Multimedia applications developers have to design and implement a user interface, program access to host operating-system services (e.g., file access), and control various multimedia functions. With the VCOS, applications developers don't have to create their own multimedia services; they have access to the services provided by the DSP3210.

Multimedia developers do not need special tools to access the VCOS. They can use familiar ones, such as Microsoft C Developer's Toolkit and the Windows Software Development Kit, to connect blocks of DSP modules or tasks to perform needed signal-processing functions.

The VCOS provides access to its DSP functions through a C function library, the VCOS Application Server. This host-resident library provides an application programming interface that lets host applications load, execute, and communicate with DSP tasks running under the VCOS on the DSP3210.

The same communication buffers (i.e., FIFO, AIAO, and parameter) available to the algorithm developer are also available to the applications developer. Communication protocols between the host application and the DSP algorithm are specified by the algorithm developer, who also specifies the module-execution order and data-buffer interconnections for each DSP module. (To see how the DSP modules work, see the text box "Putting It All Together" on page 106.)

In the VCOS Multimedia Module Library are functions to access DSP algorithms for V.32/V.29 data/fax modems, speech compression/recognition, audio compression/decompression, dual-tone modulated-frequency (DTMF) generate/receive, and image compression/decompression modules. These algorithms enable applications developers to use the DSP3210 to create multimedia applications without first becoming signal-processing experts. The continued development of algorithms by AT&T and third-party developers will ensure a growing array of DSP multimedia modules.

### Implementing the VCOS

Personal computers that incorporate the VCOS on the motherboard are less than a year away. Meanwhile, AT&T and third-party developers will address the needs of current systems with ISA expansion boards and bus-mastering boards for EISA, NuBus, and Micro Channel architecture. The bus-mastering boards access system memory; they don't require their own memory. ISA-based boards need local memory because the ISA bus is too slow to shuttle information between system memory and the DSP chip. Since the VCOS kernel loads modules into the DSP device's on-chip memory, a VCOS ISA board does not require an expensive fast-access memory subsystem.

AT&T designed the VCOS kernel with portability as a priority. Although DSP3210-based boards will be available for a variety of platforms, the code they execute will be identical; only the host applications will differ.

The design considerations in a VCOS host system are straightforward. The DSP has bus master capabilities and can directly access system memory (except for the ISA platform, where the DSP can access only its local memory, which the host CPU can also access). Because the overhead in accessing system memory occurs mainly in acquiring the bus, not in doing the actual data transfers, the VCOS kernel uses block transfers to enhance access efficiency. Typically, it uses block transfers to move DSP modules into the on-chip cache. The DSP chip uses its own RAM for processing; system memory is used for long-term data and program storage.

This scheme has the benefit of maximizing system-bus utilization and DSP performance—the chip runs much faster using on-chip RAM. Assuming that the DSP3210 takes 200 nanoseconds for an average system-bus access, most DSP tasks will require less than 2 percent of the bus bandwidth. Even the most demanding modules (e.g., speech recognition and V.32 data modems) will use less than 12 percent of the bus bandwidth.

AT&T has tried to keep the size of the VCOS kernel and the associated overhead to an absolute minimum. The kernel is less than 400 32-bit words long, freeing most of the on-chip RAM for module execution. Context-switching overhead is just over 2 microseconds, leaving most of the processing bandwidth for application execution.

With the VCOS, AT&T has brought the power of DSP to multimedia. The VCOS meets the needs of many people, from computer manufacturers looking to deliver multimedia capabilities at low cost to applications developers looking for a capable multimedia platform that doesn't require them to learn DSP. The VCOS is a complete solution that includes an innovative operating system, a DSP engine designed to easily integrate onto a motherboard, and powerful multimedia modules that enable creative multimedia solutions. ■


*John F. Lynch is VCOS program manager at AT&T Bell Laboratories. Narciso Mera is senior applications engineer at AT&T Microelectronics. You can reach them on BIX c/o "editors."*

# Introducing QEMM 386 v6

## Technology, art and magic make the best memory manager better still.

NEW **Stealth: The Ultimate Weapon.** QEMM 6 introduces an amazing new concept: Stealth. This new feature, *the first of its kind*, actually maps ROM into other areas of memory, resulting in a memory gain of up to 211K. Now you can load larger TSRs and device drivers into high-memory (the area above 640K), to give your applications more room. Stealth works on most IBM and IBM compatible computers.

NEW **New Optimize Makes it Easier.** QEMM 6 includes a completely new version of Optimize, the program which automatically configures and optimizes your memory. Now, it includes simple on-screen instructions, the ability to play "what-if" games, and a "view, browse and play" feature.


NEW **Squeeze: Flexible Memory at Start-up.** Often TSRs you wish to load into high-memory require more memory while they are initializing than they do once resident. Squeeze recognizes this, and can temporarily increase a High RAM region during a program's load and initialization.

NEW **Help for Beleaguered Laptop Users.** QEMM 6 now fully supports most battery-operated laptops, with detection of "suspend/resume".

**Manifest Changes Destiny.** QEMM includes a copy of Manifest free. This amazing memory diagnostic and analysis tool is vital when configuring today's complex PC systems.

**Much More Speed.** QEMM makes your machine faster, because it can place sluggish ROM into high-speed RAM. (QEMM is also a lightning fast memory manager.)

**Even More Memory.** QEMM's VIDRAM feature extends *conventional* memory by 96K on EGA or VGA systems. VIDRAM disables graphics, but can easily be turned on or off.

| | DOS 3.3 | | | DOS 4.0 | | | DOS 5.0 | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | DOS Prog Size | Avail High Mem | Avail HMA | DOS Prog Size | Avail High Mem | Avail HMA | DOS Prog Size | Avail High Mem | Avail HMA |
| IBM PS 802 | 581K | 211K | 64K | 572K | 211K | 64K | 620K | 211K | 0K |
| Compaq 20e | 581K | 211K | 64K | 572K | 211K | 64K | 620K | 211K | 0K |
| ALR VEISA | 582K | 211K | 64K | 573K | 211K | 64K | 620K | 211K | 0K |

**More Memory by Default.** QEMM's Optimize will now, automatically, find up to 211K of high-memory. No other memory manager is able to accomplish this feat.

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- STEALTH: MAPS SYSTEM ROMs INTO OTHER AREAS OF MEMORY. POTENTIAL MEMORY GAIN: **211K.**
- NEW OPTIMIZE: SIMPLE MENU-ING INTERFACE, "WHAT-IF" MODE, "VIEW, BROWSE AND PLAY" MODES, AND FIVE NEW PARAMETERS.
- SQUEEZE: TEMPORARILY INCREASES A HIGH-RAM REGION DURING A PROGRAM'S LOADING.
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Chart data is based on the following: Automatic Memory Gain: DOS 5 will automatically gain up to 76K (using the DOS=high and devicehigh commands), QEMM v5 will automatically gain up to 172K (using QEMM's Optimize command and DOS=high), whereas QEMM 6 will gain up to 255K using the new Stealth feature, DOS=high and the new Optimize. As with any utility, these features are dependent on type of machine and application. All trademarks or registered trademarks are property of their respective owners.



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# Applying the Internet

**Corporate, research, educational, governmental, and other real-world uses**

DANIEL P. DERN

Despite ongoing and increasing press coverage of the Internet, remarkably few people outside the Internet community have a sense of what it is used for or whom it serves. The Internet is not an individual organization or network; it is a collective term for the many backbone, regional, and site data networks that it comprises—more than 5000 networks in 33 countries. The name also refers to the more than 500,000 connected computers and the people they serve—roughly 3 million strong.

Organizations join the Internet because it is convenient and because it is less expensive than establishing their own wide-area networks. There are economies of scale in turning to established networks as well as benefits in using existing network expertise.

At the 56-Kbps-to-multimegabit rates typical of Internet links, dial-up connectivity is not an option for most people; its cross-enterprise connectivity means that even private networks would not suffice. Emerging carrier services like ISDN, frame relay, and switched multimegabit data service may offer adequate on-demand service, but the folks on the "other ends" also need some form of connection.

The value of a network lies as much in *whom* it connects as *how* it connects them. The Internet defines a common ground for internetworking communities and establishes a community of people and organizations that want to connect.

The applications, services, archives, conversations, communities, and other resources that make up the Internet easily fill a book (see reference 1). From on-line library catalog access and collaborative intercompany program development to news services, remote control of CD players, and browsing through gigabytes of software archives, the Internet has become home and facilitator to leading-edge research and everyday business operations.

And it's growing. As Steve Cavrak of the University of Vermont (Burlington, VT) commented at a recent conference, "The most important piece of information for potential users to know is that the Internet is *giant* and is growing larger." (For more information on the Internet, see the text box "Feeding the Internet," July 1991 BYTE, page 184.)

## Replacing the Flying Researchers

One of the driving motivations behind the development of the ARPANET, ancestor of today's Internet, was real-time access to remote resources: supercomputers, radio telescopes, weather analysis programs, and special databases, for example. The need for real-time access to remote resources is now

ILLUSTRATION: KERRY GAVIN ©1992

bigger than ever. A 7-billion-electron-volt Advanced Photon Source is being constructed at the Argonne National Laboratory in Argonne, Illinois (near Chicago). The APS is scheduled to start up in 1995 and will rely heavily on the Internet to support its many users.

The APS is a high-energy x-ray source, delivering a beam up to 10,000 times brighter than current devices. Each experiment (i.e., materials to be x-rayed and equipment to collect the data) is set up in the APS's data-collection ports. Initially, the APS will have 30 such ports, with up to 100 planned by the end of 1998.

According to the DS-3 Working Group Report of the Committee on Institutional Cooperation Network (Ann Arbor, MI), the APS's x-ray beam will "permit studies of materials as complex as modern alloys, events as fast as chemical reactions, and biological systems as vital as the beating human heart." (CICNet is the regional academic-consortium network for the seven-state area in the upper Midwest. The DS-3 working group was studying uses for 45-Mbps, or DS-3, network connectivity.)

APS experiments will contribute to industrial research; medicine; nuclear-waste research; biotechnology of drugs, proteins, and viruses; physics; x-ray tomography aspects of chemistry imaging; and materials science. According to the report, "For the first time, it will be possible to visualize the physical behavior of every atom in an enzyme while the enzyme catalyzes a chemical reaction." Also, "Work that previously took two years will now take a week."

In many cases, groups who are industrial competitors will be sharing data acquisition equipment to perform similar experiments, such as industrial macromolecular crystallography. But each group will perform its own tests; they won't share data.

According to the CICNet report, about 3500 scientists and engineers from national laboratories, educational institutes, and industry are interested in using the APS. As of last June, 50 requests had been received for use of the initial 30 ports by teams of 10 to 40 scientists and engineers from associations of up to 10 institutions.

These scientists and engineers don't all have to be physically present at the APS. They only need to send what they want put in the beam and the data acquisition equipment. Given the Internet's connectivity, their data can be "phoned home" to the commissioning groups. The images captured at an APS port, according to the CICNet report, will produce data rates of several gigabits per second. Data for an experiment, before post-processing, would be about 16 gigabytes per day. The results are that researchers and scientists avoid major amounts of travel time and expense, Argonne avoids having to set up hotels for transient experimenters, and other people's travel schedules don't drive APS experiment schedules.

By the time that the APS goes on-line, the planned upgrade of the National Science Foundation network (NSFnet) infrastructure to DS-3 and higher rates, as part of the National Research and Education Networking program, is expected to be in place. (For further information on NREN, see "Whither NREN?" and "A National Vision," July 1991 BYTE.)

**BYTE ACTION SUMMARY**

The value of a network lies as much in who it connects as how. From on-line library catalog access and collaborative intercompany program development to news services, remote control of CD readers, and trolling through gigabytes of software archives, the Internet has become home and facilitator to leading-edge research and everyday business operations. And it's growing.

### Coupling Simulation Programs

Many ecologists have turned to computer modeling simulations to aid in their study of the behaviors of ecosystems. By combining models of individual components, researchers can study the behaviors of complex systems with greater accuracy. One way to do this is to combine the actual code of these models. But researchers are often in distant institutions—a less than ideal circumstance for this type of programming effort.

Another way to hook the models together is through network messaging. At the Colorado State University (CSU) Natural Resource Ecology Laboratory (Fort Collins, CO), researchers are exploring how they can use the Internet to couple their simulation programs.

One simulation program, the Steppe model, created by William Lauenroth and Deborah Coffin, simulates the community dynamics of grasslands (i.e., short-grass prairie) growth. Another program, the Century model, written by William Parton, Vernon Cole, David Schimel, and Edward T. Elliott, simulates the dynamics of organic matter and nutrients in soil.

According to Tom Kirchner (Internet address tom@chloris.nrel.colostate.edu), senior research scientist at the CSU lab, "The Century model is fairly complex in how it looks at nutrients but represents the growth of plants in a relatively simple way. The Steppe model, conversely, has a lot of detail about the growth of plants and plant community dynamics but has a relatively simplistic view of soil resources."

The network mechanisms allow the group to couple the two simulations without merging the programs. "We can run the programs on the same workstation, or on different workstations, as long as there's an adequate network connection."

At the University of Virginia's Department of Environmental Science (Charlottesville, VA), Hank Shugart Jr. and others are also working with ecological modeling-simulation programs. Some of their projects include forest development and soil water.

"We're exploring how to connect models by letting them communicate and share relevant information through network messaging, rather than by merging code," notes Tom Smith, assistant professor in Shugart's department. Using the Internet, the Century model running at CSU was coupled with a copy of the Steppe program running at the University of Virginia.

Why are these groups using the Internet? Kirchner points out, "The universities are already connected, and our department machines are already on the net. So it doesn't cost us any additional funds to use it to connect to another university's systems, and getting connectivity was easy. Also, connecting to an application across the Internet uses the same programming that connects the models within the university network or even on the same machine. Only the target-system name changes, and that can be given as a command-line argument.

"This type of connection is something you wouldn't want to do via modems. These are loosely coupled models, so the amount of data exchange is low, relative to the amount of computation. It's one of the many kinds of applications that Internet connectivity is the ideal answer for. Even if we have dozens of interacting models across the country, each party only needs to be sure it's connected to the Internet."

Having demonstrated the success of Internet-coupled ecology models, Kirchner expects that CSU's group and others will network more models. He notes, "This approach means we can collaborate across distances yet do our individual programming independently. The Internet is continually connecting us to more people we want to collaborate with. It's an essential part of our research facilities, and there is no real alternative resource."

**Need an Archive? Ask Archie**

For many people, particularly programmers and engineers, the Internet means "info-booty": shareware and freeware source code, documents, graphics, and data sets available by file transfer downloads and from E-mail servers. Sites like UUNET and The World each have several gigabytes' worth of publicly available archives. These are but two of the hundreds of sites with archives accessible via these methods. Even admitting a fair amount of redundancy among archives, it still adds up to about 100 gigabytes, and new sites and offerings are coming on-line every day.

With so many different archives, it can be hard to figure out where (and at what network address) to access the items you want. If you don't know what you want beyond compilers or CP/M applications, it's even more overwhelming.

The "archie group" at McGill University (Montreal, Quebec, Canada) has one solution to the problem: archie (*archive* without the *v*), the Internet Archive Server Listing Service (for access, see reference 2). Archie is a central database of information about Internet-accessible archive sites, plus server programs that provide access by `telnet`, anonymous file transfer protocol (FTP), E-mail, and the Prospero distributed computer system.

The archie database maintains a list of hundreds of Internet-reachable sites that contain archives of software, documents, and data sets. These archives can be searched based on criteria such as string matching, site lists, site contents, and software descriptions. In addition to Unix programs, software archives include VMS, DOS, Amiga, Macintosh, and other programs.

The associated archie programs and interfaces allow you to "telnet" and perform direct database queries and searches, download lists by FTP, and send messages to an E-mail server that automatically returns site listings or the results of searches. These results can be compressed using the Unix `compress` utility.

The main players in the archie group have been Peter Deutsch (peterd@cc.mcgill.ca) and Alan Emtage (bajan@cs.mcgill.ca), manager and senior analyst, respectively, in the Computing Centre's Unix support group, and Bill Heelan (wheelan@cs.mcgill.ca), a systems programmer in McGill's School of Computer Science. But, like many projects in the Internet community, Emtage notes that "code, information, and advice have been provided by numerous other people at McGill and around the world."

How many archive files are available on the Internet? Emtage estimates that archie servers as of fall 1991 provide pointers to around 1 million files at 900 sites, adding up to over 70 gigabytes of information. And five to 10 new sites are added to the database each week. "This is not an estimate of the number of files on the entire Internet but just what we keep track of in our database," he points out. As of November 1991, archie tracks only Unix archive sites. However, the archie group plans to also cover non-Unix sites, beginning with DEC VAX/VMS sites.

Through archie's interactive and E-mail interfaces, its sites serve people on five continents. Numerous archie servers are running all around the world. (Rudimentary synchronization is under way with Australia, Finland, and the U.S.)

Satellite archies index only the archives in their own countries. This minimizes Internet traffic for redundant retrievals over often-congested transoceanic links. Global archies track all known archives worldwide (currently, Unix only). According to Emtage, "We soon expect new archie servers in the U.S., and source code has been distributed to sites in Japan, Brazil, Germany, England, and Sweden, who may set up their own servers."

*continued*

As archie's locating service becomes more well known, the request-line volume has grown dramatically. In November 1990, the archie server at McGill received about 30 log-ins per day. As of September 1991, combined archie requests to the McGill server for files and for compressed listings of file sites averaged well over 2600 per day (an estimated 4000 worldwide). These requests come from all known countries on the Internet, Emtage reports, including the U.S.S.R., Poland, Taiwan, Singapore, Iceland, and South Africa.

### Browsing Through Distant Libraries

The software and technical files found in archives appeals mostly to the engineering and programming communities. However, there's another class of information, usually in database form, that has an even wider appeal: library catalogs.

The marriage of libraries with computer networks is another fast-growing area of Internet application. Many individual catalogs are already on-line. Many libraries are networked, and many colleges, universities, and other schools and institutions are on the Internet. It's a logical next step to make their on-line catalogs reachable via the Internet and, in the long term, to deliver access to other on-line information, from CD-ROMs to digitized images.

**There's another class of information, usually in database form, that has an even wider appeal: library catalogs.**

Can't find a book in your local library? Log on, telnet over, and search through the catalogs of a few other libraries. Once you've located the book you want, your local library can probably request it through Interlibrary Loan.

The number of library catalogs accessible through the Internet is growing as quickly as the Internet itself. Marian Bremer, manager of corporate libraries for Bolt, Beranek, and Newman (Cambridge, MA), reported in July that "over 270 on-line library catalogs, 120 of them international, including libraries in Germany, Mexico, New Zealand, Australia, Israel, Switzerland, Sweden, and the U.K., are listed in HYTELNET." HYTELNET is an MS-DOS-based hypertext database of Internet resources (for access, see reference 3).

Representative library resources on the Internet include the following:

• The Research Libraries Information Network (RLIN), an on-line bibliographic database of over 40 million records, representing catalogs for over 100 special collections, archives, and research libraries. It includes not only books but also government records, maps, music scores, sound recordings, films, and photographs (for access, see reference 4).
• Over 200,000 titles emphasizing business, electrical engineering, and psychology at the University of Colorado at Colorado Springs (arlo.colorado.edu; log in as ARLO).
• Partial access to the cataloging records for the Library of Congress (telnet to dra.com).
• On-line catalogs at Boston University (library.bu.edu), URSUS at the University of Maine, Cleveland Public Library, Harvard University (hollis.harvard.edu), and many more.

### The K–12 Community

Kindergarten-through-twelfth-grade groups have sprung up within Usenet (alt.k12), along with E-mail gateways between the Internet and the Free Educational Mail network of more than 150 BBSes, which serve these students and educators around the world. But Internet connectivity means more than E-mail and BBS communications. Its hallmark is real-time applications.

For the past eight years, the Interactive Communications and Simulations Project at the University of Michigan School of Education (Ann Arbor, MI) has been giving students empirical learning experiences. The students participate in interactive role-playing simulations and other activities through programs and scenarios run in ICS's Confer computer-based conferencing facilities.

The ICS effort grew out of simulations of the Arab-Israeli conflict created in the 1970s by Edgar Taylor, then a political science graduate student. In the late 1970s, says Taylor, "we ran role-playing simulations, using the computer as a means of communication but with all the students physically gathered together. By the 1980s, it became clear we could disperse the students; we saw how we could use computer-conferencing systems to facilitate this."

Over time, the ICS "curriculum" has expanded. ICS provides materials defining the roles, scenario, rules, and other essential information. "Our simulations all involve students playing 'real roles,' rather than making up their own characters," Taylor notes. In addition to the original Arab-Israeli scenario, which has 55 roles (character slots) available, there are two other role-playing simulations intended to teach political and social science:

• Writing a new U.S. Constitution, with 70 characters drawn from the past 200 years of American history. Characters include Thomas Jefferson, Jane Addams, Barry Goldwater, Clare Booth Luce, and Martin Luther King Jr.
• Environmental Decisions, which involves planning a major dam project in Africa including evaluations of its environmental impact. This simulation has 40 characters including Rachel Carson, James Watt, Henry David Thoreau, Petra Kelly, and Gamal Abdul Nasser.

There are also two other current ICS projects:

• The International Poetry Guild, enabling students to write poetry and put journals together within the conferencing system and, ultimately, publish a collection of their work electronically.
• The Earth Odyssey, where students interact with travelers who respond to queries regarding social, environmental, and other information. In semesters when no expeditions are scheduled, previous "canned" trips are rerun. (E-mail links to live expeditions via packet radio have also been contemplated.)

What began as a project within Michigan now has participants from around the world: 29 states, three Canadian provinces, and 20 countries overseas, so far. Taylor estimates that over 10,000 students from nearly 400 schools have been ICS 'players."

"The Confer II conferencing system on the University of Michigan's mainframe acts as host, providing store-and-forwarding

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mediation of the activities," explains Clancy Wolf (clancy_j_wolf@um.cc.umich.edu), associate director at ICS. "Students must have an interactive connection to our system. Confer permits public group discussions as well as messaging and also contains previous messages, information bases created by the ICS staff, and other material."

Many schools are connecting to the ICS projects using dial-up services, SprintNet, and other commercial mechanisms. However, observes Wolf, "More school districts and states are getting connected to the Internet, and that's how they're connecting to our system and Confer." (For access, see reference 5.)

### Getting Back to Business

Internet usage was once restricted to research, education, and government-agency activity only—no for-profit or commercial traffic needed apply. But as Public Data Internets offer commercial, unrestricted connectivity, their users are not bound by these limits for traffic only within and among the appropriate portions of the Internet. (For example, no commercial traffic is allowed over the NSFnet backbone. The Commercial Internet Exchange established by the PDIs enables PDIs to exchange traffic without sending it over the NSFnet.) Hundreds of companies are, in fact, turning to commercial PDIs like Advanced Network and Services (Elmsford, NY), Performance Systems International (Reston, VA), and UUNET Communications Services (Falls Church, VA) to be part of the Internet.

**Internet technology seems to have finally made the transition from obscurity to popularity.**

Software Tool & Die (ST&D), a Brookline, Massachusetts-based Unix consulting firm, links to the Internet through UUNET's AlterNet and also through NEARnet (the New England Academic Research Network) and uses the company's Internet connectivity for many software development and related activities. "We've done consulting contracts, including porting a major software product, where we never met in person with the customers," observes Barry Shein, president of ST&D. "All the work was done via Internet connections, telnetting from our Unix system to our customers' systems, conversing by E-mail, transferring files, and so forth."

ST&D also runs The World (for access, see reference 6), the East Coast's answer to Portal and The Well, and one of the first of a new breed of public-access BBSes: a public-access Internet site. With a cluster of Sun Microsystems' workstations and servers running SunOS Unix, The World is one of hundreds of public-access Unix systems scattered around the world. On public-access Unix systems, anyone with a personal computer and a modem can get an account by simply paying the fee. ST&D's The World is one of the larger public-access Internet hosts, with more than 500 active accounts.

What distinguishes The World (and several other public-access Unix systems) is that they are Internet sites, providing not only Usenet, E-mail, and archive services, but also a suite of real-time applications like file transfer, remote log-in, and conferencing.

The Internet Relay Chat (IRC), for example, is a real-time "chat" system that replicates everyone's input to the others whose computers are "tuned" to the same topical "channel." During the Persian Gulf war, I "listened" briefly as dozens of people from all over the world—from Germany to Finland, Israel, and Australia—made comments and discussed events. There were occasional pauses as certain people had to don gas masks. More recently, as Hurricane Bob swept the East Coast and my apartment was without power, I logged into The World with my battery-powered portable and chatted briefly on the "hurricane" channel.

"The World itself is an Internet application," suggests Shein. "People telnet and log into us all the time to access our archives and use services like the IRC. Professional groups such as law firms are considering systems like ours as access methods to legal libraries and databases."

Outsourcing wide-area interoffice connectivity to the PDIs saves money and bandwidth for many. But the added value of the Internet is the community that you can plug into.

### Only the Beginning

Developers within the Internet community have put together products and toolkits for Internet and internetworking applications. Many are available from Internet public-domain software archives; others are available from commercial vendors.

But this is only the beginning. Internet technology seems to have finally made the transition from obscurity to popularity: More services, applications, and users motivates building more networks, bandwidth, and connectivity; greater availability of networks, bandwidth, and connectivity encourages more opportunities for new services, applications, and users.

What began as a serendipitous experiment in a strange form of multiplexing is evolving into the computer-based telephone/post office/CB radio/water cooler of tomorrow. The next time you hear about the Internet, remember that you, too, could be using it—in your work, education, or community, or to explore your personal interests. ■

*Daniel P. Dern is a freelance technology writer based in Watertown, Massachusetts. You can reach him on the Internet as "ddern@world.std.com" or on BIX c/o "editors."*

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1. For the Internet Resource Guide and a list of Internet service providers: NSF Network Service Center (NNSC), BBN Systems & Technologies (Cambridge, MA) or nnsc@nnsc.nsf.net.
2. For archie: Telnet to nearest archie server; for example, archie.mcgill.ca (132.206.2.3) for McGill University; archie.funet.fi for Finland; or archie.au for Australia (log in as "archie," no password). For a list of valid commands: "help."
3. For HYTELNET: WUARCHIVE.WUSTL.EDU, WSMR-SIMTEL20.ARMY.MIL, or VAXB.ACS.UNT.EDU (via anonymous FTP).
4. For RLIN: (800) 537-7546 or bl.ric@rlg.stanford.edu (a pay-for-use service).
5. For ICS: (313) 763-6716 or ics@um.cc.umich.edu.
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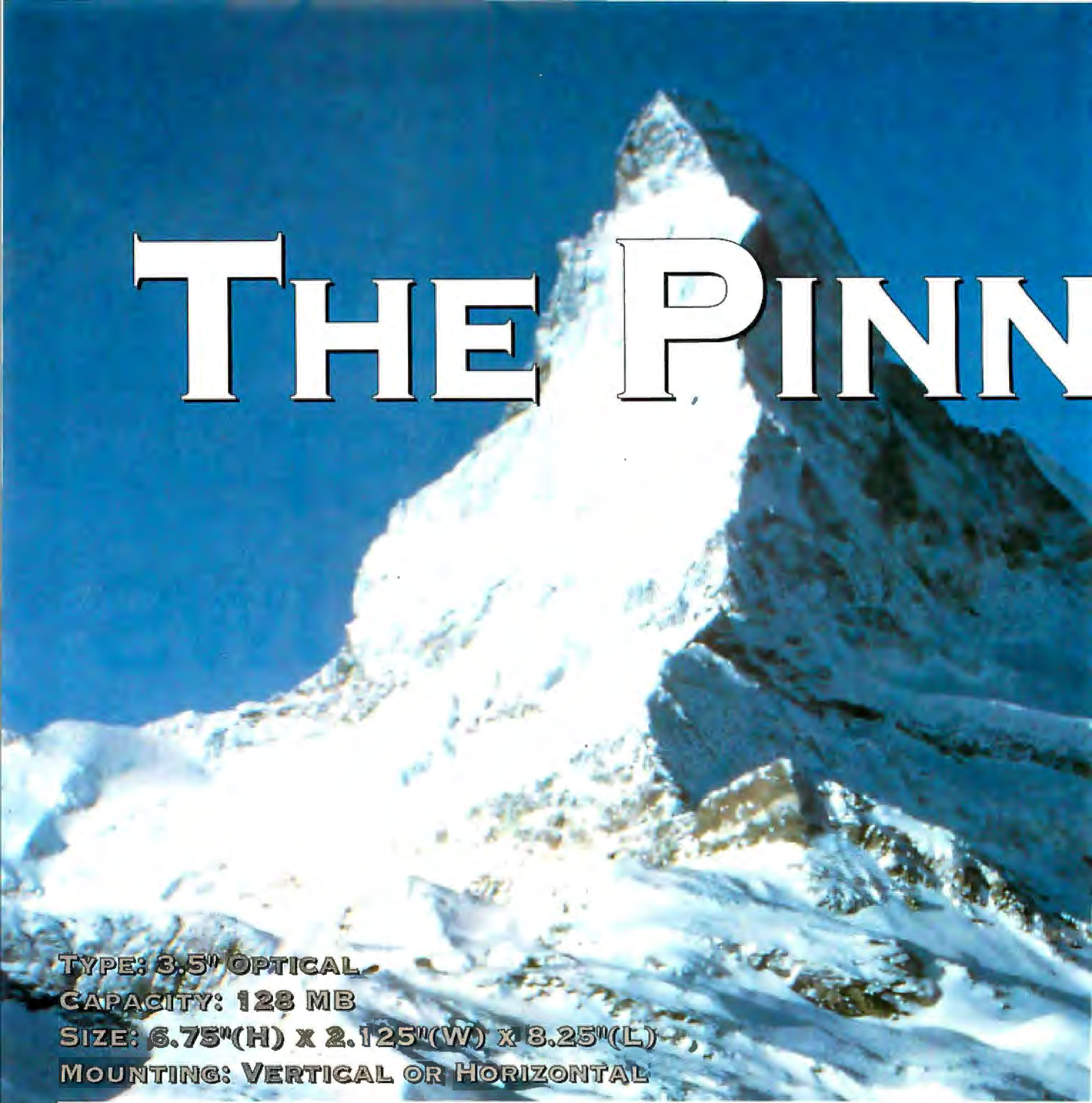

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# BUILT FOR SPEED

**The advancing architectures of chips and systems are changing the face of computing**

BOB RYAN

The past five years has seen an explosion in the complexity of personal computer software. GUIs abound, and million-line application programs seem the norm rather than the exception. The processing demands of such software strain the capabilities of even the most sophisticated desktop computers. With a future that includes multimedia applications and object-oriented operating systems, the need for faster, more powerful hardware is imperative.

To create faster computers, you build from the ground up. For desktop machines, this means starting with the microprocessor. The next few years will see advances in semiconductor manufacturing, chip packaging, and microprocessor architecture that will drive the performance of the next generation of processor chips past 100 million instructions per second. In addition, advances in systems design will make it easier to deliver most of that microprocessor performance to the end user. Powerful processors coupled with sophisticated systems designs can provide the type of platform needed to run ever more sophisticated software systems.

This month's State of the Art section examines how processor and systems designers plan to meet the challenges presented by the latest developments in software technology. This article concentrates on processor and system architecture. Another article, "Reshaping the Microchip," looks at basic chip technologies and how they are evolving. Finally, "Support Your Local CPU" examines how the use of coprocessors can boost your system performance.

## Bottoms Up

Processor designers have two basic strategies for increasing processor speed: They can decrease the average time needed to execute each instruction, and they can increase the average number of instructions executed per clock cycle. Although interrelated, these two strategies are not strictly complementary. You can, for example, increase the number of instructions executed per clock cycle without necessarily decreasing the execution time of each instruction.

In increasing the performance of a processor—or in creating a new class of processors—designers can call on a number of technologies and techniques to implement the two strategies. These techniques fall into three primary areas: the architecture, the semiconductor process, and the packaging.

A processor's architecture describes the internal arrangement of a chip's components and how these components interact. Details described by the architecture include the instruction set, the use of caches and pipelines, the structure of internal buses, and the number and arrangement of functional units. Process technology describes the materials and the manufacturing techniques used to make a chip. Different processes yield chips with different characteristics. Packaging describes how a processor integrates with its surroundings in a functioning system. Packaging can determine the speed at which you can get signals on and off a processor chip, which, in turn, determines the overall speed of a system.



## The Process and the Processor

Like any IC, a processor is made up of many thousands—and these days, millions—of transistors. Each transistor is an electrical switch that can be either open or closed, based on the state of its inputs. The size of the transistors used on a chip directly affects the speed at which a transistor can switch from one state to another, and

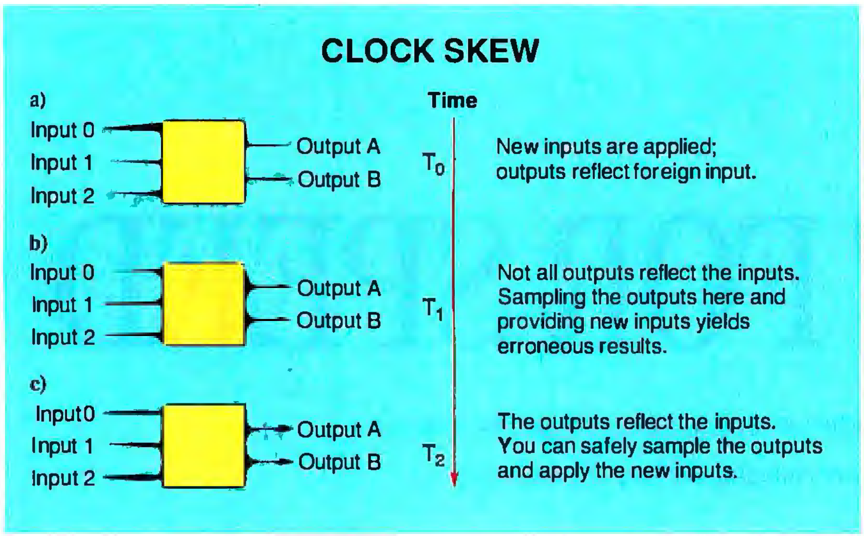


**Figure 1:** *Clock skew occurs when the inputs sent to a chip don't have time to propagate the proper outputs before the outputs are sampled. In (a), as inputs are initially applied to the system, the outputs still represent the state of the previous inputs. As the signals propagate through the system, the different lengths of the processing paths result in some of the outputs reflecting the new inputs before others (**b**). Sampling the outputs at this time gives false results due to clock skew. Only when all the input signals have had time to propagate outputs do you get legitimate results (**c**). You can then apply new inputs. The time difference between (a) and (**c**) represents the latency of the system. Sampling the system at intervals shorter than the latency period, as in (**b**), risks seeing the effects of clock skew.*

thus the potential speed of a processor as a whole. All things being equal, a chip with smaller and, therefore, faster transistors will be able to work at a higher clock frequency than one with larger and slower-switching transistors.

This smaller-is-faster rule reflects that switching a transistor from one state to another is a physical phenomenon. To switch states to match its inputs, a transistor is required to physically move carriers of electrical charge—either electrons or electron holes—from one location to another.

**BYTE ACTION SUMMARY**

Our basic models of computing and computer systems are undergoing a fundamental change caused by revolutions in the design and manufacturing of chips. The key to understanding the future of computing is understanding the impact of the technologies that drive it.

The shorter the distance that the carriers must move (i.e., the *channel length*, in semiconductor parlance), the faster the transistor can switch from off to on and from on to off. Thus, the smaller the transistors that make up a circuit, the faster the circuit.

The size of each transistor in a circuit is entirely dependent on the manufacturing process used to create the circuit, which determines the size of the components that can be engraved on the surface of a chip. Today, most advanced commercial processors, such as the Motorola 68040 and the Intel 860, are created with submicron technology: The process used to manufacture these chips can create components separated by less than 1 micron. The number used to describe a particular process (e.g., 1 micron) is called the *geometry*, or *resolution*, of the process.

Decreased switching times (and thus increased switching speeds) is not the only benefit you derive from progressively finer transistor geometries. Smaller transistors also means that more transistors will fit on one circuit. In the case of processors, increasing the density of transistors on a chip lets designers put more of the CPU's components (e.g., cache memories and floating-point processors) onto a single chip—components that once required discrete support chips. Anytime designers eliminate off-chip connections, they greatly increase the speed of a system.

The progression to packing more functions onto denser chips is called *integration*. It not only enables processors to be built with their own on-chip caches and FPUs, but it also permits the quadrupling of memory density every three years. Integration is the force that drives the personal computer revolution.

## The Packaging Problem

Processors are state machines; the outputs they produce are entirely dependent on their input voltage. However fast they may seem, though, processors do not change state instantaneously. Every IC has a latency period in which the internal transistors change in response to a change in the input level.

The component that drives the operation of a processor is the *clock*. The frequency of a clock determines how many times a processor changes state per second and sets a processor's throughput. All things being equal, a processor that uses a 40-MHz clock will have twice the throughput of one that uses a 20-MHz clock.

A processor's latency determines how fast you can drive it. If you drive a processor faster than it can process its inputs, you wind up with *clock skew* (see figure 1).

As transistors get faster, however, processor latency plays less of a role in limiting performance. At very high frequencies, processors have problems getting signals on and off a chip fast enough to support the decreased period of their clock (the period is the inverse of the clock frequency; a 100-MHz clock has a period of 10 nanoseconds and requires a processor with a latency less than this period).

Interfacing a processor to the rest of a system—getting the signals to and from it—is a function of packaging. As clock speeds get much above 50 MHz, current chip interfacing technology will not be able to deal with the higher speeds. Developing technologies are being designed to overcome the limitations of current packaging (see "Reshaping the Microchip" on page 137).

## Elements of Design

Although packaging and manufacturing technologies are vital in producing faster processors, it's the processor's architecture that differentiates the performance of one CPU from another. In years to come, architecture will play an even greater role in determining processor performance (see the text box "Moore's Law Meets MIPS" on page 125).

The most apparent element of a processor's architecture is its *instruction set*. An instruction set is the face that a processor

# Moore's Law Meets MIPS

Progress in microprocessor performance has advanced along a regular path since the introduction of the 4004 in 1972. The main determinant of processor performance has been density: the number of transistors that can be put on a single chip. Even with the architectural advances from 4 to 8 to 16 to 32 bits, the million-instruction-per-second (MIPS) curve slavishly followed the density curve.

In the past, density was such a dominant determinant that Moore's Law (which is a statement of the projected abilities of semiconductor manufacturing technologies to increase transistor density over time) became the key predictor of processor performance.

Take the Intel 80x86 family of microprocessors. From the introduction of the 4004 to the 1989 introduction of the 486, transistor density and MIPS advanced in lockstep. If Intel's greater-than-100-MIPS predictions for the P5 pan out, however, the lockstep will be broken this year. With greater emphasis on RISC technology and parallel instruction execution, the P5 appears poised to accelerate the rate of performance increase over that of previous generations of processors.

The measure used to isolate silicon performance from the effects of compiler and system design is *native MIPS*. It's simply defined as the number of instructions executed per clock pulse multiplied by the number of clock pulses per microsecond. It's an elegantly simple way to isolate and compare hardware throughput across the generations of a family of processors (it provides neither a measure of the ultimate performance of a complete computer system nor a valid comparison of performance with other families of processors).

To examine the impact of parallel architectures on processor performance, I plotted the native MIPS ratings for several generations of the Intel 80x86 processor family as well as the transistor density (see figure A).

The density plot shows the increasing benefits of transistor integration.

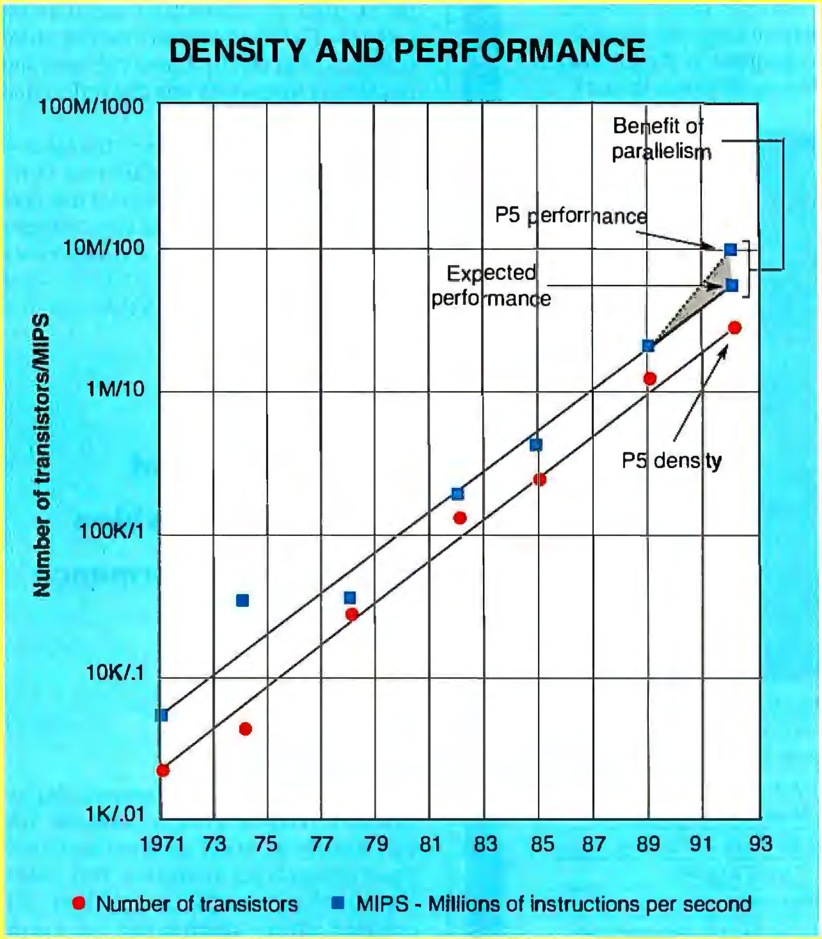


**Figure A:** *When plotted side by side, the number of transistors in Intel 80x86 family of processors and their native MIPS ratings at introduction follow nearly parallel curves. The P5 is expected to sunder the relationship between density and performance by incorporating increased on-chip parallelism.*

It's real-world proof of Moore's Law. The native MIPS rating for each processor is the value specified by Intel for the *initial* version of each generation. It's clear from the MIPS curve that performance improvement and density increase at a similar rate until you consider the P5. At that point, the performance contribution of parallel architectures causes the curves to diverge.

As multiple on-chip processing functions increase parallelism, the effects of executing more than one instruction per clock pulse will add another strong contributor to drivers of chip performance. Although the 8086 may have required an average of 20 or more clock pulses to execute a single instruction, some processors today have reached the range of two to three instructions per clock pulse. Chip researchers are exploring architectures that will, in this decade, let you execute tens of instructions simultaneously. The days of Moore's Law being an accurate predictor of performance appear to be numbered.

shows to a programmer.

Instruction sets break down into three basic types, depending on how a processor stores instruction operands in the CPU. Two of these types—stack architectures and accumulator-based architectures—are holdovers from simpler times. For example, the 6502, the processor behind the Apple II, used an accumulator-based architecture. Today, most processors store operands in general-purpose registers and implement instruction sets that reflect that fact.

Today, two instruction-set strategies—RISC and complex instruction-set computer—dominate processors that use general-purpose registers. These two strategies are distinguished by how and when they move operands into memory. CISCs—best exemplified by the DEC VAX—let you specify multiple memory operands per instruction. With the VAX, for example, you can specify as many as three memory-based operands per instruction. This makes the job of the compiler—and that of a compiler writer—much easier, and it does not waste registers on the storage of temporary values (registers are a most-precious asset in a general-purpose register machine).

**It is apparent that RISC provides superior performance over CISC.**

The complexity of including as many as three memory accesses with each instruction execution also adds enormously to the complexity of the processor control unit—the part of the processor that coordinates the execution of instructions. As a result, processors that fetch operands directly from memory require microprogrammed control units. In such processors, the control unit itself is a processor that executes microinstructions that determine how the main processor executes macroinstructions. Microcoded processors are very flexible (if you change the microcode, you change the characteristics of the processor), but they exact a penalty in both complexity and performance.

At the opposite end of the spectrum is RISC. Unlike CISC, RISC processors do not include memory accesses in instructions intended for execution by the ALU or the FPU. Instructions take their operands from registers only. This simplifies the control logic in the processor to the point where RISC processors do not require microprogrammed control units, eliminating much of the overhead and complexity of CISC processors.

Of course, a RISC processor must still be able to move operands to and from memory. It performs these tasks with separate instructions that do nothing but load registers from memory and store register contents to memory. This class of memory-access instructions is why RISC processors are also known as *load/store processors*.

For the past few years, a common topic of debate at any gathering of people of the processor industry has been the relative merits of the RISC and CISC architectures. Today, it is apparent that RISC provides superior performance over CISC. Evidence comes from performance measurements, and it's also hard to find a major computer manufacturer that hasn't recently introduced a RISC-based system. In fact, Motorola and Intel tacitly conceded the game to RISC when they built RISC-like features into their latest generation of CISC processors. In particular, both the 68040 and the 486 have some instructions in their integer units that execute without microcode—and under optimal conditions—in just one clock cycle.

Intel has even given a name to the integration of RISC features into previously all-CISC architectures: CRISC (complex reduced-instruction-set architecture). Undoubtedly, CISC processors will incorporate larger and larger nonmicrocoded RISC subsets into their core functional units as time goes by, as well as utilize other architectural advances (e.g., microparallelism in the form of superpipelining and superscalar) that are now present in many RISC implementations. In addition, suppliers of the industry-standard 386 architecture are working to differentiate their products by adding features that provide extra value but are invisible to applications software (see the text box "Beyond the 386" on page 127).

The ironic aspect of the victory of RISC over CISC is that it is thus far a hollow one. Computers based on Intel and Motorola CISC processors outsell RISC-based designs by nearly two orders of magnitude. Obviously, the marketplace doesn't consider the advantages of RISC to be great enough to scrap its enormous investment in CISC hardware and software. As the CISC processors become

# Beyond the 386

With the introduction of the 386 in 1985, Intel fixed the architecture that would carry the personal computing industry into the twenty-first century. Unlike the 286, which preceded it, the 386, with its flat 32-bit address space, provided the minimum capabilities required by sophisticated operating systems and applications software.

Establishing the 386 as the standard processor for the vast majority of desktop systems has had an enormous impact on the industry. It has led many customers to view computers as commodities differentiated primarily by price. After all, if two computers are driven by the same processor, why not buy the less expensive one? This attitude has led to the commodity pricing of PCs, much to the benefit of buyers and to the detriment of many computer makers.

The second effect shows the downside to standards—even de facto ones. Unless you want to jettison your big investment in software and training, you're stuck with the 386 architecture.

For the most part, PC users can't take advantage of the architectural advances pioneered by RISC. The 386 architecture is a good one, but it reflects the transistor budget realities and architectural state of the art of 1985, not 1992 or 1999.

Today, chip makers and systems manufacturers are concentrating on software-compatible ways of improving the architecture and performance of the 386. The most obvious example of this trend is the Intel 486. By adding instruction pipelining, memory management, and floating-point execution, the 486 extends the 386 architecture without altering the 386 instruction set. Combined with the inevitable advances in chip-manufacturing technology, these features make the 486 the most advanced 386 instruction set–compatible processor available.

Intel has also extended the 386 architecture in other ways. The Intel 386SL, for example, is a version of the 386SX containing power management logic that can be used by notebook manufacturers to conserve battery life. This power management logic is invisible to applications, allowing them to run without modification.

The emergence of 386 clones and compatibles has also led to a spate of value-added 386 processors. The first 386 compatibles from AMD concentrated on providing higher clock speeds and lower power consumption than Intel chips had. Chips & Technologies has gone further. It has added an internal five-stage pipeline and an instruction cache to the 386. In addition, C&T produces a version of its 386 with SuperState capability. SuperState lets a systems designer add functionality to the basic 386 architecture without sacrificing compatibility. Invisible to the operating system, applications, or the BIOS, SuperState code can provide functions (e.g., power management) or overcome the limitations of DOS. It lets designers add value to their 386 systems.

C&T also produces the PC/Chip, which combines an 8086 chip with all the logic required to implement the PC architecture. Without a doubt, a 386 version of the PC/Chip will be available before too long.

Another supplier of 386 chips making noise these days is IBM. Under license from Intel, IBM can make 386- and 486-derivative chips. It produces the 386SLC, a cache version of the 386SL that runs at 25 MHz and is benchmarked as improving performance over the Intel original by more than 80 percent. In the future, you can expect alternative 486 designs from IBM that add features without sacrificing compatibility.

The biggest news on the 386 front this year will be Intel's announcement of the P5, the follow-on to the 486. With over 3 million transistors to play with, Intel has a lot of room to extend the 386 architecture while maintaining software compatibility. And as if that isn't enough, the P6 project is already well under way.

The next few years will see the best of both worlds: straightforward 386 architecture chips for those who need straightforward performance and features, and value-added chips for those with more technologically sophisticated needs. The choice will be yours.

---

"RISCier," the reasons for moving to pure RISC designs will become even less compelling.

### What's Inside

Although the instruction set broadly determines the architecture of a processor, the implementation details are no less important in determining the processor's ultimate performance. Consider the example of a RISC universe that consists of at least a half-dozen major architectures that are based on the same instruction-set strategy and that exhibit a wide range of performance characteristics. The strategy is important, but it's the implementation details that matter in the end.

A microprocessor is made up of two primary elements: a control unit and a data path. The latter consists of the functional units, which include the ALU and FPU, the general-purpose registers (collectively called the register file), the special-purpose registers (e.g., the program counter), and the connections between these elements. The control unit decodes instructions and sets the latches in the data path so that the processor performs the actions indicated by the instructions. In CISC processors, the control unit is often itself a processor. It executes microcode programs that prepare the data path to execute a particular instruction. Because of their simplified instruction sets, RISC processors can use simpler and faster hard-wired control units.

Even though hard-wired control units are a benefit of the simplified RISC instructions, they are not the reason for the simplified instructions. RISC instructions are simplified to permit efficient pipelining.

An average instruction in a RISC machine may require four cycles to be completed. Using a straightforward execution scheme, nearly all CISC microprocessors would achieve a cycle-per-instruction rate of 4.0. (Don't confuse the total number of

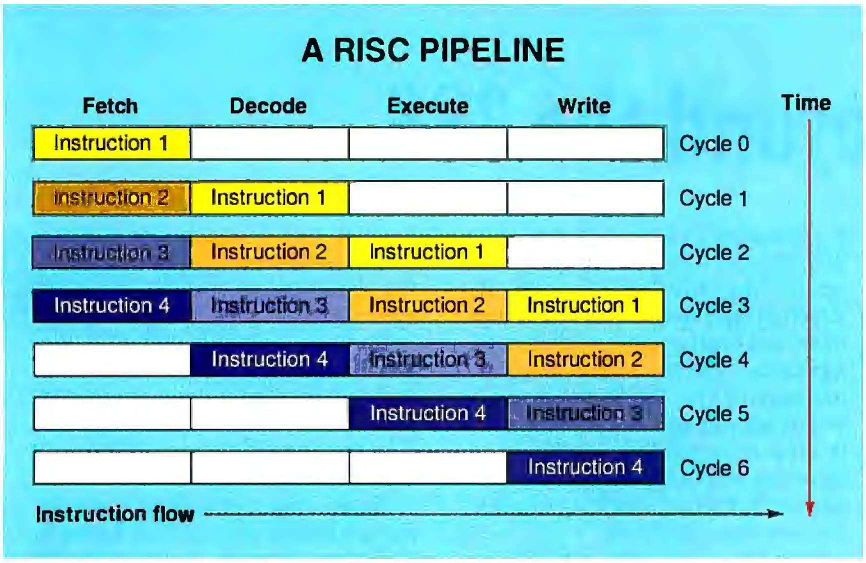


**Figure 2:** *In this simplified RISC implementation, four four-cycle instructions are issued in sequence (one every clock cycle) to a four-stage pipeline. The first instruction begins executing at cycle 0, and the fourth begins executing at cycle 3, filling the pipeline. Although each instruction requires four cycles to complete, the overlap in execution steps lets them all finish in seven cycles, as opposed to the 16 required without pipelining.*

cycles an instruction requires for completion with the cycles it requires for execution. Most RISC instructions execute in one cycle if you don't consider decoding, setup, and dealing with the results.) To increase the performance of such a processor, given a constant clock rate, you need to reduce the average CPI. The key to reducing the CPI rate is to get more instructions to execute concurrently; you need a method that lets instructions execute in parallel.

Pipelining is such a method. It recognizes that during execution an instruction is not using the whole processor. It, therefore, breaks the execution of an instruction into stages that match how a processor executes instructions. For example, consider the execution of an instruction that adds the contents of two registers and places the results in a third. The instruction goes through the following four one-cycle stages:

*Stage 1: Instruction fetch.* The processor fetches the instruction into the instruction register based on the contents of the program counter.

*Stage 2: Instruction decode/register latch.* The control logic determines what the instruction does. At the same time, the contents of the two source registers are placed on the internal source buses.

*Stage 3: Execution.* On the basis of the instruction decoding, the ALU adds the contents of the source buses and places the results on the processor destination bus.

*Stage 4: Write back.* The results are moved from the destination bus to the destination register.

From a processor's point of view, these stages are mutually exclusive. The real estate on a chip that is dedicated to any one of the stages is unique. So, it's possible to simultaneously have one instruction undergoing decoding, another executing in the ALU, and a third writing to the register file. This is the basis for building an instruction pipeline.

Figure 2 shows the basic workings of a simple pipeline. Here, a series of four instructions move in lockstep through a four-stage pipeline, each taking four clock cycles to execute. However, because they are executing in parallel, they require a total of only seven cycles to complete—as opposed to 16 cycles on a nonpipelined processor. In this case, pipelining reduces the CPI from 4 to less than 2. In fact, under optimal conditions, such a pipeline is capable of achieving 1 CPI (not including the three-cycle latency you encounter when you first fill the pipeline).

## Stall Speed

There is no such thing as a free lunch, and pipelining is no exception. Pipelining works fine as long as none of the instructions in the pipeline has to wait for the results of a preceding instruction. Sometimes, however, such data dependencies occur, and the pipeline stalls.

Consider the example of an instruction that adds the contents of two registers and writes the results to a third. If the next instruction in the pipeline uses those results, it becomes stalled in the second stage of the pipeline. It can't proceed until the preceding instruction finishes the fourth stage, losing most of the benefits of pipelining.

Data dependency points out the importance of compilers in the RISC universe. Compilers for a pipelined architecture must be able to recognize data dependencies and order instructions to minimize those dependencies without producing incorrect code. A good compiler can make a mediocre implementation shine, and a bad one can completely foul the workings of a good chip.

Another situation that can stall a pipeline is a change in the flow of instructions (e.g., a jump or branch in the program logic or an interrupt). In such situations, you either have to flush the pipeline of all instructions after the branch or stall the pipeline when you first encounter an instruction that can cause a branch. In either case, performance suffers.

Despite these difficulties, pipelines are found on all high-performance RISC processors, although they are not limited to RISC. Both the 486 and the 68040 utilize pipelines. Because most of the installed software base for these processors was not produced with pipeline-aware compilers, however, their pipelines are not highly utilized in the real world. Also, the complexities of decoding and executing CISC instructions, and their variable length, make pipelines more complex to implement and less valuable to use in CISC architectures than in RISC ones.

The future of pipelining offers more of the same, with some added attractions. Beyond basic pipelining lies superpipelining, the technology at the heart of the Mips R4000 processor. In superpipelining, instruction execution is broken into even finer steps, lengthening the pipeline and providing finer granularity in execution. The R4000 has an eight-stage pipeline that, although it is more susceptible to data dependencies and requires even smarter compilers than the R3000, vastly increases processor performance.

As transistor budgets increase due to process-technology advances, designers will be able to make pipelines smarter. The most promising area for improvement in pipelining is in handling branch instructions. Both branch-prediction logic

# Processor Progress by Design

RAVI BHATNAGAR

The chips at the heart of personal computers are becoming more and more powerful and complex. However, this progress is not due solely to the advancing capabilities of semiconductor packaging. True, semiconductor process technology can integrate an increasing number of transistors on a single chip. But the ability to economically manufacture millions of transistors on an IC defines only the upper limit of integration. You still need a producible design to give meaning to its potential.

Although the amount of integration possible is increasing at an almost-exponential rate over time, product life cycles are simultaneously decreasing. The time between the introduction of one generation of a microprocessor and the next has diminished from six years in the 1970s to three years or less today. Designers are caught between two conflicting demands: more complex products and shorter design cycles.

Now, the age of wasteful silicon awaits. Future architectural decisions will be limited not by the number of transistors that can be crammed on a chip, but by a systems designer's ability to define, model, and simulate a complex system and ensure that it will work as intended when the first device is produced.

## The Technologies Behind Design

In the last few years, the CAE industry has made significant progress in developing sophisticated tools that improve a designer's ability to partition, model, and simulate complex systems.

Only eight or 10 years ago, designing a new chip consisted of performing gate-level design and schematic entry and then simulating the logic to verify functionality. The timing was ensured by manually identifying the critical paths and optimizing them through extensive and time-consuming Spice simulations. A designer would lay out the chip on a polygon editor at the transistor level and would draw each interconnect individually.

Today, with the availability of the Very High-Speed IC Hardware Description Language modeling and simulation tools, a designer can create and verify a design at a higher level, much as a programmer can write a computer program in a high-level language. Synthesis tools reduce the verified software model to the level of IC gates. Then, hardware modeling systems verify the operation of the software model in a target system. This process makes it highly likely that a design will succeed the first time it is transferred onto silicon.

But the software models used to simulate microprocessors have also grown in size and complexity. Today, the use of hardware accelerators (available at reasonable costs) can vastly speed up simulation. These accelerators enable chip designers to increase by several orders of magnitude the number of simulation vectors they can run. When the simulation is more thorough, the designs can be more robust, and they are more likely to work the first time.

For example, a simulated software boot of operating systems has become possible, and it's now routine to perform this test before committing a new processor's design to silicon. Before committing the design of the Super386 microprocessors from Chips & Technologies to silicon, the design team simulated the microprocessor running MS-DOS on an IBM 3090 mainframe assisted by four hardware accelerators. This approach was impossible a few years ago because it would have taken months of CPU time on a large mainframe to complete the simulated boot.

Chip layout today uses precharacterized primitives (e.g., NAND gates and flip-flops) rather than individual transistors. This method not only reduces the time it takes to lay out the chip by several months, but it also ensures that critical paths are easy to isolate and that the timing is predictable.

Using automated place-and-route software rather than polygon editors to create the interconnections between the primitives drastically reduces physical-design schedules. This approach yields designs that are inherently correct by construction, and it dramatically decreases the amount of time necessary to verify them.

Static-timing analyzers perform the critical-path analysis, reducing a lot of the routine work. Full or partial internal scan flip-flop implementation provides high fault coverage and ensures reliability. At the same time, automatic test-program-generation tools work with the scan methodology to help decrease the time required to develop the test program, further shortening the time to market.

Several architecture-level tools are on the horizon. Although still in their infancy, these tools help processor architects make high-level performance trade-offs without doing too much detail work at the lower levels of the design.

## Building a Standard Framework

The chip-design community is seeking standards for its tools as aggressively as the personal computer industry is. The CAD Framework Initiative, a nonprofit consortium, was started in 1988 by major CAD, semiconductor, and systems companies. Its purpose is to develop industry-acceptable guidelines for design-automation frameworks that will enable various CAD tools to coexist and cooperate.

Frameworks will enable a number of CAD applications and framework components to become interchangeable as well as interoperable. The result will be improved intertool communications, tool sequencing, and tool encapsulation. These capabilities herald an important step forward in further improving designer productivity and reducing the time between the idea and the reality.

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and branch-target caching will help you avoid the perils of stalled pipelines.

### Tipping the Scales

Superpipelining represents one way to increase the parallelism inherent in a pipelined architecture. Superscalar takes a different approach, but it achieves the same end: increased performance due to parallelism.

In a superscalar processor, the pipeline isn't subdivided; it's duplicated. Each functional unit of the processor has its own pipeline and can operate independently of other units (see figure 3). So, an instruction that uses an integer unit goes through the integer pipeline, and a floating-point instruction executes through the floating-point pipeline. Instructions are issued into each pipeline by an instruction dispatcher, a logical unit that tries to keep the pipelines filled.

The pipelines in a superscalar processor are susceptible to the same data dependencies and program-flow problems as are the pipelines in standard processors. Their increased use of parallelism also increases the same problems as those experienced by superpipelined processors. So, superscalar processors are just as dependent on smart compilers as superpipelined processors are.

Until now, superscalar processors (e.g., the IBM RISC System/6000) have implemented parallel pipelines for different functions. In the future, superscalar processors will sport multiple copies of identical pipelines: two or more floating-point pipelines or two or more integer pipelines. Given the 10-million-transistor processors you will be seeing by the middle of the decade, complex processors are a certainty. For a look at the design challenges posed by the growing complexity of microprocessors, see the text box "Processor Progress by Design" on page 130.

The question of whether the superpipelined processor is better than the superscalar processor has in many ways replaced the old RISC versus CISC debate. Based on implementations in silicon, the question is thus far moot. Superscalar designs have achieved lower CPIs than superpipelines, but they are limited to slower clock speeds. In fact, the best performing processor, the Hewlett-Packard PA, is neither superpipelined nor superscalar; it is simply a superbly designed and aggressively clocked RISC pipeline.

Ten-million-transistor processors may also see the emergence of superscalar architectures with superpipelines. This best-of-both-worlds approach may founder, however, on software technology. Dealing with that level of parallelism is not within the capabilities of the current generation of compilers.

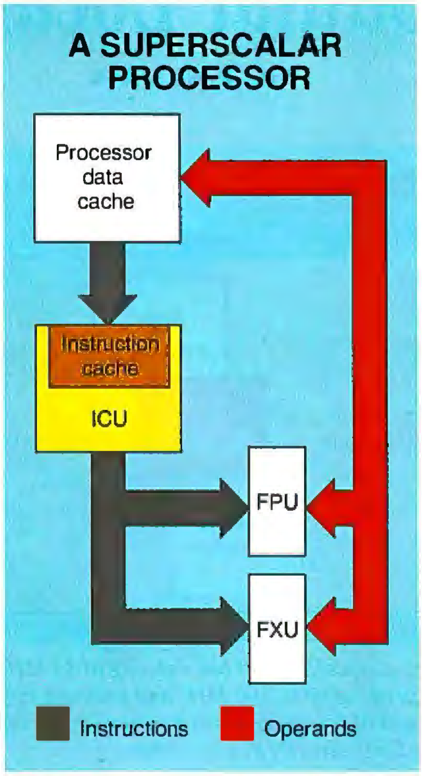


**Figure 3:** *The IBM RISC System/6000 consists of three fundamental units. The instruction cache unit fetches two instructions at a time from its instruction cache, which is fed by the processor cache. The pathways to and from the ICU cache are two words wide, which lets them move two instructions at a time. The ICU simultaneously feeds instructions to the pipelines of the integer unit (FXU) and the FPU if the instructions it receives are of the appropriate type. In addition to feeding the two functional pipelines, the ICU handles program branches and interrupts. Using instruction look-ahead, it can solve branch conditions before they occur. It also contains special registers that can hold the state of the processor during interrupt handling, eliminating the need for stack-related processing and memory access.*

When processors average less than 1 CPI, the processor-memory interface becomes a critical choke point in a system. With such processors, you will see larger and smarter caches, separate data and instruction pathways and caches, 64-bit data paths, and even RAM on the processor—all endeavoring to keep the processor pipelines filled. And beyond the primary memory interface lies the whole realm of system architecture.

### The System's the Thing

Comparing the details of microprocessor architectures may at first seem to be an exercise in silicon chauvinism. After all, isn't it the system-level performance that you really care about? Can't you take it for granted that the chip wizards will keep our systems' sockets stuffed with faster chips? Unfortunately, no. Gone are the days when the relationship of a chip to a system was simply that of a building block to an edifice. The chip and the system-performance considerations are intimately linked, and their designs are considered in parallel. A target system's intended functions and applications form part of the initial design requirements for today's high-performance processors. The seeds of the next generation of systems are delivered on each new generation of chips.

The first approach to achieving system performance is to define the types of data to be processed and the processing-time constraints to be confronted. Data types can then be categorized and assigned to processing units that can handle them efficiently, such as a floating-point math processor. This level of functional partitioning is largely provided in today's highly integrated processor. For example, the inclusion of the FPU on the 486DX was intended not to achieve the highest floating-point performance possible, but to provide a good balance of math performance in the 486's most common applications. One result is that system architects can still improve system performance by relying on specialized coprocessors for specific functions. For example, the number-crunching muscle of 486DX-based systems can be substantially enhanced with an appropriate coprocessor (see "Personal Supercomputing with the Intel i860," January 1991 BYTE).

The next consideration in achieving system performance is to remove any data-access or communications bottlenecks. For personal computers and workstations, a systems architect's first option has been to add as many speed-critical functions to a motherboard as is practical. But this approach limits the flexibility of a system and makes future upgrades to these functions expensive or impossible, so it's been used only for broadly requested functional subunits (e.g., math coprocessors). Now, some systems designers are putting graphics functions on motherboards in a coprocessor arrangement referred to as *local-bus graphics*.

The current interest in local-bus VGA architectures was sparked by the desire to accelerate graphics-intensive applications, such as GUIs. But the basic principle—avoiding the delays imposed by a system's

# A Modular Local Bus

MICHAEL JOHNS

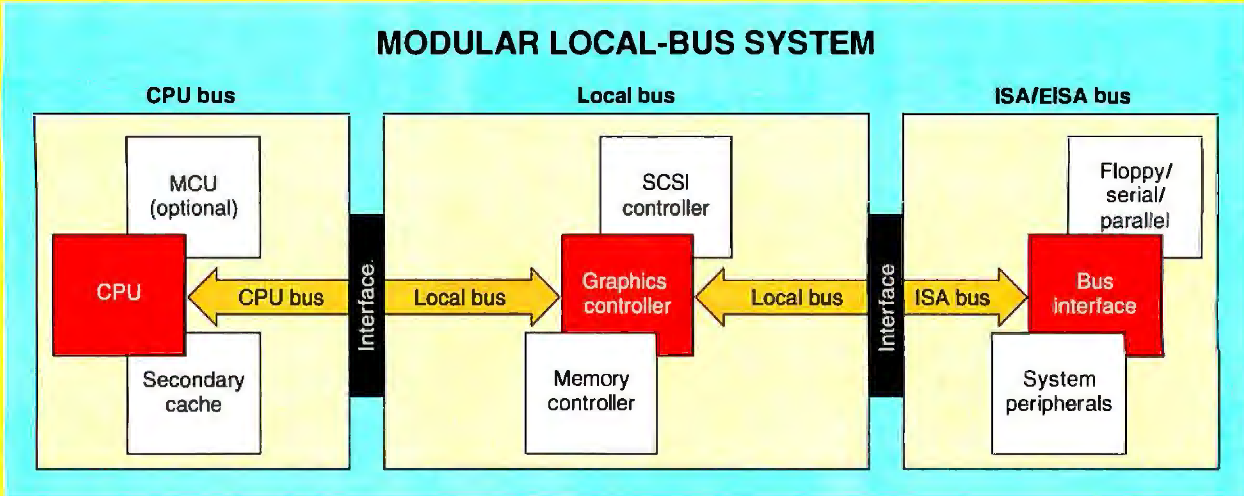


**Figure A:** *This three-layered system uses a modular local bus running at 33 MHz to interconnect speed-critical functions. The system now supports 486 CPUs at speeds of up to 100 MHz and provides connections for slower peripherals on a standard 8-MHz ISA bus. The key element of the system's architecture is the separation of the CPU bus from the local bus; other architectures may connect the CPU directly to a local bus.*

GUIs have placed huge demands on personal computers, in many cases perceptibly degrading system response. And they represent just the first wave of applications that will place much higher demands on intrasystem communications.

The standard ISA system bus is quickly running out of steam, with a theoretical maximum transfer rate of 8 MBps, address space limited to 16 MB, and marginal mastering support. Although EISA and Micro Channel architecture have been somewhat successful in addressing some of the bottlenecks of ISA, they still fail to overcome the constraints the system bus puts on the throughput of speed-critical peripherals.

Many systems developers are now exploring local-bus architectures to find ways of better coupling the CPU with speed-critical functions. Most discussions today center around local-bus implementations of VGA functions. But the concept of a local-bus connection has equivalent benefits for other functions, such as system memory and communications processors.

## Layered and Modular

One model for a local-bus system uses a three-bus modular approach consisting of a CPU-bus layer, a local-bus layer, and the traditional peripheral-bus layer (see figure A). As implemented in a system today, this architecture supports 486 CPUs as fast as 100 MHz while serving speed-critical peripherals on a 33-MHz local bus and slower traditional peripherals on a standard 8-MHz ISA bus. The key element of this architecture is the separation of the CPU bus from the local bus.

CPU speeds will continue to increase; as a result, too much peripheral activity will simply bog down a CPU bus. By separating the CPU bus from the high-performance local bus, speed-critical functions (e.g., the graphics and the disk interface) will not impact the CPU's performance. In fact, through this modular design, maximum throughout capability will be 100 MBps on the local bus—comparable to the CPU bus in nonburst mode with a 50-MHz 486 CPU.

A standard ISA-bus layer is implemented for all the less speed-critical peripherals. Alternatively, EISA or Micro Channel architecture could also be provided—as a result of this layered, modular design—with no critical architectural changes.

Because it's a modular design partitioned at the CPU layer, this local-bus model allows the rapid upgrade of a processor as CPU speeds increase, or complete CPU module changes (e.g., RISC) without changes to the local-bus or system-bus layers. Efforts and investments made to maximize the performance of graphics or disk interfaces, as an example, are preserved even when a system transitions to another type of processor. For the high-end personal computing world, this becomes a key element in ensuring that the systems available to users are able to keep pace with the power of the microprocessor without dramatic and prohibitive price tags.

With the newest implementation of this modular local-bus architecture, IDE drive performance is doubled. Simply by putting Super VGA directly on a 33-MHz 486 local CPU bus, performance routinely improves by three to five times.

In addition, the layered, modular local-bus architecture will reduce system development time and will let systems manufacturers provide the most advanced processor technology to the user quicker than they can today.

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# Massive Parallelism: The Name of the Game

FEDERICO FAGGIN

The future trend in computing architecture is clearly toward parallelism: the technology of many processors performing the job that one processor used to do. Massively parallel computers (i.e., computers containing hundreds of thousands or even millions of processors) are becoming feasible. They will dramatically alter the performance and applicability of computation.

The microprocessor, child of the marriage between computers and semiconductor technology, has renewed and permanently changed the computer industry. Soon the microprocessor will have a life of its own as the development of parallel computing drastically changes computer architectures. But the possibilities do not end there.

## A Different Approach

Today, semiconductor technology is ready to bear another child, and the father is neural systems. The union of the two will build neural computers using those same principles of information processing that a biological nervous system uses. The purpose of taking advantage of this new kind of computer is to be able to solve a whole class of problems that today's conventional computers cannot handle effectively—problems that neural systems in animals and humans can handle effortlessly.

At the heart of a conventional computer is a program. At the heart of a neural system are self-organization and learning. Self-organization implies structures that can configure themselves and provide correct answers, driven only by the temporal and spatial correlations that the data itself contains. One system is deterministic (preordained); the other is stochastic (involving an element of randomness).

Conventional computers require a priori knowledge; neural systems build their own representation of data. To change the conditions in a conventional computer, you must change the program; you cannot sever the umbilical cord between the computer and the programmer. Neural systems, however, are adaptive; they are designed to operate by themselves in the real world—a world full of unpredictable events.

Neural systems will endow machines with a new type of information processing similar to intuition and based on holistic pattern matching and collective computation. In contrast, conventional computers provide machines with reasoning: a reductionistic, sequential, logical type of computation. I believe that the combination of these two complementary types of information processing will make possible the creation of a new breed of machines—machines with intelligent behavior.

Biological neural systems are also fault tolerant. Although they are built of unreliable components, they achieve remarkable robustness and graceful degradation.

## Teamwork

To build neural systems, hardware must change in a fundamental way. The most promising method seems to be to build massively parallel structures of analog computational elements in the manner of the pioneering work carried out by Carver Mead of the California Institute of Technology (Pasadena, CA).

In such structures as these, a number of properly interconnected one- and two-dimensional arrays of adaptive analog processors map and transform information, with each processor attending to one or a few parameters and inputs. Learning occurs as each free parameter associated with a processing element is modified based on the inputs and the outputs to which the processing element directly contributes (see "What's Hidden in the Hidden Layers?" August 1989 BYTE).

The neural-systems paradigm will make possible wafer-scale integration because of the inherent fault tolerance and low-power dissipation of adaptive analog structures. By the turn of the century, neural-system chips the size of a whole wafer and containing 10 billion components will be possible. This complexity is impressive. But if you assume that a brain contains approximately $10^{14}$ synapses and that it takes approximately 10 silicon components to simulate each synapse, you will discover that the complexity of the human brain is at least 1 million times greater than that of the projected wafer-scale system.

## Brain Surgery

This is an exciting time to live in. For the first time in history, some solid clues have been discovered as to how the brain works. And a technology has been developed that can help build systems made of billions of components. Over the next 10 to 20 years, I expect that the basic information-processing principles the brain uses will begin to yield to human scientific inquiry.

Such knowledge, however primitive, will make it possible to translate those principles into a different medium than biochemistry. It will enable humans to build truly intelligent, autonomous machines. This possibility is both marvelous and disquieting.

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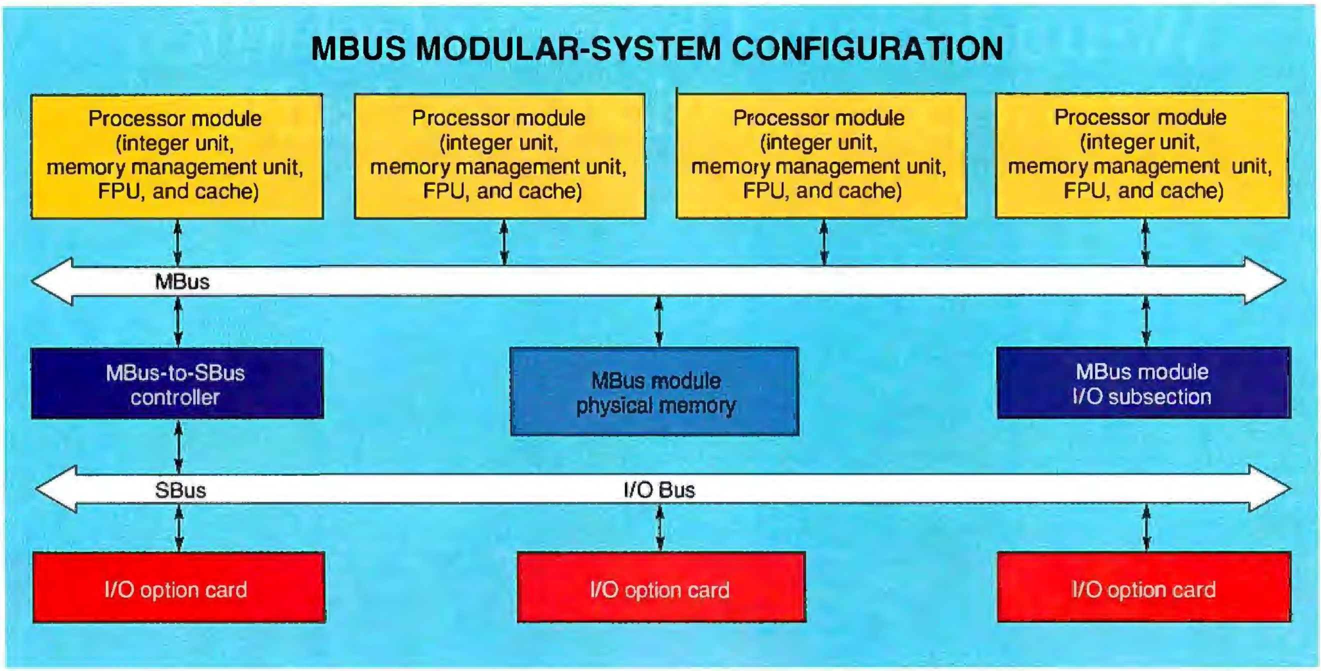


**Figure 4:** *MBus is a SPARC module interconnect bus that supports symmetrical multiprocessing for as many as eight processors and provides data transfers as high as 320 MBps. Systems using MBus as a processor bus also use a separate I/O bus, such as the SBus shown here. The MBus protocol includes the cache-coherency logic necessary for SMP operations.*

slow peripheral bus—applies to any speed-critical functions (see the text box "A Modular Local Bus" on page 132).

### "Bus" Doesn't Mean "Slow"

The concept of a local bus as a true bus that runs at processor speed isn't new. Designers of embedded-control systems use the concept to build very fast control systems. These systems consist of a powerful CPU and specially designed high-speed option modules that connect to the CPU via a local bus and tailor the system's function to specific applications.

The local-bus concept has more recently been adopted by workstation designers as a means of attaching high-performance specialty processors (e.g., digital signal processor subsystems) to the CPU of compact workstations. For example, MBus, Sun Microsystems' SPARC module interconnect bus designed for processor-to-memory interconnections, provides a 64-bit-wide data transfer path running synchronously with processors at speeds of up to 40 MHz, asynchronously at higher processor speeds (see figure 4).

MBus has a sustained bandwidth of 80 MBps and a peak bandwidth of 320 MBps. Its 40-MHz speed was selected as the highest speed achievable with standard CMOS chips (to simplify the design of modules and minimize their component costs). Its *maximum* allowable length of only a few inches does not reduce its flexibility significantly, because the bus allows modules to be stacked, with one motherboard MBus connector accommodating two or more piggyback modules.

The MBus protocol supports symmetric multiprocessing for as many as eight processors tied together directly by the bus. Implementation of SMP is simplified because all necessary cache coherence logic is built into the MBus protocol.

A personal computer bus modeled after MBus is certainly within the capabilities of many manufacturers. And the microprocessors are already running at speeds that make compact integrated CPU modules a near necessity. Intel's 50-MHz 486 CPU/cache module implements the secondary cache required for zero-wait-state operation of the 486DX at 50 MHz. It's also intended to simplify the design of 50-MHz systems.

But the module also includes features that support multiprocessing with as many as 16 processor modules (e.g., the modified, exclusive, shared, or invalid write-back multiprocessing cache protocol is built in). The remaining functions of a local memory bus are now left to the systems designer to implement, but they're well within the capabilities of a chip-level implementation.

### Toward a New World Order

Although the systems in development today are clearly driving toward higher levels of parallelism, personal computers have relied on rudimentary sorts of parallelism in their use of coprocessors. However, more recent interpretations of personal computer parallelism focus on multiple CPUs as performance multipliers.

For personal computers, more highly integrated chips, multiple CPU systems, and limited SMP architectures represent only the first flirtations with parallelism (see the text box "Massive Parallelism: The Name of the Game" on page 134). The potential of parallelism is far beyond what we can benefit from with current operating systems or software. Yet research aimed at harnessing the potential of parallel architectures is progressing rapidly (see BYTE's June 1991 State of the Art section).

The future will likely see the personal computer delivering the computing power of massively parallel architectures, perhaps as a participating node in a network functioning as a virtual supercomputer. But sooner than that, individual desktop systems will be available with over 100-x million-instruction-per-second performance. The promise of even limited multiprocessing architectures will make high-end desktop systems capable of performing over a billion instructions per second by the middle of the decade. ■

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# RESHAPING THE MICROCHIP

**Building the next generation of computers increasingly means finding new ways to build chips**

ROBERT M. BURGER AND WILLIAM C. HOLTON

The fast-moving world of network computing will dominate the 1990s just as mainframes led the way in the 1960s, minicomputers ruled the roost in the 1970s, and personal computers became pervasive in the 1980s. Every computer generation is driven by advances in semiconductor technology.

The transistor made the mainframe practical, the simple IC provided the technology required for the minicomputer, and the silicon microprocessor made the personal computer possible. Now, the technology of the high-performance 32-bit processor is providing the basis for distributed-computing networks of technical workstations.

Other innovations have also been precipitating factors. For example, the development of the high-performance workstation required advances in networking, displays, software, and operating systems. These innovations came about, however, to take advantage of new semiconductor chips that became available in large quantities to serve new markets.

## What's Coming and When

By studying the future of semiconductor technology, it's possible to predict with reasonable accuracy the capabilities that *will* be acquired in the next decade. Much of the technology for these products is already out of the laboratory and being applied in the development of manufacturing tools and chip designs.

Today, the microprocessor benchmark is the 33-MHz, 1-million-transistor chip made with 1-micrometer design rules. In the year 2000, the benchmark will be the 40-million-transistor chip implemented with 0.25-micrometer BiCMOS technology.

*continued*

ILLUSTRATION: RANDALL ENOS © 1992

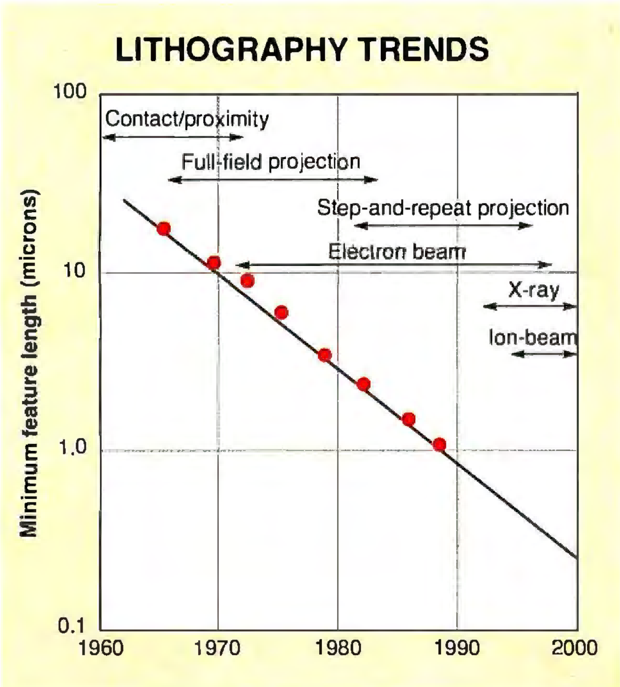



**Figure 1:** *The pursuit of the ever-finer line that has characterized semiconductor technology for the last three decades will come to an end as chips approach atomic dimensions. Depending on the material, the number of atomic spacings at 0.1 micron is in the low hundreds.*

This chip will consist of quad integer symmetric processors, with photorealistic graphics/image processing operating at 250 MHz; 4-MB cache memory; and 64-bit instruction word lengths. It will provide a capability of 1 billion instructions per second (BIPS).

With the computing power provided by these future chips, the majority of microprocessor applications will be in single-chip desktop systems in which I/O innovations will distinguish different products and capabilities. In the personal computer, we are approaching that stage today.

By the next century, the differences between personal computers and workstations will cease to exist, and machines will be nodes of networks with almost unlimited computing power and data resources. Codesign of software and hardware will help balance each element's strengths and weaknesses. Memory-chip technology will be more advanced, with 1-gigabyte DRAM chips as the commodity paradigm. Three-dimensional cell structures with footprints of 0.4 square micrometers will be built on chips that are a little larger than 1 inch on each side. Access times of 20 nanoseconds will be attainable.

**BYTE ACTION SUMMARY**

Advances in semiconductor research are creating a new vision of how computer chips and systems will be built. Chips embodying these improvements will be the foundation of the next generation of computing.

## The Roots of Further Progress

We'll get these future products from diverse semiconductor-technology research that can be broken down into four major areas: design, device and process technology, manufacturing technology, and packaging. The complexity of each area challenges the capabilities of the very computing machines that are the result of the technology.

System engineers are extending the domain of chip design from the logic structure of the chip and its implementation in a mask set to the provision of a software environment that extends from the system to the manufacturing floor. However, we can't hope to have chip designers consider a scope of contributing technologies and capabilities that includes the system and subsystem definition, algorithms, hierarchy of subsystems and buses, manufacturability, testing, device simulation, design verification, and self-repair unless they have the software tools to support them.

The future of semiconductor technology depends on finding the answers to some tough questions: What is the finest line that can be formed and used in a practical design structure? How can you obtain stability in a multimaterial system with dimensions calibrated in atomic spacings (see figure 1)? How many electrons must be stored and switched to maintain the integrity of the logic? When will engineers exhaust the benefits of smallness and find other mechanisms for increasing performance? Chip and process technology is pushing against the physical limits (for a view of the new directions for these technologies, see the text box "Computers Take a Quantum Leap" on page 140).

Manufacturing is the key to this scenario, because this environment is where the profits are generated that keep the business of building chips moving ahead. Performance in the laboratory doesn't automatically mean that you can replicate millions of chips with a high level of confidence that they will perform identically, serve a pragmatic need in an efficient manner, and be affordable. We are calling on production machinery to do more difficult tasks and yet perform better than ever before.

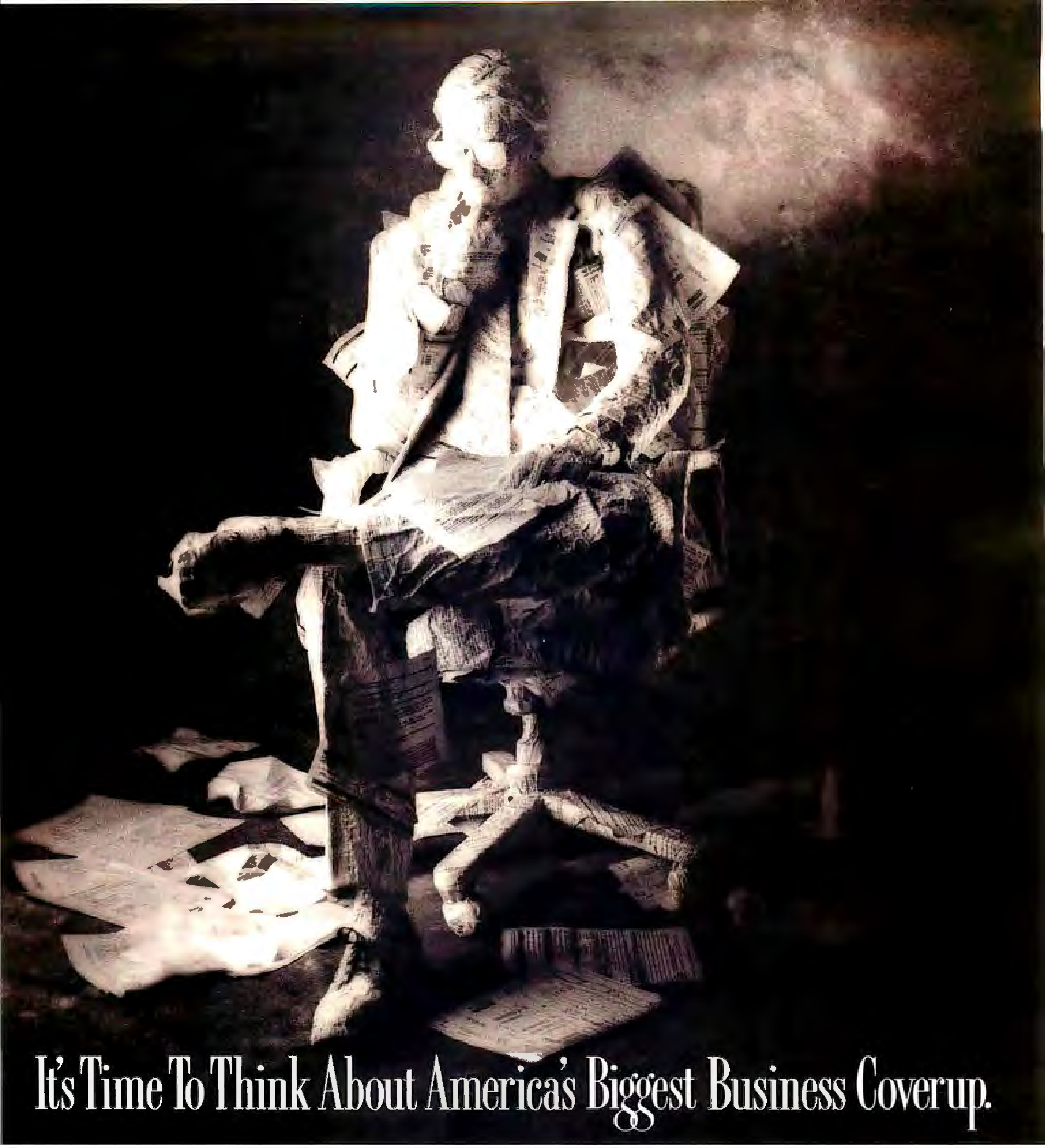
Packaging is becoming the new paradigm for performance growth. It's now apparent that technological advances in packaging are not only required, but they also provide opportunities for increasing system performance beyond that available from the more esoteric device physics and processing arts. Packaging must evolve from an industry afterthought to a rigorous discipline that challenges the intellect of the scientist and the engineer in all areas—architecture, materials, processing, and manufacturing skills.

Research in these domains is rapidly advancing the state of the art. For instance, Semiconductor Research is a nonprofit consortium that has carried out basic research in the semiconductor industry since 1982. It supports more than 600 graduate students whose work is directed toward advancing semiconductor technology. Overall, industry analysts estimate that U.S. industry and government invest $5 billion per year toward this end.

## The Growing Challenges of Design

Although device structure and manufacturing technology limit product performance and cost, design drives the return on an investment. Increasingly, success is determined by the length of time between the identification of the need for a new product and its introduction into the market, especially as product life cycles become shorter. This factor encompasses management decisions because it involves high costs, chip design, and economic chip production.

Large sales (especially during the early

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# Computers Take a Quantum Leap

SHALOM WIND AND THEOREN SMITH

In 1960, Nobel Laureate Richard Feynman issued a challenge: He would pay $1000 to the first person who could reduce a page of text by a factor of 25,000. Twenty-six years later, Thomas Newman, then a Ph.D. student at Stanford University, claimed the prize. Writing with a finely focused beam of electrons, he reproduced the first page of Dickens' *A Tale of Two Cities* in an area of 6 by 6 microns (a micron is 1 millionth of a meter). Feynman admitted Newman had passed the test, and he issued him his personal check.

The lines defining the letters in Newman's *Tale* were only about 15 nanometers wide (1 nm is 1 billionth of a meter). You can fit almost three average-size atoms in a 1-nm space. Each letter was only 50 to 60 atoms wide.

Researchers are now exploring nanoelectronic technology, seeking new ways to build smaller and faster computing components. Nanoelectronics is a science of the minuscule. It's computing on a near-atomic scale. Conventional transistors in today's microprocessors have features that are a little smaller than a micron. We can anticipate that early in the next century these transistors will become so small that they no longer will operate properly.

### Breaking the Barriers

A conventional transistor functions by applying voltage to its different elements to switch the flow of electricity from one part to another—on or off. The elements are composed of materials that have different electronic properties (e.g., highly conductive silicon and insulating silicon oxide). The smaller the size of the components, the faster they can switch on or off and the more densely they can be packed.

As the elements are squeezed into tighter and tighter dimensions, their boundaries become fuzzy, and the transistor begins to leak current. Quantum mechanical effects can begin to occur as well, with electrons tunneling from one region of a device to another. These and other effects will reduce the incremental benefits of the continued downscaling of conventional devices to the point where it will reach a dead end. New fabrication techniques are being implemented that can help reduce some of these unwanted effects.

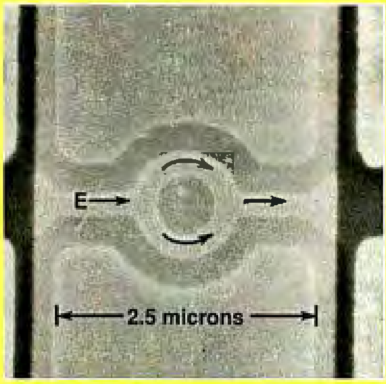


**Photo A**: *The Quantum interference device built by IBM researchers studying gallium arsenide. A magnetic field controls the interference between electron waves passing through the two halves of the ring, turning the device on and off.*

For example, new materials-growth techniques enable layer on layer of diverse elements or compounds to be formed with atomic precision. One of these techniques, molecular beam epitaxy (MBE), can lay down a layer just one or two atoms thick and align it precisely, atom by atom, with its substrate.

The sharp boundaries between such layers are known as *heterointerfaces*. In properly designed layers, electrons may coalesce at a heterointerface in a thin sheet known as a *two-dimensional electron gas* (2DEG), forming a conduit for electrical current.

### A Quantum Leap

All classes of electronic structures seem to display some sort of novel behavior if they are made small enough. This behavior is referred to as *quantum effects*. If newly available nanofabrication techniques are cleverly applied, quantum effects can be exploited to create new types of devices.

According to the fundamental laws of quantum mechanics, all matter has the properties of both particles and waves. This is known as the *principle of duality*. Although we commonly think of electrons as small particles, in certain solids, they may have wavelengths ranging from 2 to 50 nm.

In a conventional electronic device, the wave nature of electrons is unimportant. The electrons move along, carrying an electrical charge as dictated by the voltage applied. However, as the size of a device becomes so small that very few atomic impurities are present to scatter the electrons, the electron waves begin to interfere with one another.

Electrons are sensitive to magnetic fields, meaning that this interference is controllable. Researchers have fabricated small, ring-shaped devices in which magnetic fields modulate the current and control the interference of electrons traveling along different arms of the ring (see photo A).

The greatest modulation of current, however, occurs in rings fabricated at IBM's T. J. Watson Research Center in Yorktown Heights, New York, and at AT&T's Bell Laboratories in Murray Hill, New Jersey. The rings were formed in 2DEGs in gallium-arsenide films deposited by MBE. The Bell Labs scientists have also built devices in which electrons travel coherently over long distances in narrow conduits virtually free of impurities. The thin films that are laid down by MBE serve as electron waveguides, similar to optical fibers.

Another type of quantum effect occurs when an electron's motion is constrained to less than three dimensions. An example is the 2DEG, where a layer of material thinner than an electron's wavelength confines the electrons, forming a quantum well. Normally, electrons can take on a whole range of energies, but spatial confinement forces those energies into different states. Energy barriers can be far more effective than physical barriers in confining electrons.

The resonant tunneling device sandwiches a 2DEG between two thicker layers of material containing higher energy electrons. For the electrons to pass through those layers, the energy of the electrons carrying the current has to fall within the possible energy values (quantized levels) in the 2DEG layer. When this matching occurs, the layers' energies are in resonance with one another, and large amounts of current can flow.

Effects become even more dramatic when the electrons are constrained in more than one dimension. We can use high-resolution electron-beam lithography and high-precision reactive-ion etching (a technique used to transfer a lithographic pattern to the layers of material on a wafer) to form quantum wires and quantum dots only a few tens of nanometers wide. Quantum wires constrain electrons to a one-dimensional quantum well; quantum dots, to a zero-dimensional well.

The quantized energy levels of quantum wires and quantum dots become narrower and more widely spaced than in two-dimensional wells. This tighter discrimination of energy levels leads to sharper resonance effects.

At least theoretically, quantum dots have a couple of unique possibilities. First, their electrons should have distinct energy levels that accurate adjustment of the applied voltage should be able to precisely control.

Second, by virtue of their small size, quantum-dot devices could be packed orders of magnitude more densely than today's transistors—and they would draw much less power. Interconnects between dots might be unnecessary; they may be able to communicate with each other if they are placed close enough together.

Because each well has more than one resonant level, it offers a new function: multistate stability. Conventional transistors are bistable: They require a certain amount of voltage—sufficient to enable current to flow through them—to turn them on; returning this voltage to zero turns them off.

Resonant tunneling devices are multistate; they turn on or off when the control voltage moves on or off the various resonant levels (it need not return to zero). Multistate operations could lead to computers based on three or more states instead of the current two (1s and 0s). The multistate stability of quantum devices offers the possibility of multivalued logic functions at greatly enhanced speeds.

### One on One

Another type of quantum-effect device that offers multistate stability operates on a different principle that is based on each electron carrying a single unit of electrical charge. In a conventional transistor, millions and millions of electrons pass through the device in a single switching operation (this occurs about 50 million times per second in a fast desktop machine).

In the 1960s, scientists predicted that if a conductor were made small enough (e.g., a few tens of nanometers on a side), it would require enormous energy to add even one more electron. They were right.

This particular effect is known as the *Coulomb Blockade*. It has led to the recent invention of the single-electron transistor, a supersensitive device that turns on and off as electrons are added to it one at a time. (Of a somewhat similar nature is a recently announced switch invented by IBM scientists that turns on or off with the motion of a single atom.) These new quantum-effect devices and other ones like them conjure up visions of computers of the future that would make even today's best machines look clumsy and plodding by comparison.

Researchers at Moscow State University have developed sophisticated electronic circuits based on the concept of single-electron devices. These circuits offer orders of magnitude of improvement in speed and density over conventional logic schemes. Furthermore, single-electron devices offer a unique approach to memory applications: multilevel storage, where a single transistor is capable of storing several bits.

The idea of merging logic and memory functions into self-sufficient circuits may provide a new form of intelligent memory. Applications such as multimedia and memory-hungry graphics already demand considerable quantities of memory with local supporting logic. High-density smart memory will be fundamental to many future products.

### An Arctic Blast

Despite all the tantalizing possibilities that nanoscale quantum-effect devices offer, their implementation in tomorrow's machines faces some very serious barriers. Quantum-effect operation of most devices has only been demonstrated at extremely low temperatures (i.e., around -450°F). At higher temperatures, thermally activated processes tend to wash out the key quantum effects.

A 100-nm-size single-electron device that shows beautiful turn-on and turn-off characteristics at liquid helium temperatures is always on at room temperature. Only if the device could be made at least 10 times smaller would it be considered for operation under normal climatological conditions.

### Nano, Nano

Enough has been learned to know that technological limits are meant to be broken. Quite clearly, we need additional innovative research to find out where and how nanoelectronics will have a significant impact in the computing world.

Despite all the challenges, however, the potential rewards of nanoelectronic technology could be enormous. Currently, you are able to carry around with you in a laptop a few megabytes of memory and circuits that cycle every few 10 millionths of a second. Nanoelectronics might well increase these capabilities and the computer's resulting performance by a factor of 100 or more.

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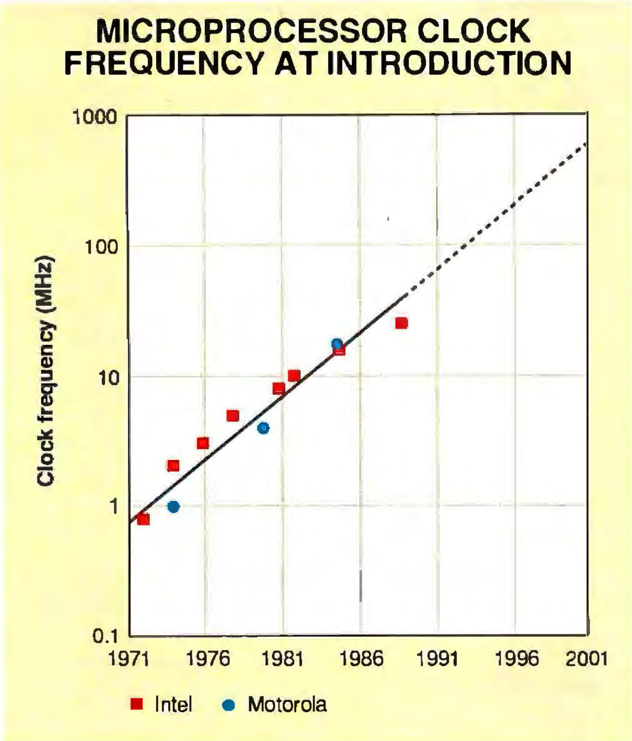


**Figure 2:** *The trend in microprocessor clock frequency is representative of the advances in ICs that will characterize the 1990s.*

phase of the product life cycle, when profit margins are highest) are essential to recovering the significant costs associated with the introduction of new products. High productivity in the design phase directly and positively affects the time-to-market cycle, and it's a direct result of the use of sophisticated and enhanced CAD tools on high-performance workstations. Improvements in design tools require rapid advancement of IC technology.

The complexity of random logic chips (i.e., the number of transistors per chip) has been increasing at an annual rate of 25 percent—for memory chips, 60 percent. Microprocessor performance has increased 60 percent per year. Complete design cycles, such as those for computer workstations, have shrunk to well under a year.

Along with advances in chip technology, designer productivity has increased dramatically over the past decade. However, to meet semiconductor-industry goals, designer productivity will have to increase an additional 30-fold in the next 10 years.

By the year 2000, the design environment will require a 2-BIPS workstation with 2 gigabytes of main memory, 20-ns access time, and 4 MB of cache. The system-clock frequency will be around 250 MHz (see figure 2). A 512-bit bus operating at 250 MHz will be required between the processor and the main memory. The display will be a flat-screen color LCD with 4 megapixels at 24 bits per pixel. The hard disk will contain more than 100 gigabytes of data, and it will use optical technology.

Because of design-methodology requirements, the focus of design research is shifting from chips to multichip modules and integrated systems, and from building tools for logic, circuit, layout, and verification to support of concurrent engineering. In the future, statistical manufacturing data will increasingly be used to both fine-tune designs and obtain greater performance.

## Today's Design Directions

At issue here is the ability to design digital systems through high-level synthesis by means of research on expert, rule-based design systems capable of bottom-up design from a top-down specification. Implementing this new design model requires a large database of component, assembly, and process specifications. The model supports all aspects of digital system design, from logic and physical design to manufacture. Use of these tools has resulted in order-of-magnitude reductions in the design cycle.

Another research effort is aimed at defining a complete VHDL-based multichip interactive design system that supports chip design through layout from a behavioral specification. This process involves determining the number of necessary chips, partitioning the specification among the chips, creating proper interchip interfaces, and synthesizing the layout of each chip. After the designer is satisfied with the distribution of the specifications and the interconnections among the chips, a chip is designed from the specifications by a chip-synthesis tool that works with constraints derived from the higher-level decision.

In other areas, researchers have made significant advances in the basic design procedures associated with logic, circuit, and device design, as well as layout. Circuit simulators based on RLC circuit moments (i.e., linear equations used to approximate the equations describing a circuit in the interest of speeding the calculations) are calculated by a path-tracing algorithm, require 10 times less memory than prior simulators, and can analyze large interconnection models several thousand times faster than a circuit simulation.

## How We'll Proceed

The rapid progress in device and process technology will continue unabated through the next decade. By the next century, the MOS field effect transistor gate length will approach 0.15 micron. As few as 400 atoms will separate the source from the drain. Reductions in minimum feature size bring with them circuit-performance improvements associated with increased circuit density and higher device speeds. However, the interconnection parasitics and the wiring complexity required to integrate 100 million transistors into a circuit will limit chip performance.

Industry analysts are forecasting 1000-MHz clock frequencies for bipolar logic with 10-picosecond gate delays and 500-MHz clock frequencies for MOS logic with 30-ps gate delays. Reaching these speeds will provide a functional throughput rate of $2.5 \times 10^{15}$. Architectural innovations that require high complexity (e.g., parallel processing and neural networks) will become available to support higher performance at the system level.

Current interconnection technology is approaching reliability and parasitic limits. The finer structures of denser ICs are causing higher current densities in on-chip connection paths, which can cause increased electromigration (an electrically driven redistribution of the elements forming the semiconductor structure) and lead to failure of the device. Even if no electromigration occurs, the closer spacing of interconnections on a chip increases the likelihood that signals on one line will interfere with those on adjacent lines (this is termed *cross talk*). Therefore, new materials are being considered to circumvent these limits, such as low dielectric constant polymers for interlevel dielectrics

# Gallium Grows Up

RON SARTORE

Gallium-arsenide materials used in semiconductors were once considered exotic, and they were used exclusively for microwave communications and supercomputer circuits. Now, in the race for economical, high-performance computing, gallium arsenide—a compound of gallium (Ga) and arsenide (As), or GaAs (pronounced gas)—is securing a foothold in advanced personal computers and workstations.

Will GaAs replace silicon in future computers? Probably not. The compound's role at first will be to support, not to replace, silicon-based processors. Then why do we need it in the first place?

Proponents of GaAs espouse its wondrous speed. Electrons move four to five times faster in the GaAs compound than in silicon. For example, if it were practical to build a million-transistor processor in GaAs today, a processor like Intel's 50-MHz 486 could be running at over 200 MHz.

Unfortunately, speed isn't the only difference between the two materials. Gallium arsenide is very brittle. Because of that, it's difficult to create large-diameter wafers (i.e., slices of the material) on which to build ICs. Currently, the largest GaAs wafers are only the size of the silicon wafers built 10 years ago. Smaller wafers mean fewer and typically less complex ICs per wafer and higher manufacturing cost per device.

## Cooking with GaAs

Two of the biggest challenges facing designers of high-performance computers involve the distribution of tightly controlled high-speed clocks and the access of data from cache and main memory subsystems. GaAs now appears to be the best candidate to easily solve these problems.

The clock distributions for 50- and 66-MHz processors are approaching the limits of silicon-based components. The trend to higher clock speeds shows no relief because processor speeds continue to double every few years. The speed of GaAs devices provides one answer.

For example, a company called Triquint offers a GaAs component that can be used to distribute the tightly controlled clocks for Intel's CPU/cache module. For a GaAs device, it loafs along internally at 500 MHz to create an accurate and symmetrical 50- or 66-MHz clock. A 25- or 33-MHz clock is distributed to the subsystems of the computer, and then they are doubled by the device.

At the system level, differences between individual clocks can be maintained within 500 picoseconds (i.e., 0.5 nm). One company, Pure Logic Systems of Chandler, Arizona, used this type of GaAs device to develop a 50-MHz upgrade for 486-based systems.

The desire to let the CPU run at the highest possible speed has resulted in the development of many sophisticated caching and memory architectures. But whatever the arrangement, the memory and CPU must be efficiently linked. It may be helpful to think of the memory and processor's dialogue described here as the processor's millions of transistors waiting on the memory subsystem's hundreds of millions of transistors.

Yet, in the path between these two system elements, there typically exist some essential logic devices consisting of only a few thousand transistors. These bridge elements cause delays that, although they are negligible in slower systems, impose a performance penalty in faster systems. The functions performed by this bridge include memory address-space decoding, address translation, cache hit/miss determination, address buffering, data-path management, processor-state tracking, multiprocessor synchronization, and a variety of small but important control functions.

If those few thousand bridging transistors run faster, both subsystems become more tightly coupled, and the entire system runs faster. This process can be achieved by implementing the bridge logic with a GaAs gate-array device. Now, there is at least one company, Vitesse Semiconductor, that is delivering GaAs gate arrays compatible with the logic levels of today's processors and memories.

The advantages of using GaAs between the processor and the memory are not limited to speed. One of the more obscure behavioral differences between silicon and GaAs is the effect of temperature on their speeds. With silicon, higher temperatures reduce the mobility of electrons and slow the performance of the device. Thus, the silicon-based CPU and its silicon-based memory become slower as they warm. With GaAs, just the opposite is true. As GaAs warms, its electron mobility increases, and it becomes faster. Using GaAs between the CPU and the memory creates a crude temperature-compensating effect.

GaAs is not a replacement for silicon yet, but it can be used effectively to extend the limits of silicon-based systems. Each technology has its own unique benefits, problems, and appropriate applications, and both will be challenged by the demands of next-generation systems.

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*Ron Sartore is a cofounder of Cheetah International, a company that makes high-performance personal computers. You can contact him on BIX c/o "editors."*

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and copper for an interconnective conductor. Some researchers are bringing what were once considered exotic materials into the mainstream (see the text box "Gallium Grows Up" above).

Manufacturing equipment will also encounter physical limits. Expected limitations on the depth-of-field for future optical lithographies impose limits on the allowable variance in the planarity (i.e., flatness) of the surface of the semiconductor wafer. Planarity limits impose restrictions

# Cubelets and Chiplets

JANET J. BARRON

The conventional microprocessor's power, speed, and bandwidth have just about reached their limits. Mull over the implications of a chip designed to use light rather than electrons to transmit information between chips. Think about the benefits of a processor that uses analog neurons as a classifier and digital electronics as the interface for the imager.

To create some of tomorrow's fantastic chips, futuristic hybrid technologies and materials are emerging. However, finding ways to most effectively package and interconnect these new types of components and materials remains a thorny issue.

## Under Construction

Parallelism is becoming more prevalent in computing, and new technologies and materials must be able to deal with it. Caltech scientists (and others) are considering using holograms to interconnect optical processors. Widespread work in neural-network design and high-speed processing has led many laboratories to study the need for optical backplanes that would provide higher-density interconnections, higher speeds, and lower noise and parasitics (i.e., undesirable energy-wasting signals) than current electronic-bus architectures are able to provide.

Scientists at Hiroshima University in Japan are experimenting with innovative methods of using optics to link memory cells. Their goal is to use optically coupled, three-dimensional common-memory elements, called 3D-OCCs, in fast parallel-processing systems. Some laboratories are also exploring a packaging and interconnection technology that supports high-bandwidth communications among a 3-D array of processors.

Georgia Tech researchers are developing a unique process to integrate hybrid devices directly onto a silicon substrate, resulting in a *chiplet*. And at least three commercial firms have implemented a 3-D stacking technology that allows the packaging of two to eight chips on an advanced substrate, creating a *cubelet*.

## Back to the Future

Lithography is the behind-the-scenes fabrication process that underlies all semiconductor technology. For years, optical lithography has seemed to be at the end of its usefulness for IC fabrication. Nevertheless, the minimum features of ICs have shrunk below 1 micron, and the process has been used to fabricate advanced chips with geometries as small as 0.5 micron (in research, as small as 0.35 micron).

Stretching thin the current fabrication boundaries is forcing researchers to experiment with more exotic materials and techniques.

## Making the Move

A hybrid of optical and electronic technologies called optoelectronic ICs may well be the only game in town soon. The process of producing OEICs will be easier if we can use conventional microelectronic processing techniques. The cost will be lower, too. Scientists at Georgia Tech have developed a new and improved method for the alignment, selective deposition, and interconnection of thin-film epitaxial gallium-arsenide devices onto host substrates, such as silicon.

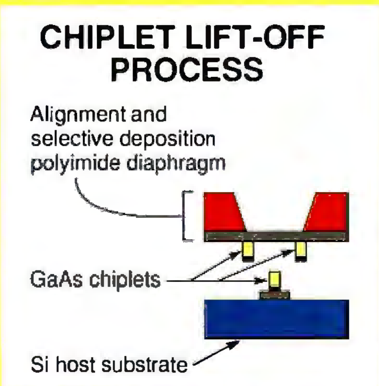


**Figure A:** *The GaAs devices on the polyimide diaphragm are aligned with respect to the silicon host substrate, and they are deposited from the diaphragm onto the silicon. Individual devices or an entire array of devices can be aligned and deposited onto this host substrate.*

This chiplet process, developed by Nan Marie Jokerst's group, enables the low-cost manufacturing of emitters, detectors, and modulators integrated directly onto a silicon substrate (see figure A). This technique should permit the production of less expensive optical devices and, eventually, the mass production of OEICs.

A Texas Instruments unnamed prototype device uses light to transmit information between chips. The goal of James Yuan, branch manager of TI's Central Research Laboratory in Dallas, Texas, is to "see if we can do optical interconnections both at the chip level and at the board level."

Among the device's potential applications are the moving of signals in and out of multichip modules and the providing of high-speed links between circuit boards (e.g., a backplane). Yuan says his group has demonstrated a device that integrates an array of eight LEDs with a CMOS output-decoding circuit.

One conceptual way to package this chip, says Yuan, is to use free space: Do away with the fiber completely, and use the chip as an optical coupler. Rather than using mechanical pins, you place the chip directly on the substrate, which has a receiver on the other side. Then, instead of one coupler, you have an array of 16 or 32 couplers.

Theoretically, a second way to package this chip would be to use a prefabricated optical waveguide made on a silicon substrate. Then the chip would drop into the waveguide pattern, providing a multiple channel aligned with the waveguide.

## Into the Extremely Exotic

Developers of exotic technologies and potential and emerging products are struggling with complicated packaging and interconnection challenges. According to the developer of an experimental bionic-nerve chip, any sort of in vivo placement of a chip (in a plant or animal's living body) will require significant research.

One challenge, passivation (i.e., the protection against contamination), although important in the IC environment, is essential in all in vivo applications. The salt present in the body will cause major problems for an unprotected in-vivo implementation.

An experimental bionic chip has been successfully used to connect the severed ends of an animal's nerve. During the healing process, nerve fibers re-formed and grew through microholes in the chip. Scientists recorded the resultant nerve activity. According to researchers, a microprocessor linked to a nerve chip embedded in living tissue might some day be able to control the motions of an artificial limb.

A number of companies already have implemented biologically inspired products. Many neural-network applications are already in use, and others are appearing daily. But in a situation unusual in the computer industry, neural-network hardware still lags far behind software.

However, Synaptics, of San Jose, California, has produced what its president, Federico Faggin, calls "the first known use of neural-net chip technology in a commercial end-user application." The I1000 chip integrates an imager with image preprocessing, an analog neural-network classifier, and digital electronics as the interface for a single-chip microcontroller.

Interconnection and packaging challenges in the development of this chip included encapsulating the device with an optical-quality lid in strict registration of the die to the optics and finding a way to produce a low-cost implementation of the assembly.

### 3-D Stacking Methods

Because conventional multichip packaging can't provide the density or the performance needed for some future applications, TI is just one of several companies using a 3-D stacking packaging technology. Others include Irvine Sensors of Costa Mesa, California, and Thomson CSF of Paris, France.

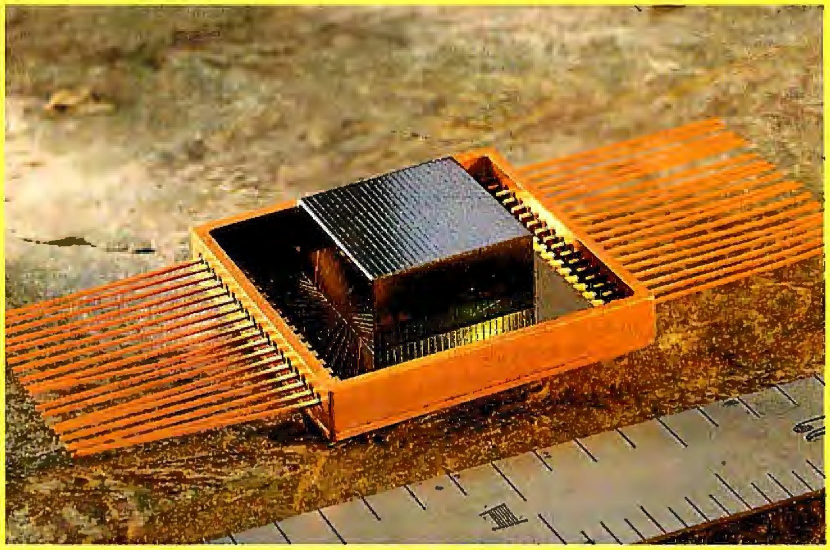

**Photo A:** *One three-dimensional IC, such as this cubelet from Irvine Sensors, stacked 92 memory ICs of 4 Mb of DRAM to create a 40-MB package.*

Myles Suer, director of marketing for Irvine Sensors, says, "We're moving away from single-chip packaging, which will probably reach its limits at 5 0to 75 MHz. As we develop faster processors, the interconnection distance between the cache memory and the processor becomes much more critical."

With a number of computer manufacturers, Suer's firm is jointly developing prototypes of a 3-D memory-stack cubelet that can be packaged next to the processor (see photo A). According to Suer, cubelets can provide higher performance—as high as 400 MHz if the chip interconnections are all on one side of the IC. With minor redesign, they can also offer significantly lower power consumption.

Cubelets enable designers to more efficiently package processors for the parallel environment and to utilize space more efficiently. They can package 40 to 80 MB of memory in a space the size of a sugar cube. Cubelets are being developed as potential computer systems in a cube (i.e., packaging processors, memory, and so forth as a unit).

### Back to Basics

A group at MIT has developed NuMesh, a new scalable, modular, 3-D packaging and interconnect technology that supports high-bandwidth systolic communications on a 3-D nearest-neighbor lattice. The primary goal is to define and support a standard communication and interconnection substrate for modules of arbitrarily complex digital systems.

By joining Lego-like NuMesh modules, Steve Ward and his associates are trying to combine a "Tinkertoy-set modularity with supercomputer performance." The group's long-range goals include integrating NuMesh nodes as a processing substrate for future workstations, allowing dynamic allocation of processors to a wide range of system tasks.

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**SEMICONDUCTOR MARKET-SHARE TREND**

*Trends in the U.S. semiconductor market share over three decades indicate that the U.S. will be a minor player in this essential technology by the year 2000.*

| Year | U.S. share of worldwide semiconductor market (%) | Source of data |
|---|---|---|
| 1960 | 78 | Electronics Industry Association |
| 1970 | 56.5 | DataQuest |
| 1980 | 42.9 | DataQuest |
| 1990 | 31.7 | DataQuest |
| 2000 | 18–40 | Estimated |

on the vertical dimensions in the chip's structure at each level of interconnect processing. All these limitations will reduce the kinds of materials that can be used, because not all materials can be kept planar.

Lithography remains the pacing semiconductor technology, determining minimum feature size and product yield. Even though extended ultraviolet optical lithography may be extendable to 0.25 micron and beyond through the use of shorter wavelengths and phase-shift masks, research is in place to develop x-ray lithography tools. Models of the x-ray lithographic process that are analogous to those for optical lithography (e.g., SAMPLE/SIMPL) are being developed.

### Broader Scope for Engineering Tools

The increasing importance of technology CAD (TCAD)—a set of software programs that model the manufacturing process—is now evident. Its use as a tool for process development to avoid expensive experiments in the manufacturing environment has resulted in the increase of efforts applied to process and device modeling.

Advanced capability workstations will be required to efficiently use these tools in an integrated product/process design environment. Because of the scale and complexity of the computational models being considered for the year 2000, no single group will have the resources to develop these TCAD systems, so the cooperation of many organizations will be required.

A TCAD framework could enable individuals to develop and share common code and integration across several levels of CAD. The sharing of databases is equally important. Data models and the durability of device and process models require a standard format for semiconductor wafer representation. Similarly, the definition of a semiconductor process representation is required. Completion of these objectives will extend TCAD simulation software to process tools and factory models that are able to relate design to yield and to cost.

### A New Model for Packaging

At some point in the trend toward greater complexity, the difficulties in working with finer geometries and larger chips will cause the IC industry to look for other means of obtaining better performance. Now, the most promising area for further development is packaging.

Semiconductor-packaging technology is experiencing a tidal wave of change. It's making the transition from being a means of protecting the active device that is compatible with the system assembly to becoming a core technology that directly affects system performance at least as much as the speed or density of the chip does. This shift will be difficult to implement because engineers with the broad knowledge required for this new packaging science are rare.

The ubiquitous plastic DIP has been used for more than three decades in spite of its shortcomings in electrical and thermal performance. One approach to projecting the future of packaging technology is to examine the trend in single-chip packages.

The current microprocessor is packaged in a ceramic flatpack with a pin count of around 400, a power dissipation rate of 7 watts, and a rise time of 1000 ps. Within a decade, the prevalent microprocessor will have 2000 I/O connections, dissipate 60 watts, and have a rise time of 150 ps. Single-chip packages for those processors will be the upper end of a family of packages that must be developed and configured for surface mounting and for tape automated bonding systems.

Single-chip packaging, however, is not the area in which the packaging science will provide the greatest contribution. These packages are many times the size of the chip they contain, a situation that mandates a large, low-performance system assembly. Performance considerations (as dictated by the 250-MHz clock speeds in workstations) will force processors, coprocessors, support chips, and high-speed off-chip cache memories to be physically very close.

### The Need for Multichip Packaging

Because each inch of real estate between chips will result in a 1-ns signal-propagation delay, the maximum width of an entire system cannot be more than a few inches. Thus, whether on a flat substrate or in a stacked-chip package configuration, chips must be brought close together and provided with up to thousands of I/O connections and their attendant wiring. Multichip modules (MCMs) will be a solution until all the necessary functions can be integrated onto one chip. This theoretical solution may never happen because of system designers' seemingly inexhaustible appetite for more logic and memory.

If we achieve the capability of mounting many chips in a single package, or MCM, so that their electrical performance is not degraded by interchip delays, the module is said to have transparent interchip interfaces. Transparent interfaces with an affordable and reproducible packaging technology may well become the source of a paradigm shift in IC technology. They may replace dimension reduction as the technology driving higher performance.

Among the remaining barriers to broad acceptance of MCMs are the absence of acceptable methods of individual chip testing before assembly, the lack of sources for these chips, and the need for better techniques to repair defective MCMs. MCMs may consist of several silicon chips on a silicon or ceramic substrate. These chips are connected with solder-bump technology to the multilayer conductors on the substrate.

Signals will flow from chip to chip by way of transmission-line structures driven by low-impedance drivers matching the impedance of the transmission line. Additionally, power distribution will require that contacts be placed closer to where the power will be used to avoid the switching noise that is associated with long on-chip power buses. Because the cost of the enclosure would then be spread over more than one chip, it will be economical to use a hermetically sealed enclosure, a class of package that contributes to high reliability.

If high-performance MCMs become economically feasible, the technology of partitioning the system must be revisited. Chip designs can be optimized to allow higher performance and yields when off-


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**Circle 117 on Inquiry Card.**

chip cache memories become a reality and the need for line drivers is lessened. One such optimal design might require that each chip include only a narrow range of similar device types so that fewer demands would be placed on the fabrication processes.

But whether you are dealing with single-chip packages or MCMs, the electrical, thermal, and mechanical design of the package will require design tools that are not currently available. Package CAD (PCAD), a set of software tools to aid in the design of IC packages, is being developed.

PCAD will include the modeling tools for advanced packages. These tools will permit the simulation and optimization of package design before the commitment to hardware and the performance evaluation of the packaged chips from the system perspective. Trade-offs of chip complexity, package costs, and system performance become a reality. Because PCAD does not address the design of either MCMs or multiple chip assemblies, it therefore must be extended to deal with both these design options.

Additional advanced technologies (including superconductivity and electro-optics) for complex high-performance next-decade chip applications are already being evaluated (for a view of the progress in advanced packaging and interconnection research, see the text box "Cubelets and Chiplets" on page 144). Because cooling silicon ICs increases their switching speeds, thermal conductivity, signal-to-noise ratio, and high-temperature superconductors should become practical. If so, they may also find application in MCMs. The decision to use these advanced technologies will be based on cost-performance trade-offs.

At the system level, the use of optical data buses is already a reality. But there is a question concerning when we will attain the precision and technology required for on-chip or in-module optical data buses. The packaging of microelectronic devices and systems is a challenge and an opportunity that will provide rewards for the companies that learn to do it successfully.

## A New Beginning for Semiconductors

Semiconductor progress has been defined by plotting a number of trends, such as the size of the minimum features on an IC. The father of all trends is the one enunciated by Gordon Moore in 1975 forecasting the number of transistors on each IC chip (see the text box "Moore's Law Meets MIPS" on page 125). This law has been so accurate that other parameters—chip dimensions, line width, wafer-fabrication costs, million instructions per second, bits, and power—have been effectively subjected to similar analysis.

In past decades, various analyses of the limits of integration have predicted an end to the progress, but creativity and innovative skills have pushed back those limits. Now, further advancement faces real physical limits. They include the size of the atom, the inherent variances involved with crystal lattices, and the small amount of charge transported through the IC structures (which ultimately becomes too small to detect and cannot be used).

These physical limits and significant economic barriers (e.g., the billion-dollar cost of a chip factory by the end of this decade) indicate that the limits of traditional trends in technological advancement have been reached in the fourth decade of the IC. New trends will be created, resulting in new paradigms for progress. Growth of electronic-system performance will continue based on the advances in packaging, quantum devices, or molecular electronics paradigms. These technologies will likely continue to be based on the silicon devices and silicon substrates simply because these technologies have out-achieved any alternative.

## The Future Shape of the Semiconductor Industry

Real concerns exist with respect to the effect of markets and industry structure on the technology base (see the table). For three decades, U.S. industry has been outperformed on the factory floor and outdistanced in market share. It's finally becoming aware that the U.S. is a runner-up in competition with other countries' nationally supported industries.

In the future, the economic realities of technology and production will reduce the number of viable broad-based IC producers. If the U.S. wants to be competitive in the advancement of semiconductor technology and the diverse industries that are served by it, it must ensure its profitable and productive future. It's not clear that this will be the case. ■

*Robert M. Burger is vice president and chief scientist at the Semiconductor Research Corp. (Triangle Park, NC), with which he has been associated since its founding in 1982. He has been active in semiconductor research for more than 35 years. William C. Holton is vice president for research operations at the Semiconductor Research Corp., which he joined in 1984. Previously, he was director of R&D and chief scientist for Texas Instru-*

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# SUPPORT YOUR LOCAL CPU

**Coprocessors are appearing in new forms to serve a wider range of applications**

TREVOR MARSHALL

Success for a coprocessor is similar to success for a therapist: If it's good at what it does, and what it does makes a difference, eventually it can work itself out of a job.

Math coprocessors, such as the 387 from Intel (Santa Clara, CA) and the 68882 from Motorola (Phoenix, AZ), are the most common coprocessors in use today. Yet, within a few years, they will have almost totally disappeared, absorbed into the integrated functions of the CPU. But why weren't coprocessor functions integrated into the CPU from the start?

## The Life and Times of Coprocessors

In the mid-1970s, the microprocessor was just beginning to become a viable computingdevice. CPUs such as the 8080 and the 6800 could run simple applications software (e.g., word processors), but they could do little else. They were limited both in computational ability and in their memory-addressing range (only 64 KB). There were two reasons for these limitations.

First, transistors were significantly larger than they are today. Only about 5000 of them could fit on a chip. By the time the integer-computation unit, register set, and address sequencer were included in the design, there simply wasn't room for any more complex functionality.

Second, the chip designers of the 1970s didn't target computers with their designs. The biggest markets expected for microprocessors were in desktop calculators and traffic-light controllers.

Thus, many of the functions that made their way into silicon were not oriented toward computing, and a need for specialized computer coprocessors arose. Early coprocessors performed I/O, RS-232C


serial communications, and other basic low-level system functions.

By the time Motorola released the 68000, nearly 70,000 of the ever-shrinking transistors could fit on a chip. As a result, the 68000 had a larger integer-calculation unit (16 to 32 bits), and it could address 16 MB of memory. When the 68020 came along, it had room for 190,000 transistors and a full 32-bit CPU, but it still needed two coprocessors to handle the needs of a fully functional computer: a memory management unit (MMU) and an FPU.

The 68851 MMU had 194,000 transistors and enabled multiuser operating systems (e.g., Unix) to efficiently handle task switching. The 68881 FPU had 155,000 transistors, and it significantly enhanced the speed and accuracy of mathematical calculations. Successive generations of CPUs have absorbed as many of the most commonly used coprocessor functions as they could.

## BYTE ACTION SUMMARY

Traditional functions of coprocessors are being integrated into the CPU. The next generation of coprocessors emerging with new functions to further enhance system performance.

Motorola's 68030 integrated the 68851 MMU and the 68020 to produce a CPU with much faster memory management capabilities than the 68020 alone. The 68040 further integrates many functions of the 68881 FPU and adds enhancements to the basic CPU. In the Intel range of processors, there has been a similar steady progression of functional integration. For example, the 486 also includes MMU and FPU functionality.

Now that both the 486 and the 68040 contain floating-point functions, there's little reason to buy a separate FPU. As 386 and 68030 computers are phased out, FPUs will disappear altogether.

### But the Numbers Don't Add Up

Some trade-offs always occur with integration, however. The 68030 combined the 68020, with its 190,000 transistors, and the 68851 MMU, with its 194,000. But the 68030 had room for only 300,000 transistors, so some of the MMU's less frequently used modes were omitted.

Both the 68040 and the 486 include the functions of the math coprocessors from their respective predecessors (the 68882 and the 387). The 68040 integrates CPU, cache RAM, MMU, and FPU functions, and the 486 encompasses the same functions in its 1.2 million transistors.

Despite the massive transistor count in the integrated CPUs, Intel and Motorola had to omit certain FPU scientific functions (e.g., sine and cosine) from the total. Luckily, software emulation of these functions doesn't cause a noticeable degradation in performance.

### A New Lease on Life

For some people, however, the performance compromises inherent in integrated CPUs are too high, and a new class of application-specific FPUs is beginning to appear. Cyrix (Richardson, TX), for example, has taken its 387 clone and produced a version designed to accelerate AutoCAD operations.

One great advantage that a coprocessor-based system has over an integrated system is that the CPU and the coprocessor can operate in parallel, performing more than one task at a time. Many computationally intensive tasks (e.g., desktop publishing, optical character recognition, and ray tracing) can benefit from concurrent processing.

Some coprocessors have grown to become complete computers on a card. A card-based coprocessor can be a lot more complex than one chip, and this complexity results in increased specialization and functionality (see "A Calculating RISC," May 1990 BYTE).

For example, most of the major suppliers of three-dimensional graphics software currently use multiple coprocessor cards based on the new Am29050 RISC chip from AMD (Sunnyvale, CA) or the 860 RISC processor from Intel. This approach provides the graphics companies with several advantages over using an integrated CPU.

Using multiple coprocessors, the graphics software can off load parts of an image to different cards and generate the total image more quickly. In addition, functions that an integrated CPU cannot handle well (e.g., the sine and cosine functions) can be hand-coded to achieve optimal performance.

### Pick a Path, Any Path

Apple Computer (Cupertino, CA) recently introduced a communications coprocessor card that implements the ISDN protocol, allowing a NuBus-based Mac to connect directly to integrated voice-and-data telephone networks. Using the Macintosh coprocessor platform, the 68000-based ISDN NuBus card performs all the interface protocol calculations, freeing the CPU for application programs.

Networking at all levels is a processing-intensive task. As such, it's a natural candidate for coprocessing. Some coprocessor cards transparently compress data as they transfer it to disk. The compression saves disk space, especially in files with a great deal of blank space (e.g., spreadsheets).

Other coprocessors are designed to compress and decompress video images for multimedia applications. Intel, IIT (Santa Clara, CA), and C-Cube Microsystems (San Jose, CA) are early leaders in this field. Speech processing is another area receiving attention, with specialized versions of digital signal processors being produced for multimedia applications by Texas Instruments (Dallas, TX), Motorola, and National Semiconductor (Santa Clara, CA).

Undoubtedly, specialized coprocessor chips will also speed the screen redraws and printer drivers in coming generations of personal computers, and future CPUs will integrate many GUI functions. But GUIs, such as Microsoft Windows (Redmond, WA), tax the performance capabilities of even today's microprocessors, and there are limits to the improvements that each new generation can add.

CPUs are already starting to exceed the speed capabilities of available memory systems, and they depend heavily on cache and page-mode technology to keep overall system performance high. Even with the 486 and the 68040, benchmarks may run well, but programs not written to take advantage of cached-memory systems will be just as fast on 386- or 68030-based hardware. GUIs tend to fall into the latter category: They need more than raw CPU power to achieve satisfactory operational speed.

There are several ways to improve the performance of GUIs with coprocessor hardware. For example, Apple manufactured a QuickDraw accelerator coprocessor, based on the Am29000 RISC CPU, to speed up its graphical user environment. This move was followed and upstaged by cards from Radius (San Jose, CA) and SuperMac Technology (Sunnyvale, CA).

Apple's QuickDraw accelerator card improved GUI performance in two areas. First, the coprocessor is closely coupled with the frame-buffer RAM, which contains the video image to be displayed. A memory system that runs general-purpose software (e.g., spreadsheets) satisfactorily just isn't the same as one that handles video images well. For video images, the VDT must continually scan image memory to update the picture on its screen. Machines that integrate display memories (e.g., video games) are typically poor general-purpose computers. But coupling the video RAM to a coprocessor avoids the degradation of CPU performance that handling a GUI can cause.

Second, RISC processors can perform the specialized operations required by display routines more efficiently than CISC processors can. Techniques such as load scheduling allow computation to continue in a RISC CPU while the VDT accesses the video memory externally.

Most major manufacturers of graphics and CPU chip sets are currently trying to speed up the operation of Windows by using either RISC CPUs or special graphics chip sets. There is a wide selection of recently announced Windows accelerator cards that plug into a personal computer's bus and speed up its screen-redraw functions.

The increased performance that Windows accelerator cards bring results from the use of special hardware to perform BitBlt operations and line drawings. The CPU issues high-level commands to the accelerator (in essence, a coprocessor on a card), which then performs the graphical operations. This division of labor frees the 80x86 to concentrate on the applications software.

Close coupling (i.e., locating the accelerator where it won't have to use the peripheral bus to communicate with the CPU) can achieve even higher performance. In the context of the graphics processor, this technique is currently being mislabeled "local-bus VGA," a misnomer because it does not implement a true bus structure. (For some examples of close coupling, see the text box "A Close Couple" on page 154.)

S3 (Santa Clara, CA) has used close-coupling technology with its special GUI accelerator, the 86C911. This chip is designed to accelerate the screen functionality of applications running under Windows and maintain VGA compatibility. The 86C911 also accelerates BitBlt and other operations common in Windows.

In a VGA display system, the 80x86 CPU has to do all the calculations at the pixel level to accommodate screen redraws. With the 86C911, a special software driver intercepts these primitive-graphics operations and issues high-level commands to the graphics processor in the accelerator, freeing the CPU for other tasks.

Coprocessors can also improve performance in the display and printing of PostScript data. Adobe Systems (Mountain View, CA) has produced a complex chip with 400,000 transistors that is designed to generate the scalable type fonts that PostScript uses. The chip has special arithmetic units that perform the scaling,

# A Close Couple

The key to performance in any system with a coprocessor is how quickly the system can transfer data between the coprocessor and the CPU. Intel defined an interface with its 8087 that was adequate for slow chips but has proven progressively less suitable as new generations of math coprocessors have evolved.

Intel's interface between the 386 and the 387 (see figure A) shows that the 387 is mapped into the high I/O address space of the 386 CPU (A31 high, M/IO low). The interface uses address line 2 to distinguish command transfers from data.

The 387 can request that the 386 fetch operands from memory using the processor's external request line. The 32-bit data bus transfers the data. This design is not closely coupled.

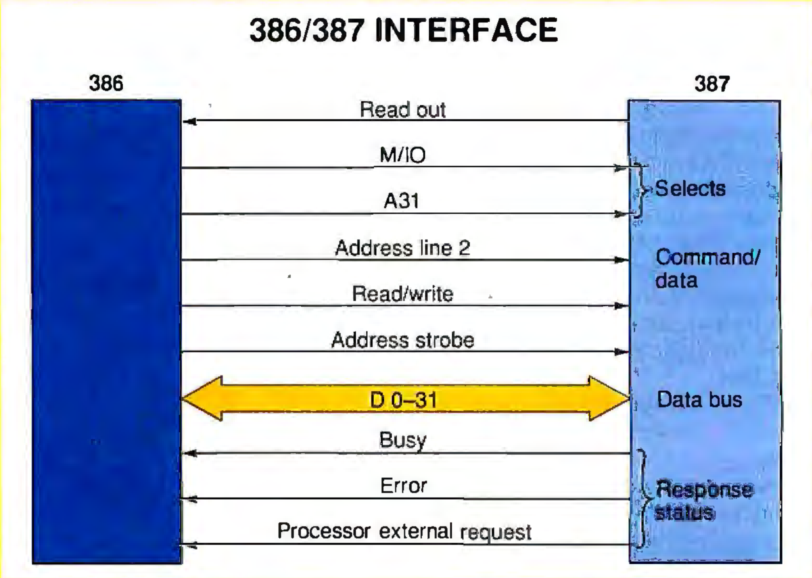


**Figure A:** *The Intel 386/387 coprocessor interface transfers data only over the 32-bit data bus.*

### A Wider Data Path

To more closely couple the math coprocessor to the CPU, Weitek (Sunnyvale, CA) developed the extended-math-coprocessor interface. Weitek's 1167 floating-point coprocessor was the first chip to use the EMC, which has been progressively enhanced with wider data buses with each generation of CPUs. Weitek's 3167 FPU uses the 32-bit version (see figure B).

Cyrix also uses the EMC interface for the Cyrix-EMC, a 387-compatible processor that also implements an advanced memory-mapped interface to further enhance performance.

This scheme communicates data and commands not only on the data bus, but also on the address lines. The FPU is mapped as a 64-KB block of high memory. Writing to specific addresses within the memory window—a different address for each FPU operation—issues commands to the FPU.

The data bus carries the data to the FPU at the same time the address lines are carrying the commands. You don't have to write a command to the FPU first, as you do with the 387 interface. Commands and data can travel simultaneously. This design is closely coupled.

Cyrix says that this interface runs as much as three times faster than the same Cyrix FPU using the standard 387 interconnection. Both schemes, however, are much faster than communicating via the expansion bus.

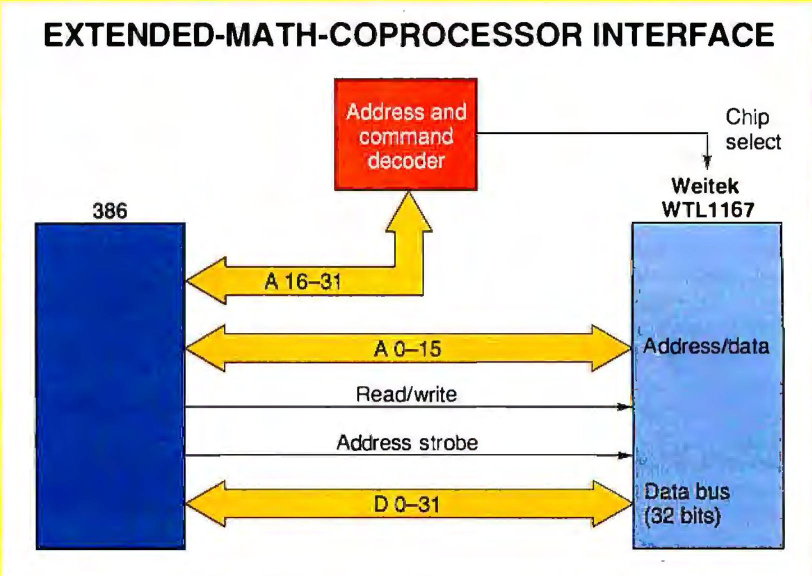


**Figure B:** *The extended-math-coprocessor interface used by Cyrix and Weitek transfers data and commands over the data bus and the address lines.*

**ACKNOWLEDGMENT**

*My thanks to Steve Fried of MicroWay (Kingston, MA) for supplying the details of the EMC interface.*

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# Multimedia Coprocessors Eye a Billion Operations per Second

YONGMIN KIM

From the viewpoint of a systems architect, multimedia simply means that some new types of data must be processed efficiently by the system. But the characteristics and volume of multimedia data demand a specialized processor. Although there are devices today that perform some of the operations envisaged for multimedia systems, it will really require a next-generation processor to perform them all. Even though the demands of multimedia are new, the role of the coprocessors that will support it is not—they will let systems efficiently process data that would overload a CPU.

The processing tasks facing a multimedia processor include image processing, three-dimensional graphics, video compression/decompression, and audio processing. Many manufacturers—including IIT, Intel, and Texas Instruments—are developing new chips for these applications. These chips will have many characteristics in common: multiple-processor architectures in which each processor incorporates extensive parallelism in time and space; large on-chip memory; integration of many functional units; extremely high bandwidth between the CPU, the memory, and the I/O devices; and the capability to perform more than a billion operations per second.

Each of the on-chip processors will include an ALU and, optionally, a hardware multiplier. Other features (e.g., a barrel shifter or an FPU) may be added. In some cases, the presence of several ALUs and multipliers in each functional unit will achieve a higher degree of parallelism for higher throughput.

It's also possible to incorporate a program control unit in each functional unit. Such a configuration results in multiple instruction/multiple data processing, since each processor (i.e., the functional unit and the program control unit) can execute its own instruction independently of others. Because different processors can perform different tasks, the MIMD configuration allows more flexibility in an algorithm meant to be used in a parallel environment. However, MIMD processors are more complex in their design than their single instruction/multiple data (SIMD) counterparts.

High-speed on-chip memory allows processors to run at very fast clock cycles. Multiport registers can also be used for easy data exchange among multiple functional units. The MMU arbitrates when several processors simultaneously request access to the same location of the on-chip memory. The memory management unit also performs data transfers between the processor, the off-chip memory, and the I/O devices.

One example of a new multimedia processor is being developed by Texas Instruments. It incorporates all the features common to the new generation of processors, and it's reconfigurable: Its multiple processors can be organized in either an SIMD, MIMD, or synchronized MIMD mode. TI's chip provides high-speed integer and floating-point arithmetic as well. A large amount of on-chip memory, which can be shared among different processors, supports simultaneous accesses from all on-chip processors and caches instructions and data. The integration of functional units and on-chip memory provides data transfer rates in excess of 1 gigabyte per second for on-chip transfers. A dedicated memory controller with sophisticated data-transfer logic allows extremely high bandwidth data transfers between on-chip memory, external memory, and I/O devices without affecting the execution of instructions in the functional units.

The processor also provides support for interfacing to video inputs and outputs via sophisticated frame controllers. The new processor is expected to perform simultaneous real-time Moving Pictures Experts Group encoding or decoding of Standard Image Format images, and simultaneous real-time Px64 encoding and decoding.

*Yongmin Kim is a professor of electrical engineering at the University of Washington in Seattle, where he is also the director of the Image Computing Systems Laboratory. He has published more than 120 technical papers in the imaging area. You can contact him on BIX c/o "editors" or on Internet as kim @ee.washington.edu.*

rendering, and filling of PostScript characters without any intervention from the CPU. Chips such as these are certain to speed WYSIWYG applications as their use widens.

### Forging a New Identity

Coprocessors enable a CPU to off load tasks it doesn't do well. By processing in parallel with the CPU, coprocessors also enable computing performance to more nearly keep pace with demand.

Coprocessors have brought more speed and parallelism to microcomputers, making new functionality possible. FPUs have enabled them to challenge the dominance of mainframes and supercomputers in the scientific arena and have brought faster and faster spreadsheet recalculations. Similarly, coprocessor technology is the likely candidate to bring fast GUIs and useful multimedia applications to the desktop.

It may take several years to design a new generation of CPUs, but designers can engineer specialized coprocessors within a matter of months. Thus, coprocessors won't disappear; they will simply evolve and reappear in forms that support specific applications. ■

*Trevor Marshall is president of YARC Systems (Newbury Park, CA) and a BYTE consulting editor. You can reach him on*

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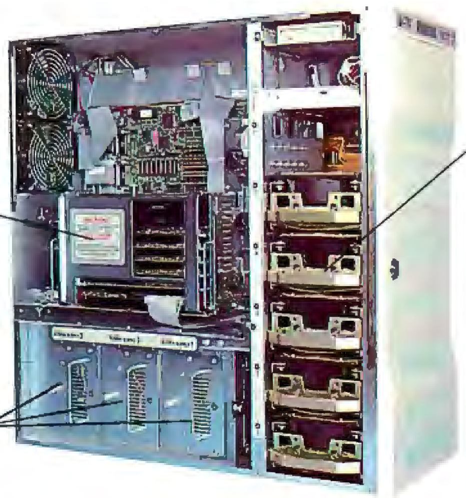

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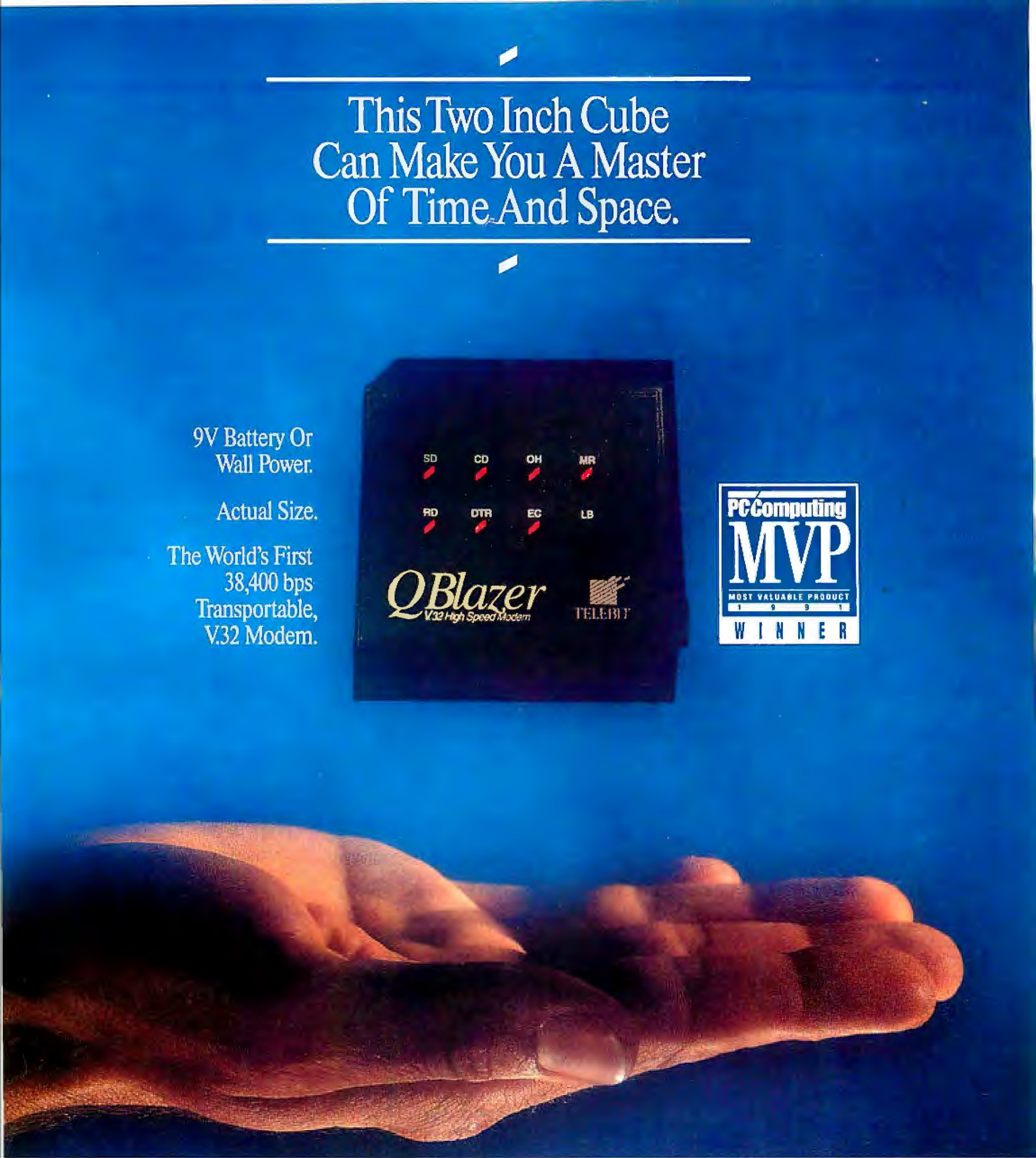


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# FILE SERVERS FACE OFF

**High-performance file servers with sophisticated drive arrays meet the demanding needs of large corporate networks**

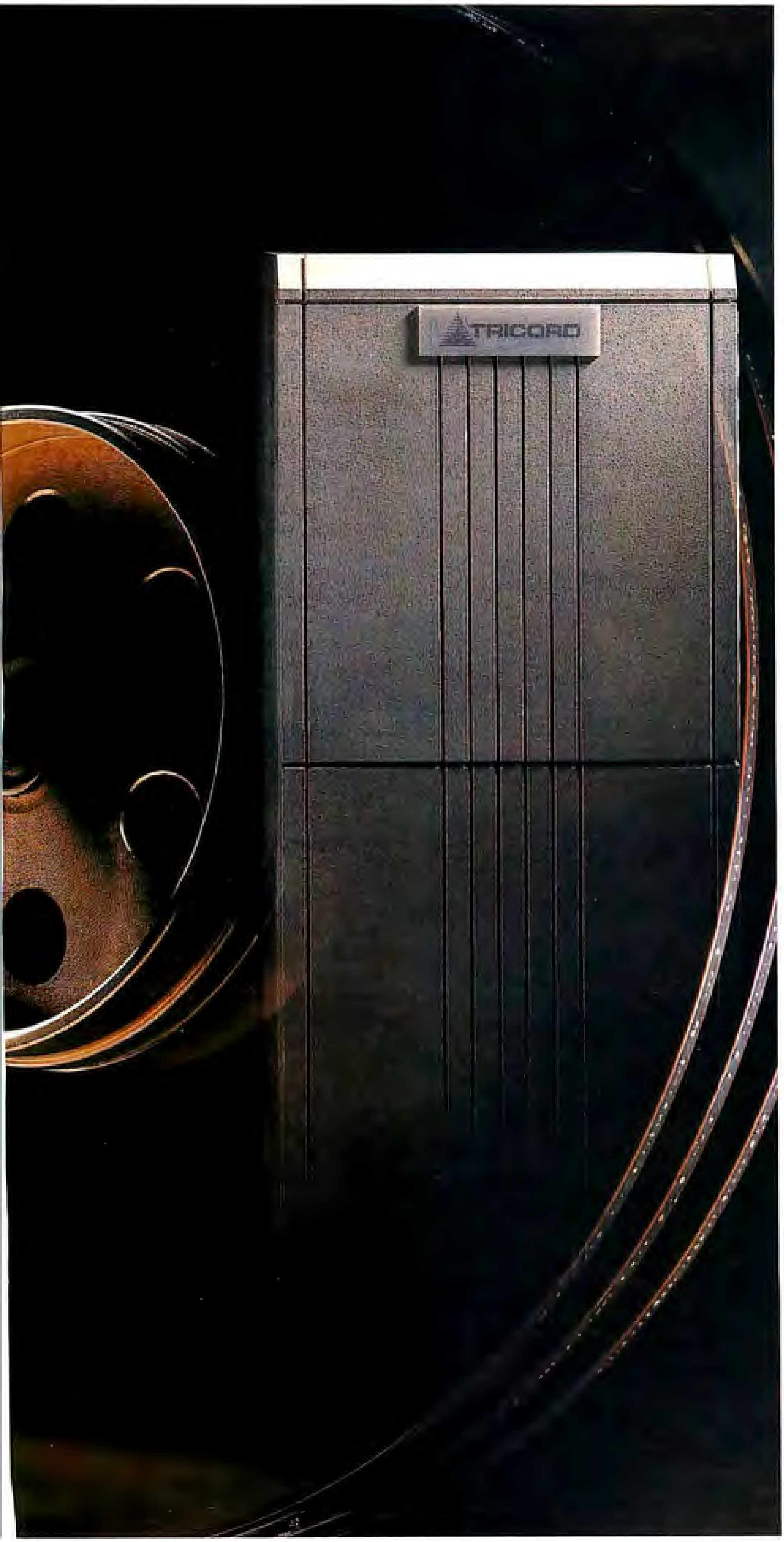
RICK GREHAN AND STANFORD DIEHL

If your organization depends on a LAN, you may be putting a lot of eggs into one basket. The performance of every worker on that LAN depends on the system server, and if that server gets bogged down with heavy traffic or—even worse—crashes with an important job on the line, you may end up with egg on your face. Yesterday's top-of-the-line systems deliver sufficient power to the most demanding single user, but large networks require even more. And while a lost drive on a single-user machine may very well drive a key worker into a frenzy, a crashed drive on a network server has the more serious consequence of putting an entire department out of business.

A new class of machine—the dedicated file server—meets many of the needs of large networks by combining powerful components, expandability, reliability, and fault tolerance. Compaq pioneered the server-only market with the introduction of the Systempro in late 1989. The first Systempro included support for multiple processors, seemingly unlimited expandability, and an array of hard drives, all built on the 32-bit bus-mastering EISA architecture. Single-handedly, Compaq set the terms for the market battles to come. This month, the BYTE Lab pits the Systempro against four other high-performance file servers: the Advanced Logic Research (ALR) PowerPro Array, the Dell 433SE, the Tangent Multi-Server, and the Tricord PowerFrame.

In the lab, we have chronicled the remarkable evolution of high-performance systems. First, we saw the steady increase of processor-chip speeds from 20 to 25 to 33 MHz. Intel then introduced the 486 and has since released a 50-MHz version of the new chip. Multiprocessor designs have earned software support (see the text box "Multiple Processors and MPX" on page 170). Processor speeds have outpaced system memory, and vendors have responded with faster RAM and hefty memory caches. Perhaps the trickiest problem of all—hard disk I/O—has been solved by faster access times, huge controller caches, and, finally, the drive

PHOTOGRAPHY SCOTT PARKER / AVIS STUDIO 1992




**BYTE ACTION SUMMARY**

■ **WHAT HIGH-PERFORMANCE FILE SERVERS DO**
These 486 systems deliver the high-end features required for servicing large networks. Internal drive arrays enhance performance, provide gigabytes of storage capacity, and enable sophisticated fault-tolerant features such as disk mirroring and data guarding.

■ **LIKES**
Network administrators should appreciate the improved performance, expansive disk capacity, and data protection provided by a high-performance server with a drive array.

■ **DISLIKES**
The cost makes these systems suitable for large networks only. Configuration and installation are tasks best left to consultants.

■ **RECOMMENDATIONS**
Tricord's PowerFrame is the best performer under NetWare, but its price makes it only for those with considerable cash resources. Dell's 433SE makes a more economical choice, and Tangent's Multi-Server scores well for file-intensive Unix operations.

array. High-performance file servers now employ every performance-enhancing strategy in the book.

## Solving the Storage Bottleneck

The key to maximum performance, as well as to fault-tolerance strategies such as disk mirroring and data guarding, lies in the implementation of the drive array. Drive arrays offer three benefits: improved throughput, increased storage capacity, and fault tolerance. Multiple drives in a single system permit the distribution of operations across drives so that multiple I/O requests can be serviced simultaneously. Increased storage capacity is an obvious consequence of having more drives in the system. Fault tolerance comes from the redundancy inherent in a drive array and takes two forms: mirroring and data guarding.

The ancestor of the drive array was a single controller with multiple drives attached. The effectiveness of this arrangement depended on the class of controller. Older ST506 controllers were able to support two drives but could access only one unit at a time. Adding more drives produced no performance gain; it

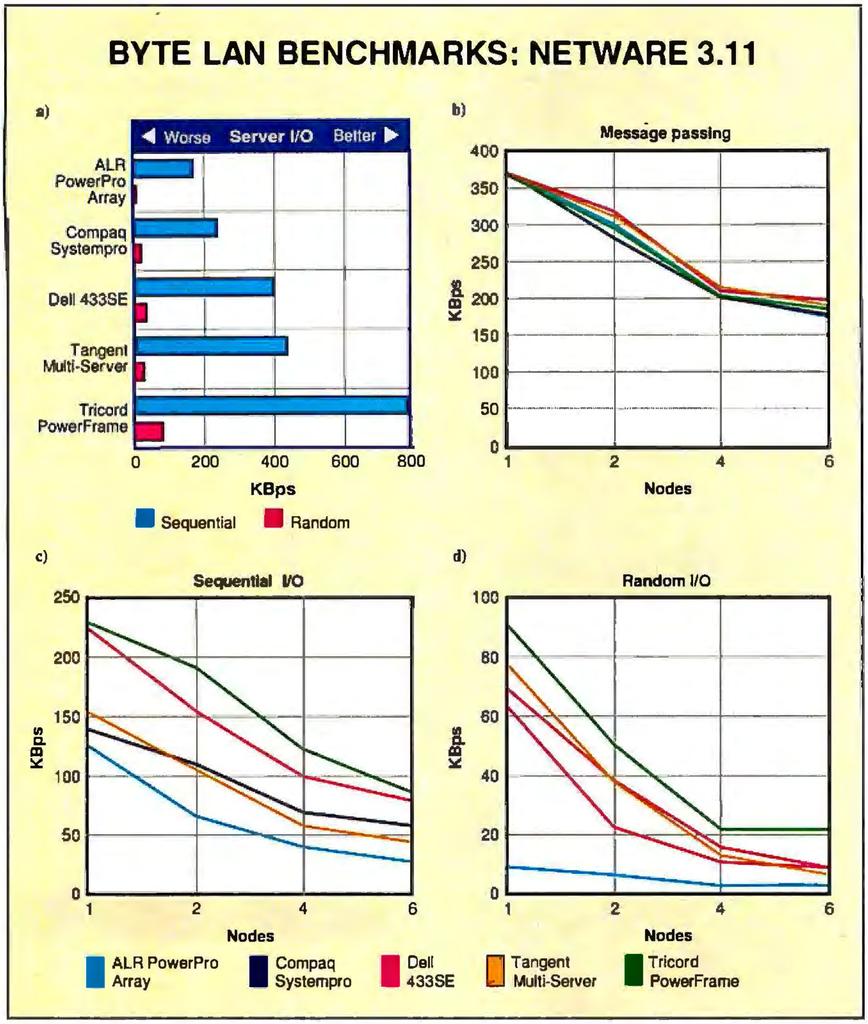



**Figure 1:** *Results of our LAN benchmark suite, with servers running NetWare 3.11: In all cases, higher numbers mean better performance. Server I/O* **(a)** *is a measure of raw performance, and this test puts the PowerFrame ahead of the rest of the pack. The test runs as an NLM, so it is not a reflection of the performance you'd expect to see from a workstation. Message passing* **(b)** *shows limitations of the actual network's response to loading; as expected, all servers turned in similar times. In* **(c)** *and* **(d)**, *you can follow each server's response to an increased load on our test network. The PowerFrame outran the other four systems on both these tests, with the 433SE running second.*

was only a capacity enhancement.

More recent drive controllers support more sophisticated protocols. SCSI, for example, lets the controller start a command on one drive (e.g., read a sector) and then disconnect from that drive and carry on a conversation with another device on the SCSI bus. Later, the controller can resume its conversation with the disconnected drive (which has presumably already read the sector into memory). In this way, a single SCSI controller can have multiple drives working on I/O operations simultaneously.

Such a configuration can improve performance on sequential operations using a technique known as *striping*. A striped drive array typically appears to the operating system as a single logical drive. Disk blocks are distributed across the array so that the first block is stored on the first drive, the second on the second drive, and so on until all the drives are used. The next block is then stored on the first drive, and the cycle repeats. When the controller receives a read request, it starts read operations on all the drives, effectively prefetching several (logically) adjacent disk blocks. Since striped drives appear to the system as one logical drive, striping allows you to combine many physical drives to create a single file system. A simpler means of extending a single file system across multiple drives, called *spanning*, allocates disk blocks from consecutive drives, one drive at a time.

There are other benefits to having a single controller manage several drives. Drive mirroring, in which the contents of one drive are exactly duplicated on a second drive, is easy to set up. Whenever a disk write goes to the primary drive, the controller simply sends an identical request to the mirror drive. If the primary drive fails, the system can access the mirror drive in its place, and the system continues to run. Drive mirroring is one of the simpler forms of fault tolerance.

If all the drives are daisy-chained on a single cable, there's still a bottleneck. Only one transfer to or from the controller can take place at any given time. The first solution to this problem is to provide multiple drive connectors on the controller, creating parallel access paths. All the systems we tested in this review incorporate controllers with multiple independent data paths. For example, the Systempro's Intelligent Drive Array (IDA) controller has four drive connectors and can carry on a conversation with up to four drives simultaneously.

Parallel access paths also permit support for another fault-tolerant feature: data guarding. Data guarding adds a parity drive to the system. The parity drive's duty is much like that of the parity memory used in most microcomputer RAM designs. A data-guarding array can be configured, for example, with three data drives and one parity drive. Each sector is distributed across the data drives. The parity drive contains information that can be used to verify or reconstruct data if one of the data drives fails. Data guarding exacts a small performance overhead, as well as a not-so-small loss in capacity, since an entire drive is devoted to holding parity information.

Another means of widening the bottleneck is to install multiple drive controllers. This is often referred to as *controller duplexing*. There is a throughput advantage to controller duplexing, particularly if the controller has a powerful on-board processor (as most of the array controllers in this review do). The controller's processor can off-load a considerable amount of work that would otherwise burden the host CPU. The effect is similar to a multiple-access-path controller in that several drives can be accessed at once.

The multiple-drive arrangements we have talked about are categorized into RAID (for redundant arrays of inexpen-

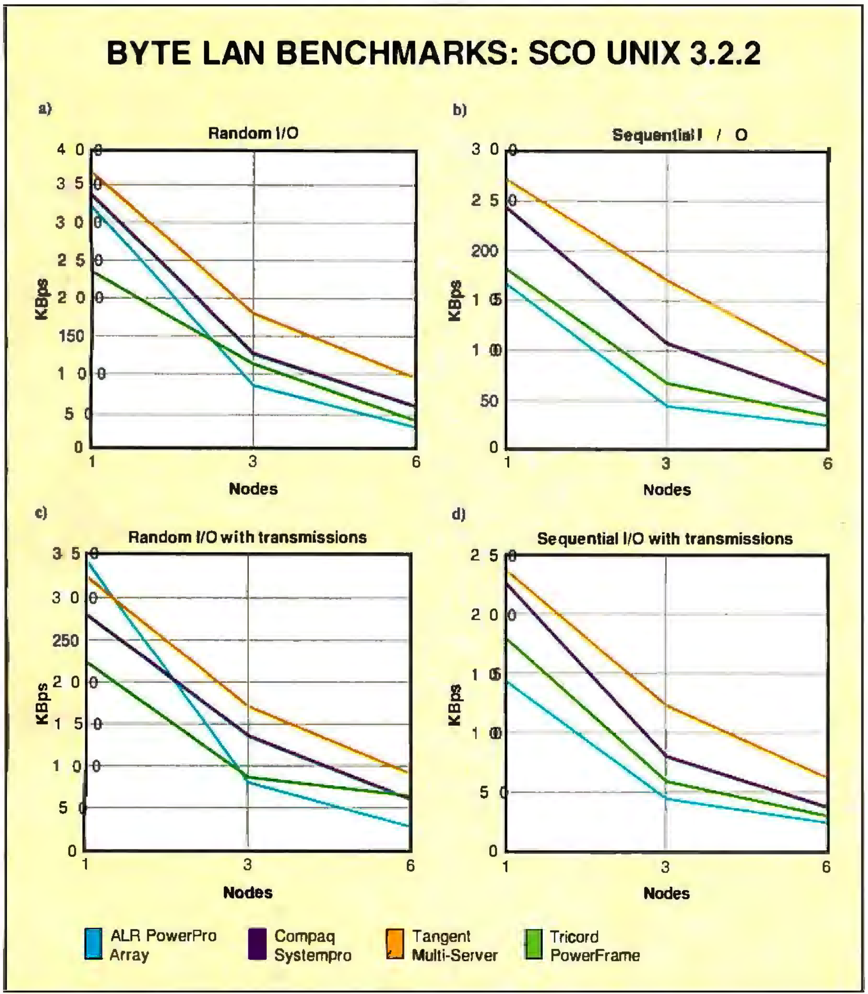



**Figure 2:** *Performance under SCO Unix put the Multi-Server consistently out front. Parts* **(a)** *and* **(b)** *represent file I/O performance without network transmission. In* **(c)** *and* **(d)**, *we measure random and sequential I/O throughput, including network interaction. In each test, the Systempro also performed well, but the PowerFrame's lack of software support for striping placed it a surprisingly low third.*

sive disks) levels. It's likely that you've come across the term, since many manufacturers now classify their hardware according to RAID levels. For example, RAID level 0 is striping, level 1 is mirroring, level 2 is bit interleaving (i.e., striping at the bit level), and level 3 refers to parallel data paths with a parity drive.

## Clocking the Speeders

This month, the BYTE Lab introduces a new suite of benchmarks to test these high-performance servers (see the text box "BYTE's LAN Benchmarks" on page 174). We tested the machines as both NetWare and Unix file servers. Under NetWare, we installed two Mylex 390A 32-bit EISA Ethernet cards and attached three workstations to each leg of the network. The six workstations included 25-MHz 386 systems from Tangent and Dell running on Eagle NE2000 network cards; we used an additional 33-MHz ALR BusinessStation as our control node. The high-performance workstations and network cards contribute to a test-bed designed to remove any performance bottlenecks not associated with the file servers themselves.

We configured each server and installed it in the test-bed. Wherever possible, we asked the manufacturers to configure their own systems; nonetheless, given EISA, SCO Unix, and NetWare, we found that setting up these systems was a monumental undertaking.

Most of our problems dealt with EISA configurations. At one point, we pulled a drive controller out of its EISA socket to examine it. When we replaced it and turned on the machine, the EISA configuration information had apparently been

*File server features include support for multiple processors, up to 256 MB of memory expansion, and various drive-array configurations. All these systems are highly customizable. Prices are for system configurations as tested by BYTE and will vary widely depending on which options are included. (● = yes; ○ = no.)*

| | ALR PowerPro Array | Compaq Systempro | Dell 433SE | Tangent Multi-Server | Tricord PowerFrame |
|---|---|---|---|---|---|
| **Price for tested configuration** | $19,490[1] | $28,276[1,2] | $12,998[2] | $14,500 | $37,990 |
| **Processor/memory system** | | | | | |
| Processor type | 486 | 486 | 486 | 486 | 486 |
| Processor speed | 33 MHz | 33 MHz | 33 MHz | 33 MHz | 33 MHz |
| Maximum number of processors supported | 2 | 2 | 1 | 1 | 2 |
| Number of processors as tested | 2 | 2 | 1 | 1 | 1 |
| Maximum cache per processor | 512 KB | 512 KB | 128 KB | 256 KB | 256 KB |
| Maximum RAM | 49 MB | 256 MB | 128 MB | 64 MB | 128 MB |
| RAM as tested | 17 MB | 16 MB | 16 MB | 16 MB | 16 MB |
| **Mass storage** | | | | | |
| Standard floppy drive | 1 5¼-inch 1.2 MB | 1 3½-inch 1.44 MB | 1 5¼-inch 1.2 MB | 1 5¼-inch 1.2 MB | 1 5¼-inch 1.2 MB |
| Tested array configuration | 4 210-MB | 4 210-MB | 4 200-MB | 4 165-MB | 4 385-MB |
| Maximum internal storage | 1.36 gigabytes | 4.08 gigabytes | 2.4 gigabytes | 9.6 gigabytes | 8 gigabytes |
| Hard drive interface | IDE | Compaq IDA | IDE | SCSI | SCSI |
| Number of drive bays | 9 | 11 | 11 | 10 | 8 |
| Tape drive standard | ○ | ○ | ○ | ○ | ○ |
| **Expansion bus** | | | | | |
| ISA slots | 2 | 0 | 0 | 2 | 1 |
| EISA slots | 8 | 7 | 8 | 6 | 7 |
| Proprietary slots | 2 (CPU/cache) | 4 (memory) | 2 (CPU/video) | 0 | 5 (CPU/disk) |
| **Ports** | | | | | |
| Serial | 2 | 2 | 2 | 1 | 2 |
| Parallel | 1 | 1 | 1 | 1 | 1 |
| Video | VGA | VGA | VGA | MDA | VGA |
| Mouse | ● | ● | ● | ○ | ● |
| **Power supply capacity (W)** | 300 | 355 | 300 | 450 | 500 |
| **Operating-system support** | | | | | |
| NetWare 386 | ● | ● | ● | ● | ● |
| Novell certified | ○ | ● | ● | ○ | ● |
| OS/2 | ● | ● | ● | ● | ● |
| SCO Unix | ● | ● | ● | ● | ● |
| Interactive Unix | ● | ○ | ● | ○ | ● |
| Other | Banyan Vines, SMP | Banyan Vines, LAN Manager, 3Com 3+Open | Banyan Vines | None | Banyan Vines |
| **Warranty** | 1 year | 1 year | 1 year | 1 year | 1 year |
| **On-site service** | ○ | ○ | ● | ● | ● |

[1] Price includes two processors
[2] Price includes tape drive

lost. We could usually restore a configuration by booting from an EISA utility disk. However, when the system decided it had no drive controller, both floppy drives, as well as the hard drive, became inaccessible. We had to install a generic ISA controller to access the floppy drives and reconfigure the EISA slots. This type of problem happened often with EISA configurations, although not to this degree. It was enough to make us long for DIP switches.

Our NetWare server benchmarks (see figure 1) include server I/O, message passing, and sequential and random workstation I/O. We ran each file I/O test on 10 2-MB files, reading and writing 512 bytes at a time. We ran the message-passing tests with 1000 packets of 500 bytes each.

In each case, we ran the first test on a workstation attached to the first leg of the network and then added the next workstation from the second leg. We tested the servers with one node, two nodes, four nodes, and six nodes attached. The line graphs show the kind of degradation you can expect as multiple nodes are attached to a network, depending on the load. Part a of figure 1 shows the performance of the server without any traffic on the network.

We used the same file and packet sizes on our Unix tests that we used with NetWare. The Unix tests include sequential and random file I/O with and without network transmission. We ran the Unix server benchmarks on a single network segment, since SCO Unix supports only one Mylex network card in a server. We ran the tests with one, three, and six nodes attached. Again, the line graphs (see figure 2) indicate the performance degradation that you can expect as new nodes are added.

All the systems in this review have drive-array controllers, 16 MB of RAM (except the PowerPro Array, which does not support a 16-MB configuration), and four hard drives. Other features vary (see the features table). Three of the systems support multiple processors: the PowerPro Array, the Systempro, and the PowerFrame. These systems differ in expansion options as well as in performance enhancements; a profile of each file server follows.

continued

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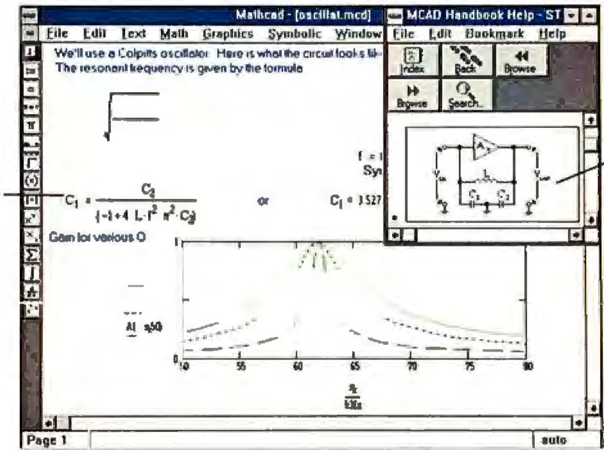


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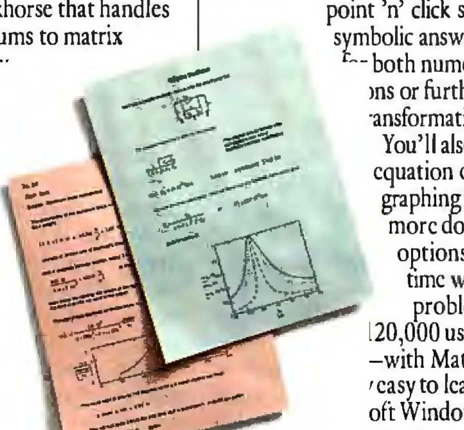

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**Circle 70 on Inquiry Card.**

A quick comparison of names makes it obvious that ALR is pitching the PowerPro Array in direct competition with Compaq's Systempro. The price is also targeted for competition with the Systempro: $19,490 for our test configuration, almost $9000 under Compaq's price. ALR claims that the PowerPro Array is register-level compatible with the Systempro, so software designed for the Systempro can be installed and run on the PowerPro Array without modifications. Like the Systempro, the PowerPro Array can accept two 486 CPUs. Also like the Systempro, the PowerPro Array has an internal high-speed bus connecting processors and memory. This allows the CPUs to communicate with memory at speeds well above that permitted by the EISA bus.

The PowerPro Array comes in a number of hard drive configurations; you can start at 150 MB and go all the way up to 1.36 gigabytes of internal storage. If expansion is high on your priority list, there are 12 expansion slots: Eight are 32-bit EISA slots, two are 8-/16-bit ISA slots, and the remaining two are proprietary (for CPU cards).

The PowerPro Array's Advanced Disk Array (ADA) subsystem consists of a drive-array controller and a carriage attached to a hinged arm that is capable of holding up to four half-height drives. If you remove the side panel and loosen a pair of thumbscrews, the arm swings out for easy access to the drives and the rest of the interior. Our system carried four half-height drives, each with a capacity of 210 MB, for a total of 840 MB. Even with the arm fully loaded, there's still room for one full-height and two half-height disk or tape drives behind the upper front panel. That's not counting the 5¼-inch 1.2-MB floppy drive that's standard with the PowerPro Array.

The ADA controller is an EISA bus master with two standard IDE connectors. This enables the ADA controller to perform parallel access along two channels. (In our test system, a pair of drives was wired to each connector on the card.) The ADA comes standard with 2 MB of cache RAM, upgradable to 8 MB. The ADA supports standard multidrive configurations: mirroring, striping, and spanning.

There is a third drive connector on the controller for attaching a parity drive. In the current version of the PowerPro Array, the parity drive connector is unused. ALR expects software soon that will take advantage of this parity connector to provide data guarding. The PowerPro Array's utility software includes a disk-caching program as well as NetWare drivers for the ADA system.

We tested a two-processor 33-MHz machine. Each processor sits on its own card. The processor cards are strapped to each other via two ribbon cables, forming a fast internal bus. Each processor card can accommodate between 64 and 512 KB of cache memory, as well as an optional Weitek WTL4167 math coprocessor.

For system memory, the motherboard RAM starts at either 5 or 17 MB, depending on which version of the PowerPro Array you purchase. Beyond that, you can take the system up to a whopping 49 MB. Of course, the standard amenities are all there. You'll find one parallel port, two serial ports, and a mouse port all integrated on the motherboard. A Super VGA card also comes with the PowerPro Array.

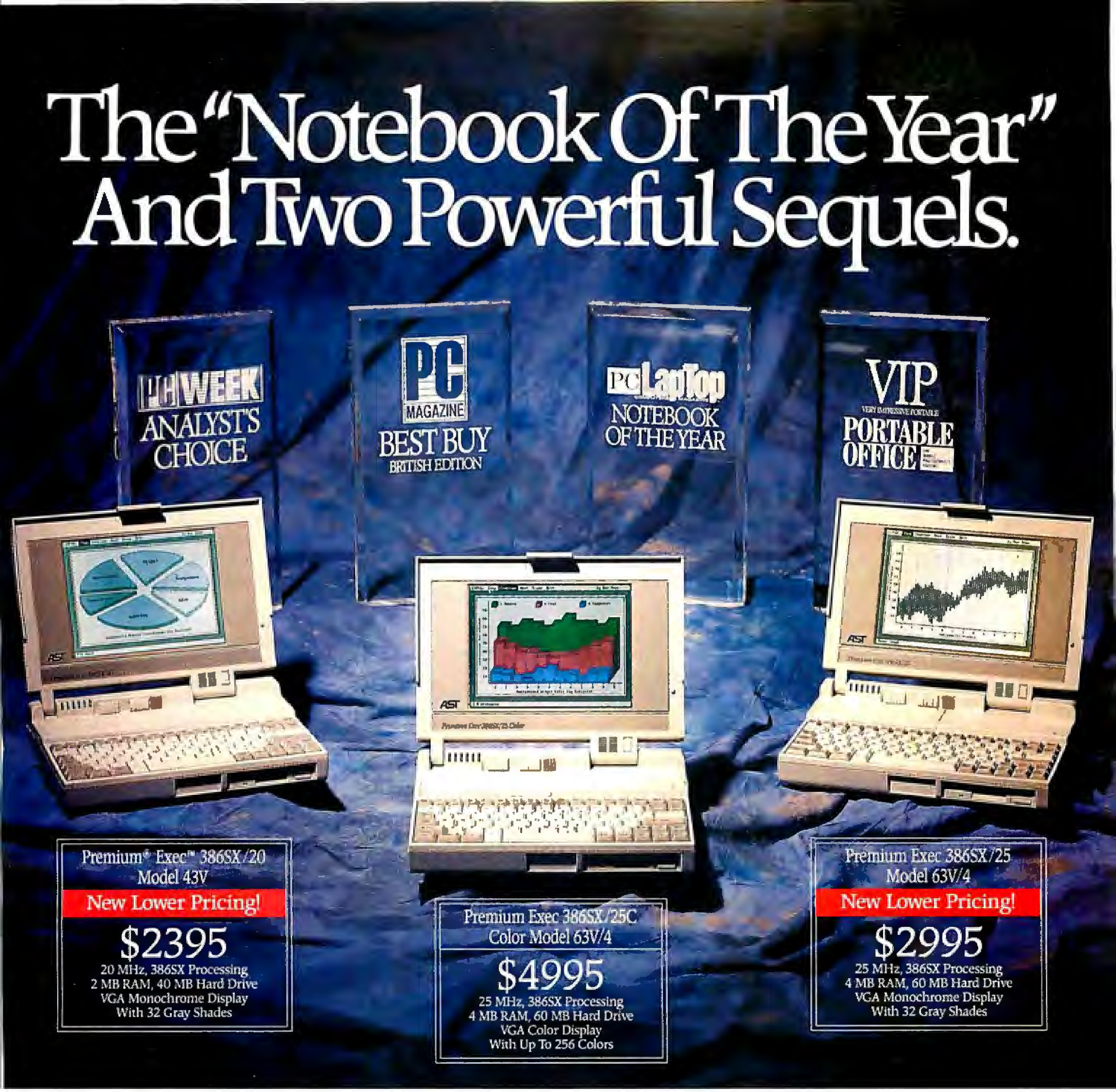
Unfortunately, the PowerPro Array chalked up the lowest scores in this fast crowd on both the Unix and NetWare tests. Worse, one of our test machines died in the middle of the benchmarking process. To ALR's credit, it was promptly replaced. We should also mention that the PowerPro's Unix drivers were preliminary, so a later release may yield better performance figures. Given the test results, however, you could probably do better for now with one of the other machines.

The Systempro has been a familiar sight around the BYTE LAN Lab, and we have been working with it for some time, using it to investigate the mysteries of NetWare 386. The Systempro we tested for this review never left us wanting. For removable storage, the Systempro has two floppy drives and a 525-MB tape drive that are all mounted in three upper front bays that constitute Compaq's QuickAccess area. The hard drives are all internal, tucked away along the bottom of the machine. Two serial ports, a parallel port, and a mouse port are all integrated on the motherboard.

The Systempro can accept two processor boards that plug into special slots on the motherboard. The CPUs can be 386s or 486s running at 33 MHz (the system we tested used two 486s). If you choose a 386-based system, you can boost its numerical calculations with either a 387 or a Weitek WTL3167 coprocessor. Although the 486 has an 8-KB internal cache, the Systempro's processor boards extend that with an additional 512 KB of cache for each 486 processor.

The Systempro's memory is also carried on dedicated boards that plug into proprietary slots. These boards come in two versions distinguished by the amount of memory they can ultimately hold. The four-socket board is expandable to 64 MB of RAM, and the six-socket board can carry up to 96 MB of RAM. You can take a Systempro up to a total of 256 MB.

continued

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**Circle 1 on Inquiry Card (RESELLERS: 19).**

# Multiple Processors and MPX

The Santa Cruz Operation's MPX is a multiprocessor extension for SCO Unix System V/386 release 3.2. This extension adds multiprocessor capabilities to the SCO Unix kernel. Since the modifications are just to the kernel, all programs already supported by SCO Unix can continue to run unmodified. MPX is modular, so you can reinstall MPX for each processor in your system (up to 30 CPUs).

We ran under MPX when testing the Compaq Systempro and the Advanced Logic Research PowerPro Array systems on our Unix LAN benchmarks. Those benchmarks are file oriented and gave little advantage to these multiprocessor machines. Still, you can expect enhanced performance for more processor-intensive tasks on your network.

MPX assigns processors to tasks in a "load-balanced" fashion. When the system schedules a task for execution, it places that task in a single queue that all processors access. The next available processor pulls from this queue the next-highest-priority task and begins executing it. Hence, all processors share equally in the work.

Systems that execute MPX are constructed with a shared-memory architecture. All processors have equal access to a common pool of system memory. The only private memory that a processor has is its cache; it's up to hardware in the computer to make certain that each processor's cache is synchronized with main memory. From a software point of view, however, a single piece of code running on multiple processors may include accesses to common memory (this can be especially true of device drivers). Software synchronization must be in place to ensure that only one instance of the code has access to the common memory at a given time. MPX includes special locking routines in the kernel that provide such synchronization. Most of the standard device drivers have been modified in MPX to run on multiple processors. The system recognizes unmodified drivers and forces them to run on a default processor—usually the first processor in the system—thus allowing non-MPX code to run unmodified on an MPX system.

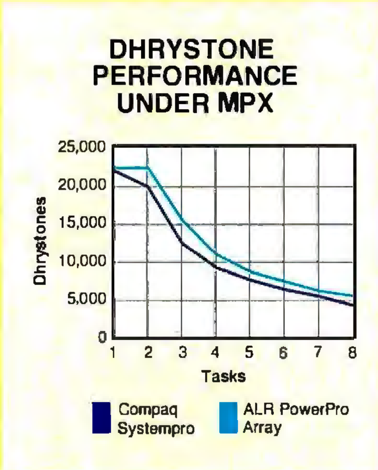


**Figure A:** *Dhrystone performance for one through eight tasks. The PowerPro Array shows no performance degradation between one and two tasks running on its dual processors; the Systempro reveals some additional overhead.*

MPX includes a handy monitoring utility called mpstat. This program lets you watch the utilization of all the processors in your system, continuously updating a display of bar graphs that show percentages of system kernel code, user code, and idle time for each processor.

We tested the effectiveness of MPX on two of our file servers using the multiprocessor Unix benchmarks developed in BYTE's Unix Lab (see figure A). This benchmark consists of a parent task and a variable number of child tasks. Each child task executes 200,000 iterations of the well-known Dhrystone benchmark. The parent task communicates with its children through a shared memory segment. The parent uses this segment both as a starting signal, so that all the children begin execution simultaneously, and as a reporting area, where each child reports its Dhrystone rating.

We ran the tests for one child task and then repeated the process, adding one additional task up to eight. The difference between executing one child task and two children was minimal on the Systempro and nonexistent on the PowerPro Array. Engineers at Compaq explained that there is a slight overhead in the Systempro's management of its second processor.

---

This might sound like a lot of boards taking up slot space. Actually, it's not; six EISA slots are available even after you've counted the hard drive controller.

The Systempro uses Compaq's Flex/MP bus architecture, an extension of the company's Flex architecture. This arrangement separates the I/O bus (i.e., the EISA bus) from the high-speed bus that connects the Systempro's processors to main memory. Flex/MP extends the bus structure to permit multiple processors on the high-speed CPU/memory bus. Each processor has access to common memory. Special hardware handles the transfer of data between the EISA bus and the CPU/memory bus.

You can start with 240 MB of hard disk storage and work your system all the way up to 4.08 gigabytes. The system we tested included four 210-MB hard drives attached to Compaq's IDA controller, which provides fault-tolerance and performance features that you can mix to match your specific needs. A single IDA controller provides four connectors, so mirroring is easily supported. Data guarding is also available; the IDA controller uses one drive out of four to carry parity information. The IDA controller we tested also had what Compaq calls "auto reliability monitoring," in which the controller runs background hardware diagnostics. The controller searches drives for bad sectors and automatically remaps them to usable sectors, all behind the back of the host CPU.

If you're running an IDA controller on a NetWare 386 file server, you can also take advantage of Compaq's IDA status utility. This is a small client-server application that lets you monitor the status of the IDA controller from any workstation on the network. The server side is a NetWare loadable module (NLM), while

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the client side is a DOS executable; the two communicate via IPX. From within the status utility, you can view a controller's type, its physical slot location, information about the drive configuration, and more. The status utility also displays historical information about each drive's performance. This lets you track the activity of controllers and drives and spot potential problems.

The Systempro continues Compaq's heritage of solid hardware and good performance. Although we had hardware problems with some of the other file servers, the Systempro never failed us. Cards were plugged and unplugged, and we installed and reinstalled Unix and NetWare 386 several times; the Systempro withstood it all. Its weak spot is price: $28,276 for our test system.

The company that has made a decent living challenging Compaq has now introduced its rival to the Systempro. The EISA-based Dell 433SE packs a 486 microprocessor running at 33 MHz and the newly released Dell Drive Array (DDA). The system shipped to BYTE (with 16 MB of memory, four 200-MB IDE hard drives, and an optional tape drive) sells for $12,998, a bargain in this market.

The system was obviously designed with expandability in mind. Two serial ports, a parallel port, a PS/2 mouse port, and a VGA controller (with 1 MB of video memory) are supported on the system board, leaving plenty of empty expansion slots for other purposes. The two DDA controllers occupied a couple of EISA slots on our system, but six slots were left free. Six of the eight slots support bus-mastering cards. The system also stocks 11 drive bays. Our system filled six of these: four with the DDA and two with a floppy drive and a tape drive.

The 433SE can hold plenty of memory: up to 128 MB. The eight SIMM slots accept 1-, 2-, 4-, 8-, or 16-MB modules. You can also upgrade the processor itself by replacing the proprietary daughterboard on which it resides. And you can upgrade the BIOS from floppy disk, thanks to its flash ROM design. A 128-KB external cache expands the 8-KB built-in cache of the 486.

The DDA provides a nice mix of features for compatibility, performance, and data redundancy. The controller is an Intel 960 RISC processor running at 16 MHz. The standard 256 KB of static RAM (SRAM) on the controller delivers an adequate disk cache and a queue for data requests. The DDA provides a couple of standard emulations to ensure software compatibility. It can emulate the task-file register interface of an ST506 controller for standard DOS applications. This interface provides a compatibility hook but does not take advantage of bus mastering.

For bus mastering, the DDA offers an Adaptec 1540 SCSI emulation. Many operating systems, including most Unix-based systems, NetWare, and OS/2, already have Adaptec 1540 drivers available. The Adaptec interface supports bus mastering, concurrency, and request queuing. The DDA can control up to 10 200-MB drives or four 650-MB drives.

You can set up the entire disk array as a single volume directly from the EISA configuration disk. However, the array runs faster under NetWare when you configure it as four independent drives. Evidently, the striping is more efficient when it is handled by NetWare than when it is handled by Dell's driver. The drive array supports striping or simultaneous seeks. In a multiuser environment, simultaneous seeks allow you to let you access different data from different disks at the same time. In addition, you can set up a parity drive so that lost data can be restored on the fly.

The 433SE performed well under NetWare, but we were unable to run our suite of Unix tests. Dell's System V release 4 implementation of Unix does not yet support any 32-bit EISA LAN adapters. Since all the other systems used the Mylex 32-bit EISA card, we thought it would be unfair to test the 433SE with a slower network interface.

Tangent has added a formidable competitor to the file-server market with its 486-based Multi-Server. The processor runs at 33 MHz and takes advantage of a standard 256-KB SRAM cache. Although the Multi-Server can use only a single CPU, it addresses the I/O bottleneck issue elegantly with the powerful combination of EISA bus mastering and a SCSI-2 interface. The unit we received carried 16 MB of memory, four 165-MB SCSI drives, two SCSI controllers, and a price tag of $14,500.

In the Multi-Server's tower design, the port connections run across the top of the unit, and the case swings open for handy access to the internal components. Three expansion slots are filled by the SCSI adapters and the standard monochrome video adapter, leaving four EISA slots and one ISA slot open. The monochrome adapter includes a parallel port. There's plenty of room for drive expansion. Even though our unit was stuffed with four hard and two floppy drives, four drive bays were still available.

The Multi-Server supports up to 64 MB of system memory. There are 16 SIMM slots, but you must load them four at a time. All this hardware is juiced by


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# BYTE's LAN Benchmarks

RAYMOND GA CÔTÉ AND RICK GREHAN

When we embarked on this Solutions Focus, we knew we'd need a new set of benchmarks to help us through, and we commissioned the considerable talents of BYTE columnist and network expert Barry Nance. Barry set out to build network benchmarks that we could use for testing the file servers in this review and that we could call on to facilitate our testing of networks and network components in the future.

The goal of the LAN benchmarks is to create tests that can isolate the performance of the various components of a network. Although we use them this month to gauge the performance of file servers, it's likely that we'll use these tests in the future to measure network interface cards, bridges and routers, and other network hardware.

BYTE's LAN benchmarks were first written for NetWare 386 and rapidly ported to SCO Unix by the BYTE Lab. The NetWare 386 version consists of two programs: a server NetWare loadable module and one or more client programs. Barry built the server NLM using Novell's NetWare NLM development system, a complete and professional development environment wrapped around Watcom's C386 compiler.

The server NLM acts as a focal point, while the client programs, executing on network workstations, simulate multiple users passing requests to the server. You can control the entire process from one of the workstations; the program is written so that the first client program to be executed anywhere on the network becomes a kind of master console. All the other clients become slaves that perform whatever tasks the control console commands.

The control console provides a continuously updated display of activity as the slaves report in. Quantities displayed include number of iterations; high, low, and average time for each iteration; and average throughputs. These quantities are displayed for each workstation. You also have the option of generating a permanent record of the test by sending the results to a printer or a file.

Our benchmarks are wrapped inside an interface built with the Mewel library from Magma Software Systems. Mewel gives the benchmarks a character-based GUI that maps directly to a Windows 3.0 model; this meant considerable time saved in coding the interface.

## NetWare to Unix

The Unix version of the benchmarks was designed to be as similar to its NetWare cousin as possible. Of course, where the NetWare benchmarks use IPX protocol as the means of communication, the Unix version uses TCP/IP. Also, there is no equivalent to the NLM in the Unix world, so the server task is simply an independent process that runs on the server. Client tasks are processes running on workstations connected to the Unix network. Unlike our NetWare test, which has a single NLM program communicating with all the clients, the Unix benchmark server forks a separate task for each client.

In this iteration of our benchmarks, the client stations were running FTP Software's PC/TCP. PC/TCP provides TCP/IP access from a DOS machine. This allowed us to simply install DOS on all our workstations and run either the NetWare or the Unix benchmarks without having to switch the machines from one operating system to the other. We ported the entire benchmark from PC/TCP under DOS to SCO Unix without any code changes.

Although the basic internals of the benchmarks are the same for NetWare and Unix, differences in these operating systems necessarily affect the code. One major difference is that NetWare 386 is a cooperative multitasking system, while Unix is preemptive. The server NLM must regularly return control to NetWare so that other tasks running on the server machine are given CPU time. The Unix server needn't worry about this.

## Basic Measurements

The LAN benchmarks allow you to run two basic tests: message passing and file I/O. Tests can be mixed and matched according to the type of load you want to place on your network. Changing the number of client workstations is the primary method for increasing or decreasing network load. You can have up to 100 users on the network under test.

In the message-passing test, one or more of the slave stations transmits IPX data packets to the server NLM. The server responds with an acknowledgment packet. The benchmark times this transaction repeatedly to yield an overall throughput number. You can specify the number of packets transmitted per test iteration as well as the packet size.

The message-passing tests can reveal the throughput of the physical network itself: its cables, interface cards, and bridges. For example, you may suspect that a network card on a specific workstation is unacceptably slow. You can run the message-passing test on that workstation and then swap the card out and run the test again to verify your hypothesis.

In the file I/O tests, workstations open and read or write to several files on the server. You can specify the number of files, the size of each chunk that is read or written, and whether the I/O is sequential or random. The file I/O tests read and write in a 3-to-1 ratio. The ratio reflects the mix of read and write operations you'd expect from a typical application.

---

an ample 450-watt power supply. We had a small complaint about the tower design: The power supply sits directly under the expansion slots, so you must be extra careful about dropping screws.

The Multi-Server can accommodate two or four SCSI host adapters, potentially supporting up to 28 hard drives. The unit that we tested came with four drives and two adapters; each of them sporting an 80186 processor for intelligent I/O control. Controllers support disk mirroring for fault tolerance, and data striping for optimum performance. The SCSI-2 interface also enhances performance.

The EISA configuration parameters needed to install Unix were a bit tricky, but Tangent technical support guided us through the procedure without a hitch. If you plan to run Unix on the Multi-Server, keep in mind that the booted drive cannot be striped. So, if you have four drives in your array, only three of them

If you specify sequential access, the workstation simply opens each file and reads and writes its way from beginning to end. Specifying random I/O causes the workstation to seek to a randomly selected offset in each file before reading or writing. The benchmark chooses the offsets from a repeatable, pseudorandom sequence. Thus, as you test different systems, each is exercised with the same sequence of offsets.

Workstations under NetWare create, read, and write files directly on the server. Under Unix, each client communicates with a server fork that reads and writes files on behalf of its client.

### Other Tests

Beyond the message-passing and file-access meat of the LAN benchmarks are other features that help to isolate the performance of specific network components. You can request that the server NLM perform file I/O locally. Running this test can give you an idea of the server's disk I/O throughput independent of network activity. Running this test while workstations are active with other benchmark tests can reveal how the server's disk I/O affects network performance.

You can also execute a server CPU test from one of the workstations. This test consumes server CPU cycles using a tight loop wrapped around some arithmetic operations. If you suspect that bottlenecks on your server are due to an overtaxed CPU, you can run a series of file I/O tests with and without CPU load to isolate the fault.

The LAN benchmarks are available in source code or executable form through BIX or directly from BYTE (see page 5 for details). We encourage you to use the LAN benchmarks to test your own networks, and we welcome any suggestions or recommendations for improving these tests.

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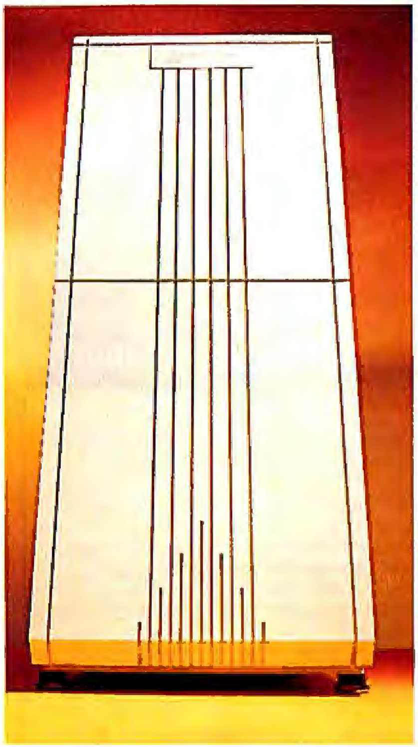
will be available for striping, unless you boot from a floppy drive.

The Multi-Server excelled under Unix. We had to configure a floppy disk as the boot device, but the software automated the process. Tangent's driver implementation under Unix is well done. The striping did its job, resulting in excellent file I/O performance. With NetWare handling the striping chores, the numbers were not quite as good, but the Multi-Server should have no problem meeting the demands of any large network. And Tangent is now shipping a burst-mode drive controller, which should deliver even greater performance.



The PowerFrame is a single- or dual-processor machine. The processor boards plug into PowerBus slots, special connectors on the motherboard that hook the processors to a high-speed internal bus. Tricord Systems supplies half-length or full-length processor boards. The half-length version supports a 25-MHz 486 and no additional cache memory beyond the 8 KB of cache on the 486 itself. However, the full-length version carries 256 KB of second-level cache memory. The full-length processor board also comes in a 33-MHz version. Our test system had a single 33-MHz processor with the additional 256-KB cache memory and 1.54 gigabytes of disk storage. It's priced at a stiff $37,990.

Inside the PowerFrame, you'll also find a standard EISA bus that can accept up to seven EISA or ISA cards. Near the top of the case on the motherboard is a lone 8-bit XT bus connector. In the system we tested, the 8-bit connector held a Paradise VGA card.

The high-speed internal bus is Tricord's proprietary 132-MBps PowerBus. The PowerBus joins the host processors, memory, and the drive controllers—the IIOPs (intelligent I/O processors).

Tricord's IIOP is a hot-rodded dual-SCSI drive controller. Each IIOP carries its own 386 running at 12.5 MHz that manages two independent SCSI channels, one of which can be configured as SCSI-2. Devoted to each channel is a VLSI SCSI controller. All this horsepower yields a throughput rate of 12.5 MBps via the IIOP. Each IIOP communicates with the host 486 processor through a 4-KB bank of dual-ported memory. This "I/O request queue" sits high in the address space, just 33 MB under the 4-gigabyte address ceiling.

The 386 processor on an IIOP does more than simply manage parallel transfers along the SCSI buses. Write requests to an IIOP are queued and sorted so that they can be performed in elevator fashion, thus reducing drive head movement. Additionally, each IIOP can be programmed to perform scatter/gather I/O, a mechanism often used in demand-paging virtual memory systems (e.g., Unix) where disk data is transferred to or from disjoint memory locations. SCO Unix supports scatter/gather for the IIOP.

You can run the PowerFrame with one or two IIOP boards installed. The system we tested was fully loaded with two IIOP controllers, each connected to a pair of 385-MB Fujitsu hard drives. Since each drive was on its own independent SCSI channel, the PowerFrame could service four read/write requests simultaneously. Ironically, the IIOP does not provide striping directly; Tricord preferred to leave that to the operating system. Tricord is beta-testing the software to support this feature, and it may be available by the time you read this.

The PowerFrame raced through our NetWare tests, easily besting the other four systems. NetWare handled the disk striping, as it did when we tested Dell's 433SE. However, we should note that the IIOP design does not support data guarding, so you'll buy the additional performance at some cost in data security.

The IIOP drivers for SCO Unix came as part of the SCO Unix package bundled by Tricord, so Unix configuration was relatively uncomplicated. However, lack of software support for striping or scatter/gather led to disappointingly mediocre results under SCO Unix.

### Top Servers

Maybe you're a power-hungry network manager with a serious throughput problem and you've decided that controller duplexing and parallel drive transfers can improve that throughput. Or maybe you have a few jitters about what might happen if your server's disk system takes a nosedive, and you've decided that controller duplexing with mirroring can provide the kind of safety net that will let you sleep at night. The same system that is a hot rod for one installation can, with a little software black magic, become a fault-tolerant workhorse in another.

If you're on a large Novell network and you want fast response at any cost, then a Tricord PowerFrame is unquestionably your best choice. Its IIOP architecture delivers dramatic disk performance, and the system is otherwise fast and well supported.

If you're on a smaller network and don't have quite the appetite for speed or quite the purse that the PowerFrame's price tag demands, Dell's 433SE is an excellent alternative. The system turned in solid benchmark results, and it supports several levels of performance and reliability optimization.

For a Unix network, we'd choose Tangent's Multi-Server for overall performance and price, but with a few reservations. Specifically, our tests exercised the machines as file servers. More processing-oriented Unix applications will likely fare better on one of the multiprocessor machines running MPX. As always, the applications that you run at your installation are your best benchmarks. ■

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**Circle 1308 on Inquiry Card.**

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**Circle 1309 on Inquiry Card.**

**Dell Computer Corp.**
(433SE)
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**Circle 1310 on Inquiry Card.**

**Tangent Computer, Inc.**
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fax: (415) 342-9380
**Circle 1311 on Inquiry Card.**

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# SOFTWARE

**They manage files and disks, they customize workspaces, they take the drudgery out of maintenance: Praise be utility programs!**

**STAN WSZOLA, TOM THOMPSON, AND D. BARKER**

Earl Weaver was the winningest baseball manager of his time because he knew how to use utility players. If the Orioles needed a long fly ball to bring a runner home from third, Weaver knew which man to send to the plate. On the bench, he always had a collection of specialists: a guy who could hit line drives to right, an expert at bunting, and a player who excelled at late-inning defense. Like Weaver, personal computer users have a roster of specialists they can call on to handle the mundane but critical chores of managing files and the space where they live: utility packages.

Over the years, as operating systems have acquired a more extensive array of features—even old MS-DOS now has a shell and a tool for undeleting files—utilities also have become more capable. Venerable packages such as Central Point Software's PC Tools have kept up with the times largely by periodically expanding their repertoire of functions. Many newer packages, on the other hand, have stretched the traditional meaning of utility programs to include products that offer a customizable work environment. And with the popularization of windows, mice, and icons, utility packages have changed their look and feel, too.

Our roundup of utility packages reflects this diversity of approaches. For DOS utilities, we look at three mainstays of the genre, Norton Utilities 6.01, PC Tools 7.1, and XTree Gold 2.5. We also look at Mace Utilities and at two DOS shell programs, Wonder Plus 3.51 and WindowDOS 3. Our choices for Windows 3.0 utilities include The Norton Desktop for Windows; hDC Computer Corp.'s collection of programs, Power Launcher, FileApps, and FirstApps; Metz Software's File F/X, a DOS-like replacement for Windows' File Manager; and WinTools, a Mac-like replacement for the Program Manager. In the Macintosh arena, we examine one package for the technically adept, Symantec Utilities for the Macintosh (SUM) II and another package, The Norton Utilities 1.1 for the Macintosh (NUM), for those less technically inclined.

Using these packages reminds us of playing with a set of nested dolls: You remove the top of one doll and find another inside; remove that doll's top and find yet another doll. In fact, these utility packages for DOS, Windows, and the Macintosh are so rich in features that you just might have to read the manuals to uncover them all. (To view the packages' most important capabilities, see the tables "Disk Managers: A Comparison of Tools" and "GUI File Managers: Main Features.")

# In A Supporting Role


**BYTE ACTION SUMMARY**

**■ WHAT THESE UTILITY PROGRAMS DO**
Utilities handle the essential tasks of managing megabytes of files and the hard disks where they live. Their capabilities range from simple backups to disk doctoring and from basic file operations to automated file launching. A new breed of utilities aims to extend the graphical file management functions of Windows and the Macintosh.

**■ WHAT YOU'LL LIKE**
You've got hundreds, thousands of files, and you've got to keep track of them. You've got a hard disk you rely on. Utilities make it easier to keep your electronic office organized and protected, while letting you customize your system to match your work habits.

**■ WHAT YOU'LL DISLIKE**
Some utility packages might not work the way you do. A tool that is too arcane or requires too much learning time is less likely to be used. Under Windows on anything less than a 386, some of these packages make routine operations just too slow.

**■ RECOMMENDATIONS**
The Norton Utilities and The Norton Desktop for Windows are sure bets for most users looking for tools to enhance their systems. On the Mac, the Now Utilities provides a whole set of useful tricks. But our bottom-line advice is to decide which functions you'll use the most, then find the program that handles them best. Get a demo. The usefulness of any tool depends on how it feels to you.


## DOS UTILITIES

When DOS users look to the bench for help with file and disk management, they can choose from a variety of utility players. Some are comprehensive packages that handle everything from file operations to rescue operations; others offer a more modest collection of basic tools. With all the time and effort locked up in the files on your storage platter, you can't afford to be without at least one of these DOS toolkits.


## THE NORTON UTILITIES 6.01

Besides making a poster boy of Peter Norton, The Norton Utilities has made DOS a more comfortable environment from which to manipulate files and manage a hard disk. Version 6.01 follows in the footsteps of previous editions, offering fine-tuned versions of many old standbys from Norton 5.0. One welcome change is that Norton's utility programs now can run safely under DOS 5.0's new task switcher. Norton 6.01 also contains several new utilities and significant upgrades of a few old ones, plus a replacement for COMMAND.COM called NDOS (an adaptation of JP Software's 4DOS). NDOS includes such features as command recall, command aliasing, and a means of associating file extensions with applications so that the command processor executes the appropriate application when you enter a filename with a related extension.

NDOS can save 20 KB to 30 KB of memory if used in place of the COMMAND.COM that comes with DOS 4.x and earlier, but it doesn't use less memory than DOS 5.0's COMMAND.COM. (It does, however, provide the capabilities of DOS 5.0's DOSKEY utility.) All told, you'l lneed about 2.5 MB of hard disk space to install the full Norton package. The program files are installed in a proprietary compressed format that slows loading but saves disk space; you can expand one or more programs to improve loading speed.

The Norton Utilities may have changed hands (it now is marketed and supported by Symantec Corp.), but it still is the package of choice for file recovery, and its disk and sector editor is second to none in power and flexibility. You can access a disk's diagnostic cylinder and split the screen, working in two sectors at the same time. When you edit a partition table, the program will do the necessary calculations for you, and a new memory-display option lets you copy conventional memory blocks to a file or sector. The improved Disk Editor also includes the ability to print the information being displayed, a great help when you're editing a corrupted disk. Equally important, the Disk Editor starts out working in a read-only mode to prevent you from accidentally corrupting data.

Norton's Image program saves FAT and directory data for later use in undeleting files, placing the data in a hidden TRASHCAN subdirectory on the disk. You can specify which drives to protect and how long to save deleted files. Image is faster than PC Tools' Mirror (Microsoft includes a version of the latter program in DOS 5.0). If you prefer, Norton can use Mirror's data instead of Image's.

The package also includes Filefix, a specialized data-recovery tool that diagnoses and repairs damage to dBase, Lotus 1-2-3 (versions 1A and 2), and Symphony files. The procedures for recovering data from a damaged file are highly automated; if problems crop up during this or any other procedure, context-sensitive help is available. Typing a command and pressing F1 pops up a window with a description of the selected command. Pressing F1 at a blank line brings up an index of all DOS and NDOS commands. The help screens are not well arranged, however, and the help screen for the "memory dump" feature of the Disk Editor simply reads, "This dumps memory."

As a concession to Windows users, Symantec includes a complete set of icons for use with The Norton Utilities' component programs. You must install these icons manually, however, because Windows' Setup Applications function does not recognize them.

The Norton Utilities 6.01 offers powerful features and fills many of the gaps that remain in DOS 5.0. Most of the present improvements are evolutionary: The utilities still retain the same look and feel of those in Version 5.0, but almost all have new options. Performance—among the best of DOS utility packages—and the program's ease of learning are key reasons why The Norton Utilities 6.01 is a must-have for any computer user whose system runs DOS.

# PC TOOLS 7.1

Central Point Software bills PC Tools as the utility package that can do it all. The latest version has programs for everything from running a DOS shell to conducting a remote-control communications session. PC Tools runs as a stand-alone DOS package, but it also works well with Windows 3.0. It can create its own Windows workgroup and has separate icons for each component in the group.

The installation process is easier than it used to be; on-screen prompts tell you what you need to know and are simple to follow. You may install all or part of the package. A full installation requires 7.5 MB of hard disk space, even though much of the package is compressed with the bundled PKLite utility.

The package comprises seven modules: PC Shell, a set of DOS utilities that functions as a shell; Desktop Manager, a note pad, outliner, calculator, terminal program, and calendar rolled into one; CP Backup, a backup-and-restore utility for hard disks; PC Secure, a file-security program; Compress, a misnamed disk defragmenting program; Diskfix, a disk- and file-repair utility; and Commute, a remote-control communications program and file transfer utility.

CP Backup remains one of the most straightforward backup programs. You can easily set up the program by selecting drives and media types with the mouse and then identifying which drive you want to back up. The program accepts a variety of removable drive media (including tape drives and Bernoulli boxes) and lets you choose exactly which files and subdirectories to back up. The package's optional compression feature lets you choose between doing a quick backup or conserving valuable disk space.

PC Tools' Mirror utility can be a lifesaver. It makes a backup copy of the root directory and the file allocation table whenever it runs, storing two copies of the directory and FAT. If your directory is damaged, Mirror's companion program, Rebuild, can reconstruct the directory using the information that Mirror saved the last time you ran the program. Rebuild also can rebuild your partition table, boot sector, and CMOS information. To protect yourself in the event that any of these areas becomes unreadable, Central Point suggests that you follow standard installation procedures for putting Mirror in your AUTOEXEC.BAT file so that it executes every time you boot up.

Compress, the PC Tools disk-optimization utility, is simpler than previous versions of the program. It looks and works like many other optimizers, displaying a series of colored blocks to graphically represent how files are distributed on the selected disk.

The newest addition to the package, Commute, lets you connect two computers using modems and a telephone line, a null modem cable, or a network. You must configure Commute on both machines, selecting the same connection method and designating one system as the master and the other as the remote machine. If you select a network connection, you can use your network login names; otherwise, you specify the COM port used and the type of modem. The Commute connection then becomes transparent, and the controlling computer can send or receive files, run programs, or perform software maintenance on the remote computer. Security features let you restrict access to the controlling or remote computer. Commute cannot transmit itself to a remote computer as LapLink Pro does, but it is a handy utility.

Despite its plethora of features, PC Tools is easy to use, and like The Norton Utilities, it works well under Windows 3.0. The package has too many manuals and lacks a central index, but the program's hypertext-like on-screen help file largely offsets this shortcoming. At only $179, PC Tools is one of the great bargains in PC software.

# WINDOWDOS 3

As its name suggests, WindowDOS is a memory-resident shell that gives you a

# Disk Managers: A Comparison

*Finding the right file and disk management program begins with analyzing your needs and comparing them against the features provided by the major products on the market. This table provides a good starting point for your search.*

| **Product** | **The Norton Utilities 6.01** | **PC Tools 7.1** | **WindowDOS 3** | **Wonder Plus 3.51** | **Mace Utilities 1990.1** |
|---|---|---|---|---|---|
| **Company** | **Symantec Corp.** | **Central Point Software** | **WindowDOS Assoc.** | **Bourbaki, Inc.** | **Fifth Generation Systems** |
| **Price** | $179 | $179 | $69.95 | $95 | $149 |
| **Features** | | | | | |
| Back up/restore disk | ○ | ● | ○ | ○ | ○ |
| Caching | ● | ● | ○ | ○ | ● |
| Change disk directory | ● | ● | ● | ● | ○ |
| Change file attributes | ● | ● | ● | ● | ○ |
| Change file's date/time | ● | ● | ○ | ○ | ○ |
| Compress files | ○ | ○ | ○ | ○ | ○ |
| Copy sector/FAT/boot file | ○ | ● | ○ | ○ | ● |
| Delayed file erase | ○ | ● | ○ | ○ | ○ |
| Disk test | ● | ● | ○ | ○ | ● |
| Display directory | ● | ● | ● | ● | ● |
| Display disk information | ● | ● | ● | ● | ○ |
| Display file information | ● | ● | ● | ● | ○ |
| Display file size | ● | ● | ● | ● | ○ |
| Display system information | ● | ● | ● | ● | ● |
| Display volume label | ● | ● | ● | ○ | ○ |
| Encrypt/decrypt file | ○ | ● | ○ | ○ | ○ |
| Find file | ● | ● | ● | ● | ● |
| Format hard disk | ● | ● | ○ | ○ | ● |
| Format recovery | ● | ● | ○ | ○ | ● |
| Network compatibility | ● | ● | ○ | ● | ○ |
| Park heads | ○ | ● | ○ | ○ | ● |
| File locking | ○ | ● | ● | ● | ○ |
| Quick undelete | ● | ○ | ○ | ○ | ○ |
| Safe format | ● | ● | ○ | ○ | ● |
| Sector editor | ● | ● | ○ | ○ | ● |
| Search for text | ● | ● | ● | ● | ○ |
| Sort directory | ● | ● | ● | ● | ● |
| Undelete file | ● | ● | ○ | ○ | ● |
| Unfragment disk | ● | ● | ○ | ○ | ● |
| Virus detection | ○ | ● | ○ | ○ | ○ |
| Virus vaccine | ○ | ● | ○ | ○ | ● |
| Windows compatibility | ● | ● | ● | ● | ● |
| Wipe disk | ● | ○ | ○ | ○ | ○ |
| Wipe file | ● | ● | ○ | ○ | ● |

window on DOS. It lets you create, copy, find, delete, and manipulate individual files or groups of files; you also can use it to format floppy disks and set your system's real-time clock.

You may run WindowDOS as a TSR program or as a stand-alone application. Used as a TSR under DOS, it pops up within another application, but we couldn't get it to work as a TSR under Windows. As a stand-alone program under Windows, it works just as any other standard DOS application does.

Installation involves copying all the files on the program disk into a WD3 subdirectory. You can configure the program from a menu; selections include defining the hot key that invokes the TSR version, establishing a password for file protection, defining the directory commands that control how files are dis-

# of Tools

○ = No ● = Yes N/A = No tApplicable

| XTree Gold 2.5<br>XTree Co.<br>$149 | The Norton Desktop for Windows<br>Symantec Corp.<br>$149 | The Norton Utilities 1.1 for the Macintosh<br>Symantec Corp.<br>$149.95 | Symantec Utilities for the Macintosh II 2.1<br>Symantec Corp.<br>$149.95 |
|---|---|---|---|
| ○ | ● | ○ | ● |
| ○ | ○ | ○ | ○ |
| ● | ● | ● | ● |
| ● | ● | ● | ● |
| ● | ○ | ● | ● |
| ● | ○ | ○ | ○ |
| ○ | ● | N/A | N/A |
| ○ | ● | ○ | ○ |
| ○ | ● | ● | ● |
| ● | ● | ● | ● |
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| ○ | ○ | ○ | ○ |
| ○ | ● | ● | ● |
| ○ | ● | N/A | N/A |
| ○ | ○ | ○ | ○ |
| ● | ● | ○ | ● |
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| ○ | ○ | ○ | ○ |
| ○ | ○ | ○ | ○ |
| ● | ● | N/A | N/A |
| ○ | ○ | ○ | ● |
| ● | ● | ○ | ● |

played, selecting file or tree displays, choosing screen colors, sending control codes to the printer, and setting up the built-in text editor.

WindowDOS is more limited than the other programs in this category. It cannot recover data; nor can it use a mouse, so you must type in commands. Although you can use the package with DOS 3.x and higher, it seems rather superfluous to use it with DOS 5.0, since the latter's built-in DOSSHELL system already performs many of the same functions.

## MACE UTILITIES 1990.1

Fifth Generation System's Mace Utilities is a no-frills package that concentrates on data recovery. The program opens with an easy-to-use menu bar that lists several submenus: Info/Edit, Performance, Format, Solutions, and Protection. The bar also includes an option called DOS, which acts as a shell for 10 DOS commands.

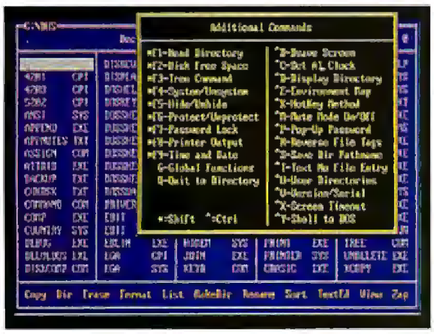
The Info/Edit submenu contains a utility called File Find for locating files, options for checking system statistics and monitoring hard disk fragmentation, and a sector editor named Muse. The latter lets you examine your hard disk in detail and is much more powerful than those in PC Tools and The Norton Utilities.

The Performance submenu lets you sort and move files, eliminate deleted directory entries, and unfragment your hard disk. Format's options are handy when you have to recover from mistakenly reformatting a floppy disk or hard disk. The Solutions option can perform more involved damage control, but it also can be dangerous in the wrong hands because you can easily make unintentional changes to your FAT or directory. Fortunately, Mace's installation program gives you the option of requiring a password before allowing anyone to use Muse.

Mace's Protection module offers two antivirus programs, a drive-parking routine, a file wiping function for completely erasing files, and an insurance function called RXBAK, which is similar to DOS 5.0's MIRROR command. RXBAK creates a backup of the boot sector and FAT, and can recover a deleted file, test a floppy or hard disk, and repair a file or disk. Two utilities, Textfix and Dbfix, let you restore damaged text and dBase files. The Remedy diagnostic utility can examine a disk drive and automatically relocate to safe sectors data stored in disk sectors that the program suspects are damaged. The option called Recovery System can examine and automatically repair the FAT, directories, boot records, and partition tables. As with Muse, you have the option of bailing out of a repair if you think the program will cause more trouble than it fixes. Recovery System can restore files that Norton's Disk Doctor can't handle.

You can run the individual utilities in this package from the DOS command line or from the Mace menu, but you'll have to use the keyboard. The menu interface does not support a mouse. And because the programs are not optimized for Windows, you must run them as non-Windows applications. A full installation requires 1.7 MB of disk space.

The Mace Utilities doesn't have the polish of The Norton Utilities nor the breadth of PC Tools. But Mace outshines both of them as a first-aid kit for data recovery.

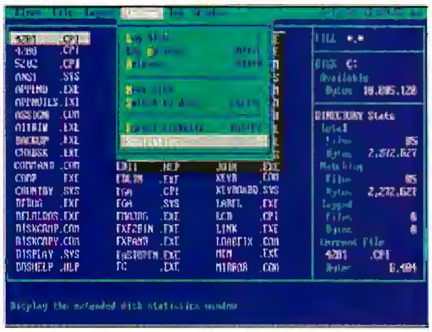


## WONDER PLUS 3.51

A DOS Shell program for hard disk management and custom menu creation, Wonder Plus 3.51 includes over 60 commands for manipulating files, displaying directories, and launching programs. The installation program starts by scanning your hard disks to find the applications you use. (While it does a good job of this, it isn't perfect; Wonder mistook my Quattro spreadsheet subdirectory for a Quicken subdirectory.) Wonder searches everything, even network drives. Fortunately, the next procedure lets you select which applications you want to include in your applications menu. Wonder displays the path and filename of each executable file and prompts you to accept or reject the application.

The initial program screen lists the files in the current directory of the default hard drive, the amount of space in use and the amount of space free on the chosen hard drive, the number of files and subdirectories, and a summary of memory in use and free in the conventional, EMS, and extended memory areas. But that is only the beginning. The program features a wide variety of what the manual refers to as "faces." You can reconfigure the display to show as many as 1 different combinations of trees, file directories, command prompts, and menus.

Although the package lacks a data recovery utility of any sort, it does have security features, password protection for menus, and a master password for the system. It's not as comprehensive a package as The Norton Utilities or PC Tools, but it is a good choice if you need a simple hard disk manager that is easily configured to work the way you want. Like the other DOS packages reviewed here, WindowDOS 3 can be run in Windows 3.0's DOS box.



## XTREE GOLD 2.5

XTree Gold works as a DOS file manager, providing a tree display of your directory structure on screen and making it easy to perform housekeeping activities such as moving, copying, and deleting files, searching for text in files, and so on. Version 2.5's file manager is more capable than those of previous versions; new features include pull-down menus that replace the hot keys for displaying file and disk management functions.

When you start the program, the initial screen shows a directory tree, a file listing for the highlighted directory, and windows showing the current file filter, space available on the logged drive, and other statistics about the current drive. From this screen, you can start any function with the press of a key or a single mouse click.

The program includes viewers for files created in over 30 applications; these viewers let you examine the contents of a file in its original format. Important additions this time around include viewers for WordPerfect, all versions of 1-2-3 up to release 3, WordStar, and Q&A. Another new feature is a facility that makes it easy to view, create, and decompress files that were compressed using the industry-standard ZIP format. You can even convert files compressed with PK.ARC to ZIP format and vice versa.

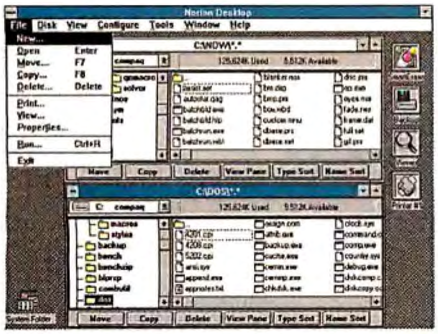
In the data recovery department, XTree Gold comes up short, limiting you to undeleting files using the `Oops!` command. When DOS deletes a file, the first character in its name is deleted. To help you retrieve deleted files, XTree simply displays the filename with a question mark as the first character. But when you undelete a file, you have to type its entire name, even though all but one character of that name is displayed on screen. This is not as convenient as using The Norton Utilities' Undelete feature, and you won't find a tool for recovering accidentally reformatted disks. Nor does XTree bundle a utility for testing disk sectors, even though a sector editor is included.

During installation, you can elect to have XTree Gold scan your hard disk and build an application menu from its own list of more than 700 applications. The menu uses a superset of the DOS batch language and includes an integrated editor. Pull-down menu commands include `Add`, `Move`, `Edit` and `Delete`.) You can launch an application by just positioning a cursor on its name and clicking a mouse button. If your application requires certain environment variables or command-line parameters, you can write a batch file and install it in the menu. XTree isn't as well endowed as PC Tools or Norton Utilities, but it does provide all the tools you need for file and disk management.

### UTILITIES FOR WINDOWS 3.0

Although Windows 3.0 has been the talk of the town, down in the streets some users have been calling for banishment of the dreaded File Manager. Next to mysterious "unrecoverable application errors," the File Manager has caused the most gnashing and wailing among Windows users. Third-party developers have responded with alternative programs that, for the most part, improve upon Windows' way of doing basic file and disk management.

Performance issues are critical with most Windows utilities, however, and many of these packages, while handy, are sluggish on midrange machines. If you've got a system with zip, you'll do fine, but users with run-of-the-mill 386SXs and hard drives will soon tire of staring at Windows' little hourglass icon. In fact, during testing the disk chugging grew tedious on some machines we used. Unless you're determined to work only in Windows, you'll fare better doing certain of these programs' operations outside the graphical environment. Norton's shell might not look that hot, but a good DOS utility can really cook with gas.



# THE NORTON DESKTOP FOR WINDOWS 1.0

Fancy younger cousin to the celebrated Norton Utilities, The Norton Desktop for Windows is a collection of 20 programs that make Windows 3.0 more versatile. The package features replacements for Windows' File Manager and Program Manager, file viewers and other disk management utilities, a screen saver, and an icon editor. The Norton Desktop combines the features of three DOS utility packages—The Norton Utilities, The Norton Commander, and The Norton Backup—and adds a few more. The package is easy to install, but you'll need to set aside 5.6 MB of hard disk space before you begin.

One of Norton Desktop's greatest strengths is that the package makes it easier to manipulate files and launch programs within Windows. You can move icons from a drive window to the desktop for launching, and you'll find equivalents of the Apple Macintosh's Trashcan icon and Wipe utility. Disaster-recovery utilities and a backup program and scheduler that operate in the background provide protection should your cleanup efforts go too far.

In The Norton Desktop, the essential data-recovery programs (an Unerase program for files and an Unformat program for disks) are called into action when you click on an icon. The Norton Disk Doctor for Windows can diagnose common disk problems and recommend solutions. Its Emergency Disk lets you repair, unformat, or optimize disks and recover erased files, even when you're not running Windows.

The Norton Desktop's File Manager displays a split window listing both a directory tree and its attendant files. The File Manager, although easy to use, takes longer to load and unload than the Windows desktop. You gain entry to the display by clicking on a group of disk-drive icons listed down the left side of the screen. If you want to view a number of drives or directories, you simply open the appropriate File Manager windows.

Double-clicking on any drive icon brings up the Drive Window display, which can include the Tree Pane directory listing, File Pane file listing, and View Pane file-contents viewer. Pane sizes are adjustable; you may save pane sizes and their positions, using them as default settings. From the package's Drive Window, you can select files singly or in groups, and click and drag the chosen files to other function icons. Dragging a group of files to the printer icon, for example, provides an efficient way of printing a group of files. You can delete files by dragging and dropping them onto the SmartErase icon, or copy or move files by dragging and dropping them into subdirectory folders in the Tree Pane (or by dropping them onto the proper drive icon). Another shortcut lets you highlight a file and choose a command from the File menu. When you select the options for copying or moving a file, a dialog box appears, and you can type in the path you want or select it from a subdirectory tree.

The Norton Viewer lets you quickly scan files from over 30 Windows and DOS applications, in their native formats. You simply drag the file icon to the Viewer icon or highlight a file and click the View button. Supported file formats include popular spreadsheet, word processor, database, and graphics files—among them Excel, Lotus 1-2-3, WordPerfect, Microsoft Word, AmiPro, dBase, and PCX, BMP, GIF and TIFF graphics files.

The Norton Desktop's built-in backup program includes many of the features found in the DOS version of The Norton Backup, including macros as well as incremental and differential backup capabilities. The program will keep track of how many incremental backups have been performed since the last full backup and perform backups according to a schedule that you establish. Because the software operates in the background, backups can be run without your supervision.

The Desktop's Scheduler utility enables you to launch a program or display messages one time or according to a schedule—hourly, daily, weekly, or monthly. The Quick Access utility lets you create graphical menuing systems. If, for instance, you arrange program icons into related groups, you can start the group's application by clicking on its icon. Groups may be nested, and icons within the group can be dragged onto the desktop for easier access.

Rounding out the package are several minor functions: System Information displays memory usage; Batch Builder provides over 100 Windows commands for creating batch files, dialog boxes, and menus to automate everyday tasks (the utility is based on the WinBatch shareware program); an icon editor and icon library; SuperFind, a text- and file-search utility; a screen saver; a scientific calculator; a file wiper; and Key Finder, a facility that shows you all the characters in each of the fonts available to you in Windows and displays them with the ASCII codes and keystrokes needed to insert them into your files.

The Desktop offers another layer of versatility, as well: You can customize its menus and keyboard shortcuts and add your own applications as menu items. The Configure module's main pull-down menu provides a broad range of user-selectable defaults, including password protection, preferences that control the appearance of the display, the options that require user confirmation before executing, shortcut keys, drive-icon selection and positioning, and choices that affect several of the Desktop's utilities.

The Norton Desktop for Windows improves the look and flexibility of Windows, especially where the File Manager, Task Manager, and user interface are concerned. If any utility package can be called fun to use, The Norton Desktop for Windows is it.

# WINDOWS SUPPLEMENTS FROM HDC

HDC Computer Corp. has built a business around trying to construct a better Windows program than Microsoft. The company sells a series of packages that themselves contain a series of utilities. hDC's latest addition to its collection of multifaceted packages is Power Launcher, a companion to the Program Manager. Using hDC's own superset of Windows commands, scripting tools, menu maker, and macro recorder, you can control your computing environment in

# GUI File Managers

*Graphical file managers offer a varied set of features. The table below summarizes the principal capabilities of the graphical utilities reviewed here.*

| | Windows Utilities | Windows Utilities | Windows Utilities |
|---|---|---|---|
| **Product** | **FileApps 1.0** | **File F/X 1 0 B** | **Power Launcher 1.0** |
| **Company** | **hDC Computer Corp.** | **Metz Software** | **hDC Computer Corp.** |
| **Price** | $129.95 | $129.95 | $99.95 |
| **Features** | Windows File Manager alternative<br>Disk viewer<br>File swapper<br>Text searching<br>Undeletes files<br>File encryption | Windows File Manager alternative<br>Task switcher and applications launcher<br>Text searching<br>Undeletes files<br>Screen saver<br>Provides system information | Windows File Manager alternative<br>Applications launcher<br>Enhanced Windows commands<br>Task manager<br>Menu builder<br>Scripting language<br>Macro recorder<br>Virtual desktop<br>Provides system information |

ways that are difficult or impossible to achieve in Windows.

As its name suggests, Power Launcher is a utility package whose main purpose is launching other programs and files; you determine how, when, and where an application is started up and the size and location of its on-screen window. It takes a bit of effort to get the hang of configuring a launch sequence, especially if you want to start multiple applications and document files. The package's Command Builder and macro recorder make this sort of customizing much easier than writing code, but even with all the pretty buttons and icons, the process doesn't always feel straightforward.

Power Launcher has a set of tools for redesigning your Windows workspace to include cascading menus that list your most frequently used commands. You then can use these menus in your applications, omitting options that you never use and putting the most important commands near the top of each menu.

Power Launcher also includes PowerApps, a function that lets you assign commands to the keyboard or mouse. These can be specific to an application or apply to all the programs you use. A module called Power Toolbox lets you assign commands to square buttons that can float anywhere on the screen. But beware: If you enjoy tinkering, you may find yourself spending hours changing the look of these buttons and icons.

If you want more control over your PC, Power Launcher's ability to automate tasks and its customization capabilities make the $99.95 program worth the price and the effort of scaling the steep learning curve. Someone who needs to keep close tabs on financial transactions, for example, could set up Power Launcher to fire up an accounting program at a certain time of day, query a database or on-line information service, dump the data into a spreadsheet, and, if you really want to get tricky, zap the worksheet to a coworker's E-mail box. This is a slick package, but it's not for everyone. As its name indicates, Power Launcher is for power users.

For more mundane operations, hDC offers FileApps, a collection of mostly handy disk and file tools that replace or enhance Windows' built-in utilities. The File Enhancer Plus program, for example, handles the basic Norton-type routines such as copying, moving, deleting, and undeleting files; making directories; and changing file attributes without jumping back into File Manager.

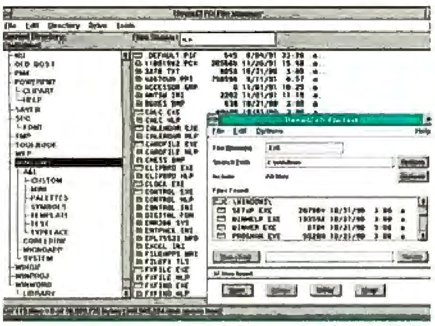
Looking for files is easy with File Search, which can ferret out documents and applications by searching for a particular filename, file type, string of text, or date. You can feed it broad or focused search criteria; once File Search finds what you're looking for, it opens the file by launching the related application. File Search is nicely implemented, but if you have anything less than a fast 386, be prepared for some waiting. On our test 16 MHz 386SX, for example, it took about 50 seconds to find a file on a crowded 40 MB hard disk; finding a file and launching the related application took about a minute and a half. If you know approximately where a file is hiding, you can improve performance by giving more detailed parameters, however.

The package also includes File Secure, for encrypting and decrypting data, and Disk Share, a program (developed by Traveling Software) that lets PCs share and swap files. FileApps's neatest component probably is Disk Viewer, a utility that displays a series of "bar graphs" depicting the contents of each subdirectory on your hard drive, so that you know at a glance where to start your disk maintenance. Using a magnifying-glass icon, you can scroll up these bars and get information on each file, then open it or drag it to the Trashcan.

HDC's older FirstApps is a less essential collection: fun, but not something likely to boost productivity. Memory Viewer, a precursor to Disk Viewer, provides a picture of how memory is allocated in Windows' real, standard, and enhanced modes. AutoSave, which as its name implies saves files at predetermined intervals, is a useful tool, and the package's alarm clock and calendar modules are better than the ones in Windows. WorkSets, which lets you group applications and files and access them with the

| Windows Utilities | Macintosh Utilities |
|---|---|
| **WinTools 1.0** | **Now Utilities 3.0** |
| **Tool Technology Publishing** | **Now Software** |
| $149 | $129 |
| Windows Program Manager alternative<br>File manager<br>Drag-and-drop interface<br>Applications launcher<br>16 virtual desktops<br>Trashcan icon<br>Image Librarian for bit maps<br>Undeletes files<br>Screen saver | Extends the capabilities of the Macintosh System<br>Super Boomerang program<br>Applications launcher<br>Menu customizer<br>WYSIWYG menus<br>Alarm clock<br>Memory viewer<br>Performs periodic saves automatically<br>Password protection<br>Provides system information |

press of a button, is a good idea; however, several BYTE readers have cited trouble with system lockups. And be forewarned that the Desktop module, which lets you craft customized start-up screens and backgrounds, could be a time-consumer for those prone to distraction. But it also can be used to set up an appointment calendar (complete with notes and reminder alarms) that you can display in the background. At $99.95 for nine utilities, FirstApps has a reasonable cost per module, but most people will likely use only a few of the package's features.



# METZ FILE F/X 1.0B

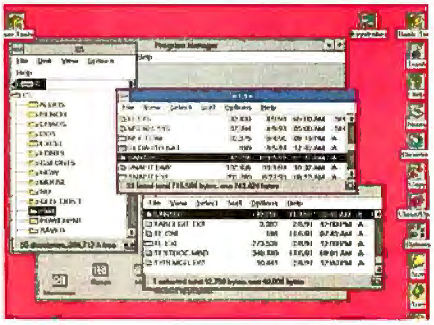
A five-pack File Manager replacement that does everything except format disks, Metz Software's File F/X also is something of a throwback: It looks like a Windows utility for DOS disciples suffering from fear of GUIs. On the left side of the screen, File F/X presents a directory tree you can scroll through; on the right side is a list of icons representing the contents of your disk. This setup permits you to easily perform file management tasks: copying, deleting, and undeleting. Unfortunately, though, File F/X won't let you move files to a different directory just by dragging their icons to the appropriate location.

The package's undelete tool is handy; it shows you a list of deleted files and tells you whether you might be able to recover them. Don't expect to rescue any file deleted more than a few days earlier, though; chances are, DOS has written new files over them. The program's file-deletion component is straightforward; you can delete a group of files just by clicking on their names as you scroll down the list and then clicking on the Delete button.

File F/X has one of the fastest search utilities for Windows. On a very crowded hard disk, it found most documents in less than two seconds. The program lets you launch the related application after finding the file you're looking for, but this procedure is a little slower than if you launched the application from Windows.

The File F/X Task Manager is a combination program launcher and Windows customizer. It has its own "Run" line and will stack up a list of the 20 most recently issued commands.

File F/X doesn't really look like a Windows program, but it is cleanly designed and easy to use. It doesn't get bogged down trying to do too much, and it doesn't carry the heavy processing overhead of a GUI. Most operations involve clicking on names listed in trees or in windows. For people who want straightforward file management and prefer tree structures, this is a capable alternative to the Windows File Manager, affordably priced at $129.95.



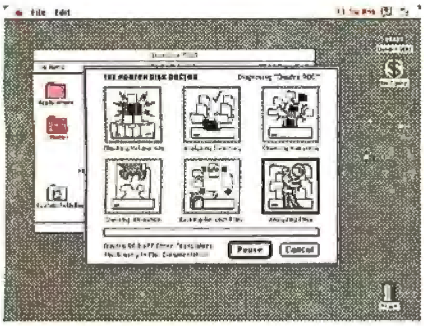
# WINTOOLS 1.0

This nifty replacement for the Program Manager brings a little drag-and-drop Macness (and a new set of icons) to Windows. Fans of an object-oriented approach will prefer WinTools' way of managing files over the Program Manager's. You can drag a file icon to a tool icon to initiate an operation; for example, dropping a document icon on an application icon launches the application and opens the document. To delete a file, you simply drag its icon to the trash can; double-clicking on the trash undeletes the file. WinTools is big on customizable icons, which can depict applications, files, and operations.

This $149 package has a few good launching capabilities, including a scheduler for automating program execution. A component called Big Sky provides 16 "virtual screens," each of which may hold a program. Big Sky is a good idea, but its implementation could be smoother and its interface more intuitive. WinTools isn't as comprehensive a package as some others in this category, but what it does, it does well.

## MACINTOSH UTILITIES

Without getting too religious, we think it's fair to say that the Macintosh environment is pretty dang near complete, especially since the introduction of System 7.0.1. The Mac's Finder and its assorted tools have, to a large extent, alleviated the need for software add-ins. But hard disks are another matter: Mac users, like other computer users, have tons of files on hard disks. Sometimes those disks go down.



## THE NORTON UTILITIES 1.1 FOR THE MACINTOSH

The Norton Utilities for the Macintosh started life at Peter Norton Computing, before the company was acquired by Symantec. The package primarily targets technically unsophisticated Mac users—those folks who, when their hard disks crash, prefer not to get involved sorting out tracks, sectors, or file extents. They just want their files back, and if the software can accomplish this without making them sweat, so much the better.

The $149 package deserves praise for providing two "crash" disks, ready-to-go bootable floppy disks containing the program's crucial disk recovery software. Having a crash disk means you don't have to horse around in an emergency: Recovery procedures begin the moment you slide the crash disk into the floppy drive and reboot. A red 800-KB floppy has System 6.0.4 installed and is for use with Mac Pluses through IIcxs. A black 1.44-MB floppy has System 6.0.7 and is for use with Mac IIcis through IIsis. PowerBook, Classic II, and Quadra owners, however, must plan ahead by first building a bootable System 7.0.1 floppy, then copying the recovery program to this floppy.

The heart of NUM's software suite is the Norton Utilities module, which consolidates in a single program hard disk diagnostics and repair functions (Disk Doctor), recovery functions for deleted files (Unerase), and accidental hard disk format restoration (Format Recover) functions. The Disk Doctor examines a drive's volume information, directory, and file allocation structures, hunts for lost sectors, and performs extensive file analysis, identifying resource problems and data corruption by computer viruses, among other things. Unerase lets you get back a critical file you just threw into the trash and emptied. Format Recover is for that really big boo-boo: accidentally reformatting a second hard disk (the Mac OS prevents you from erasing a boot-up hard disk). Format Recover also is handy for copying files from a damaged hard disk before you start repair operations.

Despite its apparent nontechnical bent, NUM has a built-in, sophisticated disk editor for examining and modifying data on the drive. Version 1.1 adds System 7 smarts: The Disk Doctor understands the new directory and file structure, such as aliases, and you can examine a drive by simply dragging and dropping its icon on The Norton Utilities icon.

The Disk Doctor gets a thumbs up for

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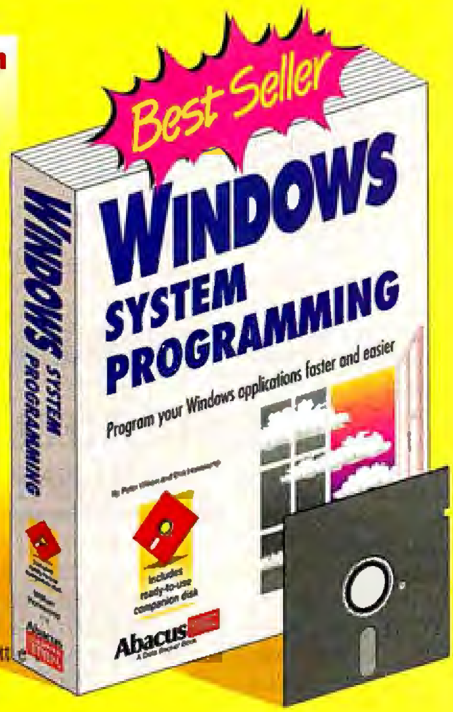


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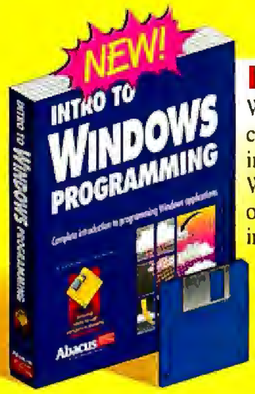


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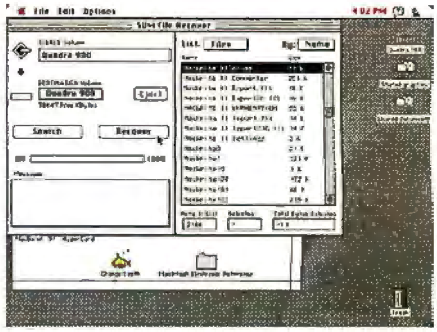
being both thorough and fast. It found all sorts of minor file problems on our IIci's hard disk—problems we weren't aware of, including a not-so-minor botched directory entry. It whipped through the 80-MB hard drive in several minutes, and repaired everything it found (after asking permission). The Unerase function, while adequate, sometimes stumbles when you're searching for specific files. It provides a list of common file types (for example, Word 4.0) that you pick to narrow its sweep through your disk's sectors. Unerase then uses the file creator and type information for this selection in its search operation. Unfortunately, if your application's file type isn't on Unerase's list (e.g., an Adobe Photoshop file), you're out of luck: The program can't search for that file.

To aid in file recovery, the File Saver cdev/INIT records the sector location and name of deleted files. NUM's Unerase function uses this information to accurately locate and restore a deleted file. A Disk Light cdev, true to its name, acts as a hard drive access light. It places a tiny disk icon in the menu bar; that icon blinks during disk I/O. A Speed Disk application defragments your hard drive and also performs drive, disk, and file checks, mapping out the organization of data on the drive. On color Macs, this data map uses different colors to show the location of various files—files such as the System, suitcases, INITs, and applications. Speed Disk earns points for its ease of use, but unfortunately, the data map doesn't work with 24-bit displays. You get a big black blob in the window.

Two of NUM's functions were made superfluous because of changes introduced with System 7: Layout Plus (used to change the Desktop layout) and Directory Assistance (used to create and view folder contents). Both relied heavily on Finder 6.0.x's organization, which has changed drastically in Finder 7.0. This isn't a problem if you haven't upgraded to System 7, of course. However, the application that counts—the Disk Doctor—thoroughly understands System 7's file structures, and for those of us who have upgraded to the new OS, this is the one utility that matters. Despite some minor flaws, NUM's ease of use, speed, and System 7 savvy make it our Mac disk utility of choice.



## SYMANTEC UTILITIES FOR THE MACINTOSH II 2.1

SUM II is Symantec's original disk utility offering. Two floppy disks (one a bootable crash disk with System 6.0.7 installed) provide hard disk recovery tools, plus a bevy of utilities that can edit files or memory and encrypt data. SUM

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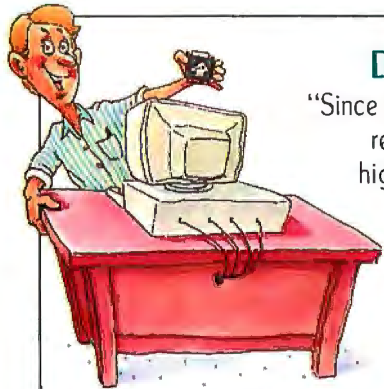

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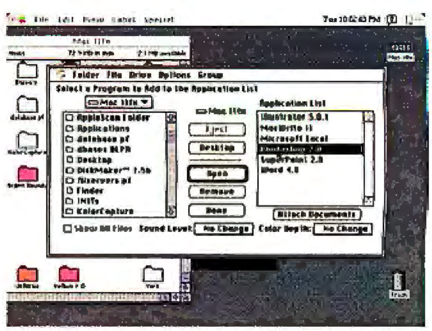
II caters to the more technically advanced crowd. The package's documentation mentions how to take snapshots of your drive's volume information and partition your hard drive using the SUM Partition utility. Obviously, there's nothing wrong with this, as long as you understand that the software expects users to be experienced.

SUM II and Symantec should take a bow for including a "panic section" at the front of the manual and outlining those pages in gray so that the section is easy to find. Included in this section are screen shots and step-by-step procedures for running diagnostics and recovering your files. These tips are quite useful if you bought SUM II because your hard drive conked out. This welcome innovation is offset by the fact that the recovery software on its crash disk demands that you customize the application with your name and company name. Users have two alternatives: Let the software write to your master crash disk in what's probably a panic situation or make a copy of the crash disk. If you choose the latter and your Mac is unusable because of a crashed hard drive, then you've got a lot of disk swapping ahead of you: a bootable System floppy, the two master SUM II floppies, and spares. Because this is not the sort of thing you should be doing in a stressful situation, you'd be well advised to buy SUM II before you need it and create a set of working floppies immediately.

SUM II's disk rescue software begins with the Disk Clinic application, which includes diagnostic functions, on-line help, and a facility for taking directory snapshots. The Disk Clinic also serves as a shell from which you can launch other SUM II applications and is the culprit that demands that your crash disk be customized. SUM's Recover program helps you first copy files from the damaged drive onto another drive or onto floppies, then repairs the drive. SUM's Shield `cdev/INIT` logs file deletions and their locations so that you can restore accidentally trashed files. It also takes snapshots of the drive's volume directory, either at shutdown or when you press the correct key combination. Disk Clinic and Restore use these snapshots to retrieve files or re-create a volume.

Other ancillary applications include TuneUp, which defragments your hard drive; BackUp, which backs up your files to other disks; Partition, which splits a large hard drive into several manageable subsections; Encrypt, which encrypts folders and files and provides password protection; QuickCopy, which does fast floppy disk duplicating; and Tools, which edits files, disks, or even memory.

Most of SUM's applications work under System 7.0.1. Both the Disk Clinic and Recover were updated to cope with System's new file extensions. For example, Recover can deal with file aliases. However, you must turn off all system extensions (by holding down the Shift key when the Mac boots) when using the SUM Installer application to install SUM II on your Mac. An annoying glitch in the TuneUp application is that when it searches for INITs (part of a diagnostic display) it finds only those within the System Folder—it can't locate INITs in the Extensions or Control Panels subfolders. The main casualty here is the Tools application: It is incompatible with System 7.0, period. This is unfortunate, because Tools is one of SUM II's most powerful utilities. With Tools, you can examine where applications were located in memory, check device driver tables, and other exotica that advanced users are interested in and can use. The loss of Tools is crippling to SUM II's usefulness; we hope Symantec brings out a System 7.0.1-compatible version soon.



## NOW UTILITIES 3.0

The Mac's native Toolbox always has offered the niftiest, fastest ways of working with files. (By Mac standards, the Windows File Manager and alternatives are lame imitations.) Because Apple has done such a fine job with the Mac desktop, few Mac file management tools exist, and most Mac users have no interest in those enhancements that are around.

But one set of Mac enhancers does improve the workspace and make it easier to get jobs done: the Now Utilities. This collection consists of 10 modules that blend in so well with the Mac environment that you'd think Apple put them there.

One of the Now Utilities' slickest components is NowMenus, which lets you build submenus up to five levels deep. You can call up a menu bar anywhere on screen just by clicking the mouse. Designer menus are nice, but the coolest thing about this tool is that it lets you pull down an application's menu list without having to click on the File, Edit, or another menu choice. This one feature can save you literally hundreds of mouse clicks a day. Another utility gives you WYSIWYG font menus; pull it down and you see the fonts as they'll look within your application (Helvetica 1 7is shown in Helvetica 1 7for example). This feature isn't something everyone needs, but publishers and designers working with multiple typefaces and sizes will really appreciate it.

Now Utilities' MultiMaster replaces Finder; with it, you can launch applications from customizable menus or pop-up windows. Configuration isn't as easy as you expect with a Mac package, but once you set up your launch scheme, MultiMaster can save you time hunting for and opening files.

Less powerful but handy tools include AlarmsClock, which is similar to but more programmable than SuperClock; NowSave, which lets you tell your system when to automatically save your work (a small tool but one that can spare you much cursing); Screen Locker, a password-protected means of hiding information; Profiler, an analysis tool for dealing with system conflicts; DeskPicture, which lets you have a PICT or MacPaint image as your screen backdrop (Elvira, say, instead of a pattern); and Startup Manager, which lets you hone performance by determining the optimum order for loading System, Control Panel, and Chooser extensions.

A good collection is elevated to supremo status with Super Boomerang, the upscaled version of an old Mac favorite. This utility, which now resides in the Apple menu, is a navigational aid that grows in importance as your hard disk gets bigger or fills with files. It sets up a menu bar for doing the most frequent operations in the standard File dialog box. The DirectOpen option replaces the Open command with a hierarchical list of files, making it possible to bypass the Open dialog box. When you open or save a file, Super Boomerang records what you did and adds the folder or file to its menus.

Super Boommerang also provides one of the fastest file finders available; in our unscientific tests with an 80 MB hard disk, it turned up files in less than a second. The search facility can hunt for a certain string of text or the date of a file's last modification. When it finds the file, DirectOpen launches the related application, too.

As one resident Mac user put it, the Now Utilities is worth the price just to get Super Boomerang. Getting all those other neat utilities makes this one of the best buys on the Mac market.

### The Last Sector

With three sets of programs covering three different environments, it's impossible to single out an overall winner for this roundup of utilities. The best choice for you depends on what you want, what kind of hardware you have, how much you use it, and how you work. For PCs and compatibles, The Norton Utilities still is the minimum requirement for data recovery. PC Tools remains the best value; it has nearly every tool you need in one integrated package and rivals The Norton Utilities for data recovery.

If you do any work with Windows 3.0, The Norton Desktop is a must. It corrects several of Windows' deficiencies and adds a tremendous amount of versatility. The other Windows packages we looked at generally improve on the Windows File Manager, but before buying any of them, you should get a demo and make sure the program works in a way that fits your computing habits. Some of hDC's packages contain a few tools most people won't ever use. WinTools, on the other hand, is a streamlined program that is easy to use and mostly intuitive. (Just because a program runs under Windows doesn't mean it's intuitive.) Many of the smaller packages, such as XTree Gold, are limited, but one of them may be all you need to quickly navigate your hard disk or arrange your files. Don't buy a do-it-all package or an overstuffed toolkit; get only the functions you need.

The right utility can make all your ordinary tasks fast and painless, which will let you concentrate on your work rather than on configuring your system or searching a vast hard disk for lost documents. All the file and hard disk utilities in the world won't do a bit of good if you don't use them regularly. Set up a maintenance routine and stick to it. To paraphrase St. Francis of Assisi, treat your hard disk well, for it bears you up. To paraphrase Earl Weaver's remark about three-run homers, praise be the handy utility. ■

---

*Stan Wszola, a BYTE Lab testing editor, is a veteran DOS user. Tom Thompson, a BYTE senior editor at large, has a B.S.E.E. from Memphis State University and is a certified Mac developer. D. Barker, BYTE Lab editor handling applications software reviews, has no hardware loyalties; he uses DOS, Windows, and Mac machines. You can reach them on BIX as stan, tom_thompson, and dbarker, respectively.*





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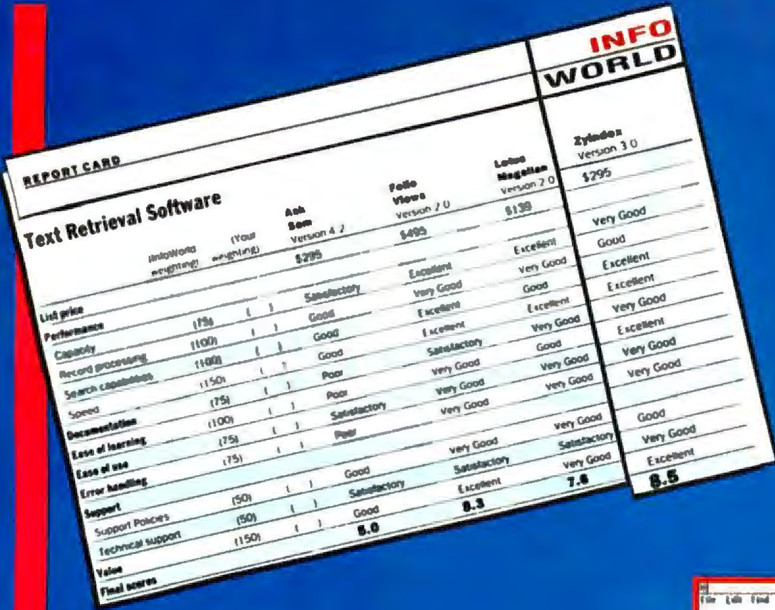

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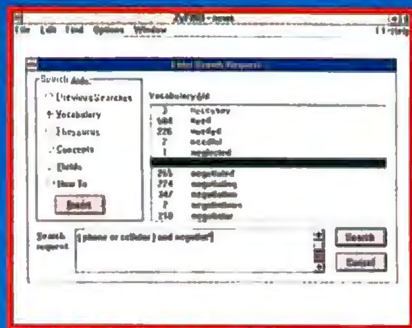

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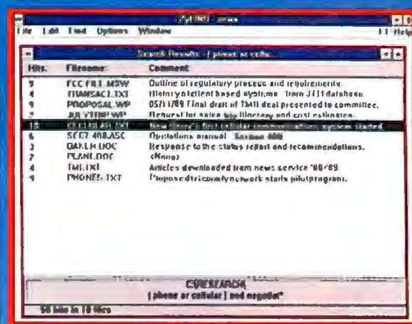

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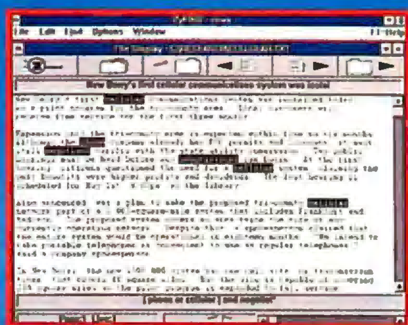

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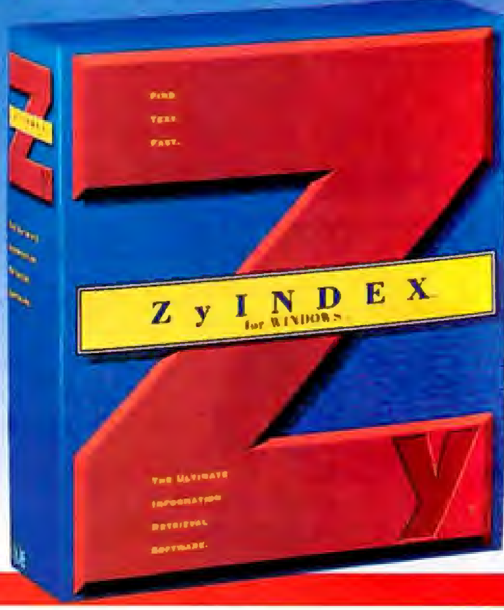



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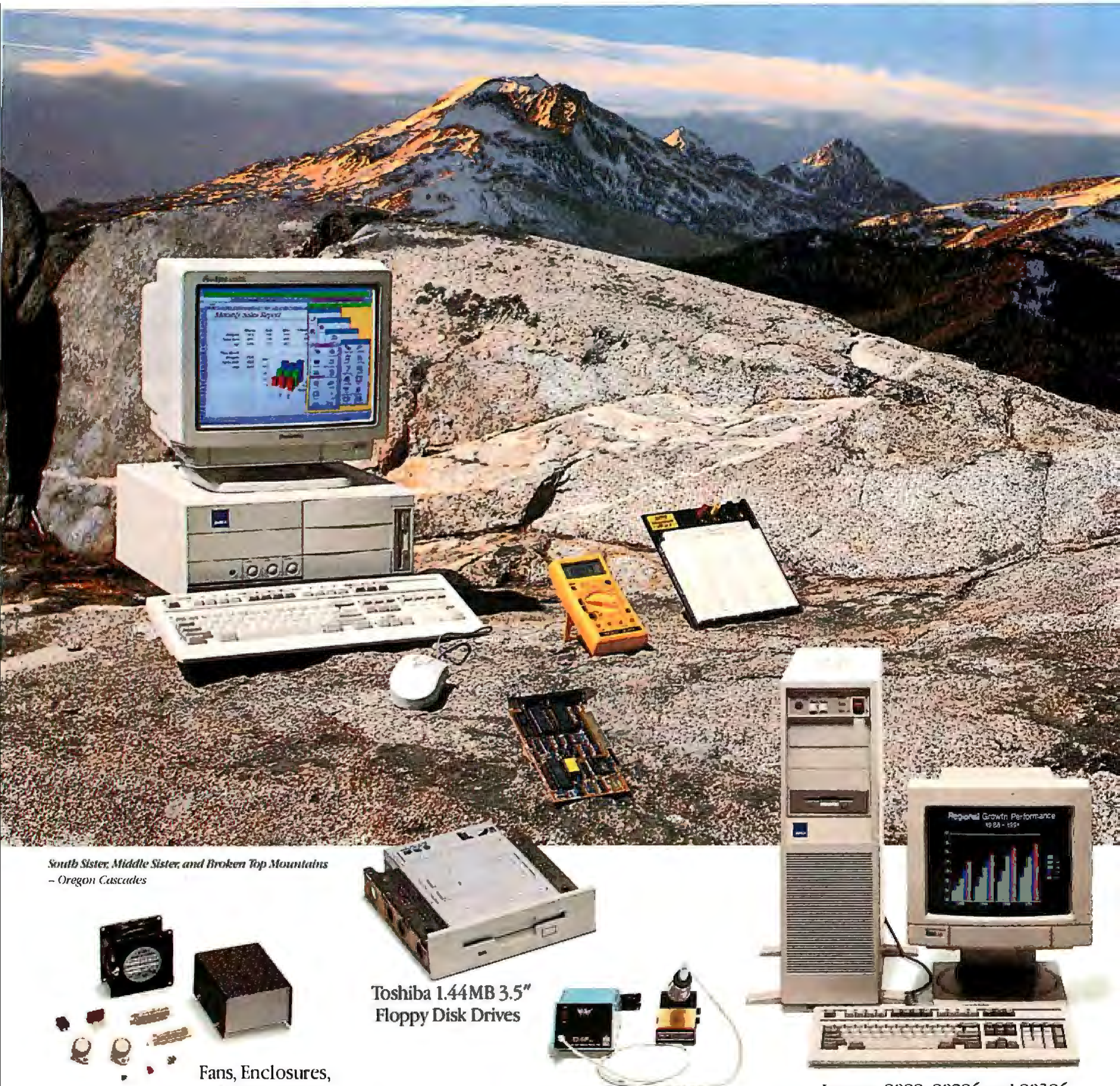


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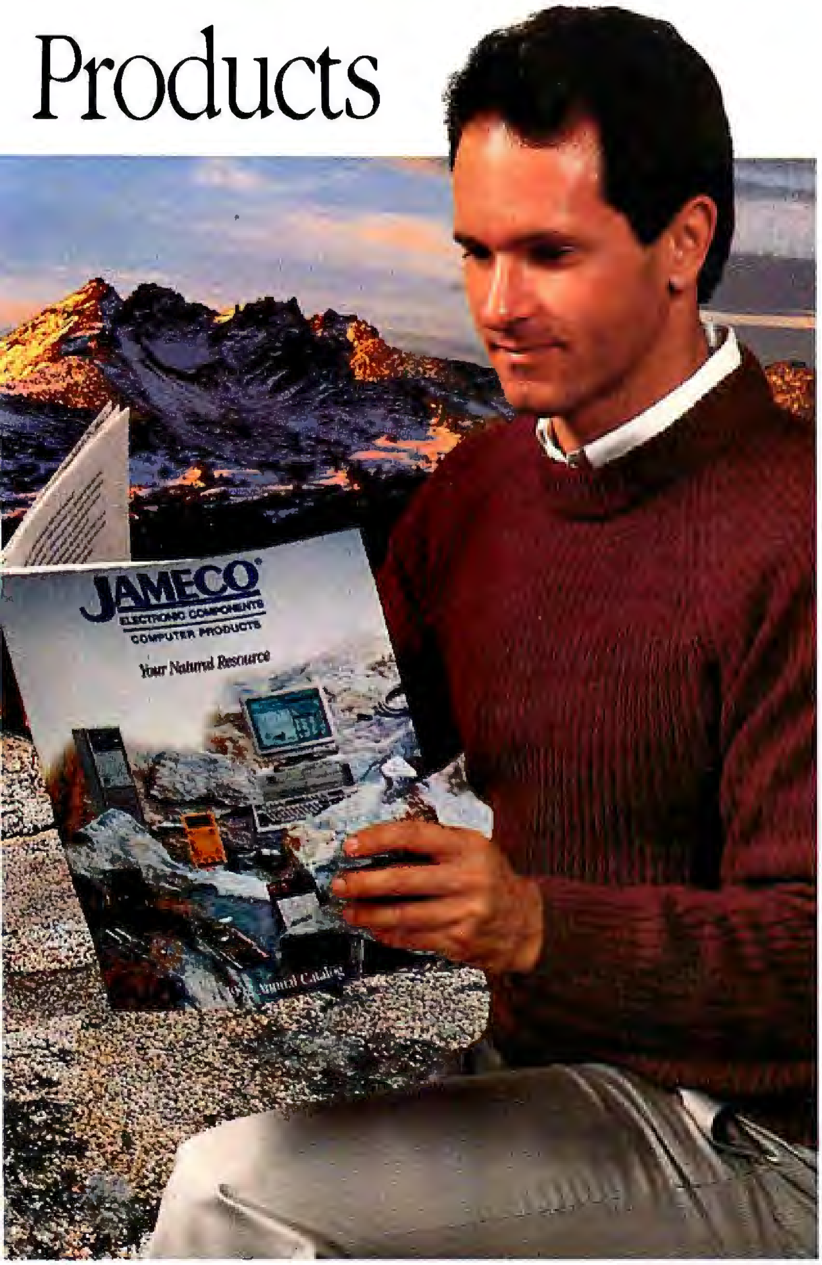



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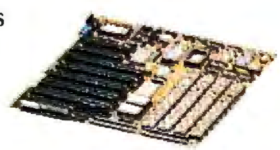

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HARDWARE

# Laser Muscle: Five Printers Built to Handle Networks

ALAN JOCH

Sharing printers has long been one of the biggest advantages of networking workgroups and offices. Unfortunately, while network operating systems offer benefits such as print-job spooling, and third-party products such as Intel's NetPort let you connect your printer directly to the network, midrange laser printers can buckle under the demands of high-volume networks. With slow processing speeds and low-capacity paper trays, six- or eight-page-per-minute laser printers provide a questionable benefit in shared environments.

Fortunately, in the last year a new generation of high-speed, high-volume laser printers arrived, with the quality advantages of desktop laser printers plus enough durability to handle a quarter-million pages a year. In this roundup, I look at five such printers designed for networks that produce everything from correspondence and spreadsheets to PostScript-based desktop publishing. These printers also accommodate PC or Mac shops or companies that run a combination of both.

For the main roundup, I looked at Eastman Kodak's EktaPlus 7016PS, Facit's P5160 LaserPrint-16, Hewlett-Packard's LaserJet IIISi, and IBM's LaserPrinter 10L. I also evaluated QMS's behemoth QMS-PS 2000, a 20-ppm scorcher whose price and performance fall outside the class of the other four printers (see the text box "QMS's Big Gun" on page 204).

Three other new network printers weren't available in time for testing but should be on the market by the time you read this review: Alps America's 16-ppm LSX1600, Xerox's 45,000-page-per-month 4213, and Texas Instruments' RISC-based MicroLaser XL Turbo.

I chose this main sample with the following general criteria: All four printers have an engine speed of 10 to 20 ppm and a monthly duty cycle of 20,000 or more prints. Each supports PostScript, and all are priced under $10,000 in their PostScript configuration. Finally, I concentrated on the market's latest offerings by choosing models that began shipping since last summer.

I allowed two exceptions: Kodak rates the EktaPlus at only 15,000 pages per month, and the LaserJet IIISi began shipping last spring. Because of the prominence of each of these printers, I decided they were important to include.

## Network Ready

As a class, these printers have a lot in common. Besides engine speeds that range from two to four times faster than those of personal laser printers, the network models typically rely on fast 68020 or RISC processors to help PostScript jobs move along swiftly.

In addition to standard Centronics parallel and RS-232 serial interfaces, some of these printers also offer AppleTalk, Ethernet, and Token Ring ports, which allow for direct high-speed connections to networks. This releases the printers from the shackles of the maximum 10-foot-long parallel cable connection to the print server.

The prime benefit is efficiency. Printers can now reside near where work gets done and pump out text and graphics with a minimum of I/O bottlenecks. And centralized printing means more than stringing together PCs, Macs, and even minicomputers or mainframes. Universal access to a sophisticated printer helps a company present a consistent corporate image. Each staff member has access to the same typefaces for correspondence and reports so customers don't receive different-looking correspondence from each department.

Consolidation can also mean lower equipment costs. You need to stock only



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**BYTE ACTION SUMMARY**

- **WHAT NETWORK PRINTERS DO**
These PostScript-compatible laser printers provide fast performance, sharp print quality, and high duty cycles for shared printing environments.

- **LIKES**
Sophisticated processors and engine speeds that average 16 ppm, flexible network connections, and high-volume paper-handling abilities.

- **DISLIKES**
Disappointing PostScript processing times and inadequate paper volumes in some models.

- **RECOMMENDATIONS**
Hewlett Packard's LaserJet IIISi bested its direct competitors in performance and offered impressive print quality for a competitive price. If heavy traffic on your network justifies the fastest in processing power, consider the pricey QMS-PS 2000.

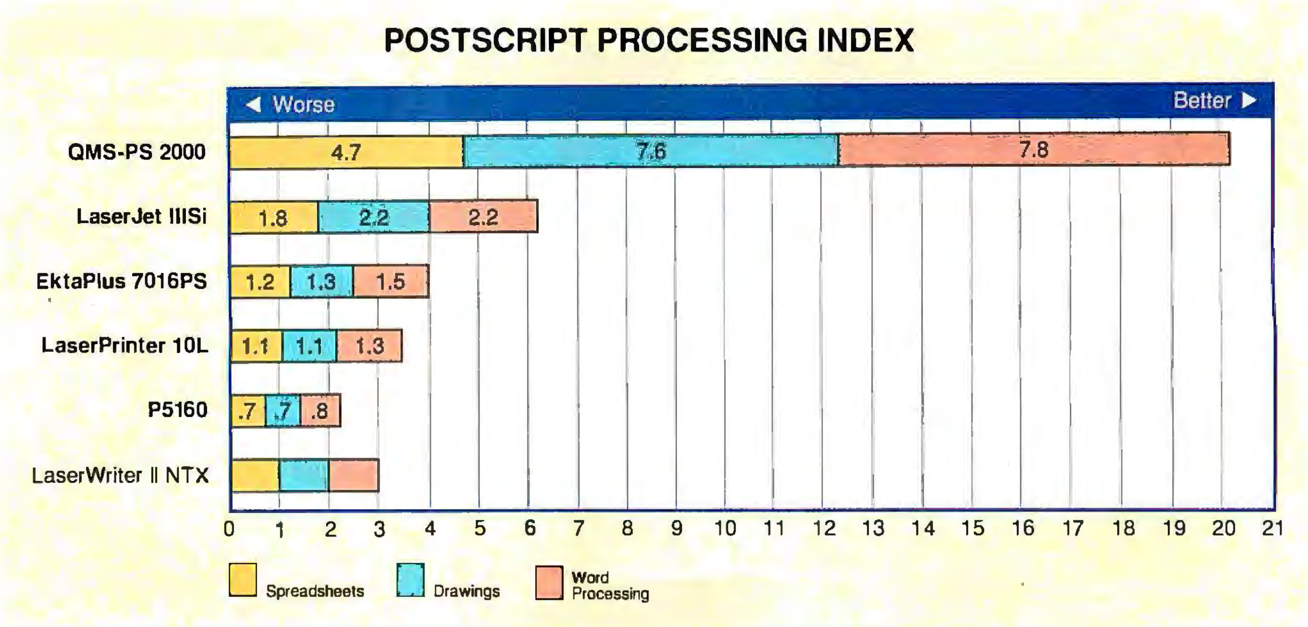
a single set of consumables when there's one printer in the office. And in space-cramped quarters, real estate is not grabbed by multiple printers.

There is a downside to networked printing, however. With centralization comes vulnerability when there is a breakdown. Paper jams, insufficient toner, and mechanical failures are bad news that quickly spreads throughout the organization. Also, the price entry point is steep. Plan to spend between $4000 and $7000 for a PostScript-equipped networked printer.

How do you decide whether a networked laser printer is right? First, look at your organization's print volume. If the network won't generate 20,000 or more pages per month, a network-class printer may be overkill. Also, consider the kinds of work your staff produces. For example, if one or two people regularly produce graphics while everyone else churns out straight Courier text, a centralized printer may be more costly and less efficient than two low-cost laser printers or a laser printer and a 24-pin dot-matrix combination. Finally, some individuals or workgroups—a personnel department, for example—simply can't cope with the lack of privacy inherent in networked printing.

## Test Suites

For those who can benefit from a shared printer, deciding on the best model is similar to choosing other types of laser printers. First, look for a printer with a rated engine speed that is efficient for your organization. Keep in mind that these ratings tell you only approximately how fast one-font text documents can be




*The BYTE PostScript test suite, which was built on industry-standard tests created by Genoa Technology, compares PostScript capabilities running spreadsheet, drawing and illustration, and word processing applications. Within the primary printer group, the LaserJet IIISi prevailed in each category. All results are indexed to the Apple LaserWriter IINTX (which equals 1 for each test). Longer bars indicate better performance.*

produced. I decided to create a more realistic test: a 20-page text file within Ami Pro with Times Roman body type, a heading in Helvetica, and subheads in Helvetica bold.

Similarly, if PostScript is important to your business, pay special attention to the printer's processor. I tested PostScript speed and compatibility using the test suite the BYTE Lab compiled for "Pennywise PostScript" (October 1991 BYTE) (see the figure). Built on industry-standard tests created by Genoa Technology, this suite accurately compares PostScript capabilities running real-world applications in three categories: spreadsheets, drawings and illustrations, and word processing. Each printer ran true Adobe PostScript Level 1.

For some companies, printer quality is even more important than processing speed. From the hundreds of pages of output, I compared the text and graphics quality of each printer. All performed admirably, although some of them offered embellishments that improved the look of 300-dot-per-inch output with edge-smoothing algorithms and fine-grain toner.

Finally, manufacturers offer a wide range of accessories designed to make network printing efficient (see the table). Check monthly duty cycles, paper-tray sizes, and input port options to find the best printer for your needs.

## EktaPlus 7016PS

In terms of print speed and quality, the Kodak EktaPlus 7016PS is a strong competitor. It ranked first in the 20-page text test and second in the PostScript suite. A 16-MHz 68010 processor powers the printer.

The EktaPlus shone when printing halftone images or charts with intricate crosshatches. The printer's ability to reproduce similar gray tones was the best in this group. Gray tones ranged smoothly from white to black with little or no banding between different weights. Also, the printer never failed to pick up details in images with shadows, while some of the competitors obscured these details in solid black. Overall, it presented a look of clarity and elegance in graphics that would grace business correspondence and collateral literature.

Text quality, while high, didn't always match the sharpness of the leaders in that category, namely the LaserJet IIISi and the IBM LaserPrinter 10L.

The EktaPlus's setup is the most demanding of the group. Plan on spending about 30 minutes to install toner cartridges, chargers, fuser wicks, and a delicate photoconductor belt. Fortunately, the manual offers illustrations and clear instructions that help the tedious process progress smoothly. Kodak rates toner life at 4000 pages; a replacement toner kit costs $115. Replacement photoconductor kits cost $75.

Serial and parallel ports come standard with the printer; an AppleTalk interface is a $195 option. With additional ports installed, you can connect up to four computers directly to the printer, which uses its print buffer to queue incoming jobs. Standard emulations are the HP LaserJet Series II, Epson FX-80, IBM Proprinter, Diablo 630, and HP 7475A graphics plotter. The printer does not offer automatic emulation switching, but you can change settings via a supplied utility or the front panel. Thirty-five Adobe fonts come standard, and font cards, priced from $150 to $200 each, provide additional choices.

*continued*

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**NETWORK PRINTERS COMPARED**

*A variety of processors, paper capacities, emulations, and other features can help you match a printer to your network's needs. Data is for PostScript configurations.*

| | EktaPlus 7016PS | LaserJet IIISi | LaserPrinter 10L | P5160 LaserPrint-16 | QMS-PS 2000 |
|---|---|---|---|---|---|
| **Price** (for base PostScript configuration) | $5535 | $6595 | $3693 | $2889 | $15,995 |
| **Memory** | | | | | |
| Standard | 2 MB | 2 MB | 2 MB | 2.5 MB | 8 MB |
| Maximum | 4 MB | 17 MB | 9 MB | 4.5 MB | 16 MB |
| **Duty cycle** (monthly) | 15,000 | 50,000 | 20,000 | 25,000 | 70,000 |
| **Paper input capacity** | | | | | |
| Standard | 250 sheets | 1000 | 700 | 250 | 500 |
| Maximum | 500 sheets | 1000 | 700 | 750 | 1500 |
| **Output-tray capacity** | 200 | 500 | 250 | 250 | 1500 |
| **Processor** | 16-MHz 68010 | AMD 29000 (RISC) | 16.7-MHz 68020 | 68000 | 25-MHz R-3000 (RISC) |
| **Engine** | | | | | |
| Manufacturer | Kodak | Canon | Lexmark | Sharp | Ricoh |
| Speed (pages per minute) | 16 | 17 | 10 | 16 | 20 |
| **Standard interfaces** | Centronics and RS-232 or RS-422 | RS-232, RS-422, Centronics | Centronics, RS-232 | Centronics | AppleTalk/RS-422, RS-232, Centronics or Dataproducts parallel |
| **Optional interfaces** | AppleTalk, Centronics, RS-232, RS-422 | Ethernet, Token Ring, AppleTalk | Ethernet, Token Ring | RS-232, RS-422, AppleTalk | Ethernet: TCP/IP or DECnet |
| **Emulations** | Adobe PostScript, HP PCL 4, HPGL, Epson FX-80, IBM Proprinter Diablo 630 | Adobe PostScript, HP PCL5 (includes HPGL/2) | Adobe PostScript, HP PCL 4, IBM Personal Data Stream, IBM-GL, and HPGL (PCL 5 optional) | Adobe PostScript, HP PCL 4 (IBM Proprinter, Epson FX-80, and Diablo 630 optional) | Adobe PostScript, HP PCL 4, HPGL |

Although the printer fared well in speed and quality, I found its paper-handling abilities lacking. The standard input tray holds 250 sheets. An optional 250-sheet letter-size tray costs $75. Paper travels along a straight-through path to a skimpy, 200-sheet output tray. When the tray is placed in its upper brackets, output collects in neat stacks, but in last-page-first order. The printer will stack pages in face-down, sequential order, but this requires some gymnastics: The sheet leaves the exit slot and flips end over end into the face-down position. In the process, the page must avoid the power cord, which sits at the edge of the paper's path. With large jobs, the pages stacked in a messy pile.

Kodak combined the printer with a photocopier, which potentially may mean even more cost and real-estate savings for some companies. However, I question the value of this bare-bones copier. It can't enlarge, reduce, or collate pages. Also, you must stop a print job to make copies, which could hinder busy networks. I'd prefer an EktaPlus sans copier, at a lower price.

### LaserJet IIISi

Hewlett-Packard's hefty 130-pound LaserJet IIISi set the pace for speed in this roundup. Thanks in part to its AMD 29000 RISC processor, the printer completed the demanding drawing test in the PostScript suite in just over 15 minutes, which was two times faster than two of the contenders. Similarly, the 20-page text test averaged 98 seconds, just under the EktaPlus's pace-setting time.

Parallel and serial interfaces are standard. HP also sells optional cards that easily slip into I/O slots and provide direct connections to AppleTalk ($275), Ethernet 802.3 ($695), and Token Ring ($895) LANs. The IIISi supports Novell NetWare and 3Com 3+Open.

Overall, the IIISi printed sharp, well-defined text and graphics. The blacks didn't always show the same level of contrast as in the IBM LaserPrinter output, but edges were clear and generally free of stray toner dots when viewed under a magnifying glass. The printer also did a fine job of printing grays, but it provided slightly less definition than the EktaPlus.

Print quality is aided by two factors. The first is Resolution Enhancement, the antialiasing algorithm HP first introduced with the LaserJet Series III. This technique helps smooth the stair-step "jaggies" that can crop up along type edges and bowls. Also, the IIISi uses a microfine toner that lets the print head deposit more dots of toner per square inch for added density and sharpness. HP rates toner cartridges for 8000 pages.

The printer ships standard with two 500-page paper trays. The output tray holds 500 sheets and includes a sensor to

# QMS's Big Gun

Based on a 25-MHz Mips R-3000 RISC chip, the QMS-PS 2000 takes networked printing to a level beyond typical 10- to 20-page-per-minute printers. For example, the QMS-PS 2000 ran through the entire PostScript test suite three times faster than the next best printer.

Performance isn't the only reason this printer casts a large shadow. Looking more like an upright refrigerator, the QMS-PS 2000, with its optional paper feeder, stands 4 feet high. In addition to sufficient overhead clearance, the unit requires about 2 by 3 feet of floor space. Fortunately, the assembly sits on wheels that let you transport it easily if changes in network topology require you to move the printer.

With its input and output options, you can load 1500 sheets of paper and not worry about an overfull output tray until your network has printed all the pages. Toner lasts about 10,000 pages, depending on page coverage. A word about toner: The QMS-PS 2000's performance deteriorates when toner is low. Once the low-toner warning light appeared, I found that the printer's times fell 50 percent.

Those who value print quality as highly as speed will be a little disappointed. The QMS-PS 2000 produced sharp graphics images and accurate ranges of grays, but the density of its blacks wasn't as solid as that of the LaserPrinter 10L. Also, the edges of text weren't as clearly defined as those of the LaserJet IIISi or the LaserPrinter 10L. Nevertheless, the QMS-PS 2000 produced what might be considered the norm in print quality for 300-dot-per-inch printers.

In addition to PostScript, the printer also emulates HP Printer Control Language 4 and Hewlett-Packard Graphics Language. The QMS-PS 2000 includes QMS's automatic emulation switching technology, called ESP.

Standard interfaces in the QMS-PS 2000 are RS-232, AppleTalk, and Centronics and Dataproducts parallel ports. A SCSI connector is available for attaching an external hard drive. An Ethernet interface is available for $1995.

The QMS-PS 2000 can print paper sizes from 8½ by 11 to 11 by 17 inches. QMS rates the duty cycle at 70,000 pages per month. The standard input tray holds 500 sheets, and an optional 1000-page input subsystem with duplexer costs $3495.

The printer comes with 8 MB of memory standard and can be upgraded to a maximum of 16 MB. Also, an optional 40- or 120-MB hard drive can perform the traditional chores of storing and caching fonts. Or you can meld RAM and disk memories into one memory pool. As a result, you can create buffers assigned to each of the operating I/O ports and tailor the buffer size to the ports that receive the most use on your network. The QMS-PS 2000 keeps all its ports active, so you can send a print job to one port while another interface is active.

Fully decked out with the optional input feeder and hard drives, the QMS-PS 2000 jumps in price from the base of $15,995 to more than $20,000. Clearly, only networks that generate 70,000 pages a month of multiple-emulation print jobs can justify this cost. If that happens to be your network, the QMS-PS 2000 can be a bargain.

tell you when you've reached the maximum page number.

Standard fonts include 13 proportionally spaced scalable typefaces and 14 bit-mapped fonts of fixed size. Inherent in the IIISi's Printer Control Language 5 is Hewlett-Packard Graphics Language/2 (HPGL/2) plotter support. Two slots accept additional fonts via cartridges. The PostScript configuration ($6595) includes 2 MB of RAM and 35 Adobe fonts. The IIISi doesn't automatically switch between PCL 5 and PostScript emulations.

As with all printers based on the Canon engine, setup simply requires installing the integrated print drum/toner cartridge, adding paper, and turning on the power. If you already own HP equipment, note that the IIISi doesn't support HP PostScript and HPGL cartridges designed for earlier LaserJet models.

### LaserPrinter 10L

Although it offers the slowest engine speed in the review group, this new 10-ppm laser printer from IBM sells for a $3000 base price that's hard to quibble with. The PostScript option and additional memory bring the price tag up to $3693, but that's still an economical amount, if you can live with only adequate processing speeds.

Test scores were noticeably slower than those of the EktaPlus and not in the same league as those of the IIISi. The 20-page text test ran at 141 seconds, the slowest of the group. The PostScript test suite bogged the printer down even more. For example, the Group 2 tests required nearly 31 minutes, twice as long as the time needed by the IIISi. A 16.7-MHz 68020 processor powers the LaserPrinter 10L, which runs a proprietary IBM engine.

Print quality, however, proved to be one of the LaserPrinter's finer points.

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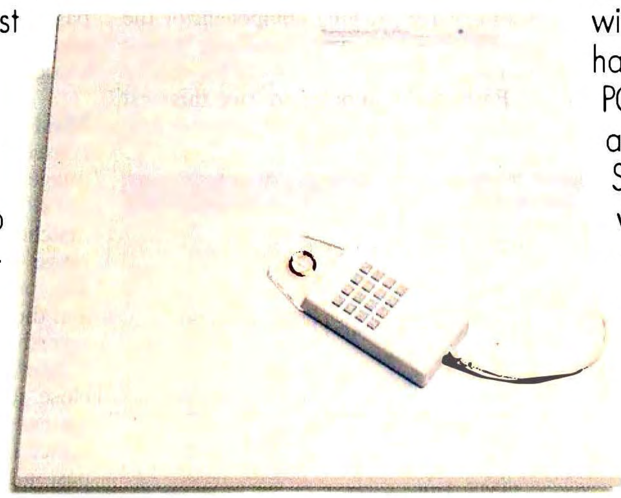

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IBM calls its antialiasing technology PQET, and, like HP's equivalent, it does a good job of smoothing edges. When the PostScript option is teamed with a minimum of 5 MB of memory, the LaserPrinter can lay down sufficient dot coverage to produce either 600- or 300-dpi resolution (the evaluation printer didn't have sufficient memory to test this capability).

The printer fared particularly well at producing dense blacks, whether in boldface type or in a solid black background from which to reverse type. In the latter, banding that was common in some other printers didn't mar the black areas. This tendency toward dark prints, however, was less successful in some of the graphics texts. Details sometimes disappeared in shadow areas.

In its standard configuration, the printer supports HP PCL 4, a plotter mode (supporting IBM-GL and HPGL), and IBM Personal Printer Data Stream. The latter includes 10 bit-mapped and 16 scalable fonts and provides for multiple page orientations. IBM sells HP PCL 5 emulation as a $199 option.

Like the IIISi, the LaserPrinter can attach directly to networks via the optional Ethernet or Token Ring ports, which cost $845 and $945, respectively. However, these options support only OS/2 or AIX operating systems. If you want the LaserPrinter to connect directly to a Novell network, you must purchase a third-party connector, such as Intel's NetPort. The LaserPrinter can automatically switch between PCL 4 and PostScript emulations.

The exit bin holds 250 sheets. Two standard input trays hold 700 letter-size sheets.

### Facit P5160 LaserPrint-16

Based on a Sharp LCD print engine, this compact 16-ppm printer produces high-quality text and graphics at relatively slow speeds. Its scores in the text test were in pace with the other contenders. But when the P5160 tackled the graphics-intensive drawing component of the PostScript suite, its processing power stalled.

Forty-eight minutes to run this test suggests the marginal usefulness of this printer if your network produces anything other than straight text. However, if text is your emphasis, the P5160 can do a yeoman's job: The 20-page text test ran at a respectable 121 seconds.

The P5160 emulation offerings are rather limited: LaserJet Series II ships with the $2889 PostScript configuration, which includes 17 Adobe fonts and 2.5 MB of memory. If your network requires support for plotters, this isn't a viable candidate. IBM Proprinter, Epson, and Diablo emulations are also optional at $209 each.

Only a Centronics parallel interface comes standard with the printer. You can add an RS-232 interface for $49 or combined AppleTalk, RS-422, and RS-232 interfaces for $149.

The control panel offers the handy capability of storing up to four font, emulation, and I/O configurations so you can easily select from among them depending on the job at hand.

The LCD print engine produces good-quality output, although text edges were typically rougher than those produced by the IIISi or the LaserPrinter. The P5160 output solid blacks but occasionally lost image details.

The printer uses an easily installed toner cartridge that's rated for 60,000 pages. A 250-sheet input tray comes standard, and a 500-page optional sheet feeder costs $529.

### Most Muscle

If exceptional print quality of gray-scale images is your highest priority, Kodak's EktaPlus excels. None of its competitors matched the level of detail and smooth range of tonality. IBM's LaserPrinter 10L produced solid, well-defined type and did an especially good job printing reversed type.

However, the LaserJet IIISi came in a close second in both categories, and if your network printer must be a generalist rather than a specialist, the IIISi is the best all-around printer in this group. When you consider the IIISi's unparalleled processing speed and high-volume paper-handling capabilities, it looks even more impressive. Other printers cost less than the IIISi, but the price differences shouldn't be great enough to sway those who look at the big picture. If, after evaluating your work load, you decide a network printer will mean more efficiency for your company, I recommend the LaserJet IIISi. ■

*Alan Joch is a technical editor for the BYTE Lab. You can contact him on BIX as "ajoch."*

**COMPANY INFORMATION**

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**Facit, Inc.**
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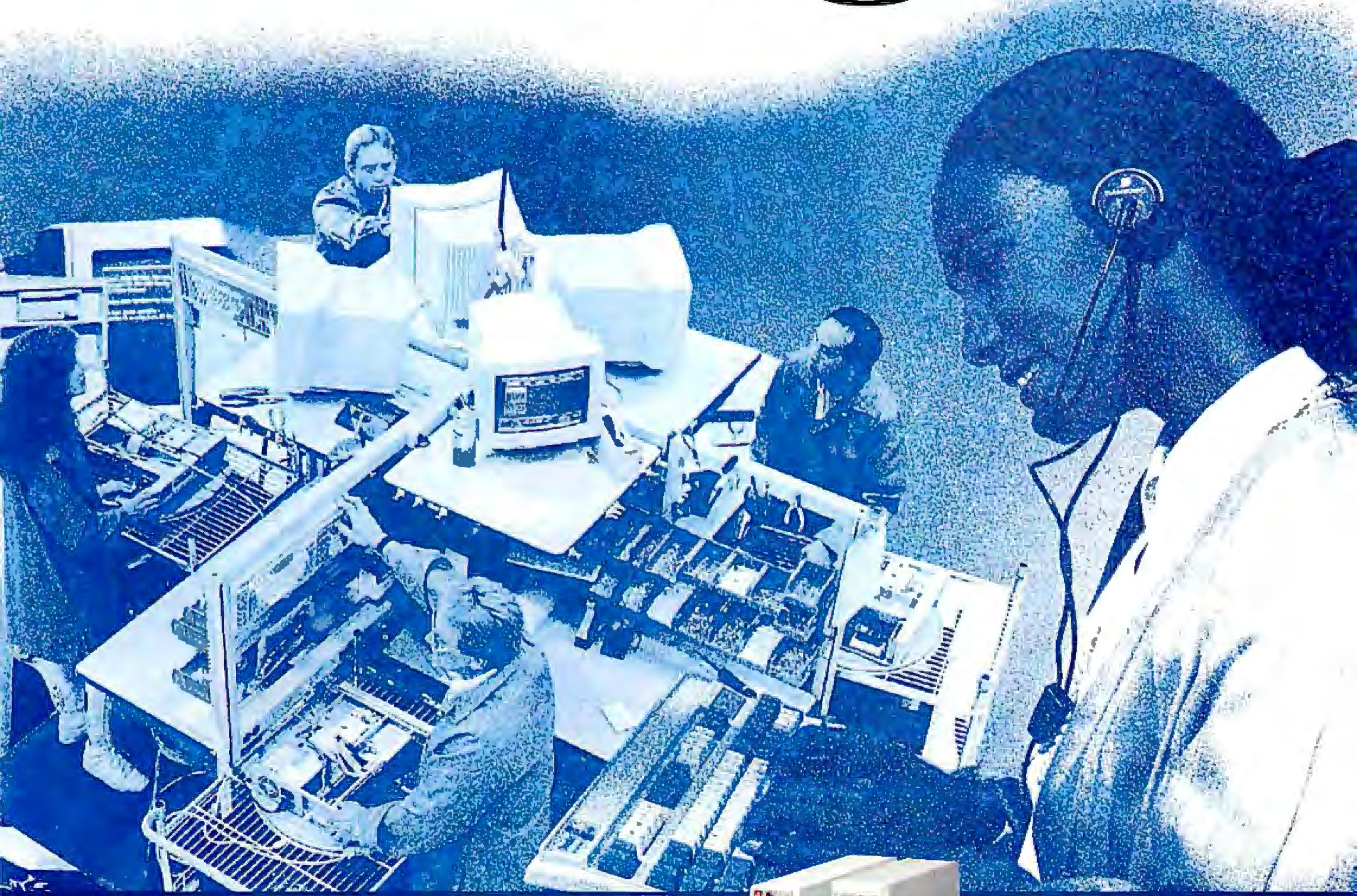

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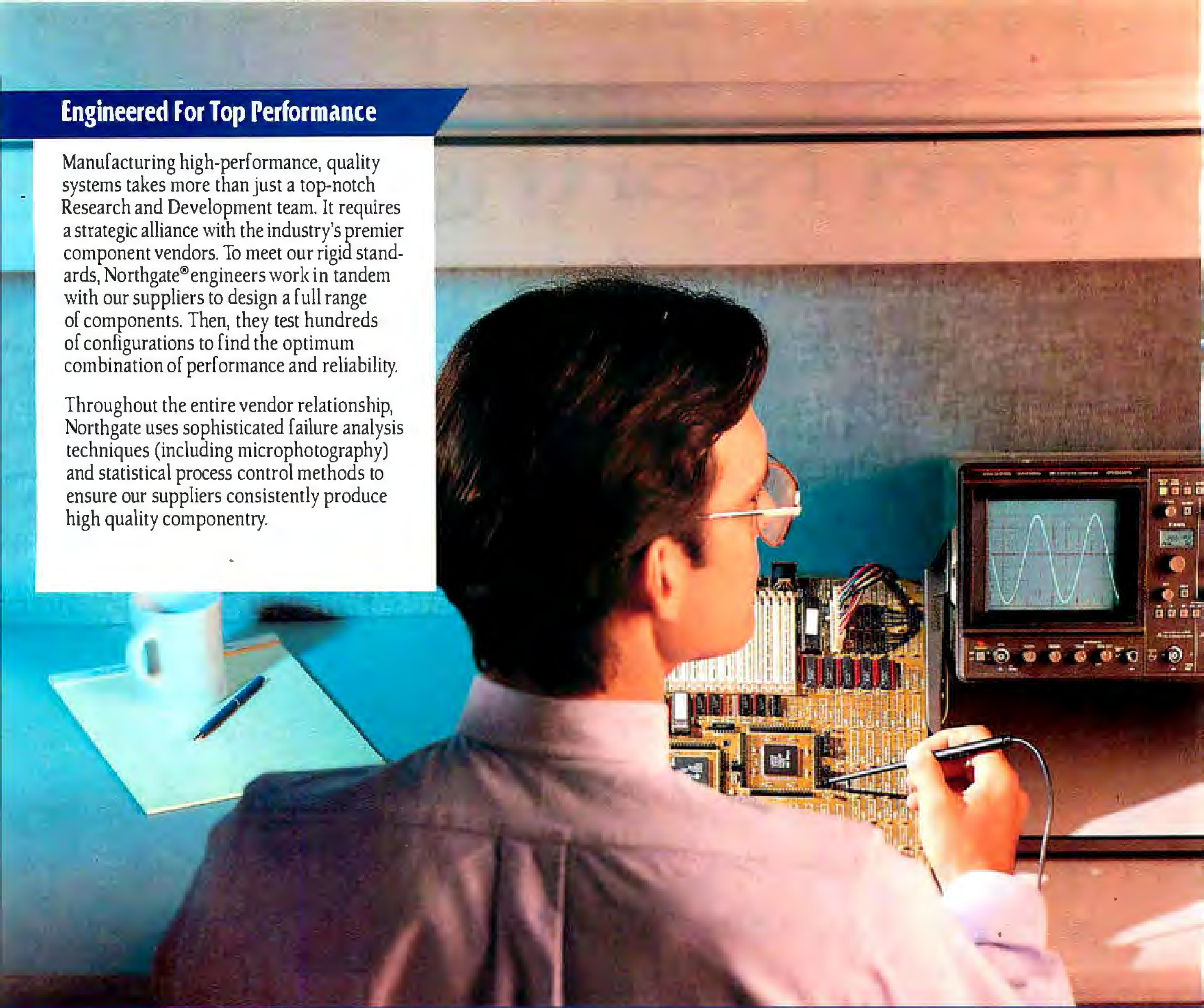

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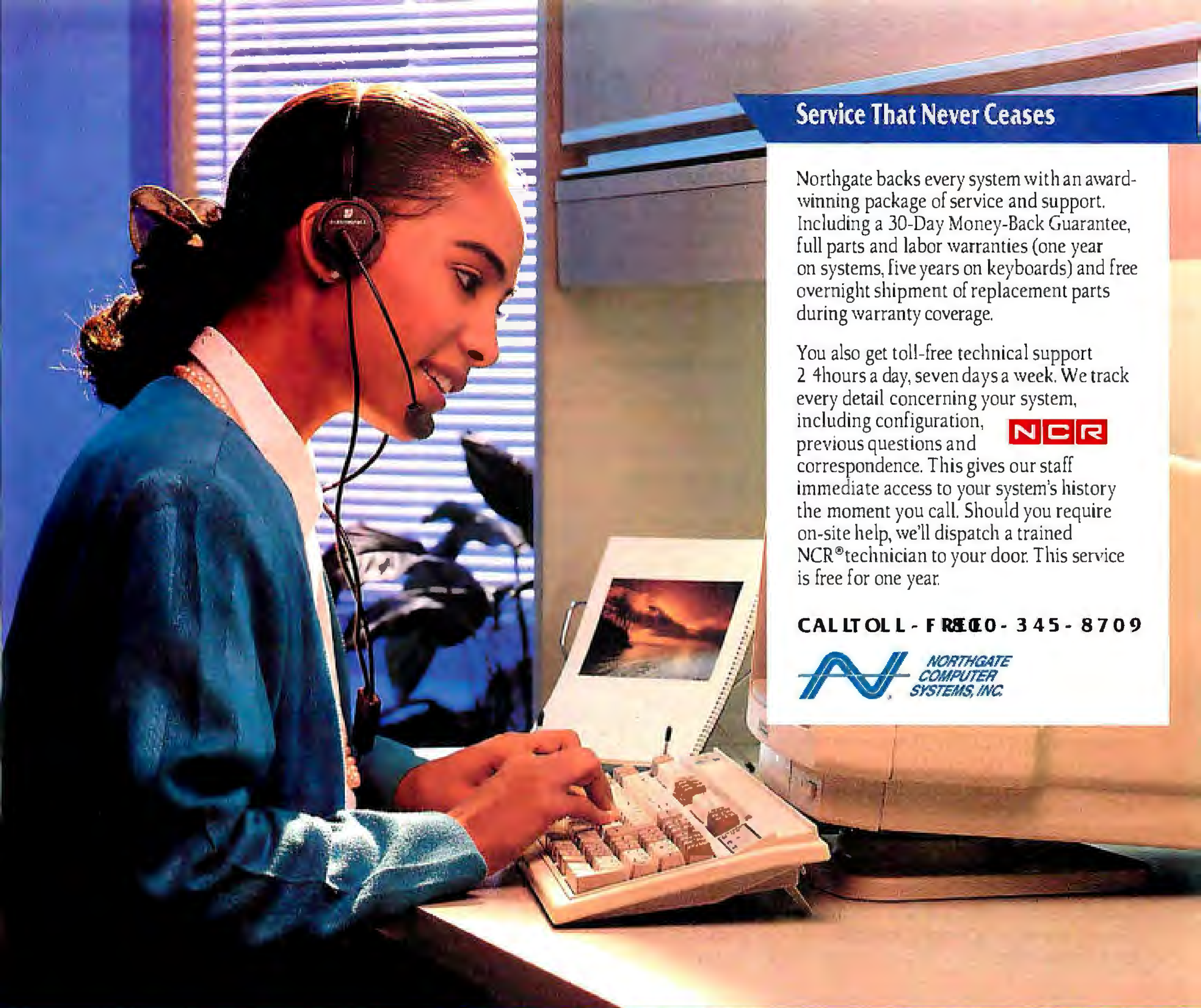

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Business phone (      ) ______________________

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Fax # (      ) ______________________

1. Are you interested primarily in computers for your:
   ☐ Home ☐ Business ☐ Both
2. If you indicated "business," what is your role in the purchase of computer systems?
   ☐ Decision-maker ☐ Decision-influencer ☐ None
3. What computer products have you been considering?
   ☐ 386SX™-based systems ☐ 386DX-based systems
   ☐ 486SX™-based systems ☐ 486DX™-based systems ☐ Notebooks
   ☐ Dedicated network servers ☐ LANs
4. How many computer systems do you already have at your company? ________
5. When will you most likely make your next computer purchase decision?
   ☐ Less than 3 months ☐ 3-6 months ☐ Within 12 months ☐ Don't know
6. What applications will you be running?
   ☐ Word Processing ☐ Accounting ☐ Spreadsheet ☐ Desktop publishing
   ☐ Database ☐ Networking ☐ Other ________________
7. Are you thinking about leasing systems?
   ☐ Yes ☐ No

☐ Clisdox if you would like to have a Northgate Systems Consultant call you.



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HARDWARE AND SOFTWARE

# The Multimedia PC: High-Powered Sight and Sound on Your Desk

TOM YAGER

It's not every day you get to see history made. On October 8, 1991, Microsoft (along with some friends) raised the curtain on the Multimedia PC, and some of us have a hunch that personal computing will never be the same. The Multimedia PC, or MPC, seems to have something for everyone. For developers, it's a standard for building advanced multimedia capabilities into applications. For users, it's a set of guidelines for constructing PCs, or upgrading existing ones, to support these applications. For vendors, it's the logo of an organization that will work to put multimedia power in the hands of as many PC users as possible. But for all, it spells opportunity: the PC may have finally emerged from the drab, silent shroud that has surrounded it for so many years.

## What's an MPC?

The MPC specification leaves room for capabilities that technology can't even support yet. But even today, an MPC-capable system sports a worthwhile set of talents. A CD-ROM drive is a required component, bringing not only an incredibly affordable 600-MB storage medium to desktop systems but high-quality CD audio as well. Digital information and audio tracks can share the same disc, but MPC systems also allow you to use your computer to precisely control the playback of a straight audio CD.

Digital audio support is also required, allowing you to record and play back audio data (voice, music, or whatever) to and from your hard disk. Varying data rates are supported, so you can set the balance between small audio file size and high-quality sound. An on-board synthesizer adds polyphonic music playback capability, and a MIDI interface lets you drive an external electronic musical instrument or other MIDI component.

Beyond added audio capacity, MPC gives developers more room to maneuver. The specification supports the playback of animation through a proprietary movie file format (Microsoft offers a converter that translates MacroMind Director [an animation program for Macs] movies to the MPC format). It also provides enhanced support for the display of bit-mapped graphics, and an interface to a timer that helps in the synchronization of events. With additional hardware and drivers, MPC can control laser disc and other external video devices, as well as video overlay/video-in-a-window graphics cards.

While the MPC specification declares minimum functionality, there's plenty of room for vendors to add value to their systems and peripherals. The specification calls for 256-color VGA, for instance, but any Windows-compatible display adapter will work. Similarly, if you have a need for higher-quality audio than what the most basic products can deliver, there are already MPC-compatible boards that are capable of generating professional-quality electronic music. *You* have control, within the MPC specification, over whether economy or quality reigns.

MPC's software base is a CD-ROM edition of Windows 3.0a, with a set of extensions that support the standard facilities offered by MPC-capable systems. The extensions can be applied to existing installations of Windows, so you can upgrade to full MPC compatibility without tossing out your current Windows setup (assuming you have one). But whether you're running Windows or not, installing from CD-ROM is a breeze; the entire release is on one disc, so once you've answered all the setup questions, you can walk away.

Future BYTE articles will delve into the technical details of MPC hardware and software. In this article, I'll recount my experiences with a sample of the first batch of MPC products. I selected products I considered to be representative of the mix you're likely to encounter, including a stand-alone multimedia PC, an MPC upgrade kit, a software development tool, and a couple of finished multimedia applications.

The MPC rollout was accompanied by quite an impressive array of finished hardware and software, so this is by no means an all-inclusive review. It should, however, give you a hint of what MPC is capable of and how you might apply it for your own use.

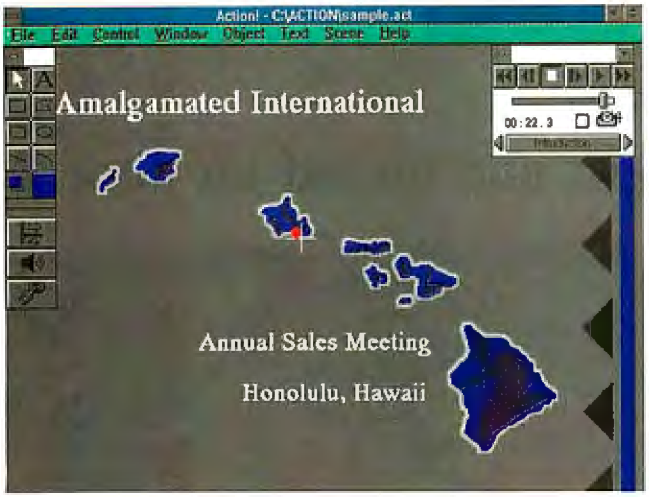
BYTE

- **WHAT MPC IS**
  A standard that brings multimedia capabilities to personal computers.
- **LIKES**
  The standard is thorough, and both stand-alone machines and upgrade kits are affordable.
- **DISLIKES**
  The animation standard depends (for now) on a Macintosh.
- **RECOMMENDATIONS**
  MPC brings standardized multimedia capabilities to the PC realm, catching it up to the Mac and Amiga.

continued

## MacroMind Action

*MacroMind Action takes a "point in time" approach to creating multimedia presentations.*




Action, MacroMind's multimedia presentation software for MPC systems, is a bit less than a full-fledged MPC application. For basic MPC systems, Action fails to support MIDI (and, by relation, the internal synthesizer). Music can be an important part of a presentation, and Action sets a bad example by failing to include support for this standard media type.

The lowest level at which Action operates is typical for presentation programs: Templates (containing graphical backgrounds and layout data) are combined with foreground elements to build the frames (or, in Action parlance, *scenes*) of the presentation. The twists added by Action are mostly its control over time and motion. In addition to organizing portions of the presentation into distinct scenes, Action also allows you to apply motion, special effects, and other events to the objects that make up each scene. Each event is keyed to a particular time.

In addition to using a time line, Action offers a control-panel dialog box that appears over the window used to build the presentation. To cause an event to take place at 35 seconds into the presentation, for example, you would drag the control-panel slider to 35 seconds and change the window to reflect how you want it to look at that point.

Graphical elements, including text, can be made to move, dissolve, sparkle, and attract attention in dozens of other ways. But for all this sizzle, some staples of presentation graphics, such as shadows, do not exist. It is easy to import graphics from other applications, but because Action lacks credible paint tools, those graphics won't always work the way you plan. It's difficult, for example, to get a nonrectangular imported graphic to blend well with objects created inside Action.

The control panel that keys events to particular times shows tenths of seconds, suggesting a high degree of accuracy in the timing. That view isn't realistic; Windows, lacking real-time capability, can't ensure that *anything* will happen when you ask it to. As a consequence, if you want a "twinkle" sound effect each time a new bulleted item hits the screen, you will have to play with the timing until it works just right. Everything about your system—the CPU speed, your display card, your hard drive, you name it—affects the accuracy of the timing in an Action (or any, for that matter) presentation.

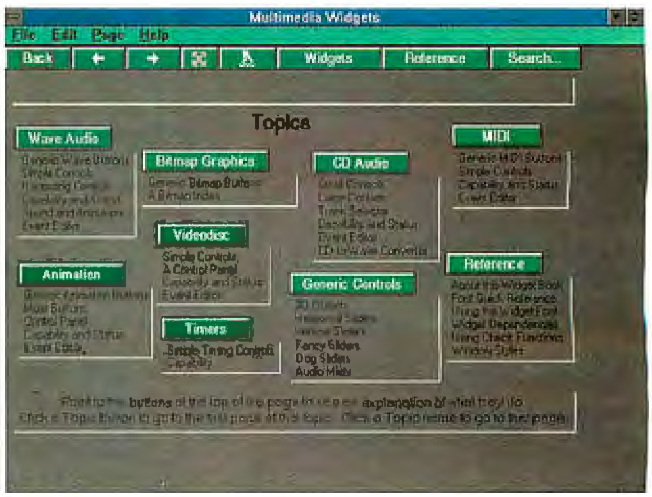
Beyond that unavoidable flaw, Action has one that I have trouble looking past: loading time. The README file warns that lengthy presentations may take a long time to load on some machines. I ran Action on a Tandy 4033LX Multimedia (see below), and the load times for even my first two-scene test were outrageously long.

Action seems to do well with simple presentations (e.g., bulleted charts and graphics). I am even more impressed, however, with the output of software such as Brown-Waugh's Curtain Call. It's tuned to helping ordinary people work style into their graphics. Action includes a number of templates, some of them attractive, but I was able to produce much better looking output from scratch using Curtain Call and other presentation tools (like Symantec's More on the Macintosh).

All told, my reaction to Action is "I've seen better." Once you get your file loaded, Action may live up to its claim of helping you churn out presentations faster, but I think you would be better off investing in Curtain Call or waiting for some of the presentation graphics heavy hitters to take on multimedia capabilities.

## Asymetrix Multimedia Resource Kit

*The Asymetrix Multimedia Resource Kit provides both program-level callable functions and prebuilt control panels for the MPC media types.*




ToolBook has become a mainstay of Windows developers in a hurry, and Asymetrix's new Multimedia Resource Kit does not disappoint, either. As it turns out, most of what's contained in the new software amounts to shells that call Microsoft's own Multimedia Extensions' dynamic link library (DLL) functions. The programming interface is well constructed, however, and it lays a good foundation for both native ToolBook programs and applications prototyped in ToolBook and later moved to a more optimal environment.

The Multimedia Resource Kit starts with the basics—simple, direct interfaces to Microsoft Multimedia Extensions' DLL functions—and works up from there. Asymetrix's 87-page manual may not weigh much, but it's the most concise description I have seen of what it takes to create MPC applications. The heart of ToolBook's multimedia muscle is MPC's Media Control Interface, and Asymetrix handled support for this in a very elegant, "hands-off" manner, leaving it to the developer to build the command/argument strings that are passed to the MCI handler.

ToolBook was the first tool I picked up after breaking the seal on my first MPC system, and within 30 minutes I not only understood the basics of writing MPC code but had a working ToolBook application that combined CD audio with digitized voice-overs. This stuff works.

By focusing on MCI, the Multimedia Resource Kit automatically supports every existing MPC media type, and all possible new types, without requiring you to purchase upgrades. And for those who are in a *real* hurry, Asymetrix throws in a sample book loaded (and I *do* mean loaded) with preprogrammed controls for most of the MPC media. There are even full-fledged control panels for CD and wave audio that you can build, by pointing and clicking, into your own applications in seconds. I chose to create my own, of course, but more sensible people may be inclined to let Asymetrix's engineers do the work instead.

A hidden benefit of ToolBook is that it is a supremely extensible environment. It not only communicates with multimedia procedures through MCI calls, but it also leaves room to hook into any function that is contained in a Windows-compatible DLL. Those hooks don't require access to the DLL source code, and, with some exceptions, ToolBook allows you to communicate with DLL-embedded functions on their own terms. It's not uncommon to find ToolBook examples for complex Windows peripherals. My pet example is Fluent Machines' Fluency full-motion video board set. The demonstration application *is* a ToolBook program. Fluency and many other multimedia products ship with the ToolBook definitions you need to start writing useful programs right away.

The only real drawback with Multimedia ToolBook is one that has applied to ToolBook all along: Even on a fast machine, ToolBook can be slow. After working with it for a while, you begin to get a feel for where the bottlenecks are and how to keep your applications responsive. But again, Windows is not a real-time environment, and its problems are exacerbated by an interpretive programming system like ToolBook. Even so, I found it irresistible. For now, there isn't a better or faster way to get full-featured MPC applications out the door than with Multimedia ToolBook.

## Tandy 4033LX Multimedia

*Tandy's 4033LX Multimedia is a standard 33-MHz 386 system with a Sound Blaster Pro audio card, a Super VGA display adapter, and a Tandy CD-ROM drive and interface card.*

Tandy was among the first to bring fully packed MPC systems to market. The company has built itself a reputation as a provider of systems that are solidly built and perform well. The 4033LX Multimedia lives up to that tradition, with one exception (which I'll get to later).

The 4033LX Multimedia isn't fundamentally different from an ordinary 4033LX—a 33-MHz 386, modular CPU card design, scant internal drive slots (two 3½-inch and two half-height 5¼-inch), one serial port, one parallel port, and one mouse port. What sets it apart is that the factory builds these systems into stand-alone MPC machines by adding Tandy's CD-ROM drive and controller and a Creative Labs Sound Blaster Pro sound card.

The big downside to manufacturers' bundles is that you generally wind up missing something. In my case, the system lacked all documentation and DOS software for the Sound Blaster Pro. Maybe it's part of the deal Tandy struck with Creative Labs, but the manuals, program and demonstration disks, and even the Voyetra MIDI sequencer that are part of the normal Pro package were left out. Everything needed to run the board under Windows was there, however, and all was preconfigured and ready to run.

When Tandy's smartly designed system boots up, it asks for the CD-ROM disc included with the system. This disc has several application demonstrations, but it starts with a series of digitized pictures that show you how to hook up your audio card and then segues into a Tandy demonstration that mixes audio, music, and Autodesk 3D Studio animation. It looks nice enough (once) and does a fair job of testing out the system and your audio connections.

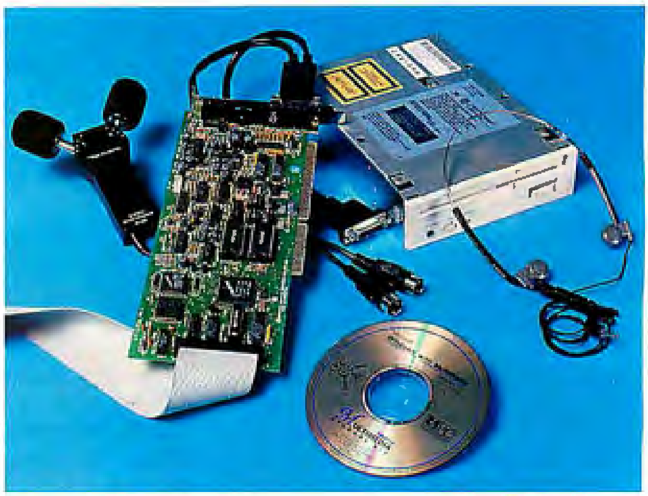
My system arrived from Tandy configured with 4 MB of memory and a 100-MB hard drive. That comes out to one wrong and one right, at least where *developing* MPC applications is concerned. Tandy can't be faulted here, but if you intend to write MPC programs, you will want an 8-MB system. The 100-MB hard disk, on the other hand, turned out to be just the right size, even for my demanding requirements.

While the system performs well, there are a couple of key areas that need improvement. One is something you should improve, and the other is Tandy's responsibility. Depending on how you intend to use your 4033LX Multimedia, you may want to invest in an accelerated graphics card (see "Tweaking Windows: New Adapters Boost Speed and Clarity," January BYTE). Tandy bundles a 512K Paradise VGA card, a popular and economical choice, but not a top performer.

The second performance issue is Tandy's CD-ROM drive. Again, its design helps keep the cost down (and I do like the lack of need for the never-there-when-I-need-one CD caddy), but its seek time leaves much to be desired. If the drive's sole purpose were to get from one audio track to another, I would say "So what?" but most of the work of CD-ROM is retrieving data. Once it gets there, the drive transfers data fast enough to satisfy MPC requirements. But when the drive is forced to seek, look out. I'm all for using lower prices to get technology into the hands of the masses, and frankly there were only a few times when the drive's seek time became a major annoyance. But I did have that feeling more than once.

So should you buy a prepackaged MPC system or roll your own? If you don't already have a PC ready to upgrade, the difference in cost is relatively small. So it all boils down to convenience. If you like the idea of having everything installed for you at the factory, even though that means you don't get some manuals and software you might get otherwise, get the Tandy (or one of the other standalone MPC systems). In return, you'll have one-stop service for everything in the machine. On the other hand, if you want to spend a little more for a system that performs a lot better, build from components and include a Windows accelerator board and a faster CD-ROM drive.

## Creative Labs' Sound Blaster Pro



*Creative Labs' MPC Upgrade Kit, shown here with an internal CD-ROM drive (the microphone and headphones are not included).*

Mac users once kicked sand on the poor PC victims who lacked digitized sound and music. Creative Labs helped change all that, and its latest sound card, the Sound Blaster Pro, is fast becoming one of the leading sound boards for MPC systems.

The Sound Blaster Pro is, first and foremost, an audio card. In that role, it has some pretty respectable specifications that mesh perfectly with MPC requirements: 22 simultaneous voices of FM (a method of sound synthesis popularized by Yamaha) synthesized sounds; two channels of direct digitized audio I/O, with sample rates of from 4 to 44 kHz (8-bit); a software-programmable audio mixer that provides control over levels of on-board audio as well as CD audio, external line/microphone, and master volume; and a 4-watt-per-channel (at 4 ohms) stereo amplifier.

Beyond its ability to create and control sound, the board also has MIDI input and output ports (with an optional cable), an IBM-compatible analog joystick port, and a CD-ROM controller. This card, plus a CD-ROM drive and Windows with Multimedia Extensions, *is* an MPC upgrade kit. Creative Labs sells it that way, CD-ROM drive and all, which makes it very easy.

Before I talk about Creative Labs' full upgrade kit, I'd like to focus for a moment on the board itself. The Sound Blaster Pro's roots are in the video game realm, so this board is *not* going to put synthesizer companies out of business. The FM synthesizer on this board is functional and is capable of producing some nice sounds, but most of the sounds are rather thin and, well, something like what you would get from a $100 department-store portable keyboard.

I may be fussier than the average consumer in this regard, but I can't imagine banking my company's image on a musical soundtrack that makes the audience squirm in their seats. My view of the internal FM sounds is that they exist for convenience. If you plan to use the MPC MIDI facilities, the FM synthesizer on the Sound Blaster Pro will give you a convenient preview of your work. Then avail yourself of a Roland Sound Canvas or similar external MIDI sound module, push a few buttons on a Windows control-panel dialog box, and record or present your music in a way that will impress rather than amuse.

The Sound Blaster Pro's digital audio capabilities are expansive. The top sampling rate is 44.1 kHz, which is more than enough to capture all the sounds in

the audible spectrum. Again, don't expect digital-audiotape-quality audio from this 8-bit digitizer, but if you've got the disk space, the Sound Blaster Pro has the ability to capture and replay very nice digitized sound. The lower sampling rates are a boon for audio voice notes (taking up very little space), the middle range is perfect for even presentation voice-overs, and the top rate will handle music with minimal distortion.

There isn't much more to say about the upgrade kit that comes with the CD-ROM drive. It works, it comes with a fair assortment of free CD-ROM titles, and the drive itself seems to seek good and fast compared to the Tandy. The drive isn't top-of-the-line—the manual eject mechanism is slightly awkward—but it does what it's supposed to.

If the Sound Blaster Pro is used mostly as a delivery system for desktop applications, I can't recommend it more highly. It's a relatively inexpensive way to add good-quality digitized sound and mediocre synthesized sound to a PC. I can recommend the card for those who plan to use it for business presentations, but if you're not pulling your music tracks directly off an audio CD or digitizing them to disk, I suggest you invest in an external MIDI sound module to pick up the quality slack.

## Applied Optical Media's MediaSource

*Applied Optical Media's MediaSource brings a huge library of digitized photos, music, and sound effects to multimedia producers. All items are cross-referenced in a keyword database.*


MediaSource is a set of well-crafted CD-ROM collections of digital scanned images and audio files. Its visual half is what publications know as a "stock service"—general-purpose images, taken by professional photographers, that you can copy and use in your computer-based presentations. Dozens of scanned images on this disc cover every imaginable category from arcades to zoos. I was generally impressed with the quality of the images. There wasn't any evidence of dark or washed-out images, and the color was generally right on the money. Images are sized for display at 640 by 480 pixels—enough to fill a standard VGA screen.

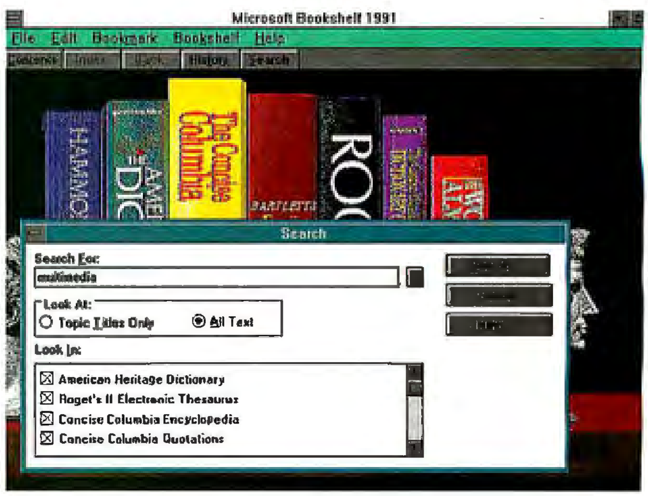
The audio files are a good mix of production music (the kind of tunes you hear behind TV and radio commercials) and sound effects recorded as MPC .WAV files. The quality of the recordings is good—there's no clipping or distortion—and the files sound about as good as MPC-standard 8-bit audio boards can sound. As for the musical quality, I got about what I expected: I couldn't wait to use some of the tunes, while others ranged, in my view, from mediocre to almost amusing. But one man's Beastie Boys is another man's Mozart. It was wise of Applied Optical Media to include so many different styles of music in this collection. I was especially pleased to find such an impressive assortment of bridges, short musical segments that are used to accompany scene transitions and other similar visual effects.

It might have been enough for Applied Optical Media to cram all the image and audio files it could onto a CD-ROM, but MediaSource includes a graphical application that lets you run simple database scans on the CD-ROM data. Every item on the disc has a keyword list associated with it, and the database program lets you use those cross-referenced keywords to zero in on specific images or sound files. Want to find a photo of an arcade and a sound file to go along with it? How about a number of photos depicting medical emergencies? These are there, and the MediaSource interface not only scans the database for keyword matches, but it allows you to browse through the images or audio files that match the search.

I consider MediaSource to be an indispensable tool for anyone who plans to use MPC products to create computer-based presentations. Not only will it save you a world of time, but it will add a very professional edge to anything you create.

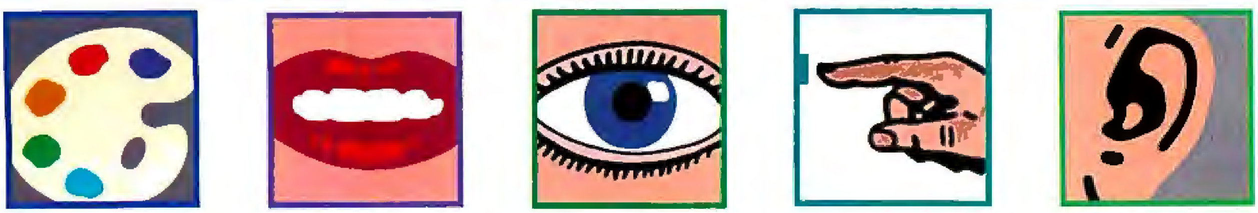
## Microsoft Bookshelf for Windows

*Microsoft Bookshelf for Windows includes useful reference volumes annotated with digitized audio and animation. You can search the entire library for a keyword or phrase.*




Microsoft's Bookshelf reigned, in the days before MPC, as one of the more useful PC CD-ROM titles available. This reference set has been updated to run under Windows and to take advantage of MPC's multimedia prowess.

The assortment includes just about everything you need to beef up your writing: the Second College Edition of The American Heritage Dictionary, Bartlett's Familiar Quotations, The Concise Columbia Dictionary of Quotations, The Second College Edition of The Concise Columbia Encyclopedia, the Hammond



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Atlas, Roget's II Electronic Thesaurus, and The 1991 World Almanac and Book of Facts. I can't spend any time discussing the relative usefulness of any of these volumes. What makes the Bookshelf special is its presentation.

Microsoft Bookshelf was obviously carefully designed to be a good demonstration of MPC features, and it works. One tip-off to the demonstrative nature of Bookshelf is that it allows you to skip right to the "good part"; you can browse through the animations, graphics, and audio files contained in the collection. The encyclopedia entry for *refrigerator*, for instance, includes an animation with synchronized audio that provides a glorious example of the proper application of multimedia: It manages to encapsulate the entire concept into several seconds of moving pictures and sound. While this obviously helps grab youngsters' attention, don't underestimate its power for grown-ups, as well.

In general, Microsoft Bookshelf for Windows makes excellent use of the functions that are added by MPC. Every entry in the dictionary has its pronunciation clearly demonstrated by a speaker's voice, and some entries are accompanied by illustrations. The Atlas has an assortment of detailed maps and can play national anthems. And selected quotations can be heard as well as seen.

**Microsoft Bookshelf was obviously designed to be a good demonstration of MPC features.**

As you'd expect, the Bookshelf is endowed with impressive text-search capabilities that allow you to rapidly search any or all volumes in the set for combinations of keywords. Windows lends its text and graphical cut-and-paste facilities, so when you find that clip or image you're looking for, it can become part of your work in seconds.

My only disappointment with Bookshelf was an idealistic one. Once I grew used to having Bookshelf available, I was loath to swap its CD-ROM for another. Even though Windows lets you run multiple applications at once, you can only run one that requires its own CD-ROM. There's no easy solution (save CD-ROM changers), but Microsoft did its best to put all the standard reference materials you might need on one disc.

### Promises Kept

I went on to look at many other MPC products in addition to the ones described here. Unfortunately, I can't discuss them all (at least not now). This first harvest is a bountiful one, and any skepticism I had about the practical worth of MPC's brand of multimedia faded quickly as I worked with one application after another.

Multimedia technology is like most technology in general in that no one really *needs* it. I have made the case for

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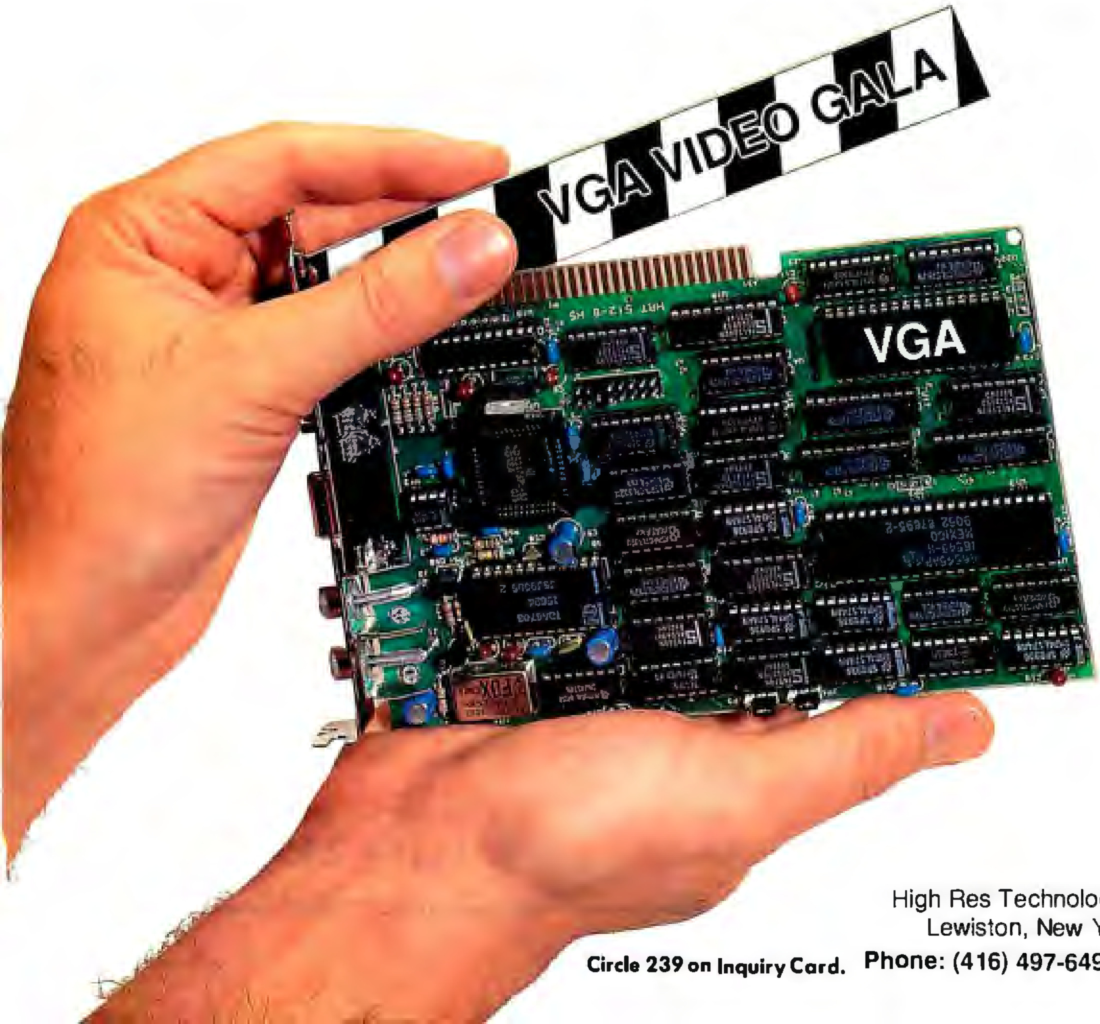


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Circle 239 on Inquiry Card. Phone: (416) 497-6493 Fax: (416) 497-1636 the practical, serious use of sound and graphics in the past (see "Information's Human Dimension," December 1991 BYTE). If used well, multimedia is a wrapper for information that makes it easier to digest and retain. MPC brings together the tools, the standards, and the vendor support needed if multimedia has any hope of occupying more than the occasional desk. ■

*Tom Yager is a BYTE technical editor who manages the Multimedia Lab. He is author of* UNIX Program Design and Development for IBM PCs *(Addison-Wesley, 1991). He is on BIX as "tyager."*

## ITEMS DISCUSSED

**Applied Optical Media Corp.**
1450 Boot Rd.
West Chester, PA 19380
(215) 429-3701
fax: (215) 429-3810
*MediaSource* ..........*$395 (per volume; nine currently available)*
**Circle 1229 on Inquiry Card.**

**Asymetrix Corp.**
110 110th Ave. NE, Suite 700
Bellevue, WA 98004
(206) 637-1500
fax: (206) 455-3071
*Multimedia Resource Kit* ........... *$300*
*Multimedia ToolBook* ...............*$695*
**Circle 1230 on Inquiry Card.**

**Creative Labs, Inc.**
2050 Duane Ave.
Santa Clara, CA 95054
(408) 986-1461
fax: (408) 986-1777
*Sound Blaster Pro* ................*$299.95*
*MPC Upgrade Kit*
*internal CD-ROM* ..............*$849.95*
*external CD-ROM* ..............*$949.95*
**Circle 1231 on Inquiry Card.**

**MacroMind·Paracomp, Inc.**
600 Townsend St., Suite 310W
San Francisco, CA 94103
(415) 442-0200
fax: (415) 442-0190
*Action* ..................................*$495*
**Circle 1232 on Inquiry Card.**

**Microsoft Corp.**
1 Microsoft Way
Redmond, WA 98052
(206) 882-8080
fax: (206) 936-7329
*Microsoft Bookshelf for Windows* ..........................*$195*
**Circle 1233 on Inquiry Card.**

**Tandy Corp.**
700 1 Tandy Center
Fort Worth, TX 76102
(817) 390-3011
fax: (817) 390-2774
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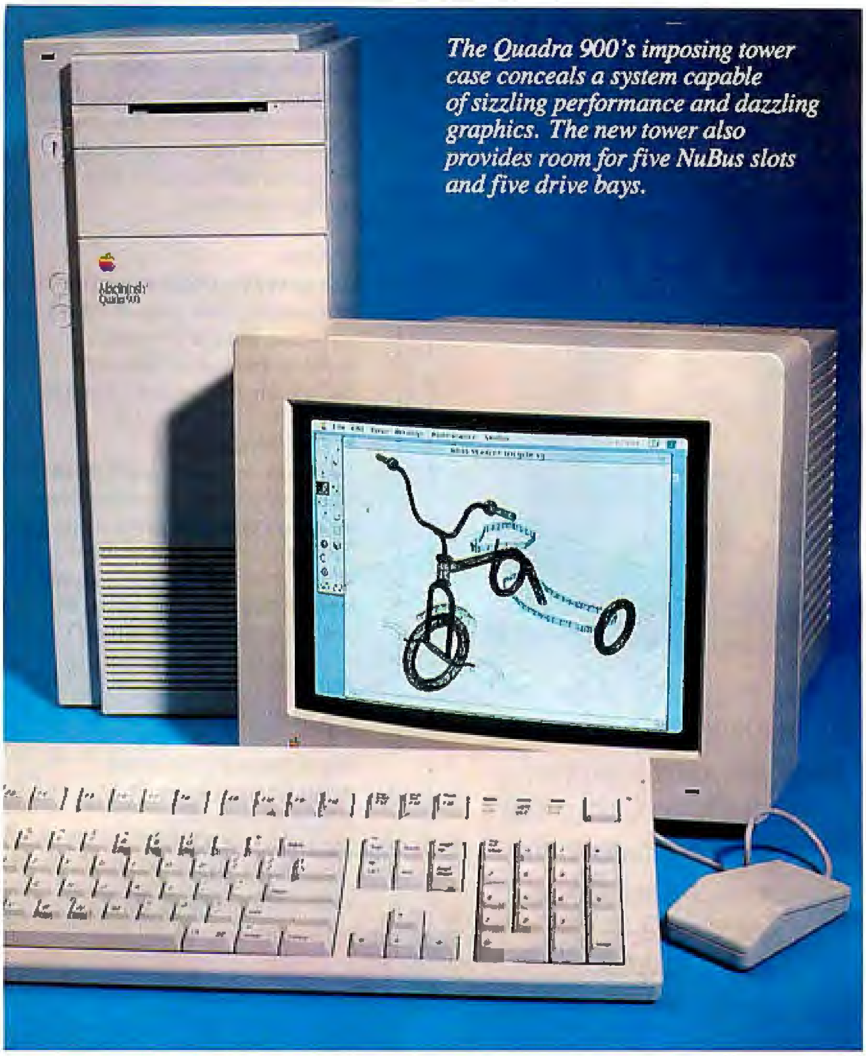
HARDWARE

# Apple's Quadra 900 Sizzles and Dazzles

TOM THOMPSON



*The Quadra 900's imposing tower case conceals a system capable of sizzling performance and dazzling graphics. The new tower also provides room for five NuBus slots and five drive bays.*

Unless you've been off the planet, you've caught Apple's introduction of its long-awaited, much-rumored 68040-based Macs. The two systems are the Mac Quadra 700, a small desktop machine, and the Mac Quadra 900, a tall, floor-standing tower. I wrote a detailed description of them based on a brief hands-on session in "A Peck of New Apple Macintoshes" in the November 1991 BYTE. Naturally, I wanted to put the Quadras through a more thorough evaluation. I didn't have to wait long: Within days of the announcement, a Quadra was sent BYTE's way for review. The demand for these new computers was high enough that only the high-end Quadra 900 was available.

There are only minor differences between the Quadra 700 and 900: At the heart of both is a 25-MHz 68040 processor and 1-MB ROMs that contain extra code to support 68040-specific features. The Quadra 700 packs this all into a Mac IIci case, along with two NuBus 90 slots and a single 68040 Processor Direct Slot (PDS). In fact, IIcx and IIci users can step up to a Quadra 700 via a main logic board swap for $3499. The Quadra 900's larger case has more slots and bays for extra hard drives for those with demanding expansion or storage needs.

## Exteriors

The Quadra 900 comes with the bevy of ports common to most Macs, including an Apple Desktop Bus (ADB) port for mouse and keyboard, two serial ports for LocalTalk network and modem connections, a built-in video port, a microphone input port, and a DB-25 SCSI connector for peripheral devices. It also includes a built-in Ethernet port and two RCA sound-input jacks. Currently, the signals from these two jacks are mixed before being digitized, but an upgrade may be in the works to give the Quadra 900 stereo input capability. A third sound-input port located on the main logic board can accept CD audio from an optional, internally mounted CD-ROM drive.

Two things become apparent after a quick tour of the exterior. First, the reset and interrupt switches, concealed to the point of invisibility on other Macs, are large, prominent buttons here. Obviously, Apple designers expect serious MacFolk to use this box, and they did not go out of their way to protect users from themselves. Second, there is a three-position security lock with a removable key. When the lock is in the "off" position, the machine is locked in a powered-down state. The "on" position allows the Quadra 900 to operate like a normal Mac. The "secure" position disables the ADB port and SuperDrive floppy drive, so you can't disturb programs running on the Quadra unless you press the reset button. This provides a measure of security, but this setup could be improved if the programmer's switches were disabled as well.

## Hardware Details

The basic Quadra 900 package includes a SuperDrive floppy drive and 4 MB of 80-nanosecond Mac IIci RAM, but no hard drive. The cavernous tower case houses up to four 5¼-inch half-height drives and one 5¼-inch full-height drive, so you can easily install a high-capacity drive from another vendor.

The Quadra 900 uses two NCR 53C96 SCSI controllers: One handles the internal SCSI devices, while the other manages SCSI peripherals connected to the external port. The two buses are logically connected, so you are still limited to a maximum of six SCSI devices.

Because the Quadra can rely on the quality of its internal SCSI cabling, the internal 53C96 can transfer data at up to

## BYTE ACTION SUMMARY

- **WHAT THE QUADRA 900 IS**
  A high-performance, 25-MHz 68040-based Macintosh.

- **LIKES**
  Fast disk, math, and video operations. Plenty of NuBus slots, abundant hard drive bays, and a 300-watt power supply to support the power demands of a fully configured system.

- **DISLIKES**
  Compatibility problems require that you upgrade some of your software. The programmer's switches aren't disabled when the key is in the "secure" position.

- **RECOMMENDATIONS**
  This machine is suitable for those who need a powerful workstation for graphics, image processing, CAD, and complex simulations. In the future, the Quadra's security features will make it useful as a process or transaction se ver.

- **PRICE**
  $8499

- **FOR MORE INFORMATION**
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5 MBps, while the external 53C96 is limited to 4 MBps. These higher transfer rates translate to faster hard disk performance. The separate external bus helps to minimize high-speed signal problems among peripherals, eliminating the Mac IIfx's infamous "black terminator" that held noise-reducing filter capacitors.

Inside the Quadra 900 are five NuBus 90 slots and one 68040 PDS. There are 12 SIMM sockets so that you can expand the memory to 64 MB. Six video RAM SIMM sockets can expand the video frame buffer to 2 MB, which enables the built-in video to support 24-bit-deep displays on 16-inch monitors. This frame buffer memory is directly connected to the 68040's buses, which makes for rapid screen drawing.

The Quadras use an enhanced version of the Apple Sound Chip, now called the Enhanced Apple Digital Sound Chip. The EADSC has important new features, such as a record mode for sound input (which requires the assistance of an A/D converter), real-time hardware decompression of stored sounds, hardware sample rate conversion, and 16-bit digital serial output. Missing is the four-voice synthesis capability found in the ASC.

While the EADSC can handle 16-bit data, the Mac OS doesn't support this capability. The chip still uses 8-bit digital sound. However, the EADSC, along with improved analog sound circuitry, provides a bandwidth of 16 kHz. That's up from the 7.5-kHz bandwidth provided by existing Macs, and it's apparent that the Quadra 900's acoustic range, along with its CD audio input, makes it a significant machine for multimedia applications.

### Life with Quadra

The review system I had came with 4 MB of RAM and an internal 160-MB hard drive. Extra-long monitor, power, and ADB cables let you park the Quadra under your desk, and a large speaker ensures that you hear sounds generated by the Quadra even from across the room. When you start the machine, the improved sound capabilities become obvious: The boot-up hardware test tune sounds like an entire orchestra rather than the usual lone electronic banjo.

The display's drawing speed is dramatic, with brisk screen response on a 13-inch AppleColor RGB monitor. In order to get a taste of the faster video and improved sound, I connected an Apple CD-ROM drive to the Quadra and ran Reactor's Spaceship Warlock, an interactive movie CD. The results were awesome: smooth graphics with superb sound, even though the data was coming from a CD drive.

I connected the Quadra directly into BYTE's Ethernet network using one of Apple's Thin Coax Transceivers. The hookup was almost as simple as a LocalTalk connection: Move a few cables and you're set. The Ethernet copy operation of BYTE's 17-MB application benchmarks moved smartly from a Mac IIci with an Asante NuBus Ethernet board to the Quadra. Faster network transfers are welcome perks, since you can expect Quadras to regularly move large amounts of information across networks.

I tested the Quadra's performance with new versions of the BYTE Macintosh benchmarks that include timing performance with a suite of newer applications (see the figure). The Quadra 900, at 25 MHz, outgunned a 40-MHz 68030-based Mac IIfx by 20 percent to 30 percent on many applications. The Quadra

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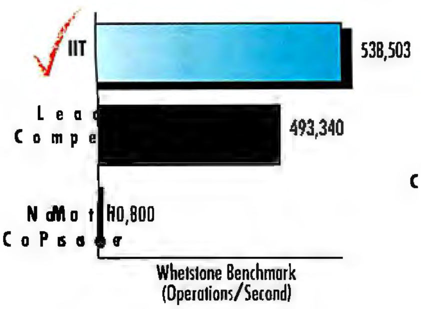


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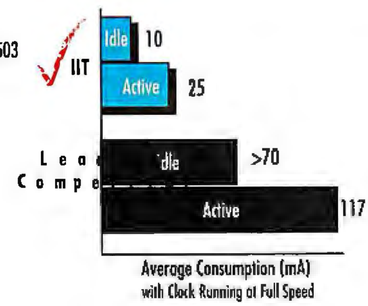


### HIGHEST SPEED GRADES

| | | | | | | |
|---|---|---|---|---|---|---|
| IIT | 3C87 | 16 MHz | 20 MHz | 25 MHz | 33 MHz | 40 MHz |
| | 2C87 | 8 MHz | 10 MHz | 12 MHz | 20 MHz | |
| | 3C87SX | 16 MHz | 20 MHz | 25 MHz | | |
| Leading Competitor | 387 | 16 MHz | 20 MHz | 25 MHz | 33 MHz | |
| | 287 | 8 MHz | 10 MHz | 12 MHz | | |
| | 387SX | 16 MHz | 20 MHz | | | |

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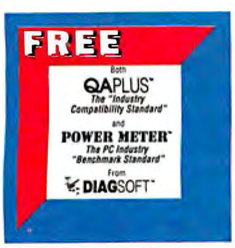


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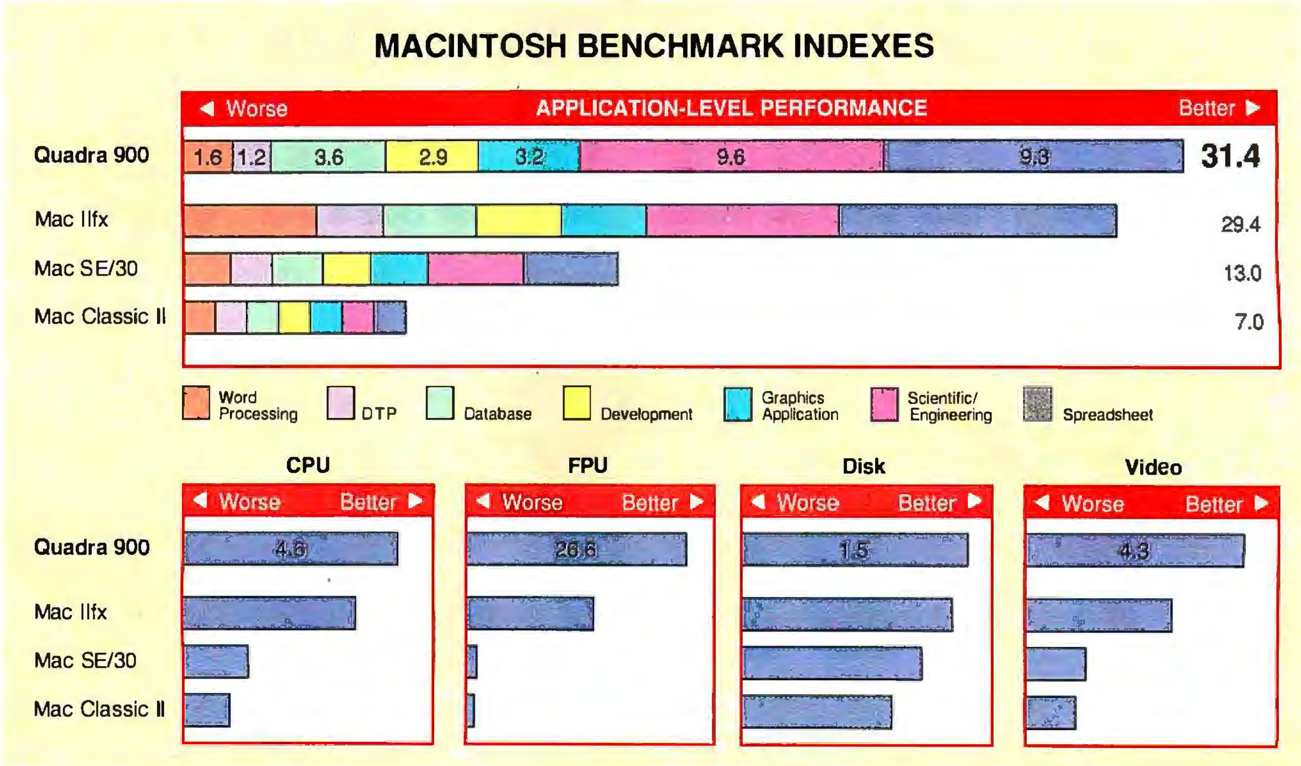


*Not surprisingly, Apple's top-of-the-line Quadra 900 delivers top-of-the-line performance. Most scores were outstanding—significantly higher than those of the Mac IIfx. Unfortunately, incompatible versions of major applications mandated disabling the 68040's cache on BYTE's DTP and Word Processing application benchmarks, so performance on these applications is below par. See the text for details.*

All machines were tested using System 7.0.1. Except for the Dhrystone test, all results are indexed. For each test, a Mac Classic II = 1, and higher numbers indicate faster performance. The floating-point benchmarks use the SANE library. Comprehensive test results and detailed configurations are available for all machines on request.

| | Dhrystones |
|---|---|
| **Mac Quadra 900** | 16,666 |
| Mac IIfx | 10,000 |
| MacSE/30 | 3125 |
| Mac Classic II | 2000 |

gets some of its performance boost by using the 68040's cache in copyback mode. In this mode, cache information isn't written to main memory until data is flushed from the cache. While this speeds processing, it can cause problems in keeping main memory in sync with the cache's contents.

Most Mac applications ran without problems on the Quadra: It was a relief to see that Adobe Illustrator 3.0.1 worked, as did White Knight 11.12, using Shiva's network drivers to connect to a Shiva network modem. INITs such as Now Utilities 3.0.1 and Suitcase 1.2.11 worked fine. A beta version of Timbuktu 5.0 also worked, allowing me to view and control a Compaq 386 system running Windows 3.0 from the Quadra.

Unfortunately, some major applications suffered incompatibility with the Quadra 900, including Microsoft Word 4.0, Microsoft Excel 3.0, and Aldus PageMaker 4.0. Each of these applications crashes when confronted with the 68040's cache.

Apple provides a short-term fix with a Cache Switch cdev that disables the cache. You suffer a huge hit in performance with the cache disabled: The Quadra's word processing (Word 4.0) and desktop publishing performance (PageMaker 4.0) plummeted to that of a 16-MHz 68030-based SE/30. The long-term fix will be to get the 3.0a maintenance version of Excel (the version I used for testing) and to upgrade to Word 5.0 and PageMaker 4.2 when they become available. Some vendors rushed out electronic patches to make their products 68040-compatible: Symantec's Think Technologies division patched its compilers, and Berkeley Systems updated After Dark, to name a couple.

For third-party device checks, I used an Irwin SCSI tape drive to restore some scanned images archived on DC-2000 cartridge tapes. For the display, I installed SuperMac's Thunder/24 24-bit accelerated display board. Opening the Quadra 900's housing is just a matter of pushing on two tabs on the rear and swinging the side of the case out. This provides ready access to the RAM SIMM sockets and NuBus slots. Once it's installed, the Thunder/24 board, like the Quadra's built-in video, automatically senses the monitor's screen size and configures the scan rate to match. With acceleration on, scrolling through the restored 24-bit scanned images on a 13-inch Apple monitor or a 19-inch SuperMac monitor was boosted by a factor of six to eight times. A Quadra, when combined with the Thunder/24, makes for a powerful image-manipulation engine.

Who needs a Quadra? With its high-speed processing power and improved floating-point performance, it makes an ideal CAD workstation. Professional designers creating complex artwork or image retouching will need its fast graphics capabilities. Its security features will also make it an ideal transaction or process server as System 7.0 applications evolve. ■

*Tom Thompson is a BYTE senior technical editor at large with a B.S.E. from Memphis State University. You can contact him on BIX as "tom_thompson."*

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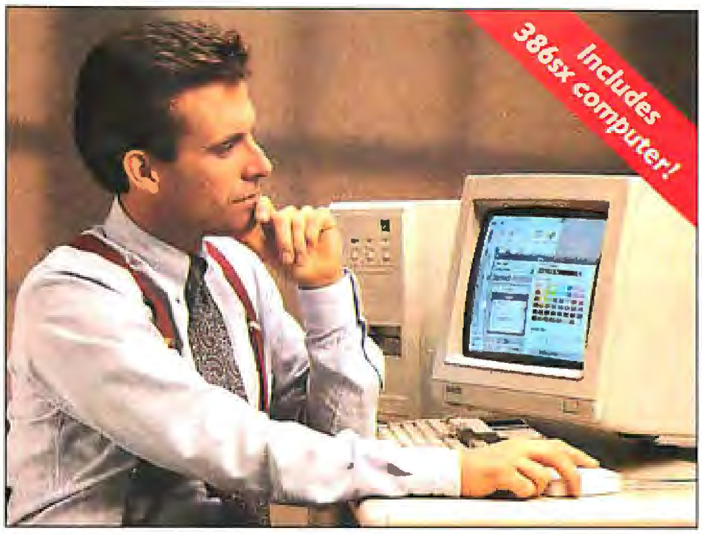


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## New Outbound Takes On the PowerBooks

*The Outbound Notebook System is a comfortable traveling companion, but loose connections can lead to frustrating failures.*

For the second time, Outbound Systems has beaten Apple to the punch in the portable Macintosh arena. Outbound's new $4099 Notebook System shipped just before Apple's barrage of PowerBooks (see "A Peck of New Apple Macintoshes," November 1991 BYTE). But a slight advantage in timing won't be enough for the Outbound Notebook System Model 2030 if a few quirks aren't ironed out shortly.

With the Outbound Notebook System, Outbound has come to a licensing agreement with Apple that allows it to use Apple ROMs in its computers. Customers buy a used Mac Plus as part of their purchase of Outbound's notebook.

The CPU of our Model 2030 Notebook System was a 20-MHz 68EC030, which is a 68030 without a memory management unit. With Mac Plus ROMs, the Model 2030 can't take advantage of the 68030's MMU anyway, so Outbound spares some expense by leaving it out. Outbound had to create the glue code to make features such as the Apple Desktop Bus, power management, sound recording, and LCD work with Mac Plus ROMs.

The new modular design of the 2000 series lets you change the CPU and 40-MB hard drive in the field, which is a commendable feature. Unfortunately, the review machine exhibited hardware difficulties throughout the test period.

After a few rounds on the phone with Outbound technical support, we got the system healthier by reseating ROMs and generally fiddling with connections. But considering how much jostling a portable takes, it's scary to have such loose connections.

The 20-MHz CPU and 68882 FPU position the Outbound's performance squarely between that of Apple's PowerBook 140 and 170 notebook systems. The PowerBook 140 offers a 16-MHz 68030 CPU but no FPU, while the PowerBook 170 uses a 25-MHz 68030/68882 combination. If you need extra processing power beyond what a PowerBook 140 supplies, give the Outbound a serious look. However, before you buy, check for sturdy connections.

## Unix Workstations Access Mac and PC Applications

If you're moving to a Unix workstation from a PC or a Mac, or if you just want convenient access to applications on these systems, a couple of solutions now can ease the transition. XGator 1.0, from Cayman Systems, provides workstation (and other) users access to Macintosh applications. Logicraft's Omni-Ware 1.66 offers workstation users access to DOS, Windows, and OS/2 applications.

Both products make native applications available to any qualified user on the network. In our tests, both products ran, with very few exceptions, even the most demanding applications without flinching.

Once you connect, a "virtual screen" window opens on your workstation. With XGator, you see the Macintosh desktop; with Omni-Ware (and the optional VGA board), you get the equivalent of a VGA screen.

Everything you type in the virtual screen window is sent to the application server as though it were a locally typed keystroke. Every time the application server's Mac or VGA screen changes, those changes are shipped over the Ethernet to your workstation. In effect, your workstation's keyboard, mouse, and display become wired to the remote Mac or PC for your entire session.

XGator users need Ethernet, TCP/IP, Telnet, and X Window System server software. No special hardware or software is required on the remote system. Omni-Ware requires special software on the remote host, and therefore it will run only on workstations that are supported by Logicraft.

Once it's set up, XGator is ridiculously easy to use, and it runs almost perfectly under System 7.0 (aside from the MacTCP glitches, which will probably be fixed by the time you read this). This is one of those programs that, delightfully, does what it promises.

Omni-Ware is highly compatible and adept at fooling applications into thinking they're dealing with ordinary DOS hardware. Logicraft's software has a few not-so-shining moments. For example, programs that don't use a DOS mouse driver (including some graphical programs that run in protected mode) can't see the mouse unless you use a special Logicraft driver. Overall, however, Omni-Ware proved itself to be stable and quite usable. ■

—The BYTE Lab

*Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products and product categories.*

**ITEMS DISCUSSED**

**Omni-Ware 1.66**
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**XGator 1.0**........................$495
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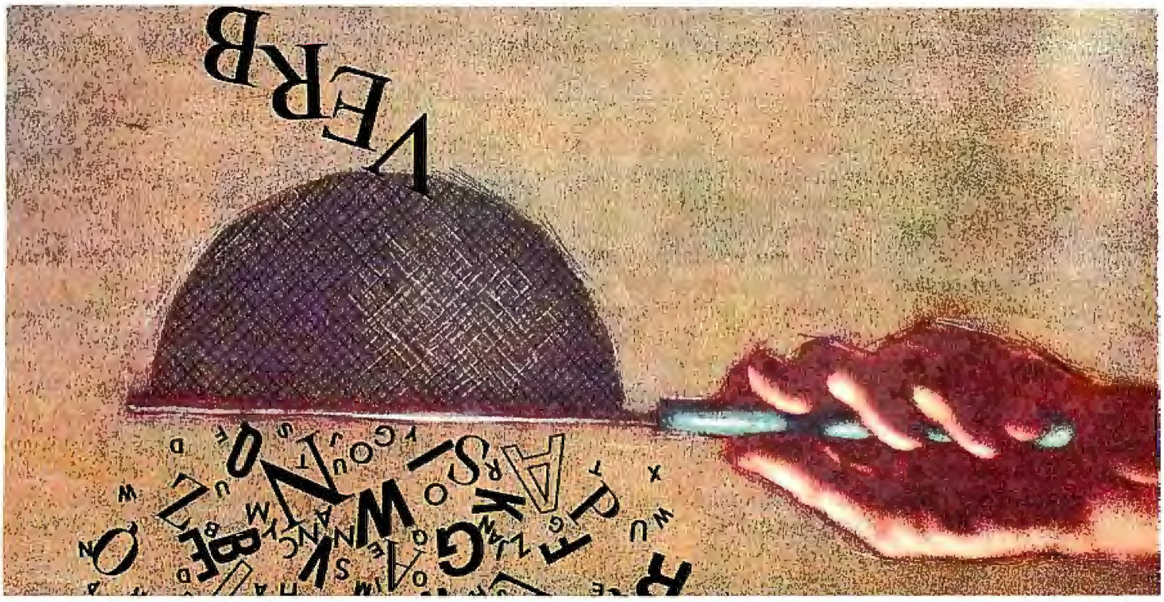
DAVID PERELMAN-HALL

# A Natural Solution




**Grammar and computer language parsing techniques make a C++ program for evaluating natural language**

The expression "time flies" may seem commonplace, but it is far from trivial for a computer to understand. Computer evaluation of natural language is also far from trivial; it is useful for building truly user-friendly interfaces, automatic language translators, and query languages. This is the field known as *computational linguistics*, and it is as much related to compiler design as to the elements of grammar.

The program that evaluates text for grammatical structure is called a *parser*. Parsers often use *tokens*, which are intermediate symbols that represent the elements of the input. In natural language, these tokens often represent parts of speech. A sequence of tokens can abstractly represent the grammar of the input. The first step is determining the grammar, and for that task you need a natural-language parser.

## Parts of Speech

To handle the phrase "time flies," the natural-language parser could start by deriving the part of speech (PoS) of each word. To do this, it could have a dictionary lookup function (`getPoS()`) that takes a single parameter, consisting of the word under consideration, and returns its part of speech as a token. Possible values returned for "time" and "flies" might include the following:

```
getPoS(time) → noun
getPoS(time) → verb
getPoS(flies) → noun
getPoS(flies) → verb
```

To handle these PoS values, the computational parser has to be equipped with a set of grammar rules that authorize sequences of words that are linguistically sound. Certainly one of these sequences consists of a noun followed by a verb. In fact, the basic sentence consists of these elements, and, therefore, you could assign the basic sentence word order based on a grammar rule of the form, "A sentence can be a noun followed by a verb."

## Backus-Naur Form

The rule "a sentence can be a noun followed by a verb" can be compactly expressed as S → N V. I use this descriptive form (known as the Backus-Naur form, or BNF) along with simple abbreviations for the parts of speech (e.g., S = sentence, N = noun, V = verb) to describe the grammar for parsing natural language. The parsing grammar is a context-free phrase-structure grammar (PSG), the key elements of which are as follows:

- a finite set of grammatical categories, such as N and V

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**ELEMENTS OF GENERALIZED PHRASE-STRUCTURE GRAMMAR**

1) S — Start symbol
2) NP, VP, PrepP — Finite set of grammatical categories
3) S → NP VP
NP → DET N
VP → ADV V — Finite set of rewrite rules
4) Boy, dog, silly, girl, love, the, a, above — Finite set of terminal symbols

**Figure 1:** *The rule set is context-free. It consists of rules specifying how the left-hand side can be rewritten as the right-hand side. The rules are specified using grammatical categories and lists of terminal categories (i.e., words of the natural language).*

- a finite set of rules specifying how the left-hand side (LHS) can be rewritten as the right-hand side (RHS)
- a start symbol—usually an S for "sentence"
- a finite set of terminal categories that are the words of the language

Figure 1 shows an example. With the context-free nature of this rule set, rewrites can take place regardless of the context in which the LHS appears.

A deeper linguistic analysis of common phrase and sentence structures shows that many other constructions are permitted in English in addition to the standard subject-verb-object word order. For instance, there is the structure of imperatives. The command "Eat fruit" is clearly acceptable English, but it consists in its surface form of a S → V N word order.

Furthermore, such unusual phrasal constructions are permitted in English as concatenated nouns that act as modifiers instead of nouns. For instance, you would readily admit that "The Jones's evening car ride joke punchline" makes sense enough to be acceptable English, even though five words in a row are all nouns and you might never utter such a silly phrase. Nonetheless, this example shows that English sanctions constructions of the N → N N type.

**RULE SET**

*The rule set for a simple phrase-structure grammar.*

| Rule | Meaning |
|---|---|
| S NP VP | Sentence consists of a noun phrase followed by a verb phrase. |
| NP DET NP | Noun phrase consists of a determiner followed by NP. |
| VP TV NP | Verb phrase consists of a transitive verb followed by NP. |
| DET the | |
| NP they | |
| NP cows | |
| TV see | |

So, the senses of the two-word phrase "time flies" rendered admissible by these grammar rules include the following:

- The commonplace meaning of "time moves quickly." This invokes the S → N V rule.
- The command "to time flies," as in "find out how long it takes for flies to do something." This invokes the S → V N rule.
- A breed of flies, as in the phrase "horse flies." This invokes the N → N N rule.

The computer parser encountering these two words would find each of these parses correct, depending on the grammar it was using.

## The Chart Parser

Since I am looking at this question from the computer's perspective, I'll design the parser that could yield the results I've just given. The type of parser that I will design is a chart parser, which gets its name from the chartlike object in which assertions about the developing parse are housed.

This parser will proceed in a bottom-up fashion, which means that it begins with the input words (which are some portion of the set of terminal symbols) and recursively seeks to derive an LHS category from RHS values. The process is complete when the parser encounters the LHS category S (sentence). For example, if the PSG embraces the rules in the table at left, and you submit the sentence "they see the cows," the parser rewrites each RHS value as shown in figure 2. The steps in the process are as follows:

- "they" will be rewritten as NP;
- "see" will be rewritten as TV;
- "the" will be rewritten as DET;
- "cows" will be rewritten as NP.

At this stage, the original sentence is represented as NP TV DET NP. Working from the bottom up, the RHS category sequence DET NP can be rewritten to the LHS category NP, so a new stage evolves, consisting of NP TV NP. Now, TV NP can be rewritten as VP, and the resulting NP VP can be rewritten as S. At this point, since I've spanned the entire input string of "they see the cows" and reached an S, the parse succeeds.

The PSG has the power to handle most of the grammatical structures of natural languages, but it also has deficiencies. In particular, it is ill-equipped to handle syntactic ambiguity where, as I'll show later, the parser does not know which to prefer of two authorized parses for a single input. The general utility of this approach to parsing, however, has been well established, and with the addition of specialized linguistic tests, the PSG can handle many situations of grammatical ambiguity.

## More on the Chart

The chart records assertions about the developing parse, and the assertions are taken from the PSG rules. There are two classes of assertion: those that have been confirmed and those awaiting confirmation.

At the beginning of a parse, only the initialization assertions have been recorded; all others are still unconfirmed. Because all assertions originate from phrase-structure rules (PSRs), they represent relationships such as "a sentence comprises a noun phrase followed by a verb phrase." When the RHS can be rewritten as the LHS of a PSR (remember, I'm going bottom-up), the assertion that sanctioned that parse changes from unconfirmed to confirmed. For example, the assertion that NP TV DET NP → NP TV NP is confirmed by the rule NP → DET NP (the underlined symbols are the ones involved in the assertion).

The newly confirmed assertion is then added to the chart. Eventually, all claims for the parse, both confirmed and unconfirmed, are recorded in the chart; they are stored as `Edges`—a C++ object that I'll create for the parser. Since there

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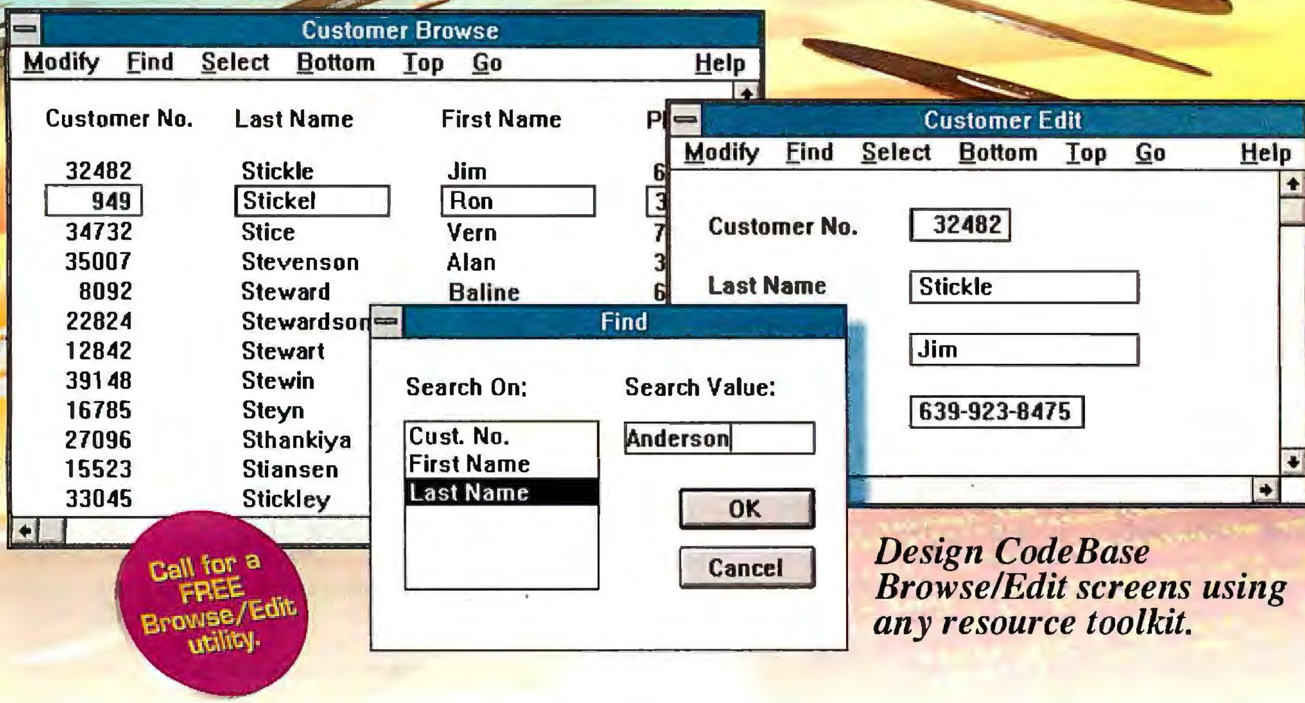


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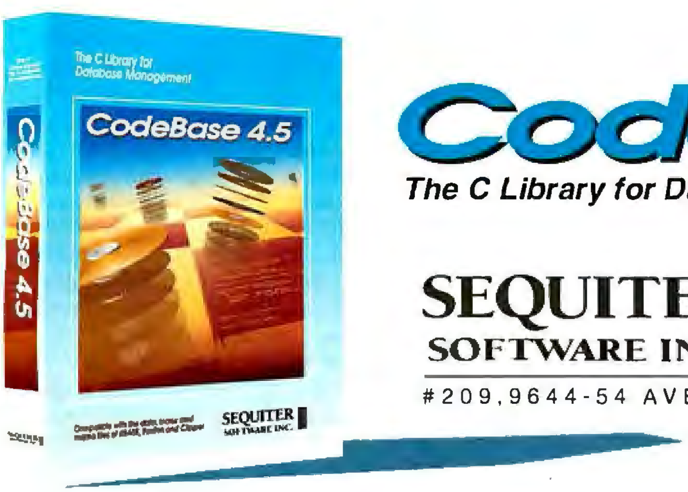


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can be more than one correct parse, those parses that span the entire input sentence and satisfy the start symbol are successful.

The beauty of maintaining a chart of all assertions lies in its practicality: Depending on the grammar rules, a parser can frequently parse the same subsection of a sentence. For example, say the parser is working on the sentence "the horse raced past the barn fell," and it has put these assertions

- "the horse" is an NP
- "raced" is a V

in the chart. If it fails to parse the sentence correctly the first time through, it won't have to reconfirm and re-add these assertions. It can merely check in the chart to see if they exist already, and if so, use them.

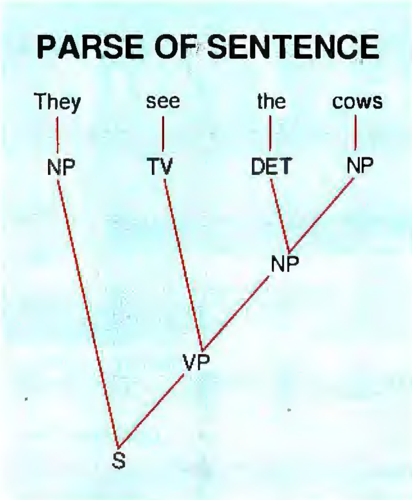


**Figure 2:** *Following the rule in the table, the sentence "they see the cows" is resolved to an S in four passes.*

### A Category

The chart parser uses an object-oriented design and is implemented using C++. My object-oriented design for a chart-based parser begins with defining the classes Category and Category_Sequence.

The Category class is the basic class to which LHS, RHS, and other parser objects belong. It constructs a basic Category object out of a string of 20 characters, the maximum word length. LHS, RHS, grammar rules, and words of the input sentence are all instances of this basic class. It also defines operator tokens used for copying and comparing the Category objects.

The Category_Sequence class is a singly linked list of CategoryNodes, each of which contains a Category and a pointer to the next node. The individual words of the input sentence together form an instance of a Category_Sequence, as do the Categorys forming an RHS. You create the structure required for an RHS by appending a Category to the Category_Sequence. An input sentence is also contained in this structure. Like the Category class, the Category_Sequence class also defines operators for copying and comparing. In addition, it defines special overloaded += and + operators that append either a Category or a Category_Sequence to a Category_Sequence.

The access functions for Category_Sequence are as follows:

- first()—returns the Category of the first node
- rest()—returns the Category_Sequence minus its first node
- length()—returns the length of the Category_Sequence; that is, the number of Categories in it
- a Boolean check for an empty Category_Sequence
- pop()—removes and returns the first Category in the Category_Sequence

The Chart class and the Edge class are related in that a Chart maintains the list of Edges in the chart parser. Each Edge contains an assertion from the parse. An Edge consists of four elements:

- an integer Start value
- an integer Finish value
- a Tree that contains the parsing history that led to the Edge
- a Category_Sequence, ToFind, which represents the unconfirmed portion of an assertion. This quadruple is represented as Edge E = <Start,Finish,Tree,ToFind>.

The Start and Finish values bracket the portion of the input sentence to which the assertion applies. A parse is not complete until the final assertion applies to the entire source sentence—in other words, until the Start value is 0, and the Finish value equals the length of the sentence. Any other condition represents a case where the parse covers only a portion of the input sentence.

The Edge class defines member functions for copying; comparing; testing whether an Edge's assertion is confirmed or unconfirmed; testing for combinability (which tests whether two Edges can form one new Edge between them; this makes an assertion about a longer portion of the sentence); and a nonmember function for doing the actual combining of Edges, in accordance with the Fundamental Rule (described later). It also has access functions to return the various elements of an Edge, such as Start and Finish. Two Edge functions, canCombineWith() and isActive(), relate to the creation of new Edges that are being added to the Chart. (More on these functions later.)

The Edge_List class contains a singly linked list of EdgeNodes that comprise an Edge and a pointer to the next EdgeNode. Since the Edge_List is made of Edges, you can do anything to an element of the Edge_List that you can do to an Edge. The Chart is constructed from an Edge_List, so access functions add (push) and remove (pop) Edges from an Edge_List and determine whether an Edge already exists in a Chart (in which case it is not duplicated in a Chart). A member function determines whether an Edge_List is empty.

### The Chart Class

Understanding the Chart class is crucial to understanding how this parser works: The Chart constructor actually creates two Charts (i.e., Edge_List arrays), where the array size is set to the number of words in the input sentence. One of these arrays is called active_edges_arr, because it will contain the Edges with unconfirmed assertions—Edges actively seeking confirmation. The other Edge_List is called inactive_edges_arr, for the obvious reason that it will contain Edges with confirmed assertions. Henceforth, the position of a word in the input sentence determines where in the appropriate Chart object array it will be indexed.

The Chart class also contains an integer value, last_pos, for sentence length, which is established at run time by determining the length, in number of words, of the input sentence. Using two Edge_Lists helps optimize the parser by accelerating lookup time; the parser attempts to confirm an active Edge by matching the active Edge with an inactive Edge that corresponds in sentence position and PSR.

However, if all Edges were housed in one chart, the search space would be larger, and an additional Boolean test for whether an Edge is active or inactive would have to be applied at every attempted matching; both of these conditions would slow down the parser appreciably. In fact, an implementation in Lisp took 146 seconds to parse a 14-word

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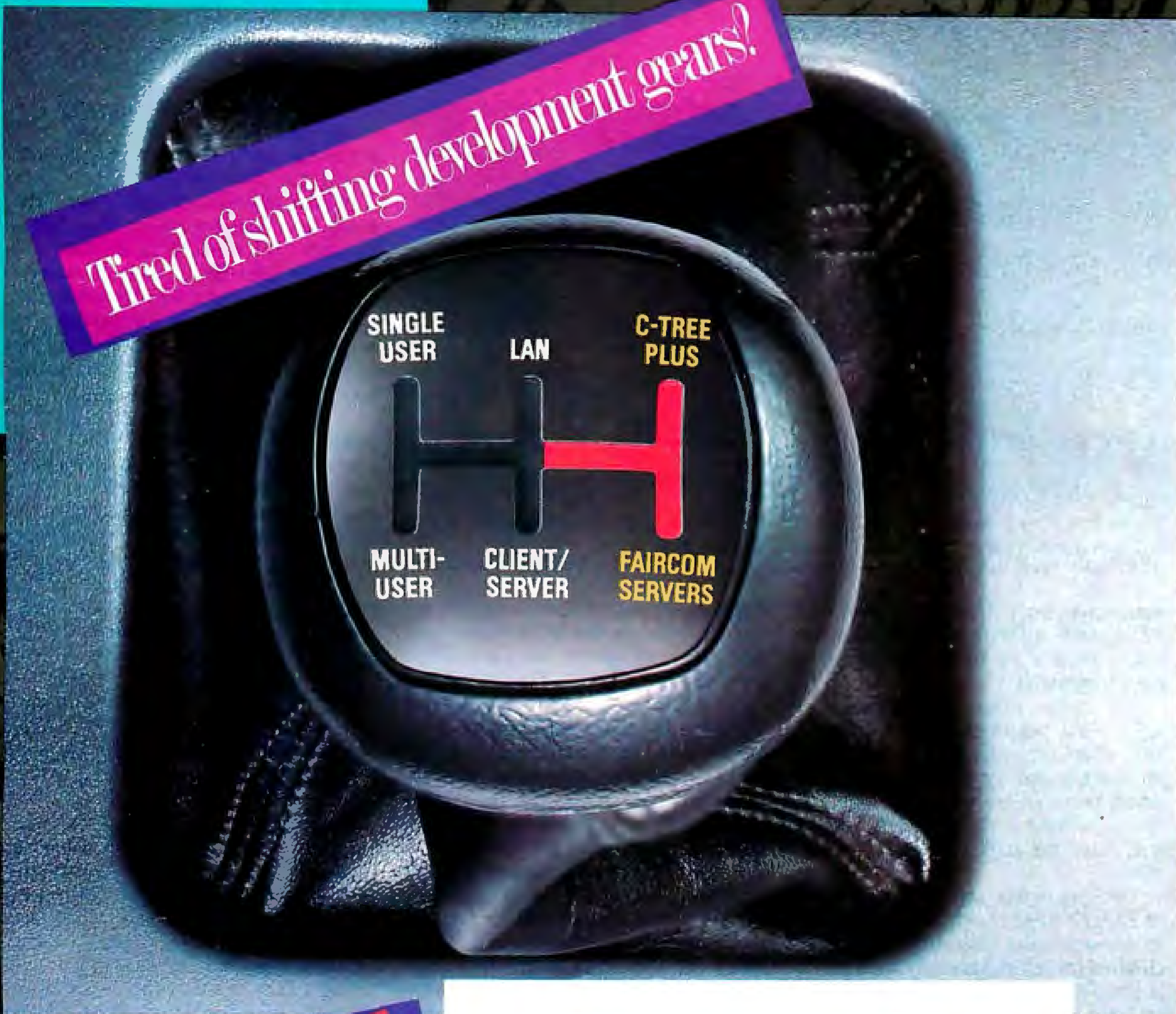


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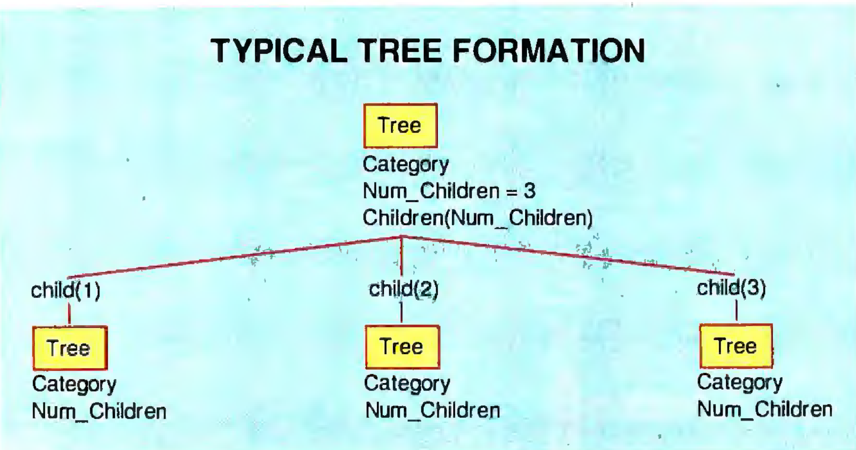


**Figure 3:** *A* Tree *comprises a* Category, *an integer value indicating how many children the current* Tree *has, and an array of pointers to sub-*Trees.

sentence without this optimization, but 32 seconds after this optimization—that's roughly an 80 percent improvement in speed.

The Chart class has the Boolean isIn() test, which checks for the presence of an Edge in a Chart. It also has the Boolean test for a successful parse, which seeks an inactive Edge spanning the entire input string and satisfying the goal (i.e., the start symbol—S—of the PSG).

The Tree object is the third element of an Edge. A Tree comprises a Category, an integer value indicating how many children (more linguistically appropriate is *daughters*) the current Tree has, and an array of pointers to Trees that themselves contain the children of the developing parse, as depicted in figure 3.

The Tree structure is used in an Edge for the confirmed portion of an assertion. The Edge was originally configured by Gazdar and Mellish as a quintuple, as follows:

```
Edge E = <Start,Finish,Label,
  Found,ToFind>
```

where Start and Finish are integers indicating what portion of the input sentence the Edge spans; Label is a Category indicating what LHS of a PSR the Edge pertains to; Found is a Category_Sequence indicating what portion of an assertion has been confirmed; and ToFind is a Category_Sequence indicating what portion of an assertion has not yet been confirmed.

As figure 4 shows, my renovation of the Edge replaces both the Label Category and the Found Category_Sequence with a Tree, in which you can see that the history of the parse that generated the Edge still retains these elements. That is, a Tree comprises a Category, which is effectually the LHS label, and each child of a Tree has an RHS Category that, taken altogether, form the Found Category_Sequence.

These elements are housed in a Tree structure because this structure affords a means of maintaining the entire history of parse development that occasioned each Edge. The Tree structure currently allows a maximum of five children; this constrains the number of RHS Categorys of any PSR to five Category elements. Thus, at present, the parser will not accept a BNF rewrite rule with more than five RHS elements.

Besides the Boolean comparators and access functions for adding and returning such Tree elements as children and Category, this object (and all objects discussed in this article) has user-defined output operators for writing objects to standard output devices (e.g., the screen) or, through redirection, to an output file.

## Agendas and Rules

The Agenda object is nothing more than a stack that comprises a list of Edges (i.e., an Edge_List). There are access functions for pushing Edges onto and popping (getNext()) Edges off the Agenda. The function isIn() determines whether an Edge is already in the Agenda and, therefore, prevents duplication of effort; another function determines whether the Agenda is empty of Edges; if this is the case, then the parser searches for a successful parse. The Rules object is responsible for building the PSRs that constitute the grammar that is used by the parser.

Two important functions that relate Rules to Edges are the Boolean function appliesTo(), which determines whether or not a Rule applies to an Edge, and the apply() function itself, which applies a Rule to an Edge, returning a new Edge that is pushed onto the Agenda. Applying a Rule creates either a new Edge with an unconfirmed assertion that is based on the Rules, or an Edge with part or all of its assertion confirmed. If a Rule is found to apply to Edge E, then a new Edge, E1, is created in which the result of the application of the Rule is designated.

Following Gazdar and Mellish, the "dotted rule" provides a means of designating when an assertion has been confirmed; a dot divides the confirmed

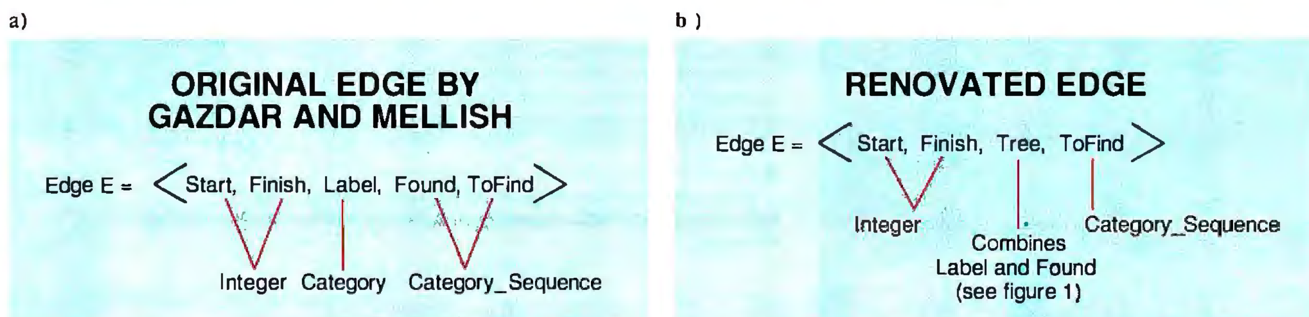


**Figure 4: (a)** *The original* Edge *and* **(b)** *its renovation, which replaces both the* Label Category *and the* Found Category Sequence *with a* Tree.

**Listing 1:** *A rule set for parsing, among others, the sentence "the nurses on the report see outrageous fortune."*

| | | | |
|---|---|---|---|
| S NPVP | NPN CONN | N NURSES | ADJRED |
| SS CONJ S | NP NCPO NNP | N BOOK | ADJBLACK |
| VP VCPO NVP | P PP NP | N BOOKS | ADJYELLOW |
| VPI V | P PP ADJNP | N TRAVEL | IVTRAVEL |
| VPI VPP | P PP PCONBP | N ARROW | IVTRAVELS |
| VPT VNP | ADJADJCONADJ | N ARROWS | IVREPORT |
| VPT VNP PP | CONAND | N FORTUNE | TVREPORT |
| VPT VNPVP | DETTHE | N FORTUNES | TVHEAR |
| VPT VRE IS | DETA | N REPORT | TVSEE |
| NPDETNP | DETHIS | ADJOUTRAGEOUS | IVSEE |
| NPDETADJNP | DETHER | ADJSILLY | TVSUFFER |
| NPDETADJ NP | NPHER | ADJBLUE | IVSUFFER |
| NPDETNPPP | NPHE | ADJGREEN | P ON |
| NPADJNP | NPTHEY | ADJHEAVY | P OF |
| NPN | N NURSE | ADJWHITE | REITHAT |

(Found) portion from the unconfirmed (ToFind) portion of an assertion. Note that an Edge containing any unconfirmed portion is considered unconfirmed—that is, an Edge still actively seeking confirmation.

In the following sentence and quintuple Edge,

```
0 they 1 see 2 the 3 cows 4
<0,4,S,NULL,.NP VP>,
```

you can see that this Edge asserts that an S will span the entire sentence from position 0 to position 4 and that the Found Category (i.e., the confirmed assertion) is empty or NULL, while the ToFind Category_Sequence contains an NP and a VP. The dot before the NP indicates that nothing has been confirmed (there is nothing to the dot's left) and that NP and VP await confirmation (to the dot's right).

Assume that the parser confirms an NP for this Edge. The resulting Edge would be

```
<0,4,S,NP,NP.VP>,
```

where the dot has moved to the right of the NP but the VP still lies to the right of the dot, awaiting confirmation.

### The Fundamental Rule

Gazdar and Mellish describe the action of extending the confirmed portion of an Edge as the Fundamental Rule. They informally describe this rule by saying, "If an active Edge meets [as determined by sentence position] an inactive Edge of the desired category, then put a new Edge into the Chart that spans both the active and inactive Edges."

Formally, the definition states that if the Chart contains edges Edge E = <1,2,A,W1,.B W2> and Edge E1 = <2,3,B,W1 B,.W2>, where A and B are Categories and W1 and W2 are Category_Sequences, then add the edge Edge E2 = <1,3,,A,W1 B,.W2> to the Chart. The Finish of Edge E (Finish = 2) matches the Start of Edge E1 (Start = 2). By the dotted rule representation, you can see that the dot has moved to the right of Category B in Edge E1; therefore, you can add a new Edge E2 as depicted, spanning E and E1.

### Initialization

The task of initialization is to ensure that there are inactive Edges in the Chart. This is done immediately through a dictionary lookup process that places all possible confirmed assertions in the Chart for each lexical entry in the input sentence. Thus, for a sample sentence of "they see the nurses report," and using the PSG provided in listing 1, you could initialize the Chart with the following confirmed assertions:

```
NP → they.
TV → see.
DET → the.
N → nurses.
IV → report.
N → report.
```

This example illustrates the manner in which syntactic ambiguity can creep into the parser, for this simple grammar leads to allowable structures containing both verb and noun for the word "report." As it stands, the parser would be obliged to accept both (or all) of the parses as correct.

### The RuleList

The RuleList object contains an array of the Rules and an integer value that indicates how many Rules there are. This object has functions for reading in the file of PSRs and for adding the read-in Rules to the list of Rules kept in the RuleList.

The parsing function passes messages to the objects, creating a list of Rules from the RuleList file, then loading up the Agenda, and running the parse by attempting to apply the Rules to the Edges as the Edges are popped off the Agenda or found in a Chart. Once the Agenda has run out of work to do, the Chart that houses all the confirmed assertions is passed to a function that seeks a successful parse, as already defined. The source for the rules file is shown in listing 1.

### To Do

There are improvements that could be made to this parser to optimize its performance and to regulate its ability to handle ambiguity.

Can you think of a means for improving the organization or retrieval of Edges within each Chart, active and inactive, that would not rely on sentence position alone, but perhaps also on PSR, Label, or other grammatical evidence? Would there be any sense to ordering the rules of the PSG to produce a hierarchy from most-likely-to-be-used to least-likely? If the parser encountered a successful parse on the first pass, is it plausible that this parse would be sanctioned by the more-likely rule? ■

Editor's note: *The complete source code for this application is written in Borland C++. Both the source code and the compiled executable code are available in a variety of formats. See page 5 for details.*

**ACKNOWLEDGMENTS**

*I thank Jamshid Afshar, a computer science student at the University of Texas, for his help in developing the C++ code for this parser. This* Chart *parser implementation is based on the work of Gerald Gazdar and Chris Mellish in their text* Natural Language Processing in Lisp *(Addison-Wesley, 1989). Design principles for the object-oriented program were taken from Grady Booch's text* Object Oriented Design with Applications *(Benjamin/Cummings, 1990).*

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

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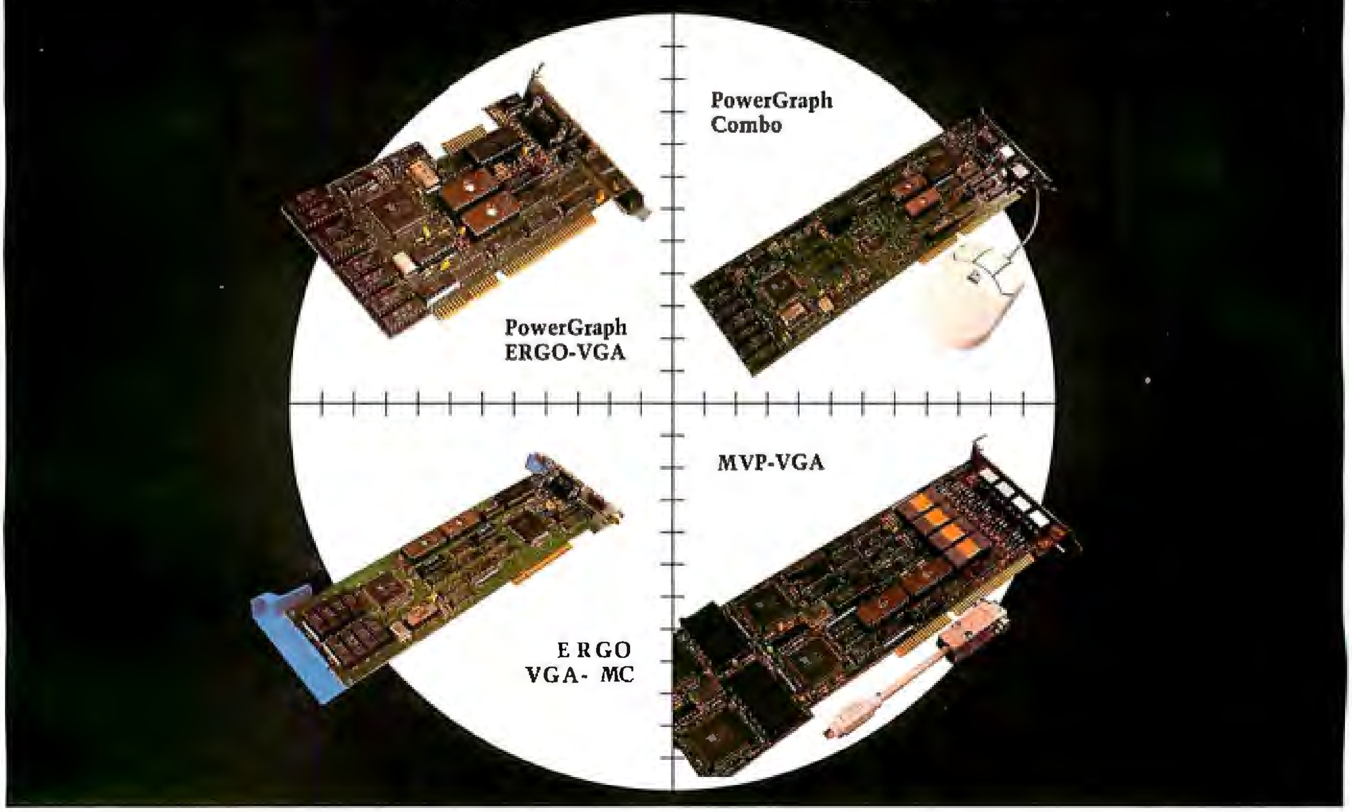


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# HOW INTERRUPTS WORK

**Interrupt-processing mechanisms in PC systems**

Our daily lives are filled with asynchronous events that vie for our time, interrupting the orderly, sequential plan for the day. The telephone rings; there's a knock at the door; the baby cries for a diaper change. You can't predict their occurrence and plan them into your schedule, yet they must be accommodated. You could, of course, regularly check (or *poll*) for events—Is the phone ringing? Is someone at the door? Does the baby need to be changed?—but, clearly, that would be an inefficient use of time; it is better to let such asynchronous events capture your attention as they need to.

Similarly, your computer must respond to asynchronous events (e.g., keyboard presses, mouse movements, disk accesses, timer time-outs, and data communications). If the processor in your computer had to continually poll the various I/O devices, it would not be very efficient at doing the real work you ask of it. So to maintain efficient use of the processor's time, computers use interrupts to handle asynchronous events.

Like people, a processor executes instructions in a scheduled, sequential manner until an interrupt request (IRQ) occurs. When this happens, the processor drops what it's doing and services the interrupt, and then resumes sequential execution where it left off.

As for supporting interrupts, the conventional implementation of today's PC systems is lacking in some areas, but certain key problems have been overcome in the newer EISA and Micro Channel expansion buses. Following is a detailed look at how PCs handle interrupts.

## Interrupt Basics

There are three general types of interrupts that can occur in a PC: hardware interrupts, software interrupts, and processor exceptions. Hardware interrupts are the focus of this article, but I'll describe the others as well.

I/O devices electrically generate hardware interrupts to get the attention of the processor. The first PCs, of course, used Intel's 8088 processor, which has essentially the same functionality as the newer 286, 386, and 486 processors operating in real mode. All these processors have two pins that are used for interrupt purposes: INTR and nonmaskable interrupt (NMI).

## Maskable Interrupts

INTR is the conventional interrupt input to the processor. This interrupt input is maskable, meaning that it can be enabled or disabled under software control. An interrupt enable flag (IF) in the FLAGS register enables INTR interrupts when set and disables them when cleared. With interrupts enabled, when the INTR input goes high, the processor completes its current instruction and then responds to the IRQ with two successive interrupt acknowledge (INTA) cycles.

The first INTA cycle is essentially a dummy to ready the interrupting device for the second INTA cycle.

*continued*

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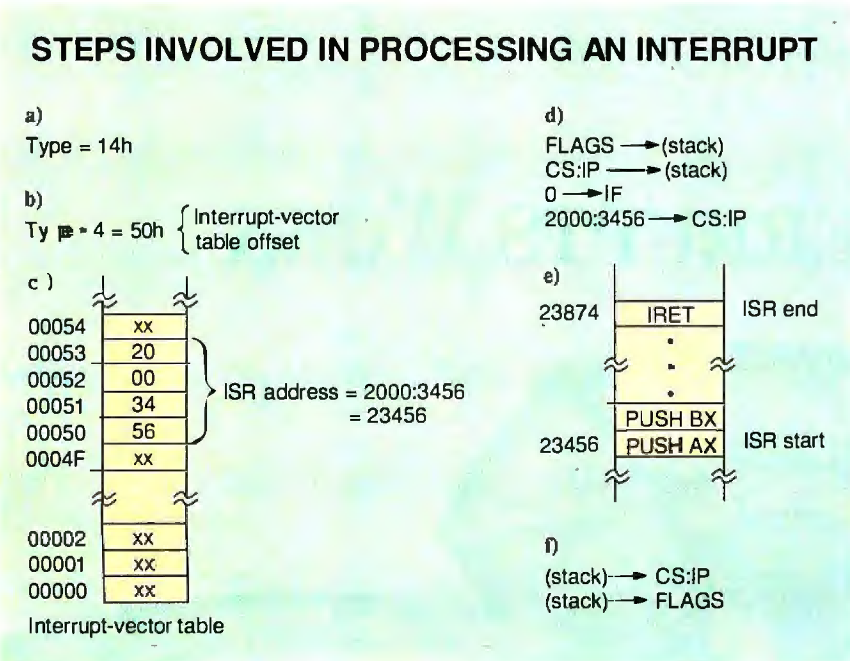


**(a)** *Type byte received: type 14h;* **(b)** *multiply type byte by 4 to get interrrupt-vector table offset (50h);* **(c)** *get ISR address (2000:3456) from interrupt-vector table (location 00050h);* **(d)** *push FLAGS register, Code Segment, and Instruction Pointer onto the stack, clear the interrupt-enable flag (IF), and branch to the ISR;* **(e)** *execute the ISR (at location 23456h), terminating with an IRET instruction; and* **(f)** *restore Instruction Pointer, Code Segment, and FLAGS register from stack.*

During the second INTA cycle, then, the interrupting device must place an 8-bit interrupt-vector (sometimes called an *interrupt-type*) byte onto the data bus to further direct the processor's handling of the interrupt. In most systems, including PCs, a special IC called an interrupt controller interacts with the processor to place the interrupt vector on the data bus at the appropriate time.

When the processor receives the interrupt type from the interrupting device, it multiplies the value by 4 (by shifting it 2 bits to the left) to create an offset into the interrupt-vector table. This table—which contains 256 4-byte entries (1 KB total) starting at the very bottom of memory—holds the addresses of the service routines for the implemented interrupts. Note that a maximum of 256 distinct interrupts can be supported in this fashion.

The processor now retrieves the 4 bytes at the calculated offset in the interrupt-vector table to form a pointer to the interrupt-service routine; the pointer is in standard 80x86 segment:offset format. After pushing the FLAGS register onto the stack and clearing the IF bit in the FLAGS register, the processor begins to execute the ISR.

To keep problems from occurring after returning to the interrupted program, the ISR has to save any CPU registers that it uses and restore them when it is finished. An ISR generally terminates with an interrupt-return (IRET) instruction, which restores the FLAGS register from the stack (reenabling interrupts) and resumes program execution where it left off. The figure shows the steps that are involved in processing an interrupt after the interrupt-type byte has been received.

Most systems have several I/O devices that generate interrupts, so it's the responsibility of external circuitry to combine the various IRQs into a single IRQ presented to the processor. To differentiate the various IRQs, a unique interrupt-type byte is returned to the processor for each different IRQ. The external circuitry must also prioritize the IRQs, so it can decide which type byte to return to the processor when multiple IRQs are simultaneously active.

An interrupt controller generally encompasses all these features. In most 80x86 systems, including all PCs, Intel's 8259A (or a functional equivalent) Programmable Interrupt Controller (PIC) does this job.

The INTR input of the 80x86 processors is *level sensitive*. When the processor sees a high signal level at this pin, it considers that to be an active IRQ. If the IF flag is set in the FLAGS register, an interrupt will occur at the end of the current instruction.

If an ISR reenables interrupts when it begins executing (as is often the case), it must first ensure that its own IRQ is no longer present at the INTR pin. Otherwise, a duplicate (or *nested*) interrupt will occur, causing a second instance of the ISR to be executed (interrupting the first instance of the ISR), then a third, and so on until the stack overflows.

The interrupt controller helps here, too. It disables further INTR activations for the current IRQ—until the ISR indicates its completion by sending an end-of-interrupt (EOI) command to the interrupt controller.

## Nonmaskable Interrupts

The processor's second interrupt input, NMI, is a *nonmaskable* interrupt, which means that software cannot disable the interrupt input. When NMI is activated, the processor internally generates an interrupt-type byte of 2; no INTA cycles are generated.

Unlike the INTR input, the NMI input is *edge sensitive*. A low-to-high signal-level transition triggers the interrupt. Once the interrupt is processed, a continued high signal on the NMI pin will not retrigger it; the signal must return low and then go high again to generate another nonmaskable interrupt.

NMI has higher priority than INTR and is primarily intended for handling system-critical situations, such as a power failure or a memory parity error. Even NMI can be overridden in a PC, however, since an external circuit allows masking of the interrupt.

## Software Interrupts

Intel provides an interrupt (INT) instruction that allows any of the 256 possible interrupt types to be generated by software. When an INT instruction is executed, the processor treats it just like an INTR interrupt, except that the interrupt-type byte is specified by the instruction, so no INTA cycles are needed to retrieve a type byte.

The INT instruction has a higher priority than the hardware interrupts, so if the INT instruction is executed at the same time that an NMI or INTR IRQ is received by the processor, the INT instruction takes precedence.

## Processor Exceptions

During normal program execution, a processor should proceed along without a

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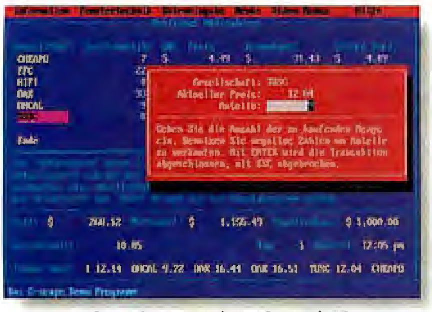

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**80X86 PROCESSOR EXCEPTIONS**

**Table 1:** *When it built the original PC, IBM assigned interrupt types that Intel had reserved for future use. That created grief for protected-mode operating systems, such as Windows and OS/2, that must reprogram the Programmable Interrupt Controller to avoid conflicts.* (● = *yes;* ○ = *no.*)

| Processor exceptions | Interrupt type | 8088/86 | 286 | 386/486 |
|---|---|---|---|---|
| Divide error | 00h | ● | ● | ● |
| Single step | 01h | ● | ● | ● |
| Array bounds check | 05h | ○ | ● | ● |
| Invalid opcode | 06h | ○ | ● | ● |
| Device not available | 07h | ○ | ● | ● |
| Double exception detected | 08h | ○ | ● | ● |
| Coprocessor segment overrun | 09h | ○ | ● | ● |
| Invalid task state segment | 0Ah | ○ | ● | ● |
| Segment not present | 0Bh | ○ | ● | ● |
| Stack segment overrun | 0Ch | ○ | ● | ● |
| General protection violation | 0Dh | ○ | ● | ● |
| Page fault | 0Eh | ○ | ○ | ● |
| Coprocessor error | 10h | ○ | ● | ● |

care in the world. But of course, life is not always so wonderful, and problems can crop up. For instance, say a processor is politely asked to perform a division operation, but the denominator is zero. Division by zero is, of course, illegal, and there is no value the processor can generate for the quotient. Instead, the processor generates an exception, which is an internal interrupt of a predetermined type. The divide-error exception is type 0.

Functionally, the processor treats an exception exactly as it would a software interrupt, with the caveat that the interrupt type is defined by the specific exception. The 8088 (and 8086) generates only the divide-error exception, while higher 80x86 processors can generate other exceptions as well, such as an invalid-opcode exception. Table 1 shows the exceptions and the respective interrupt types for the 80x86 processors.

### Hardware Interrupts in a PC

The 8259A PIC is the key to hardware-interrupt handling in PCs. PC and XT systems include a single 8259A that can handle eight IRQs (IRQ0–IRQ7), while AT (286, 386, and 486) machines have two 8259As to support 15 IRQs. One potential IRQ input is lost due to cascading—the interrupt output of the second PIC (or the *slave*) goes to one of the IRQ inputs (IRQ2) of the first PIC (or the *master*).

The 8259A has all the desirable features of an interrupt controller. It prioritizes its IRQ inputs; it allows the IRQs to be individually masked (enabled or disabled); it automatically tracks which interrupts are being serviced by the processor (to prevent multiple occurrences of the same interrupt); and it automatically issues the interrupt-type (or *vector*) bytes to the processor during INTA cycles. The 8259A also allows its IRQ inputs to be configured as level-sensitive or edge-sensitive inputs.

The 8259A's Initialization Command Word (ICW) registers are configured by the system BIOS at initialization and normally should not be changed. PC interrupts are configured as edge-sensitive. The high-order 5 bits of the interrupt-type byte to be returned by the PICs are also programmed into the devices by the BIOS. The PIC itself generates the 3 low-order bits, depending on which of its eight IRQs is active and has the highest priority. The master PIC (the only PIC in the 8088 systems) is programmed to generate interrupt types 08 hexadecimal–0Fh, while the slave PIC in AT systems is programmed to generate interrupt types 70h–77h.

IBM assigned the interrupt-type numbers generated by the PIC in the original PC and erred by not adhering to Intel's guidelines. Intel specified the first 32 interrupt types (00h–1Fh) as reserved for current and future use by Intel processors. A few of these were already assigned, such as type 0 for the divide-error exception and type 2 for the NMI interrupt. Despite the warning, IBM assigned interrupt-type values 08h–0Fh to the PIC, resulting in later grief, as I will explain shortly.

Of the PIC's Operation Command Word registers, OCW1 and OCW2 are used the most. OCW1 is the mask register for the eight IRQ inputs. Each bit that is set masks (or *disables*) the corresponding IRQ input, while cleared bits enable the corresponding input.

OCW2 is primarily used to give the PIC an EOI command at the completion of an ISR (generally 20h—a nonspecific EOI command), so that the PIC can keep track of which interrupts have been processed and which are still pending. Once an EOI is received for an interrupt that was being processed, the PIC can allow any lower-priority interrupts to be issued to the processor.

The Interrupt Request Register and Interrupt Service Register can be read by the processor to determine which interrupts are currently being processed and which are pending. Other PIC registers are used to facilitate the cascading of multiple PICs. Only one PIC can act as a master, while up to eight slave PICs can be supported. The interrupt output of each slave PIC goes to an interrupt input of the master PIC. In the case of PC and XT systems, no slave PICs are present, while AT systems have one slave PIC cascaded to the IRQ2 input of the master device.

In PC systems, lower IRQ inputs have a higher priority; thus, IRQ0 has a higher priority than IRQ1, and IRQ12 has a higher priority than IRQ13. Note that, since the slave PIC is cascaded to the IRQ2 input of the master PIC, IRQ0 and IRQ1 have a higher priority than the slave PIC IRQs (IRQ8–IRQ15), while IRQ3–IRQ7 have a lower priority than the slave PIC IRQs.

Table 2 shows the interrupt assignments for XT and AT systems. Note that some of the interrupts have fixed assignment to functions on the logic board (i.e., the system timer, keyboard, real-time clock, and math coprocessor), while the other interrupts are available on the expansion slots. Of the ones on the expansion slots, several are reserved for specific functions (such as IRQ6 for the floppy drive controller), while the others are available for general use by plug-in boards.

Several general-purpose interrupts are commonly used for certain I/O functions. For example, serial port COM1 is almost always assigned to IRQ4, while COM2 is assigned to IRQ3. Many network adapters use IRQ2. Since the higher interrupts (i.e., IRQ10–IRQ15) were introduced only with the AT, they are present only on 16-bit expansion slots in ISA systems. The 8-bit slots have only the lower IRQs. Thus, boards designed to operate in 8-bit expansion slots are

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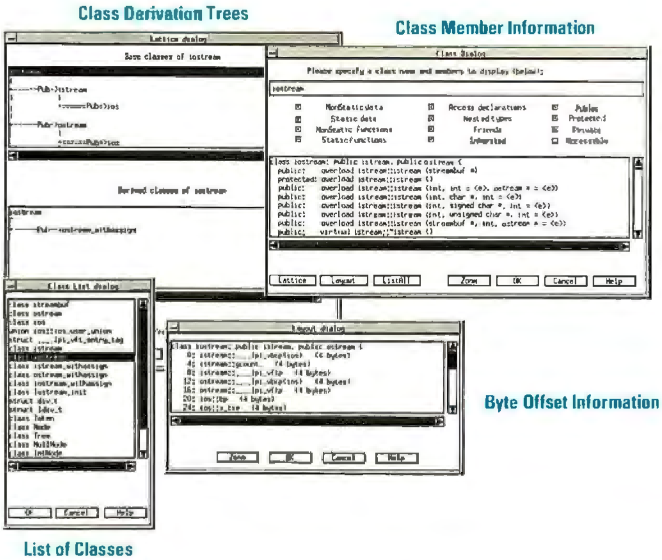


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**INTERRUPT USAGE IN PC SYSTEMS**

**Table 2:** *The sharing of IRQ2 by network and VGA cards is one perennial source of interrupt conflicts for Windows users.*

| IRQ | Fixed assignment | Normal use |
|---|---|---|
| NMI | Memory parity error | |
| 0 | System timer | |
| 1 | Keyboard | |
| 2 (9) | | General (often network, VGA card) |
| 3 | | General (usually COM2 or COM4) |
| 4 | | General (usually COM1 or COM3) |
| 5 | | General (XT hard drive, LPT2) |
| 6 | | Floppy drive controller |
| 7 | | General (usually LPT1) |
| 8 | Real-time clock (AT) | |
| 10 | | General |
| 11 | | General |
| 12 | | General |
| 13 | Math coprocessor (AT) | |
| 14 | | AT hard drive controller |
| 15 | | General |

restricted to using IRQ2–IRQ7; the higher-numbered interrupts are unavailable.

An interesting situation arises with respect to IRQ2. IRQ2 was a general-use IRQ line on early PC and XT systems and was present on the expansion bus. When the AT was developed, however, IRQ2 was committed internally as the cascade input for the second (or slave) 8259A and was, thus, no longer available to be placed on the expansion bus. To maintain backward compatibility with its earlier systems, IBM chose to use the new IRQ9 input on the slave PIC to operate as the old IRQ2 input. Thus, in AT systems, the IRQ9 input of the slave PIC is routed to the IRQ2 pin on the expansion bus.

With IRQ9 being substituted for IRQ2, AT systems generate a type 71h interrupt when the IRQ2 expansion slot IRQ is asserted, instead of the type 0Ah interrupt of the older machines. To achieve complete software compatibility with older machines, the INT 71h ISR branches to the INT 0Ah ISR address, thus responding as if it were a true IRQ2 interrupt.

## Interrupt Sharing

IBM failed to "teach" its PC interrupts to share. It is conventional in most computer systems to allow IRQs to be shared—that is, allow multiple devices to use a single IRQ signal. This is accomplished by using IRQ drivers that have *open-collector* or *open-drain* outputs, or by using drivers with *three-state* outputs. In these cases, unlike in the PC, the IRQs are active when the request line is at a low-voltage (and low-logic) level. A single pull-up resistor keeps the IRQ line high (or *inactive*) when no requests are present.

In the case of the open-collector/open-drain drivers, the outputs are normally in a high state, which is essentially floating, allowing the resistor to pull the line up to the 5-volt high logic level (or no IRQ). When a device wishes to request an interrupt, the driver output is pulled low, forcing the IRQ line to a logic low level, generating an IRQ. Using this approach, multiple devices could potentially request an interrupt simultaneously. The ISR must then determine which of the devices are requesting an interrupt and service them accordingly.

In the case of the three-state drivers, the outputs are normally in their disabled high-impedance state, where they are effectively removed from the IRQ line. The resistor, then, pulls the line up to the 5-V high logic level (or no IRQ). To generate an IRQ, the output is switched to an active state at a low logic level, forcing the IRQ line to a low level. Again, multiple devices may simultaneously request an interrupt, and the ISR must determine which devices are interrupting and how they should be serviced.

In contrast, interrupting devices in PC systems typically use active *totem-pole* drivers to drive the PC interrupts. If two totem-pole drivers connect to the same IRQ line and go to different states, bus contention occurs. The outcome is uncertain and is determined by which driver is "stronger."

PC users spend too many hours trying to resolve problems arising from conflicting interrupt usage. Serial communications are one notable sore point. Serial ports COM1 and COM2 are, for the most part, universally assigned to IRQ4 and IRQ3, respectively. The more recent COM3 and COM4 serial ports are also normally assigned to these same IRQ lines. The problem is, COM1 and COM3 cannot both be assigned to IRQ4 simultaneously, and neither can COM2 and COM4 be simultaneously assigned to IRQ3.

The most common manifestation of this problem is when a computer already has two serial ports (i.e., COM1 and COM2) installed, and then an internal modem is installed, assigned to COM3 or COM4 (with the appropriate corresponding IRQ line). Weird things often start happening when modem communications are attempted.

Four-port serial boards do exist that implement all four serial ports on a single board, including the appropriate circuitry to allow sharing of the IRQ lines. Most drivers (ISRs), however, do not support multiple devices on one interrupt, so additional, special drivers must be used.

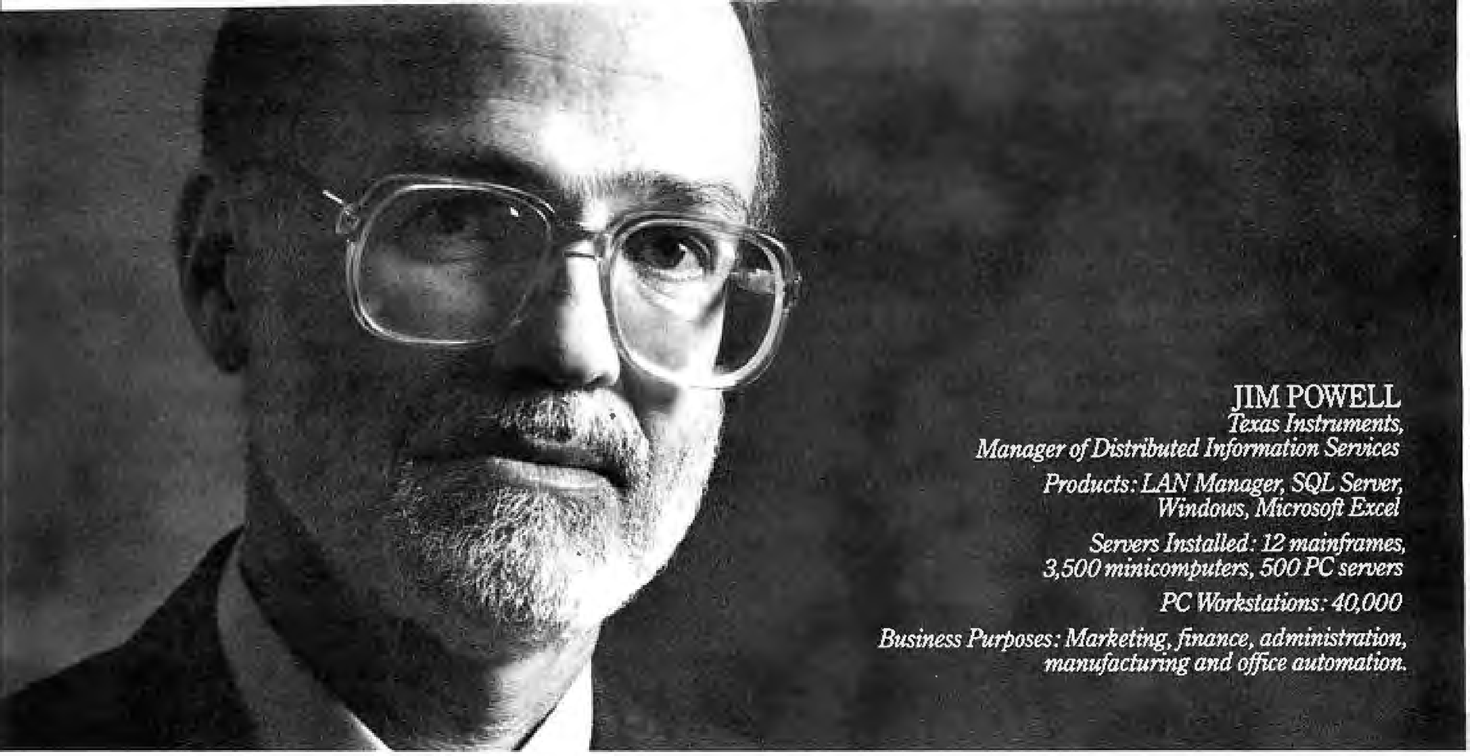
Another common interrupt conflict is the use of IRQ2 by VGA video boards and by many network controllers. Since the video board interrupt was generally unused by most systems, it could be safely disabled (usually by removing a jumper on the video board). Windows 3.0, however, uses the video interrupt to perform certain operations during the vertical retrace period, making the interrupt conflict a bigger problem.

Novell offers a special driver, VPICDA.386, that replaces Windows' VPIC.386 driver and attempts to sort out which IRQ2 interrupts are for the VGA ISR and which are for the network controller ISR. Of course, since the ISA bus is not designed for shared interrupts, reliable operation cannot be assured. It is always best to change the network board IRQ line, if possible.

## Interrupts in EISA and Micro Channel Systems

In addition to support for edge-sensitive interrupts like those found in conventional ISA XT and AT systems, EISA systems also allow their interrupts to be configured as shared, level-sensitive interrupts. Thus, in EISA systems, multiple devices can share a single IRQ line, overcoming one of the big drawbacks of the conventional ISA interrupt structure.

Similarly, the IBM Micro Channel

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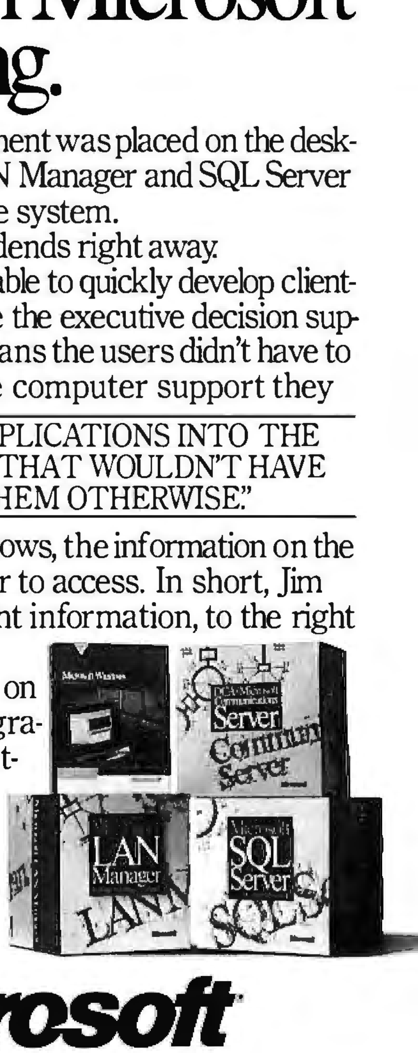


**Microsoft**

systems use shared, level-sensitive interrupts to facilitate simultaneous IRQ usage by multiple devices. Level-sensitive interrupts may also have a further benefit in the area of reliability, since an inadvertent glitch on an edge-sensitive IRQ line will be latched by the interrupt controller until serviced by the processor. In contrast, a glitch on a level-sensitive IRQ line will probably be ignored by the processor. Even if it does cause an interrupt, it is easier to recover from.

**Protected-Mode Interrupt Usage**

The PC interrupt operation described above is all pretty straightforward, and it is typical of most computer systems. Things get much more complicated, though, when it comes to handling interrupts in protected mode on an AT-style system.

The first problem arises because of IBM's choice of interrupt-type numbers generated by the 8259A in the original PC (and propagated to successive generations). The PIC outputs interrupt vectors in the range 08h–0Fh, which are within the range Intel originally designated as reserved. The 286 and 386 processors use these interrupt types for various processor exceptions.

To avoid this problem, operating systems and environments that work in protected mode, including Windows 3.0 and OS/2, reprogram the PIC to generate different interrupt vectors (e.g., 50h–57h in the case of Windows and OS/2). The operating system then uses "mirrors" to get the appropriate ISRs to be executed for the various remapped interrupts. In protected mode, the operating system prevents applications from writing directly to the interrupt-vector table.

While the interrupt-vector table is used to specify the routing of interrupts in real mode, a similar Interrupt Descriptor Table is used for this purpose in protected mode. Like the real-mode table, the IDT contains 256 entries, but in the case of the IDT, the interrupt-type byte is multiplied by 8 instead of by 4, since each entry in the IDT has 8 bytes (to accommodate a larger addressing space). Each IDT entry then points to an IDT descriptor (or *gate*) that, in turn, points to the ISR. While Windows 3.0 remaps the master PIC to the 50h–57h vector range when operating in its standard mode, the enhanced mode uses the 386/486 virtual 8086 mode. This enables Windows to create a Virtual PIC Device that makes the master PIC vectors once again appear in the 08h–0Fh range to the application.

Handling interrupts in a protected-mode environment is noticeably more complex than real-mode interrupt processing, and Windows interrupt processing is even further complicated by the fact that the interrupts are handled differently depending on which mode Windows is operating in.

Interrupts are critical to the operation of PCs, allowing asynchronous events to be handled "in the background" as they occur. Knowing how PC interrupts work can help you resolve board functionality conflicts and allow you to develop your own interrupt handlers for special applications. The interrupt-sharing features supported by EISA and Micro Channel systems indicate an important trend in next-generation PC systems: better support for add-on devices. ■

*Roger C. Alford, a BYTE consulting editor, is president of Programmable Designs, a Michigan-based electronics design firm. He can be reached on BIX as "rogera."*

BEN SMITH

# PERL: NOT JUST FOR UNIX

**This utility language runs on Unix, DOS, and OS/2 machines**

Despite another BYTE editor's cruel jokes, I love Perl. Perl, in this case, is the programming language that was developed by the prolific Larry Wall, a senior scientist at NetLabs in Los Altos, California.

Perl can generate utility programs that involve text parsing, file manipulation, and process control. This one language ties the utility of shell scripts to the Unix stream editor `sed`, the calculation and format utility `awk`, and the program flow control of C. In fact, Perl far outstrips any of those—and it is not limited to Unix.

Although Perl appears to be an interpreted scripting language, it's actually a compiled language—sort of. At run time, the Perl processor scans the source program into a parse tree and then interprets the tree.

This method runs much faster loops than does a traditional interpreter, yet it avoids the development steps of a standard compiler. (You can force Perl to dump an image of itself while running a program and use the image as an executable binary.)

Perl is amazingly fast, both for developing utilities and for running them. In many cases, it's faster than C.

For example, I wrote a Perl program that parses downloaded "blink" files from BIX conference activity, maintains a file tree-based database of article "Titles," and breaks the articles into separate UseNet-style news files for reading with Unix news readers. The UseNet "Subject" is derived from the BIX "Comments" thread that is maintained in the "Titles" database. The Perl program is a mere 100 lines long, and it can process a 3000-line file in approximately 40 seconds on a 33-MHz 386-based machine.

Another Perl program (60 lines long) edits the UseNet news `active` table to reflect the new article files; it does this in 8 minutes for a tree of 5000 files. The program spends most of the time running `find` to generate the file list. By comparison, the UseNet `expire` utility requires nearly half an hour to complete the same task.

With Perl, you don't have to declare variables before using them. Variable-name prefixes (and suffixes in the case of indexed lists such as arrays) specify what kind of structure the variable name represents; all variables—lists, arrays, and simple variables—are built from the only data type, a *scalar*, that can hold either a string of characters or a numeric value.

Perl functions can intelligently handle any kind of scalar. It is not exactly like the overloaded functions in object-oriented programming, but it leans in that direction.

Perl includes functions for network communication; interprocess communication; report formatting from a mask; and mathematics, including trigonometric and logarithmic functions. It excels at string operations.

The best documentation for Perl is the book *Programming Perl* by Larry Wall and Randal Schwartz (Cambridge, MA: O'Reilly & Associates, 1990). You can compile Perl for Unix, DOS, and OS/2, as well as a number of other operating systems. Perl is too large to be distributed on disk, but you will find the source code on BIX and at most UseNet archive sites. ■

MAC/Tom Thompson

## FileTyper Fixes File IDs

What's a MacFolk to do when confronted with a generic document icon on the Mac Desktop? The Mac OS doesn't recognize the file—if it had, it would have slapped the appropriateicon on the screen. File utilities such as Apple's ResEditor CE Software's DiskTop extract the file's creator and type and then change this information, but using ResEdit to change file IDs is potentially dangerous, and DiskTop is overkill.

The best utility I have seen that deals with this problem is Daniel Azuma's FileTyper 1.0. Under System 7.0, you drag the file in question over FileTyper, which launches and pops up a window that shows the file's creator, type, and Finder bits. (Under System 6.0.x, you launch FileTyper and select the Open command in the File menu.) Press the Change button, and FileTyper makes the change and quits.

FileTyper does exactly what is needed, and, like most great hacks, it's free.

PC/Barry Nance

## Disk Tools for DOS Users

These three programs make hard disk management chores a bit easier. They're all free, are written in C, and include source code.

DCOPY uses best-fit logic to let you copy as many files as possible to a single floppy disk. DCOPY fills up disks right to the last byte. It also keeps track of the number of files that will fit into a disk's root directory and asks for the next disk when it reaches capacity.

TREELIST outputs a list of all subdirectories and associated files. Using different arguments, you can direct the output to the screen, a printer, or a file.

CHAINSAW prunes directory branches by recursively visiting each directory level and deleting associated files and directories. Because CHAINSAW is so powerful, I put a protective edit in the program; be sure to read the CHAINSAW.TXT file for full details.

Editor's note: *Software Corner highlights freeware and shareware programs. The programs are available in a variety of formats. See "Program Listings" on page 5 for details. We solicit your contributions. We pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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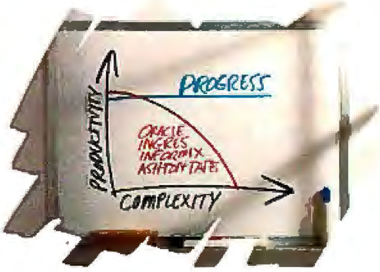


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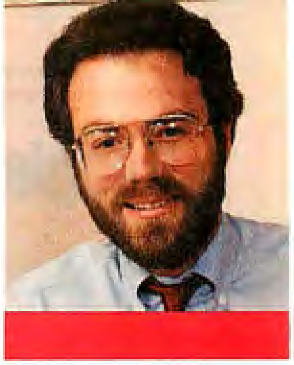


MARK J. MINASI

# CURES FOR C SICKNESS

Things were going well: My Power Windows seminar was on schedule, and it looked like everyone was happy. Then someone asked "the question": "What would you recommend for someone who wants to program in Windows but doesn't want to deal with C?" I don't mind "the question" because it's a dumb one (it's not) or because it doesn't have an answer (it does). The trouble is that there are so many answers....

When Windows hit the big time, tool vendors saw a variety of ways to enhance its success. What, beyond Windows itself and the Software Development Kit (SDK), was needed?

I found myself looking for the following three things: script languages akin to DOS's batch, mechanisms to harness and Windowize existing DOS programs, and simpler ways to build whole new Windows applications.

I'll discuss a trio of products that have met these needs for me. The products are BatchWorks (Publishing Technologies, Austin, TX, (512) 346-2835), Visual Basic, or VB (Microsoft, Redmond, WA, (206) 882-8080), and Turbo Pascal for Windows, or TPW (Borland International, Scotts Valley, CA, (408) 438-8400).

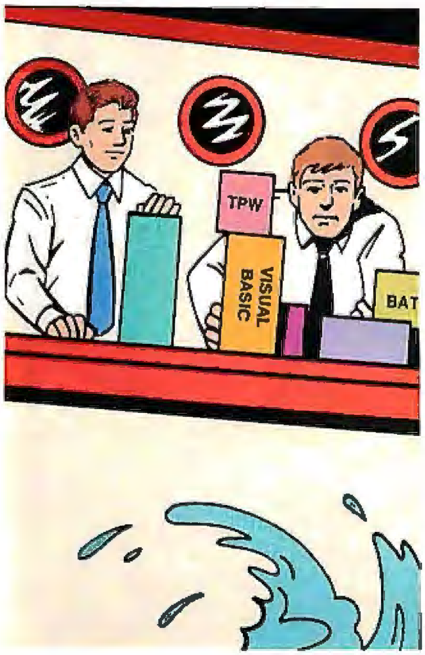
## Windows Batching

Although Microsoft hinted broadly that VB was to be a sort of all-purpose control language for the Windows environment, that's not really its forte—or TPW's forte either. Suppose you always want Windows to start up with the clock minimized and the Notepad running in the upper right-hand corner of the screen. That's a job for a Windows batch processor. Like DOS batch files, a Windows batch processor saves you keystrokes, clicks, and drags. For its breadth of abilities and reasonable price ($100), I favor BatchWorks. Now, in version 2.0, the desired window arrangement can be accomplished with just three lines:

```
runicon("clock.exe")
run("notepad.exe","")
winplace(500,0,1000,500,
"Notepad")
```

BatchWorks can even produce standalone .EXE files with its optional SDK. These .EXE files don't require a run-time module of any kind, so you can easily and legally distribute batch files. That means that you can use them for simple Windows installation programs. What I like more than batch files are Publishing Technologies' macros, which I think of as the Windows equivalent of Mac desk accessories. Desk accessories are useful Mac programs that are handy because you can get at them from any window's menu.

**Three alternative programming toolkits for Windows**




For example, while working on the textbook for my Power Windows seminar, I found that I constantly needed to do hexadecimal-to-decimal conversion. As I like to keep my word processor maximized, that meant minimizing the word processor (Ami Pro), loading the calculator, keying in the hexadecimal value, telling the calculator to convert it to the decimal value, and then closing the calculator and rezooming Ami Pro. BatchWorks lets you do that with this easy code:

```
numin=askline("Input","Number
to convert?","")
clipput(numin)
run("calc.exe","")
sendkey("{f5}!ep{f6}!ec")
winclose("Calc")
numout=clipget()
Message("Corresponding Decimal
Value",numout)
```

The askline function puts a window on the screen looking for the input hexadecimal value. The clipput function puts the value in the Clipboard, and then the calculator runs. The sendkey function simulates keystrokes—in this case, pressing F5 (go to hexadecimal mode), pasting, pressing F6 (go to decimal mode), and copying the result to the Clipboard. Then the calculator shuts down, the decimal value is retrieved from the Clipboard, and it appears in a message box.

All these functions are built into BatchWorks; there's a pretty complete set. A few other commands attach this to Ami Pro's control icon, so whenever I click on the control icon, "Convert hexadecimal to decimal" shows up as an option alongside Minimize/Maximize/Size and the rest.

## Making Old Applications Do Windows

Everyone I know who's played with VB has a testimonial. Here's mine. I write magazine articles that are supposed to be of a particular word length, so it would be

ILLUSTRATION: BRAD HAMANN © 1992

convenient to be able to mark a block of text, copy it to the Clipboard, and have a Windows program count the words in it. If I were working in Microsoft Word or Ami Pro, I could just do a spelling check and the word count would happen in passing.

But magazine articles are best done in ASCII, so the Notepad or a Windows text editor serves well there, except that they don't have word counters. That meant I was looking for a Windows word counter just about the time that VB arrived. Here's the upshot: The elapsed time from when I pulled the shrink-wrap off VB to when I finished the application—complete with a pretty icon, speed keys, and a menu—was just 3 hours, and now I use that silly program all the time.

VB is a language of interfaces and events. If you want to build a simple GUI application, VB is often the fastest way to get it done. But I think it's destined to be not a *builder* of applications, but a *rebuilder* of applications.

Suppose you've got an engineering application in FORTRAN that models the effects of stresses on some kind of material. Written years ago, this code is a tried-and-true touchstone in your part of the engineering world. But it's 1992, and you've got a problem. The math's not the problem. But the world has changed: People don't want to type in 32 parameters sequentially as if they were typing at a teletypewriter, press Enter, and wait. They want something in a GUI. What should you do?

Simple: You write a VB application that lets the user input the 32 parameters. It's an improvement over the teletypewriter input because it's not sequential and probably contains defaults, and it's a Windows application. Then—and here's the best part—you don't touch the FORTRAN code that does the calculating. Instead, you link it into a Windows dynamic link library. The VB application can then easily call the old FORTRAN subroutines, because it interfaces seamlessly with DLLs. Result: The "engines" of your old FORTRAN/C/COBOL programs are unchanged and now live in DLLs; you need only implement the front end in VB, which is a relatively painless task.

A few brief notes about using VB, however. It's not fast, so I wouldn't build large sections solely in it. VB .EXE files are quite small (5 KB for my word counter), but, mainly because they can't run without a run-time module called VBRUN100 .DLL:, the .EXE files are not stand-alone. It's as if Microsoft did this to remind us that VB is a toy and that real applications are written only in C. I wonder. (I also wonder why the manual refers to an OS/2 version of VB, when Microsoft says that

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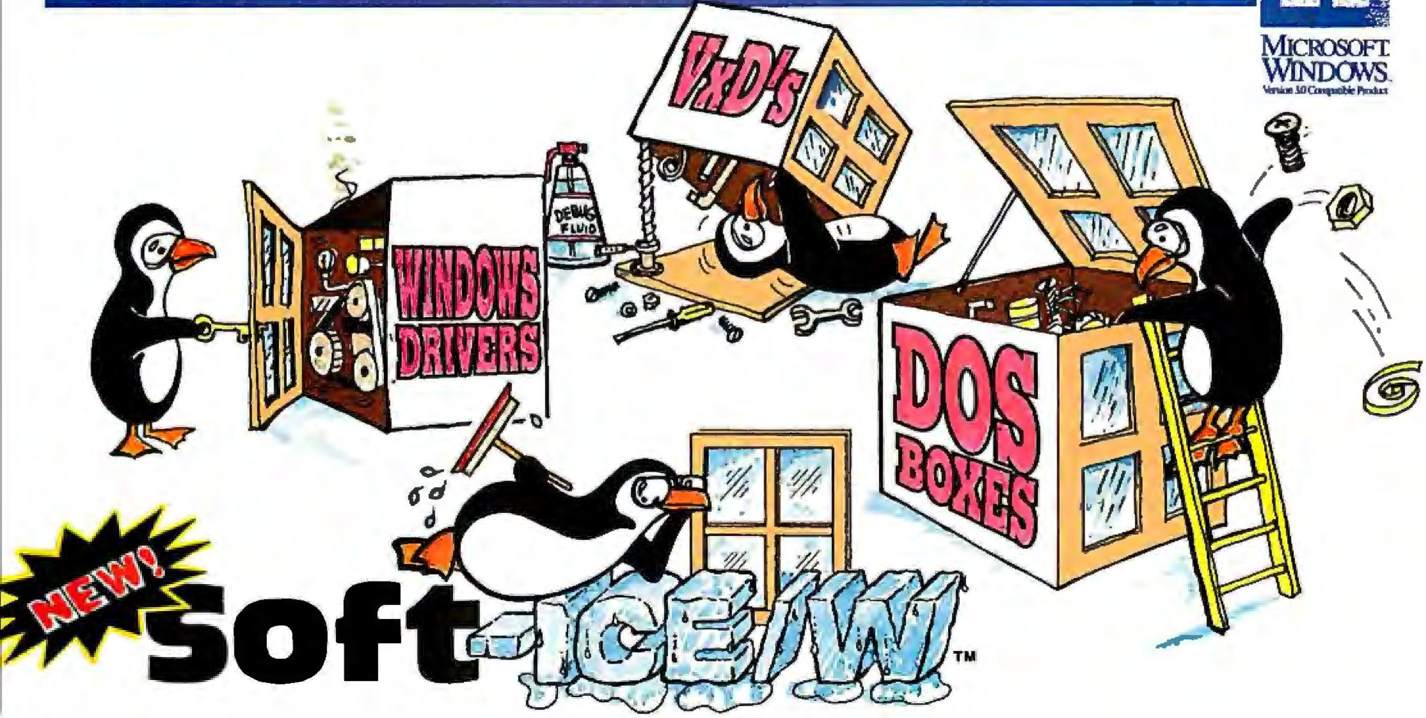


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it doesn't have one.)

On the plus side, VB has created a fire storm of interest in the developers' community. The sheer volume of VB applications uploaded to CompuServe is tremendous compared to those built with any other tool. Because of that, we'll no doubt see a pile of third-party products that will make VB even better.

### C's First Real Challenger

If you want to develop professional standalone applications, TPW is an excellent choice. It's quick, object-oriented, and complete in terms of being a full-featured development environment, but nobody's going to accuse it of being easy to learn. Don't get me wrong—TPW is still easier to work with in many ways than C. But to get anywhere with TPW, you must first master Turbo Pascal and then master objects in Turbo Pascal. If you've done that, you'll find TPW a simplified introduction to Windows. (I'm a biased observer. I've been working with Turbo Pascal since version 1 0 ,and it thus comes more easily to me than does C. This is probably not the case with most of you who are reading this article.)

TPW takes a two-pronged approach to building Windows programs. If you're ambitious, you can go the route of learning TPW's object-oriented application framework, which supports the development of "real" Windows programs. If you're less energetic, you may want to start with the WinCRT unit, which, in effect, lets you take your old character-based DOS Turbo Pascal programs and stuff them into a window.

For example, my old word-counter program was a Turbo Pascal application. I just added the line `uses WinCRT` to the code, compiled under TPW, and voilà—my old word counter was an instant Windows program. Now, it's not an exciting Windows program—it doesn't have menus, graphics, or dialog boxes, and it doesn't use the Clipboard—but it runs in Windows without having to shell out to DOS and thus runs fine even in Windows real mode. I thought WinCRT was kind of silly when I first unpacked TPW, but I've found that its facility to bang out quick-and-dirty Windows applications has helped me a few times.

TPW comes with the Whitewater Resource Toolkit and a complete guide to the Windows application programming interface. TPW also shines when it comes to creating DLLs, which is something VB can't do. And you can take advantage of the Turbo Pascal data types. I don't enjoy handling strings in C.

The Borland development tool isn't without its problems, however. I find that the character-mode debugger is a bit disconcerting to run, because the screen flashes between the debugger's text screen and Windows' graphics screen.

So there you have it: three tools, three purposes. Which will sell the most copies? Well, watch VB. Microsoft BASIC has had a habit of growing into whatever crevices exist in the programming world, and I imagine that its GUI cousin may be able to do the same. ■

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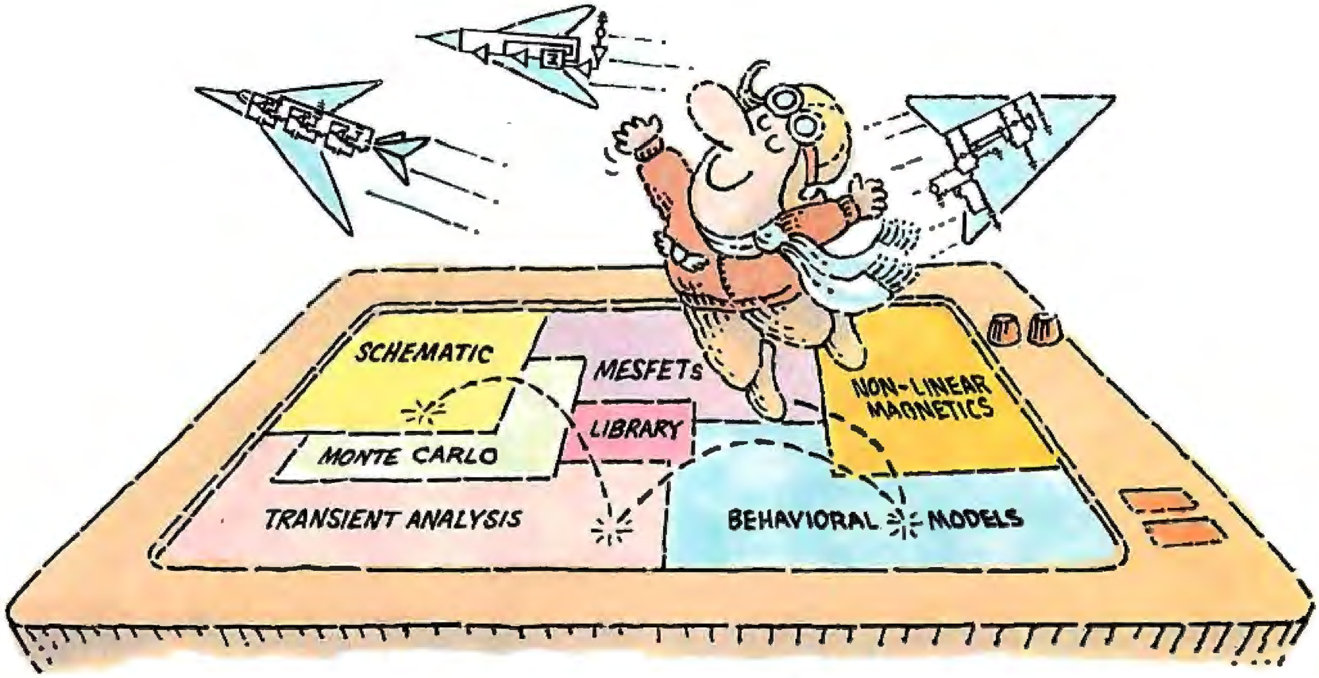
*Mark J. Minasi writes and runs basic and advanced seminars on Windows and OS/2. His firm, Mark Minasi & Company, is based in Arlington, Virginia. You can reach him on BIX as "mjminasi."*

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

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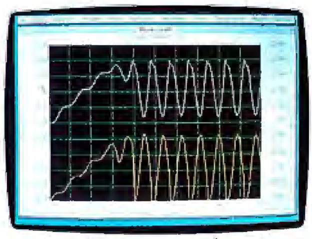
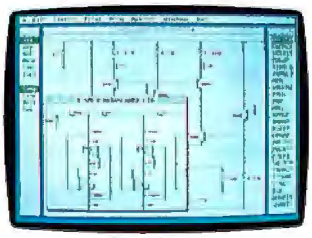


Transient Analysis



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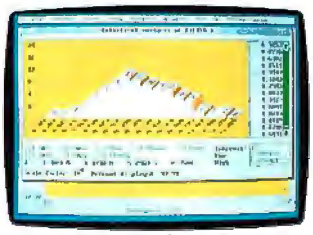

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BRUCE D. SCHATZMAN
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# LAN MANAGER GETS A FOOT IN THE DOOR

After three years of slow but steady growth, LAN Manager is positioned to explode. If you have NetWare, there is a high probability that LAN Manager 2.1 will be in your future, and you will be faced with integrating these two network systems.

Until recently, accessing resources on both LAN Manager and NetWare networks was impractical, because each client workstation needed two redirectors and two network cards. With Microsoft's new NetWare Connectivity (which comes with version 2.1), you can access files, applications, printers, and communication services on both LAN Manager and NetWare servers from the same workstation using a single network card and without rebooting. Version 2.1 also supports TCP/IP, Mac connectivity (as an option), and remote access by modem, all of which put LAN Manager in a much higher league.

## A Rising Storm

From a market-share standpoint, the network arena has been relatively stable for the last four years. NetWare has the lion's share, with LAN Manager and Vines dividing up a fairly small remainder. Although LAN Manager has matured considerably, the stigma of OS/2-based server technology, coupled with the somewhat dubious feeling that NetWare is a safe decision, prevent this product from capturing additional market share.

Most companies with large NetWare installations believe there are few incentives for implementing LAN Manager on a widespread basis, even with NetWare Connectivity. There are a variety of situations (especially in client-server applications) where LAN Manager is a better solution than NetWare, but most network managers don't want to go to the trouble of implementing a new network system.

This may all change dramatically when Microsoft announces LAN Manager (both client and server) on Windows New Technology. Once LAN Manager is planted firmly within the Windows architecture, Microsoft can begin weaving its applications, operating systems, and network software into a more unified—and more formidable—offering. If Microsoft does a good job of this, corporations will look more seriously at implementing LAN Manager as a primary network.

A key factor will be whether or not Microsoft bundles LAN Manager client software with every copy of Windows it ships. If this happens, LAN Manager will find its way to virtually every desktop that has a PC on it. At this point, network managers will begin experimenting with LAN Manager's capabilities, even if NetWare is their primary solution.

**New features could move LAN Manager into NetWare shops. Here's why, and how to integrate them.**

Although this poses a serious threat to Novell, the company has its own plans. It is with great curiosity that we await the outcome of developments under way with DR DOS. Novell's future depends on a sound strategy that fully embraces Windows, while at the same time offering more operating-system and networking features than Microsoft. This will be a challenge.

In the meantime, it makes sense to take a hard look at integrating these two networks. Companies that have both NetWare and LAN Manager will benefit immediately from NetWare Connectivity because it will let users on different networks share resources and communicate with each other. For NetWare-dominated sites, installing a small LAN Manager network is a good idea to gain firsthand knowledge of the competitive differences between these two systems. If you believe the future scenario described above, we recommend that you begin experimenting with these two networks now so that you can move smoothly into the inevitable, rather than react quickly to a situation that is suddenly forced upon you.

## A Look at NetWare Connectivity

When 3Com abandoned its core network-operating-system business and announced that it would focus exclusively on internetwork connectivity products, Microsoft purchased ownership rights to 3+Open, a derivative of LAN Manager. Among the more interesting technologies that 3Com added to LAN Manager's capabilities was its Demand Protocol Architecture, which provides a better way for multiple network protocols to coexist on the same workstation. Before DPA, LAN Manager users had to reboot their workstations and load a new network driver configuration to access a different LAN. This made using resources on anything but LAN Manager networks impractical, to say the least.

DPA provides special memory management facilities that you can use to load and unload network protocols without rebooting. For example, if you are already running LAN Manager, typing NWLOAD at the DOS prompt will load NetWare's IPX.COM and NETx.COM. Thereafter, both LAN Manager and NetWare drivers coexist in memory without conflict, letting you access resources on LAN Manager and NetWare servers during the same work session. The "NetWare" driver is actually one that is 100 percent compatible with NetWare, which LAN Manager generates when you install the software. LAN Manager drivers are built to conform to Microsoft's Network Driver Interface Standard, which lets both protocols use a single network card.

This dual-network capability is especially attractive under Windows, where you can use the File Manager to view resources on both NetWare and LAN Manager networks. The improved network interface and speed of the Windows 3.1 File Manager make this much easier than it is under Windows 3.0.

Clicking on a network drive that represents a remote LAN Manager directory opens a child window that lists files in one of LAN Manager's shared directories. Clicking on a network drive that represents a NetWare directory opens another child window listing NetWare-resident files. You can copy files from one server to another simply by dragging them between windows. The same kind of intuitive interface is available for printers on both networks.

If you don't like the File Manager or you don't have Windows, you can configure resources using MAP (NetWare) or NET USE (LAN Manager) from the DOS command prompt and then switching between the two by entering the appropriate drive letter.

### Memory Management

Before installing NetWare Connectivity, you should first ask yourself whether your PCs are up to the challenge. As usual, the primary consideration is memory. On DOS 3.x or 4.x workstations running both protocols, available memory is reduced to 384 KB when you run the NetWare shell, IPX, the LAN Manager redirector, NetBEUI, and NetPopup. With few exceptions, this means that a high memory manager (e.g., Qualitas's 386Max or an upgrade to DOS 5.0) is necessary for each client. These should be included in your purchase order from the beginning. If your workstations do not have 640 KB of RAM, plan to purchase additional memory as well.

Microsoft claims that you can conserve memory by loading NetWare when you want to access a NetWare server and unloading it when you're done. Although this is an acceptable strategy for infrequent access to NetWare servers, it is not acceptable if you want to run NetWare-specific applications all day or perform frequent filing and printing operations with NetWare servers.

To use NetWare Connectivity the way it was designed to be used, load it (along with LAN Manager) into upper memory blocks from your CONFIG.SYS and AUTOEXEC.BAT files. If you're running DOS 5.0, try loading DOS into upper memory as well, if space is available. You can usually achieve about 500 KB of free conventional RAM if your upper memory blocks are not already filled with other drivers or TSR programs.

### Drive Mappings

NetWare Connectivity is easy to install on a client that has not been configured for a

network. However, installing LAN Manager with NetWare Connectivity on an existing NetWare workstation poses a few problems, one of which is drive mappings.

NetWare log-in scripts typically assign a range of drive letters to each workstation. These letters refer to different file resources on the server. The problem with these preexisting drive mappings is that LAN Manager requires its own drive letters for access to its shared directories. Network administrators must therefore determine which letters should refer to NetWare resources and which should refer to LAN Manager resources. Frequently, NetWare consumes every drive letter from F through Z, leaving nothing for LAN Manager.

To deal with this problem, you may need to change NetWare log-in scripts to free up some drive letters for LAN Manager. You may also need to modify network search paths that are set from batch files.

Be aware that many networked applications under both DOS and Windows have drive letters that are coded into search paths within various start-up files (e.g., WIN.INI). Remapping drive letters can disable your applications if you are not careful, so be sure to modify these files as well.

The best strategy is to experiment with a few workstations first. Once you find a mapping scheme that works on these PCs, slowly begin to change drive mappings on other clients. Microsoft's recommendation to reserve drives A–M for LAN Manager and N–Z for NetWare makes sense in most cases.

### Multinetwork Planning

Among the mistakes made when implementing NetWare and LAN Manager together is the failure to design a network architecture prior to installation. Giving in to the temptation to install now and take care of the details later usually proves disastrous.

Because LAN Manager and NetWare servers support different organizational models, directory structures, and security systems, an ad hoc approach to integrating these two networks leads to a variety of problems. An important issue to discuss prior to installation is which applications should reside on NetWare servers and which should reside on LAN Manager servers.

Other questions include: How will user accounts be organized in a dual-network environment? Will they have the same passwords on both LAN Manager and NetWare servers? Will having two home directories confuse them? Will data be distributed across both types of servers in a random fashion, or will there be a structure? How will this affect your existing backup system, and how will you distribute updates to applications?

This is by no means a comprehensive list, and there are many other issues. The point is to begin thinking about them before you start to install software. Although an effort should be made to give users maximum flexibility, ease of administration should never be compromised. If it is, both administrators and users will lose. ■

*Bruce D. Schatzman and Jeffrey H. Lubeck are systems consultants in Issaquah, Washington. They provide systems design and implementation services throughout the U.S. You can reach them on BIX c/o "editors."*

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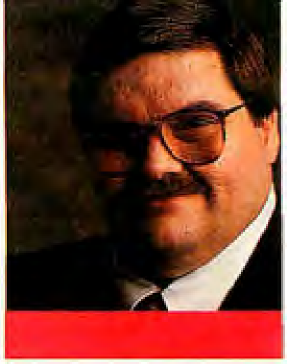


DON CRABB

# DESIGNING MACS

Several months ago, I acted as a consultant for a large international company to help with its wide-area network and to automate its product design group. This group designs consumer products, mostly personal electronics equipment and home appliances. The group employed graphic designers and engineers, who created new designs using drawing boards and clay models. Just to confuse things, there were a few personal computers that no one used. The personal computers contributed nothing to the design efforts; indeed, the design offices in three cities didn't share any sort of computer communications.

### A Machine Decision

Where did I start? First, I surveyed the designers to get an idea of their computer skills and experience. Most of them were novices. I let them pick their work environment, believing that some sort of GUI was a good point of departure. I set up a loaded Everex Step 486 PC running DOS 5.0 and Windows 3.0, with a 21-inch Super VGA monitor and adapter, 16 MB of RAM, and a 210-MB hard drive. I also set up a loaded Mac Quadra 900, with 64 MB of RAM a 21-inch AppleColor RGB monitor, and two 160-MB hard drives.

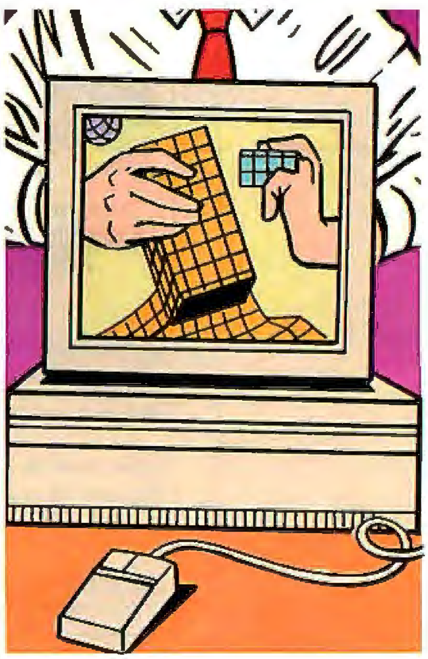
I put Microsoft Word, PowerPoint, and Excel on both machines, along with AutoCAD, Aldus FreeHand, and PageMaker. Then I let the designers play with the machines for a week and checked their reactions. They clearly favored the Quadra over the Everex machine. After some additional needs analysis, I recommended the Quadra.

### Drawing and Design

Because the Quadras were in short supply at the time, the company bought a few Mac IIfxs just to get the designers started using computer-aided drawing and design tools. I set up a training regimen using Paracomp's Swivel 3D, Illustrator, Aldus FreeHand, Virtus WalkThrough, AutoCAD, and several other drawing and design utilities.

None of these quite fit the bill. These designers were used to thinking in three dimensions using clay models; the two-dimensional manual drawings they cranked out represented 3-D objects. They needed a fast, easy-to-use 3-D drawing package that wouldn't inundate them with tools or features they didn't need. Swivel 3D wasn't it; it had animation features that they didn't need and lacked some 3-D freehand drawing tools they wanted. Virtus WalkThrough could help them peek inside drawings, but it too lacked needed 3-D drawing tools.

**Apple's Mac Quadra 900 and Alias's Sketch make for a powerful three-dimensional design workstation**



### Sketch

I was about to install a second round of 3-D software for them to try, when I remembered seeing an alpha version of Sketch at the MacWorld Expo in Boston. This is a $1995 3-D drawing package from Alias Research (110 Richmond St. E, Toronto, Ontario, Canada M5C 1P1, (416) 362-9181).

Being a pushy type, I snagged a copy of Sketch that was literally hot off the disk duplicator and gave it a try. Keeping in mind that I can't draw a straight line with a T square, I was wary of Sketch. However, the program won me over in short order. Sketch extends your innate 2-D drawing prowess into the third dimension almost without your knowing it.

I wanted to get the designers' reactions, so I installed it on the Quadra. These folks had been uniformly disappointed with the quality of the 3-D drawing tools they'd been using. Sketch changed their minds. They got into this program almost instantly, and they particularly liked the way they could import Illustrator 2-D outlines and Adobe Photoshop images into their Sketch designs.

But the real plus for these designers was the way that Sketch became an extension of their own hands. Its unique ability to draw and render directly into the true perspective of their existing images and its 3-D-aware drawing tools made one designer remark, "This thing works like a computerized glob of clay." While that sounds silly, it captures the essence of how Sketch works.

Sketch validated our choice of the Quadra 900. As fast as the Mac IIfx is, Sketch seemed to poke along on it. But Sketch zipped along on the Quadra, even on complex photo-realistic rendering. The Quadra performs only about 50 percent to 70 percent faster than a Mac IIfx on BYTE's Mac benchmarks, but in practical use with

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*Recommended, required, and compatible system software for the Mac product line.*

| | 7.1 | 7.0.1 | 7.0 | 6.0.8 | 6.0.7 | 6.0.5 | 6.0.4 | 6.0.3 | 6.0.2 |
|---|---|---|---|---|---|---|---|---|---|
| Plus | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Classic | 2 | 3 | 3 | 2 | 1 | 4 | 4 | 4 | 4 |
| Classic II | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| SE | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| SE/30 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | 4 |
| LC | 2 | 3 | 3 | 3 | 1 | 4 | 4 | 4 | 4 |
| II | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| IIx | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 1 |
| IIcx | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 4 |
| IIci | 2 | 3 | 2 | 3 | 3 | 3 | 1 | 4 | 4 |
| IIfx | 2 | 3 | 2 | 3 | 3 | 1 | 4 | 4 | 4 |
| IIsi | 2 | 3 | 2 | 3 | 1 | 4 | 4 | 4 | 4 |
| Quadra 700 | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Quadra 900 | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Portable | 2 | 1 | 3 | 3 | 3 | 3 | 1 | 4 | 4 |
| PowerBook 100 | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| PowerBook 140 | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| PowerBook 170 | 2 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

1—Required version.
2—Recommended version.
3—Compatible version.
4—Machine does not work with this version.
Note: Apple no longer supports System 6.0.6.

software as demanding as Sketch, that difference is astounding. And it points out how misleading benchmarks can be.

Sketch is based on a different kind of 3-D mathematics than most of its competitors. It uses nonuniform rational b-splines to provide its lifelike 3-D handling characteristics. Combined with its own open file format (Style!Guide) and the ability to import standard file formats (i.e., DXF, IGES 4.0, and Alias UpFront), Sketch can fit into a lot of work environments.

The Sketch/Quadra environment hasn't been perfect for my clients, however. Their biggest complaints are a tedious installation process and the required Apple Desktop Bus hardware key to make the application run. The latter is an onerous form of copy protection that often interferes with other ADB devices chained off of the ADB port. My client hopes that Alias will drop the hardware key, which mars an otherwise outstanding product.

### Software of the Month

Apple is a hardware company that just happens to make some fine system software. Just about every time that Apple revises its system software to meet the design

goals of new CPUs, it manages to add more value. Two perfect examples are System 7.0.1, which ships with PowerBooks, Quadras, and the Classic II, and System 7.1, which should be available by the time you read this. The upgrade for both versions is free to Mac owners.

Apple does not recommend System 7.0.1 for every Mac owner. It should. Apple's internal support mechanism always runs at the highest level for new System releases that support new hardware. That's reason enough to upgrade to 7.0.1. But System 7.0.1 also provides a significant improvement in the Mac's floating-point performance if you have a Mac with the necessary FPU. The reason, as first reported in the November 1991 Microbytes, is that Apple's Standard Apple Numeric Environment package has been extensively tightened and tweaked in System 7.0.1. System 7.1 includes these same SANE tweaks, plus built-in support for QuickTime, improvements in virtual memory performance, Connectix's Mode32 32-bit addressing patches, and Adobe's Type Manager PostScript rasterizer.

Quadra owners should note that System 7 software includes a special Control Panel called Cache Switch, which flushes and turns off the 68040 processor cache. This allows some current software to run that can't cope with the 68040 caches turned on. Normally, you have to reboot the Quadra for Cache Switch's settings to take effect, which is a royal pain if you do this often enough. However, if you press the Option key while changing Cache Switch's settings, you can turn the 68040 caches on or off on the fly. Be aware that changing the CPU's processing speed this way might perturb timing-dependent code and cause trouble. I've had good luck with this trick so far, but you should exercise caution.

With System 7.0.1 and 7.1, the number of Mac OS versions out there has gotten more complicated. What operating-system software should you be using? The table gives you a breakdown of the currently supported versions of the Mac OS and what's appropriate for each machine. Save yourself some trouble by checking to see that your Mac is running the appropriate version. ■

*Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE and the author of a book on System 7.0. You can contact him on BIX as "decrabb."*

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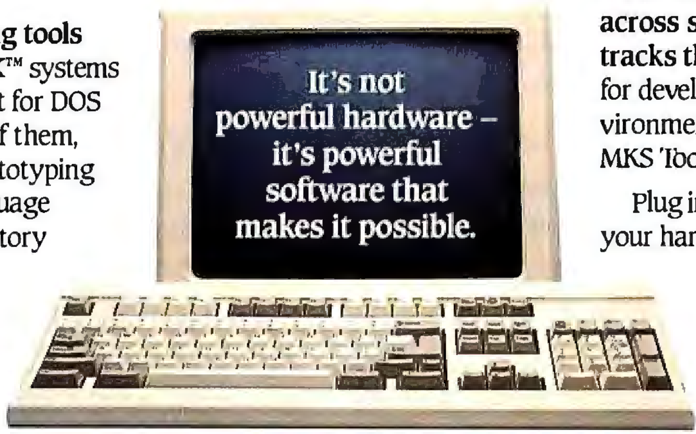


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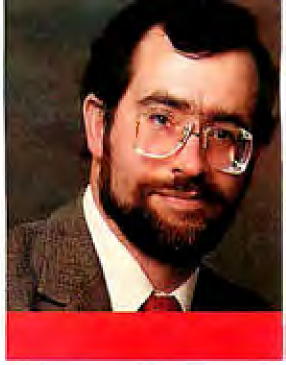


DAVID FIEDLER

# MY FIRST NETWORK

It was hopeless. Thoughts of utter failure and depression filled my mind. I considered getting drunk, but that's only for hard-boiled, Hemingway-type fiction writers, not BYTE columnists. We're supposed to be even tougher than that.

Some weeks before, I had made the rash decision that, no matter what, I was going to hook up my own network and write about it in this month's column. I had blocked out plenty of time, arranged for all the hardware to be available simultaneously, and even read the parts of the Unix manuals I generally avoid (you know, the parts with strange terms like *NFS*, *remote mounts*, and `ruptime`).

## Those Pesky Datagrams

You can read all the books and articles you want about networks, but few of them will tell you the real nitty-gritty about setting one up. There are a few things that you may have to learn by "oral tradition."

For example, you can't just plug an Ethernet cable straight into a normal Ethernet socket; you have to use a little gimmick called a T-adapter, the other end of which must go either to another Ethernet cable or to a second device called a terminator. A terminator does exactly nothing (it's just a 50-ohm resistor inside a BNC plug), but without one at each end of your cable, your whole expensive network will also do nothing.

Then there's the matter of network addresses. Every network adapter card sold has its own unique 48-bit Ethernet address (something like 00:80:C7:DF:51:BE). And if you've looked into networks at all, you probably know that every machine on the network must also have the right address. So, once you install network adapters on all your computers, make sure you write down the addresses, lock the paper in a drawer, and throw away the key.

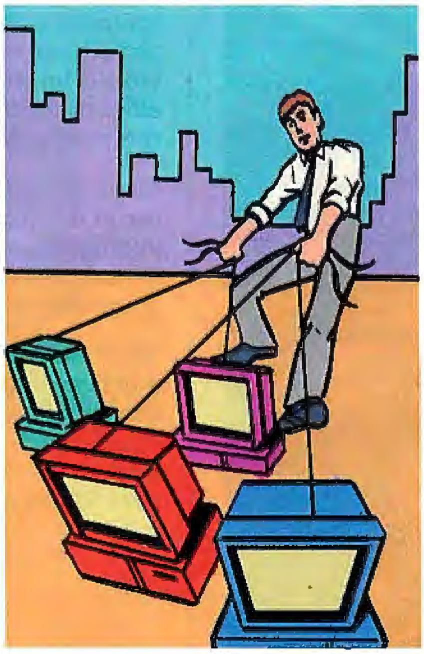
Apparently, nobody cares what the Ethernet addresses of the cards themselves are—just the machine addresses—and you can often make up almost any address you want. Perhaps this notion is a bit exaggerated—people running Address Resolution Protocol diskless workstations and large networks really do care about hardware Ethernet addresses—but it can be quite true for smaller, in-house networks.

## Addressing Antics

The reason for the confusion and discrepancy? The host address, or Internet Protocol (IP) address, is 32 bits long (something like 192.5.27.52). While the Ethernet adapter manufacturer assigns the Ethernet address and guarantees that it's the only one of its kind in the world, the host address is simply an entry in a file on a computer and can be changed at any time.

The network administrator therefore must

**Setting up the first one is always the hardest**



make sure that all host addresses on the LAN are unique. And if the network is to be connected to another one, especially the worldwide Internet, you must obtain a unique class C address. You do this by contacting the Network Information Center, a central registration authority (DDN NIC, Chantilly, VA, (703) 802-4535). All host addresses on the LAN must then conform to the registered network address to prevent confusion with machines at other sites.

The only file you have to work with to get started is the `/etc/hosts` file (listing 1 shows an example). The first entry is a special one that provides an internal loopback capability; it doesn't send data over the network, but it lets you make sure that your software can at least "talk to itself." The next entry is for the server machine itself; in this case, I'm naming the node "infopro" and assigning it the IP address 192.5.27.2. The last entry associates the name "pc" with the address 192.5.27.52; since only the last part of the address differs from the server's, it's on the same subnet.

Actually, the whole business of making up names is simply for human convenience. You could just type commands like `telnet 192.5.27.2` and the software would work fine, but it's hard to remember all those numbers.

## Network in Your Pocket

I thought I understood all this stuff before I tried setting up my first network. My problem was that I had too many variables: a new workstation/server—an absolutely wonderful Mobius PWS/433cx—an Ethernet cable and terminators that I had made, and a somewhat strange setup on a PC.

One thing I have always hated is opening up computers, plugging in new cards, having the system crash, figuring out which interrupts and addresses conflicted, finding and changing tiny jumpers on the cards, rebooting, and so on. The Xircom pocket Ethernet adapters sounded like a

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**Listing 1:** *A sample* `/etc/hosts` *file.*

```
127.0.0.1      local      localhost
192..527.2     infopro    infpor.oinfopr.com
192.57..225    pc
```

dream in comparison: You just plug one into a spare PC parallel port, attach the AC adapter and Ethernet cable, load the appropriate self-configuring driver and network software for your system, and you're on the network. Imagine how perfect that is for laptop computers.

The Xircom pocket adapters (Xircom, Inc., 26025 Mureau, Calabasas, CA 91302, (818) 878-7600) are available for thick- or thin-wire Ethernet, as well as twisted pair. They support Novell NetWare, Sun Microsystems' PC-NFS, Wollongong's WIN/TCP, Atlantix's CocoNet, FTP's PC/TCP, and quite a few other networks. And they have an internal 32-KB buffer, larger than that on many plug-in cards. The only Unix-based server implementation I could find was the one from Interactive Systems' TCP/IP 1.3, which at this writing has just been released.

Naturally, I had to try something different, so I `ftp`ed a copy of NCSA Telnet from `ftp.ncsa.uiuc.edu` (141.142.20.50). This is a publicly available package for DOS environments that provides you with `telnet` and `ftp` programs, as well as remote printing and execution capabilities. It's also supported by Xircom's "packet driver" (a TSR program that serves as a kind of device driver for Xircom hardware). So this took care of the PC end, which I planned to use initially as a terminal, moving up to X Window System and NFS as I got the hang of networking.

### Instant Workstation

A few words are in order about the Unix platform I am using. The Mobius PWS/433cx (Mobius Computer Corp., 5635 West Las Positas, Building 4-410, Pleasanton, CA 94588, (415) 460-5252) is a competitively priced ISA-technology "personal workstation" that packs over 15 million instructions per second of power into a neat 12-inch-high minitower case. The hardware includes an Intel 486 CPU running at 33 MHz with 64 KB of cache memory, 16 MB of system RAM, a 170-MB SCSI hard drive, a 16-bit Ethernet card, both sizes of floppy drive, and a mouse. It also comes with an incredibly sharp and fast 17-inch monitor capable of up to 1280- by 1024-pixel resolution.

The software that comes standard with the PWS/433cx is Interactive Systems' Unix System V/386 3.2 version 2.2.1 with all the trimmings: X, OSF/Motif, Visix Looking Glass, VP/ix, Lachman TCP/IP, and NFS. Unlike Open Desktop, Interactive's Unix lets the PWS/433cx act as both a workstation and a server simultaneously. (ODT has a server upgrade package, but it adds considerably to the price.)

Perhaps as important as all this power is the fact that you're not just left with 35 floppy disks and a manual. Installing Unix, a task that has daunted countless potential users, is now a thing of the past. Mobius preloads your software to the hard disk and then tests the system in the final



 

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configuration. This means that Mobius customers don't have to worry about software or hardware compatibility.

And they don't have to worry about much else, apparently, because Mobius provides a 30-day guarantee as well as a 15-month full parts and labor warranty. It's a true plug-and-play workstation and certainly the easiest Unix system I've ever set up. I had it running X just 15 minutes after opening the boxes (and without opening the manuals). I was counting on this easy setup for Unix, because I figured I'd have my hands full with the network.

### A Real Panic

After configuring the system name (`uname -S infopro`) and the `/etc/hosts` file, attaching and terminating the cable, and successfully running hardware diagnostics, I thought I was ready. First, I tested the server with the command `ping local`, proving that loopback worked.

The `ping` command actually has more to do with the sonar familiar to fans of *The Hunt for Red October* than the fact that it's a contrived acronym for Packet InterNet Groper. `Ping` sends out packets of data to a host and then measures its accessibility via the network by timing how long it takes for the echoes to return.

A `ping infopro` command similarly showed that my fooling with the system files hadn't disturbed anything major. So now I configured the NCSA Telnet package on the PC, which consisted of editing one file to tell it the IP address I was assigning to the PC and the IP address where the server could be found. I then sat down at the PC, typed `telnet infopro`, and waited. Nothing happened, so I went back to the other room and found the PWS/433cx in a panic.

A few more tries convinced me that there was something here well beyond my troubleshooting abilities. But was the problem in the PC, the cable, the software, or what? Mobius technical support went so far as to page the head technical engineer to call me with advice. But as the column deadline inched closer, I started panicking. Sure, I could use `telnet` to send files to myself from the PWS/433cx console, but that isn't networking.

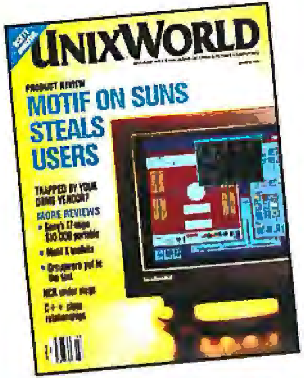
So I called in reinforcements, in the person of Brian Lloyd, a network guru who happens to live down the road. I took over both computers, and we hooked them to his network. The PC worked perfectly. The PWS/433cx crashed again, so Brian took it apart.

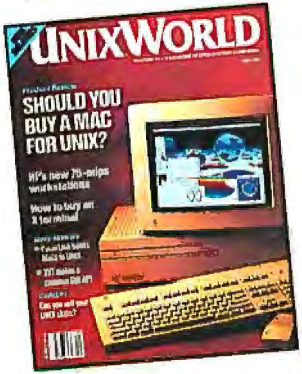
It seems that the Ethernet card was a WD8013, which is software configurable. At some point, the software configuration got lost. When I had relinked the Unix kernel in an attempt to fix it, the Interactive default address and interrupt for the card didn't match the configuration, so it still didn't work. In about 5 minutes, Brian changed a jumper to force the card to a known, nonconflicting address, relinked the kernel to match, and rebooted Unix, and it worked. Best of all, the PC talked to the PWS/433cx when I got them both home. So I really *did* know what I was doing all along. I think. ■

---

*David Fiedler has been a consultant and writer on Unix topics for over a decade and has started several Unix publications. He's also the coauthor of* UNIX System V Release 4 Administration *(Hayden, 1991). 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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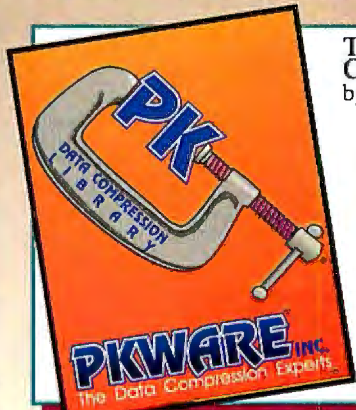


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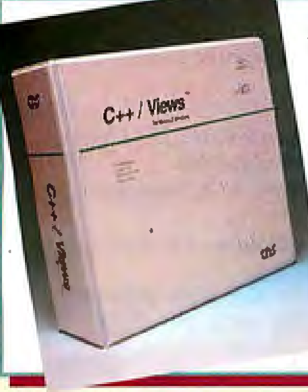

**C++/Views–**
by CNS, Inc.

*C++/Views V2.0*, the premier MS Windows 3.0 OOP environment for C++, provides a large class library of over 95 C++ classes (source included) and a complete set of development tools such as a fully functional C++ Class Hierachy Browser, a code generator for dialogs, and automatic source documentation tools. *C++/Views* is designed as an OOP cross-platform development toolkit with versions for OS/ 2 PM, the Apple Macintosh and UNIX systems running X-Windows/MOTIF.

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## .RTPatch
by Pocket Soft, Inc.

.RTPatch allows you to update files or entire systems by sending only the changes between versions. .RTPatch compares the old version of a file (or set of files) to the new version, and creates a small patch file that contains just the differences. This patch file is then sent to the end user. The patch file is then used to change the end user's old version into the new one.

The advantages of patching are numerous: Patches are typically very small and therefore use less disk media or BBS time. Patches are also very easy to create and apply, thus taking the hassle out of updating. Patches can also be posted on public BBS's without fear of theft since the patch is useless if you do not have an original copy of the program. Finally, patches are very safe. Extensive verification insures that a correct patch is created and applied.

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# ASK BYTE

## Trash RAM

I own a 20-MHz 386DX motherboard with 4 MB of RAM, AMI BIOS, and MS-DOS 5.0 (loaded in upper memory, of course), and I'm having trouble with expanded-memory emulation. I have HIMEM.SYS using my system's extended memory, and I'm trying to run an EMS emulator to use some of that extended memory as EMS.

When I try to use EMM386.EXE, some of my programs act weird. For instance, when I move the cursor around in Borland's C++ 2.0 IDE editor, either numbers mysteriously appear from time to time or parts of the file are highlighted as the cursor travels across the window. Other strange things happen when I use programs that make use of EMS, and they always seem related to the keyboard. The programs do not have to use EMS for these strange things to happen; EMM386.EXE just has to be loaded.

I tried everything I could think of, from using different switches with HIMEM.SYS and EMS386.EXE to using other EMS emulators, without success. Any suggestions?

Colin Vernon
*Newmarket, Ontario, Canada*

*Since the problems continue even when you use other EMS managers, I suspect your system's EMS configuration is trashing your video RAM area. First, check the documentation of your video card and see the memory address for VRAM. Next, try using other, more intelligent memory manager programs, such as 386Max or QEMM386, to exclude these memory locations.*

*When faced with a memory configuration problem, you'll find no easy solutions. You should start with the simplest configuration: delete everything in your CONFIG.SYS and AUTOEXEC.BAT files and then, one by one, add drivers and programs to determine where the conflicts lie.* —Stan Wszola

## Cyrillic Solutions

In my line of work I have quite a few contacts with Russians, and, therefore, I would like to use Cyrillic letters with my word processor. On the Mac, I just choose the Moscow font. Since I have a standard Swedish keyboard, I have a problem mapping the Cyrillic letters on the Latin keyboard, but that is manageable. I prefer, however, to use a PC.

I understand from Microsoft that buying a copy of the Russian version of MS-DOS won't do me any good, since it requires the Russian characters in ROM. Besides, I want to mix Cyrillic and Latin characters. There are products that load as TSR programs and let you switch between the Latin and Cyrillic character sets, but that seems to me like a limited kludge. What I really want is a Cyrillic font for Microsoft Windows that can be used with all the different applications. Where can I get such a font?

Niklas Rudemo
*Järfälla, Sweden*

*Even if you were to get a Cyrillic font for Windows, most of your applications (e.g., word processing programs) would not be able to function fully with the Cyrillic alphabet. I suggest you try a word processing package such as PC-Write Lite from Quicksoft, Inc. (219 First Ave. N, Suite 224, Seattle, WA 98109, (206) 282-0452). PC-Write Lite 1.03 has added features that support custom alphabets in general and Cyrillic (the Russian alphabet) in particular. Quicksoft also offers a Russian spelling checker, and Gamma Productions (710 Wilshire Blvd., Suite 609, Santa Monica, CA 90401; (213) 394-8622) offers a Russian-English dictionary program.*

*The following companies provide Cyrillic fonts and support:*

*Exceller Software, Cornell Research Park, 223 Langmuir Lab, Ithaca, NY 14850, (800) 426-0444.*

*Weaver Graphics, 5165 South Hwy. A1A, Melbourne, FL 32951, (407) 728-4000.*

*Digi-Fonts, 528 Commons Dr., Golden, CO 80401, (303) 526-9435.*

*Image Processing Software, P.O. Box 5016, 6409 Appalachian Way, Madison, WI 53705, (608) 233-5033.*

*VN Labs, P.O. Box 9878, Newport Beach, CA 92658, (714) 474-6968.* —Stan Wszola

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*Attention Wells American A*Star and CompuStar owners: Michael E. Hoyle, president of CornerStone Technologies (and former product manager for Wells American), has announced that his company offers service and support for previous Wells American products. CornerStone accepts computers for repairs and has parts, schematics, accessories, and CPU upgrades. For further assistance, contact: CornerStone Technologies, Inc., 151C Riverchase Way, Lexington, SC 29072, (803) 796-7800.* —Stan Wszola

## One Bit at a Time

In your July 1991 issue, the article "Macintosh Sound Revealed" referred to the PC compatible's sound as "1-bit." The explanation given for how the PC achieves different sounds is that the PC "[turns] its speaker on and off at different rates." This suggests that the PC is incapable of reproducing digitized sound.

Several pieces of software play digitized sound through the PC's speaker. It was my understanding that the PC can't do more than beep through its speaker. How is this feat accomplished?

Phil Combs
*Dayton, OH*

*The PC speaker system is simply a single data bit amplifier and speaker. A timer on the motherboard can toggle the bit at any given frequency, or, with the timer disabled, software can simply set the bit to either setting.*

*The timer-driven mode doesn't do much for digitized sound, but by careful programming, you can use the program-driven mode to create some sounds.*

*The Mac's 8-bit sound hardware can reproduce a waveform by driving the speaker in any of 256 discrete steps. Since the PC has only two steps, you have to make the speaker act as if it had more steps using* delta modulation—*a technique for compressing a waveform into a single bit stream. It does this by comparing each sample to the previous value. It represents a larger value with a 1; a smaller value becomes a 0.*

*When you play back the sound, the program sends the 1s and 0s directly to the speaker. The resulting waveform is a coarse representation of the original, with much high-frequency noise. (The speaker cone and magnet dampen this somewhat.) While an 8-bit sound system can get reasonable sound with an 8-kHz sample rate, a 1-bit system must sample faster. I've achieved reasonable results at 22 kHz, although the best results come from 44 kHz and higher rates.*

*Hopefully, as multimedia gains a stronger foothold in the PC marketplace, PCs will start shipping with high-quality sound hardware. Maybe then PC users won't have to settle for sound effects that sound like they're coming from a broken Victrola.* —Howard Eglowstein

### Why 40 Will Get You 28

I own a vintage 1987 IBM PC. Last year, I upgraded to 640 KB of memory. I recently had a 40-MB hard drive installed, and the technician who did the work told me my system would not recognize more than about 28 MB. FDISK confirms this and reports 819 cylinders. The technician says that the problem is the ROM BIOS module, dated October 27, 1982.

I'm running MS-DOS 3.3. I know that DOS versions lower than 4.0 are limited to 32 MB on hard drives, but that doesn't seem to be my problem. The hard drive is running fine; I simply cannot access the rest of my disk.

Glenn Walters
*Fort Wayne, IN*

*I assume that you bought the machine in 1987, as the BIOS date suggests a much older machine. It confirms that you have a PC, not an XT or AT. A PC-class machine has no specific hard drive support. It looks for a hard drive ROM on the system bus during boot-up. That ROM must provide BIOS-level access to the hard drive. I suspect that the controller you bought is not properly matched to your drive. It's not a problem to use less than the full capacity of the drive—I'd guess that the technician simply used the largest setting on the controller that your drive would support. Changing the controller should do the trick.*

*The 32-MB limit only applies to DOS 3.2 and lower. Version 3.3's extended-partition support allows several partitions, each up to 32 MB on a single drive. Lots of folks run DOS 3.3 with 40-MB drives and still use the entire capacity. They simply create two partitions and split the drive into two logical drives. Better yet, DOS 4.x or 5.0 lets you configure the whole drive as a single partition.* —Howard Eglowstein

### LCDs in Living Color

Our company has need for a lightweight, flat-screen LCD color monitor for use with a mobile projection system. (The system consists of a PC driving a scan converter and large-screen LCD projector.) I have seen such a device but failed to clip the article. Can you help?

John B. Echols
*Lynwood, CA*

*In Focus Systems, Inc. (7770 South Mohawk St., Tualatin, OR 97062, (800) 327-7231) has a 640- by 480-pixel, 5000-color active-matrix LCD monitor. This unit weighs less than 5 pounds and has a 10½-inch diagonal screen. Depending on the selected driver hardware, the LCD monitor can emulate CGA, EGA, VGA, or Macintosh displays.*

*In Focus doesn't sell to end users but was finalizing distribution through resellers and OEMs as we went to press. Call the company for details.*—Raymond G A Côté

### Did We Say That?

*Several readers pointed out an error in our answer to L. D. Thomas's letter in the November 1991 Ask BYTE. Thomas wanted to have both MS-DOS 3.21 and 5.0 available on his computer. We suggested that he install DOS 5.0 on his hard disk and boot up with DOS 3.21. That won't work, because DOS 3.21 can't access extended partitions you create with DOS 5.0. The correct solution is to install DOS 3.21 on the hard disk and boot up with DOS 5.0 on a floppy disk as necessary.*

—Stan Wszola

### Video Labels

I am looking for labels for my laser printer that are shaped like the labels on a videocassette tape, both the square ones and the long ones. Do you know of a source?

Ronny Richardson
*Chamblee, GA*

*Blank labels for videocassette tapes are hard to find. A videocassette requires two different sizes of labels: the face labels (3⅛ by 1⅞ inches) and the spine labels (5⅞ by ¾ inch).*

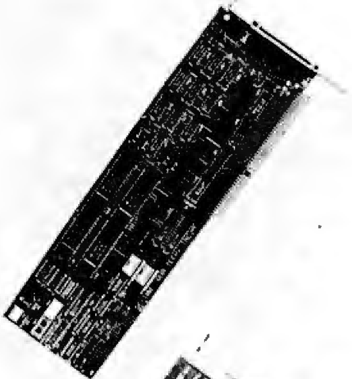
*Laser printer owners can use Avery Laser Printer Labels #5199, which costs $38.95 for 300 each of the face and spine labels. You can order these from any well-stocked office-supply store or from Paper Direct (205 Chubb Ave., Lyndhurst, NJ 07071, (800) 272-7377). Avery also has the LabelPro label-design program ($64.95) for both the PC (#5100) and the Mac (#5117).*

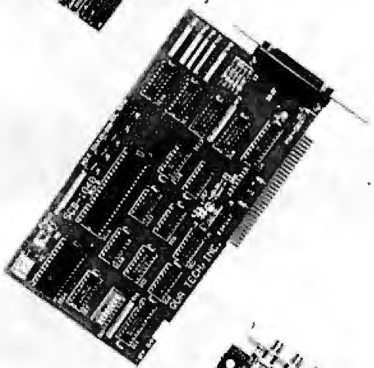
*Owners of pin-feed-type printers can try Power Up Software (2929 Campus Dr., P.O. Box 7600, San Mateo, CA 94403, (800) 851-2917). The Video Cassette Pack ($9.95) includes 100 of both the face labels and the spine labels.*

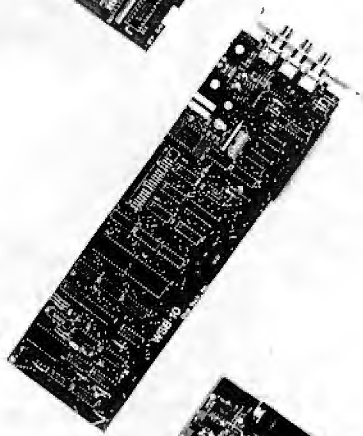
*In addition, Power Up sells the Video Tape Log program ($29.95) and the Labels Unlimited 3.0 label-design program ($59.95) for PC compatibles.*—Stan Wszola ■

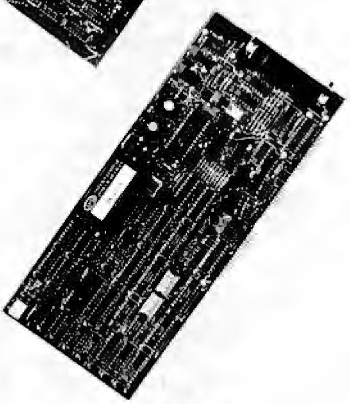
QUATECH

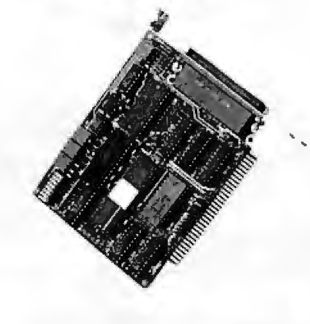
# *"not just another board game"*











# COMMUNICATION

Quatech produces a full line of communication boards for the PC-XT, AT and MicroChannel systems including:

**Asynchronous:**
2 port for PC/AT
- DS-100:RS-232
- DS-200:RS-422
- DS-300:RS-485

2 port for PC/XT/AT
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- DS-202:RS-422
- DS-302:RS-485

**Synchronous**
Bisync, SDLC, HDLC
- SCB-1020
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- SCB-1040
  1 channel RS-422
- SCB-1050
  1 channel RS-485

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- ES-100
  Block addressing
- MS-100
  Selectable addressing by port

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- QS-100
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- 10 Megahertz maximum output

**WSB-100**
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- Output signal defined up to 32,000 points
- 20 Megahertz maximum output
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  WSB-D16: 16 channel digital pulse generator module

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Quatech has developed a full line of data acquisition products for the IBM PC-XT, AT, MicroChannel and compatibles. These high performance, low cost boards provide analog-to-digital, digital-to-analog, and digital input/output functions.

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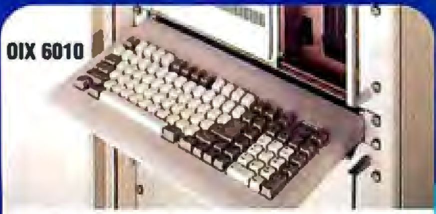
## PC SYSTEMS




### Elma Rack-Mount Keyboards

If you use a standard keyboard with your rack-mounted system, you know what a nuisance and a hazard it can be. These new industrial keyboards are designed to fit easily into any EIA 19" rack. Rugged and reliable, these keyboards are made in the U.S.A. by a Swiss company and demonstrate classic Swiss craftsmanship.

- Full 101-key layout.
- Full-travel construction with excellent tactile feel for touch-typing.
- **OIX 3010** keyboard is set in a drawer (not shown).
- **OIX 6010** keyboard slides out w/a locking door.
- Occupies only 1 rack space (1.75" high).

**#OIX 3010** Rack-Mount Keybd — 24" D Rack....**$295**
**#OIX 6010** Rack-Mount Industrial Keyboard......**$395**

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Running out of space for boards in your PC? Did your portable computer come with just 1 slot and you need more? At CyberResearch, we have the answer! Our 12-slot AT expansion chassis gives you a net gain of **1 0additional slots**, providing your PC with the power to handle even the largest jobs. 100% compatible, no software required.

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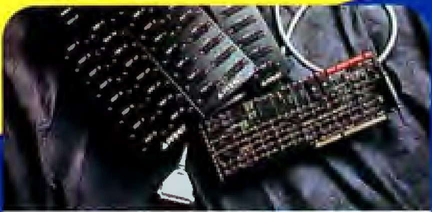
**#INST 1011** Micro-Channel GPIB Controller ...**$2995**



### Arnet Intelligent Serial Boards

**Your P Cis no longer limited to 2 serial ports!** Multi-port serial boards from Arnet let your DOS-based PC support up to 66 serial ports. All Arnet boards come complete with DOS Driver Software and an external 25-pin "D" connector box.

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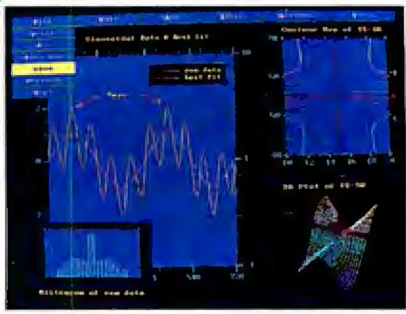
Use modules as an integrated package or stand-alone



### EasyPlot II Scientific Plotting and Graphing Software

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Tape VGA Animation

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Redlake's **TapeCaster** converts VGA screen output to video for applications such as animation and creating training tapes. The TapeCaster is extremely easy to use: no base addresses, no interrupts, no software — just plug and play.

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- Simultaneous VGA and video display.
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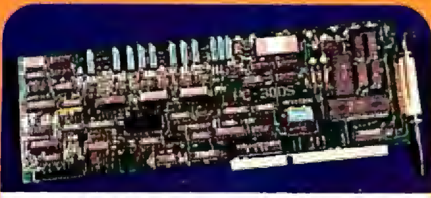
**#PAL 200** TapeCaster - PAL (Europe) Video Out. ...**$750**
**#NTSC 10** Spectrum-NTSC Video Digitizer and VGA Overlay Controller with software.......**$1650**



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PC 30 boards from **UEI** bring high-speed data acquisition to the low-cost market. Complete with menu-driven **Status-30** software and programming drivers for BASIC, C and Pascal, the **PC 30D** and **PC 30PG** are two of the best deals around.

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- 12-Bit Resolution for Accurate Measurements.
- Up to 30,000 Samples Per Second.
- 16 Digital Input Lines & 16 Digital Output Lines

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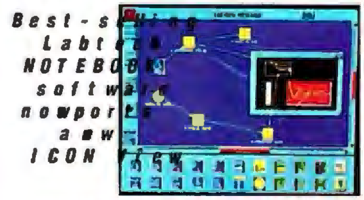


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- BASIC & QuickBASIC Drivers

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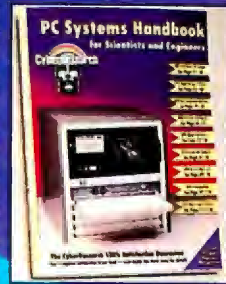


The *PC Systems Handbook* is available outside the United States for $14.95US, prepaid, including surface delivery (allow 2-4 weeks). Send $19.95US for express airmail delivery.

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| EISA 486-25C $1,628 | | | | | 286-20 $388 |
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| ISA 486-25C $898 | 386-33C 64k cache $648 | 386-25C 64k cache $618 | 386SX 25 MHz $498 | 386SX 16 MHz $438 | 286-12 $338 |

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## VIDEO OPTIONS

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| Sony 1304 HG (1024x768, 0.25) | $ 568 |
| Nanao 9070U/9080i | $ 898/1078 |
| Oak VGA-256k (800x600, 16-bit) | $ 48 |
| Trident 1MB (1024x768x256) | $ 88 |
| Orchid Prodesigner IIS with 1MB | $ 178 |
| Orchid Prodesigner IIS w/ Hi-Color | $ 218 |
| Orchid Fahrenheit 1280 | $ 298 |
| Diamond Speed Star with 1MB | $ 178 |
| Diamond Speed Star Hi-Color | $ 218 |
| Video 7 1024i (512 KB) | $ 188 |
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| Citizen GSX-145 (24-pin) | $ 398 |
| Color option for Citizen printer | $ 48/68 |
| Panasonic Printers | $ Call |
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## 486/33 MHz Plus

- Same configuration as our 486/33 except this system has 8 MB RAM, 210MB 15ms IDE 64K Cache Drive Diamond SpeedStar Hi-Color Card.

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128K High Speed Cache
4 MB RAM (70ns)
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130 MB 15ms IDE 64K Cache Drive
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4" Non-interlaced .28dp Color Monitor
(VESA Standard for Flicker-free Display)
2 Serial, 1 Parallel & 1 Game Ports
Enhanced 101-key Keyboard
Hi-Resolution 400 DPI Serial Mouse
Free MS-DOS 5.0 & Windows 3.0

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1.2 MB & 1.44 MB Floppy Drive
130 MB 15ms IDE 64K Cache Drive
16-Bit 1024x768 SVGA Card with 1MB
14" Non-interlaced .28dp Color Monitor
(VESA Standard for Flicker-free Display)
2 Serial, 1 Parallel & 1 Game Ports
Enhanced 101-key Keyboard
Hi-Resolution 400 DPI Serial Mouse
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4 MB RAM (70ns)
1.2 MB & 1.44 MB Floppy Drive
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16-Bit 1024x768 SVGA Card with 1MB
4" Non-interlaced .28dp Color Monitor
(VESA Standard for Flicker-free Display)
2 Serial, 1 Parallel & 1 Game Ports
Enhanced 101-key Keyboard
Hi-Resolution 400 DPI Serial Mouse
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4 MB RAM (70ns)
1.2 MB & 1.44 MB Floppy Drive
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16-Bit 1024x768 SVGA Card with 1MB
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(VESA Standard for Flicker-free Display)
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Hi-Resolution 400 DPI Serial Mouse
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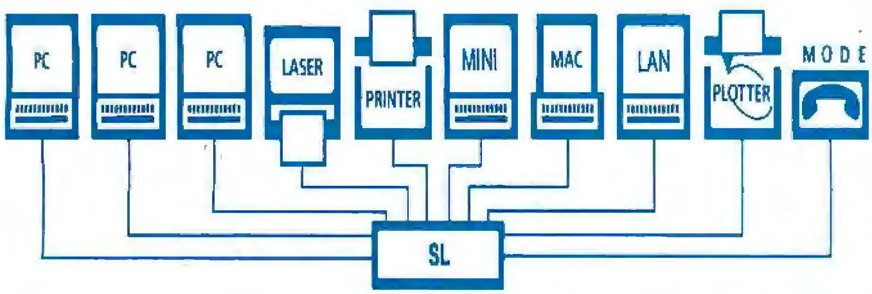


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|---|---|---|---|---|
| SL | 6 Ser/4Par | Any Combination | 256KB-4MB | $495 |
| SLP | 8 Par/2 Ser | Any Combination | 256KB-4MB | $495 |
| HXS | 4 Serial | Any Combination | 256KB-16MB | $295 |
| HXM | 2 Ser/ 2 Par | Any Combination | 256KB-16MB | $295 |
| HWP | 5 Parallel | 3/2, 4/1 | 256KB-16MB | $295 |
| HXP | 4 Parallel | 2/2, 3/1 | 256KB-16MB | $245 |
| HCP | 2 Parallel | 1/1 | 256KB-16MB | $225 |
| AS31 | 4 Parallel | 3/1 | None | $175 |
| AS41 | 5 Parallel | 4/1 | None | $195 |
| AS81S | 9 Ser/ 1 Par | 8/1 | None | $189 |

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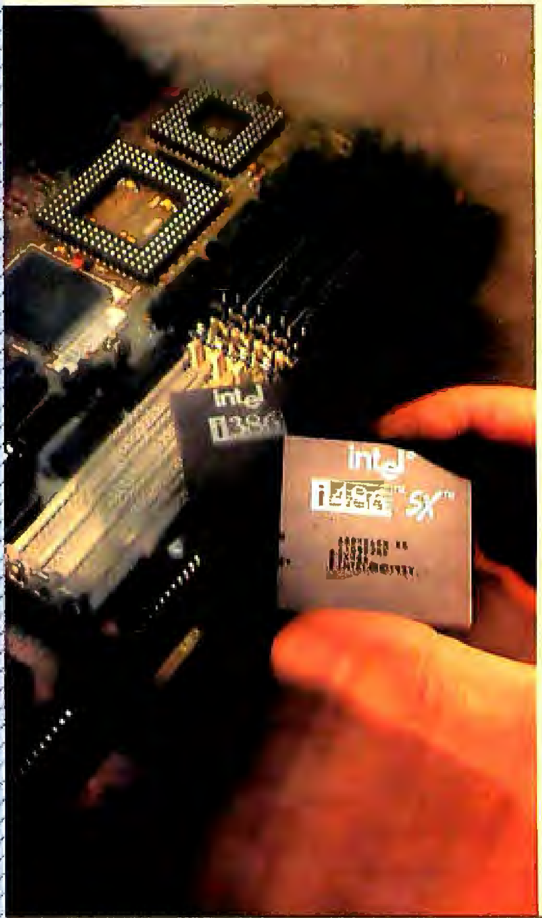


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**$1989**

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Hi-Res Serial Mouse
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Teac 1.2MB 5.25" & 1.44MB 3.5" Drives
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Flicker-Free Color Monitor
2 Serial, 1 Parallel, & 1 Game Port
MS DOS 5.0 & Windows 3.0
Starkey 102 Keyboard
Hi-Res Serial Mouse
Desktop CPU Case (Verticals optional)
Upgradeable to 33/40 MHz &
486sx 20, 486 33/50

### 386sx 16MHz
**$1299**

Intel 80386SX/16 Processor
2MB RAM & 42 MB Hard Drive w/Cache
Teac 1.2MB 5.25" & 1.44MB 3.5" Drives
1MB SVGA Color Card
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MS DOS 5.0 & Windows 3.0
Starkey 102 Keyboard
Hi-Res Serial Mouse
Desktop CPU Case (Verticals optional)

### 386sx 25MHz
**$1349**

### 386 40MHz
**$2049**

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### 486 33MHz
**$2399**

Intel 80486/33 Processor w/8KB internal
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1MB SVGA Non-Interlaced Color Card
14" SVGA 1024x768 Non-Interlaced
Flicker-Free Color Monitor
2 Serial, 1 Parallel, & Game Port
MS DOS 5.0 & Windows 3.0
Starkey 102 Keyboard
Hi-Res Serial Mouse
Mid-Vertical or Desktop CPU Case
Upgradeable to 50MHz

### 486 50MHz
**$3279**

### 486sx 20MHz
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Intel 80486sx/20 Processor
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2 Serial, 1 Parallel, & Game Port
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Hi-Res Serial Mouse
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**Circle 177 on Inquiry Card.**

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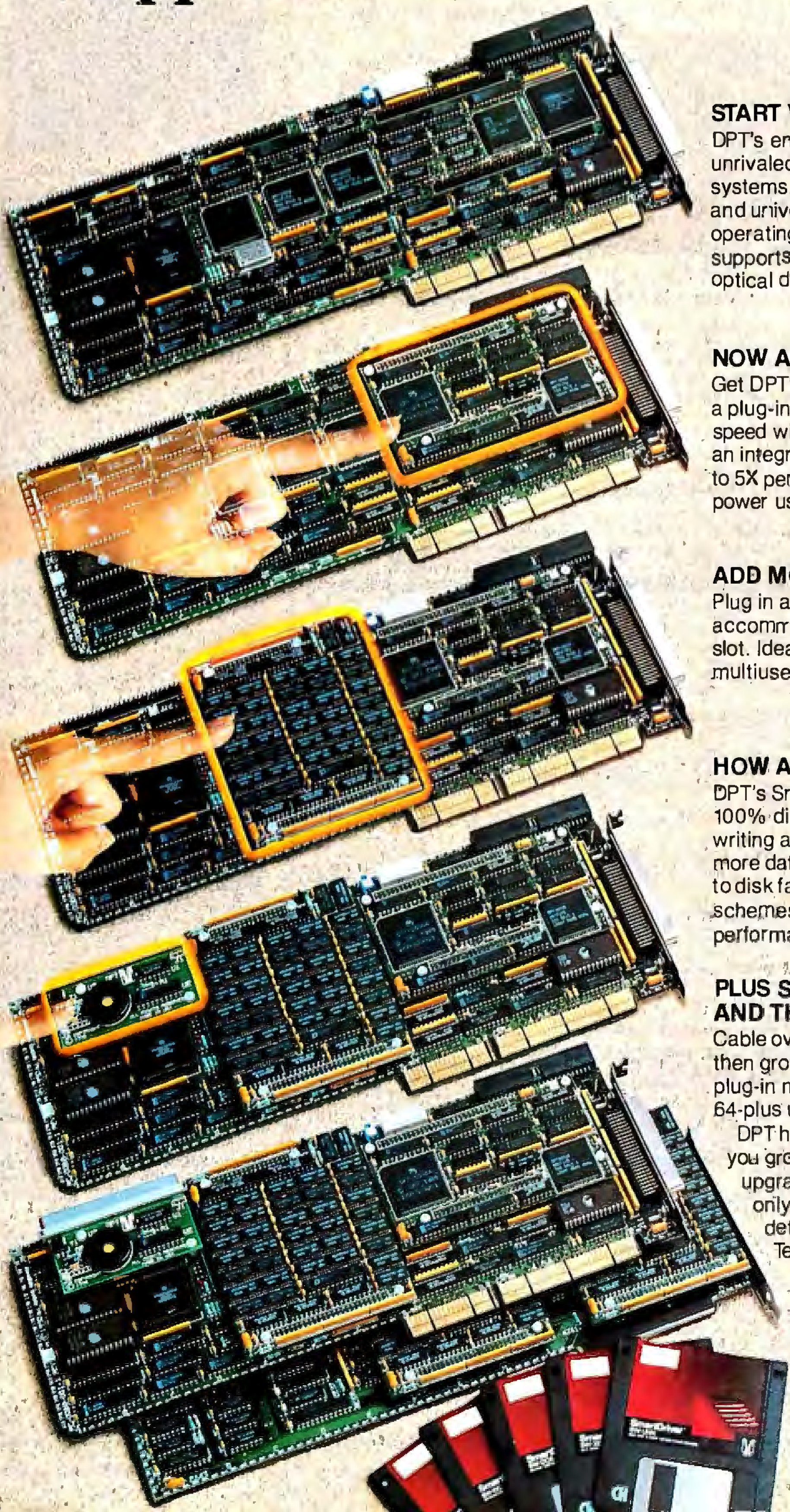

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DPT's entry level SmartCache Plus board offers unrivaled price/performance for single-user systems. It features ISA or EISA bus mastering, and universal SCSI disk compatibility for all PC operating systems. Smart Diver software supports S CS 2 peripherals like tape and optical drives.

**NOW ADD CACHING!**
Get DPT's award-winning caching technology in a plug-in module! Move up to disk caching speed without investing in a new controller. With an integral 512K cache, the module provides up to 5X performance gains for workstations, power users, and small multiuser systems.

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DPT's SmartCache mirroring module provides 100% disk fault tolerance by simultaneously writing all data to a second "mirrored" drive. No more data loss or costly system down-time due to disk failures. And unlike software mirroring schemes, fault tolerance is achieved with no performance penalties.

**PLUS STILL MORE CACHE, AND THEN SOME...**
Cable over to DPT's 4 MB Cache Expansion Card, then grow your system to 16 MB by adding more plug-in memory modules—enough power for 64-plus users!

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**Circle 234 on Inquiry Card (RESELLERS: 235).**

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## IBM MEMORY

| | | |
|---|---|---|
| **PS/1** | | |
| 2MB | IBM PN N/A | $119 |
| **PS/2 30/286, 1497259** | | |
| 2MB Kit | 30F5360 | $109 |
| **PS/2 35SX;LS,40SX,50Z,55SX;LS,65SX;LS,70** | | |
| 1MB | 6450603 | $59 |
| 2MB | 6450604 | $119 |
| **PS/2 70-A21;A61;B21;B61** | | |
| 2MB | 6450608 | $129 |
| **PS/2 35SX;LS,40SX,55SX;LS,65SX;LS,34F30XX** | | |
| 4MB | 34F2933 | $269 |
| **PS/2 35SX; LS, 40SX** | | |
| 8MB | 6450129 | $589 |
| **PS/2 57SX, 90, 95** (NEW) | | |
| 8MB | 6450130 | $509 |
| **PS/2 80-141** | | |
| 1MB | 6450375 | $79 |
| **PS/2 80-111/311** | | |
| 2MB | 6450379 | $139 |
| **PS/2 90, 95 and P75 (Install in pairs)** | | |
| 2MB | 6450902 | $119 |
| 4MB | 6450128 | $209 |
| **Expansion boards for all models 50 and 60** | | |
| 2-8MB w/2MB | 1497259 | $319 |
| 2-16MB w/2M | 6450609 | $339 |
| **Expansion boards for all models 70 and 80** | | |
| 2-14MB w/2M | 34F3077 | $349 |
| 4-16MB w/4M | 34F3011 | $459 |

## NEC MEMORY

| | | |
|---|---|---|
| **Powermate SX** | | |
| 2MB Brd. | APC-H855 | $499 |
| 4MB Brd | APC-H853 | $729 |
| **Powermate SX Plus** | | |
| 1-2MB Brd | APC-H850E | $239 |
| 4-8MB Brd | APC-852E | $629 |
| **Powermate SX/20** | | |
| 2MB CPU | OP-410-8101 | $199 |
| 2MB Brd | OP-410-8102 | $239 |
| **Powermate 386/20** | | |
| 2MB | APC-H655E | $359 |
| **Powermate 386/25** | | |
| 2MB | APC-H655X | $389 |
| **Powermate 386/25S** (NEW) | | |
| 2MB Kit | OP-410-5201 | $199 |

## HP MEMORY

| | | |
|---|---|---|
| **Vectra QS/16S; 20PC, RS/20PC; 25PC, 20C** | | |
| 1MB Kit | D1540/1640A | $69 |
| 4MB Kit | D1542/1642A | $199 |
| **Vecta 386/16N, 386/20N** (NEW) | | |
| 2MB | D2406A | $159 |
| 8MB | D2404A | $609 |
| **Vectra 486 PC (Install in Pairs)** | | |
| 1MB | D2150A | $69 |
| 4MB | D2151A | $299 |
| **Vectra 386/25,486/25T, 33T (Install in Pairs)** | | |
| 2MB | D2381A | $129 |
| **Vectra 486PC and 386/25 PC** | | |
| 8MB | D2152A | $549 |

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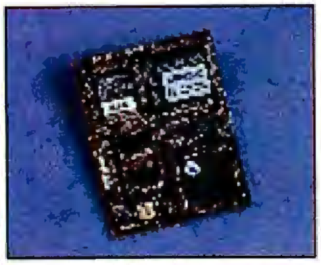
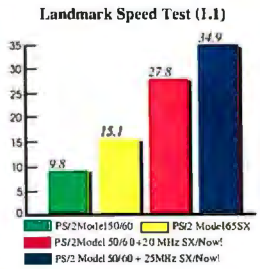
-PC Magazine October 29, 1991



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SX/Now! 25MHz Accelerator ........ $539

## PRINTER MEMORY

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|---|---|---|
| **Hewlett-Packard LaserJet IIP, III, IIIP, IIID** | | |
| 2MB | 33475B | $125 |
| 4MB | 33477B | $199 |
| **Hewlett-Packard LaserJet II and IID** | | |
| 2MB | 33444B | $125 |
| 4MB | 33445B | $195 |
| **Hewlett-Packard DeskJet 500 and Plus** | | |
| 256K | 22707B | $99 |
| **IBM Laser 4019 and 4019e** | | |
| 2MB | 1039137 | $149 |
| 3.5MB | 1038675 | $219 |
| **IBM Laser 4029 All Models** (NEW) | | |
| 2MB | 1183334 | $179 |
| 4MB | 1183335 | $359 |
| **Canon LBP-4** | | |
| 2MB | PN N/A | $249 |
| **Brother HL-8, 8E** | | |
| 2MB | MB-820 | $199 |
| **Panasonic 4450I and 4420** | | |
| 2MB | KX-P441 | $149 |
| 4MB | PN N/A | $239 |
| **Toshiba Page Laser 6** | | |
| 4MB | LS6-NB0100 | $219 |
| **OkiLaser 400** | | |
| 1MB | 70014701 | $109 |
| 2MB | OKI PN N/A | $149 |
| **Texas Instruments MicroLaser and XL** | | |
| 1MB | 2555739-0001 | $79 |
| **Epson EPL 6000** | | |
| 2MB | IBS401 | $149 |

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| SIMMS AND SIPPS | | DRAM CHIPS | |
|---|---|---|---|
| 4MX9-80 | $169 | 1X1-80 | $4.50 |
| 1MX9-80 | $48 | 256X4-80 | $5.00 |
| 256X9-80 | $15 | 256X1-80 | $1.80 |

## COMPAQ MEMORY

| | | |
|---|---|---|
| **DeskPro 386-20, 20E and 25** | | |
| 1MB | 113131-001 | $89 |
| 4MB | 113132-001 | $219 |
| **DeskPro 386S/16** | | |
| 1MB | 113646-001 | $89 |
| 4MB | 112534-001 | $219 |
| **DeskPro 286N, 386N and 386SX/20** | | |
| 1MB | 118688-001 | $69 |
| 2MB | 118689-001 | $119 |
| 4MB | 118690-001 | $269 |
| **DeskPro 386-33, 486-33 and SystemPro** | | |
| 0K Board | 116569-001 | $229 |
| 2MB | 115144-001 | $129 |
| 8MB | 116561-001 | $419 |
| **DeskPro 386-20e and 25e** | | |
| 1MB Board | 113644-001 | $139 |
| 4MB Board | 113645-001 | $309 |
| **DeskPro 386S** | | |
| 1MB Board | 113633-001 | $139 |
| 4MB Board | 113634-001 | $329 |

## AST MEMORY

| | | |
|---|---|---|
| **Premium 386C, 386-16** | | |
| 4MB Kit | 500510-008 | $189 |
| **Premium 386, 386-20** | | |
| 4MB Kit | 500510-004 | $249 |
| **Bravo 386-SX, WS/286, 386** (NEW) | | |
| 2MB Kit | 500510-002 | $99 |
| 4MB Kit | 500510-008 | $189 |
| 8MB Kit | 500824-001 | $389 |
| **Premium 386/25;33, Premium II 386SX/16;20** | | |
| 1MB w/WPB | 500780-003 | $69 |
| **All Premium and Bravo 486 Models** | | |
| 2MB w/WPB | 500718-004 | $129 |
| 8MB w/WPB | 500780-001 | $459 |
| **Premium II 386SX/20 and 386SX/16** | | |
| 4MB w/WPB | 500780-004 | $229 |

## LAPTOP MEMORY

| | | |
|---|---|---|
| **AST** | | |
| Executive Notebook | 1MB | $79 |
| | 4MB | $219 |
| **COMPAQ** | | |
| Portable LTE386S/20 | 1MB | $179 |
| | 4MB | $379 |
| Portable LTE 286 | 1MB | $89 |
| | 4MB | $219 |
| SLT-286 | 1MB | $129 |
| | 4MB | $449 |
| SLT-386 | 1MB | $129 |
| | 4MB | $399 |
| **IBM** | | |
| L40SX laptop | 2MB | $129 |
| | 4MB | $219 |
| | 8MB | $449 |
| **TOSHIBA** | | |
| T1000SE/LE/XE, T2000SX | 2MB | $229 |
| T1000LE, T2000SX | 4MB | $359 |
| | 8MB | $789 |
| T2000SXE (NEW) | 2MB | $229 |
| | 4MB | $359 |
| | 8MB | $789 |
| T1200XE, T1600, T3100E | 2MB | $129 |
| T3100SX, T3200SX, SXC | 2MB | $129 |
| | 4MB | $229 |
| T3200 | 3MB | $229 |
| T5100 | 2MB | $129 |
| T5200, T5200C, T8500 | 2MB | $129 |
| | 8MB | $469 |
| **NEC** | | |
| Powermate Port. SX | 2MB | $399 |
| | 8MB | $1399 |
| ProSpeed 286, 386SX16 | 1MB | $129 |
| | 4MB | $399 |
| ProSpeed SX20 | 1MB | $159 |
| | 4MB | $449 |
| **ZENITH** | | |
| MastersPort SL | 2MB | $209 |
| MastersPort 386SX (NEW) | 2MB | $209 |
| S.S. SX, 286E, SlimsPort | 2MB | $169 |
| SuperSport SX | 2MB | $169 |
| SuperSport 286, 286E | 1MB kit | $119 |
| SuperSport 286E, SlimsPort | 4MB | $449 |
| TurboSport 386, 386E | 1MB | $169 |

## ZENITH MEMORY

| | | |
|---|---|---|
| **Zenith 486/33ET** (NEW) | | |
| 4MB Kit | ZA-4200-MZ | $293 |
| 16MB Kit | ZA-4200-MB | $1279 |
| **Zenith Z-386/20/25/33 and 33E** | | |
| 1MB | ZA36/3800ME | $69 |
| 4MB | ZA3800MK | $299 |

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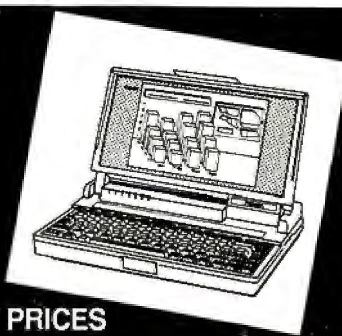

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| 1 Mb | $98 |
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| 4 Mb | $298 |
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## TOSHIBA MODEMS ON SALE

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| AST PREMIUM EXEC | 386SX/25 | 80MB *WITH 8MB RAM* | $2,698 |
| AST PREMIUM EXEC | 386SX/25 | 60MB *WITH 8MB RAM* | $2,448 |
| AST PREMIUM EXEC | 386SX/20 | 60MB *WITH 8MB RAM* | $2,328 |
| ASTPREMIUM EXEC | 386SX/20 | 40MB *WITH 8MB RAM* | $2,078 |
| EVEREX TEMPO/LX | 386SX/20 | 60MB *WITH 5MB RAM* | $2,318 |
| EVEREX TEMPO/LX | 386SX/20 | 40MB *WITH 5MB RAM* | $2,148 |
| ***SHARP PC-6661*** | | ***60MB WITH 6 MB RAM*** | ***$2,218*** |
| ***SHARP PC-6641*** | | ***40MB WITH 6 MB RAM*** | ***$2,098*** |
| SHARP PC-6781/PC6881 | | 80MB *WITH 8MB RAM* | $CALL |
| TEXAS INSTRUMENTS TM2000 | | 20MB *WITH 3MB RAM* | $1,158 |
| TEXAS INSTRUMENTS TM2000 | | 40MB *WITH 3MB RAM* | $1,468 |
| TEXAS INSTRUMENTS TM3000 | WINSX | 80MB/*6MB RAM* | $3,178 |
| TEXAS INSTRUMENTS TM3000 | WINSX | 60MB/*6MB RAM* | $2,958 |
| TEXAS INSTRUMENTS TM3000 | | 60MB *WITH 6MB RAM* | $2,668 |
| TEXAS INSTRUMENTS TM3000 | | 40MB *WITH 6MB RAM* | $2,448 |
| TEXAS INSTRUMENTS TM3000 | | 30MB *WITH 6MB RAM* | $2,418 |
| TEXAS INSTRUMENTS TM3000 | | 20MB *WITH 6MB RAM* | $2,258 |
| ZENITH MASTERSPORT 386SX | | 60MB *WITH 4MB RAM* | $2,828 |

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| T5200C | 200MB *WITH 14MB RAM* | $6,188 |
| T5200 | 200MB *WITH 14MB RAM* | $3,868 |
| T5200 | 100MB *WITH 14MB RAM* | $3,598 |
| T5100 | 100MB *WITH 4MB RAM* | $1,978 |
| T5100 | 40MB *WITH 4MB RAM* | $1,598 |
| T4400SX | 85MB GAS PLASMA *WITH 10MB RAM* | $CALL |
| T4400SX | 85MB LCD *WITH 10MB RAM* | $CALL |
| T3300SL | 85MB *WITH 10MB RAM* | $CALL |
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| T3200SX | 120MB *WITH 13MB RAM* | $3,268 |
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| T3100SX | 80MB *WITH 13MB RAM* | $2,958 |
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| T2200SX | 40MB *WITH 10MB RAM* | $3,538 |
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| T2000SXE | 40MB *WITH 10MB RAM* | $2,758 |
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| T1600 | 40MB *WITH 5MB RAM* | $1,738 |
| T1600 | 20MB *WITH 5MB RAM* | $1,338 |
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| SHARP PC-6641/TI TM3000 60MB HARD DRIVE | $498 |
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| COMPAQ LTE/386s 4MB UPGRADE | $288 |
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| GRID 1720/1750 2MB/4MB UPGRADE | $128/228 |
| HP 95LX PALMTOP 512K/1MB/2MB UPGRADE | $228/328/$868 |
| IBM PS2 L40SX 2MB/4MB/8MB UPGRADE | $128/$198/$378 |
| NCR 3125 512K/1MB UPGRADE | $228/328 |
| PANASONIC CF170 1MB UPGRADE | $68 |
| PANASONIC CF270/370 2MB UPGRADE | $128 |
| PANASONIC CF270/370 4MB UPGRADE | $228 |
| POQUET PALMTOP 512K/1MB UPGRADE | $228/328 |
| SANYO MBC-17NB/18NB 2MB UPGRADE | $128 |
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| TANDY 2810HD/3810HD 2MB/4MB UPGRADE | $128/248 |
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| TOSHIBA T3100SX 4MB UPGRADE (1 SLOT) | $178 |
| TOSHIBA T3200 3MB UPGRADE | $168 |
| TOSHIBA T5200 2MB/8MB UPGRADE | $98/$398 |
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| HP II/IID 2MB MEMORY UPGRADE | $118 |
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| HP IIP/IIP+/III/IIID/IIIP 2MB MEMORY UPGRADE | $108 |
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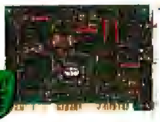

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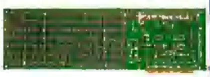

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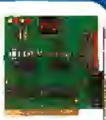

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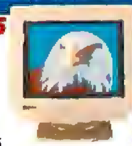

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| 1MB-80 | 1048576x1 | 80ns | DIP | 5.99 |
| 1MB-60 | 1048576x1 | 60ns | DIP | 6.99 |
| 41256A9B-80 | 256K x 9 | 80ns | SIMM | 21.95 |
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| 421000A9B-10 | 1MB x 9 | 100ns | SIMM | 49.95 |
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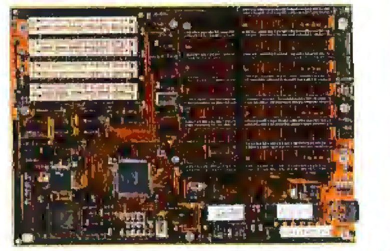

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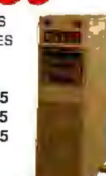

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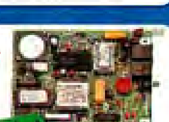

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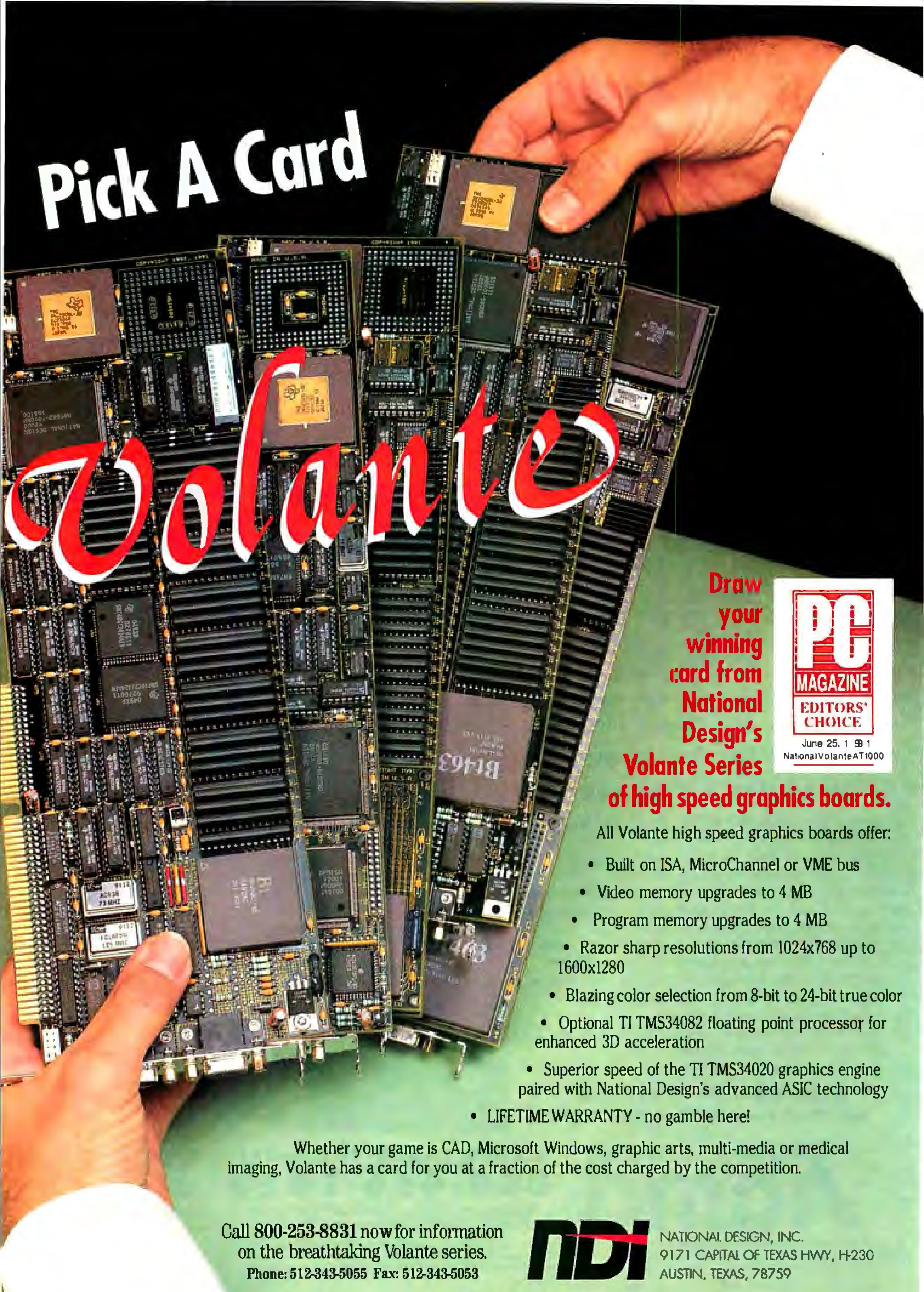


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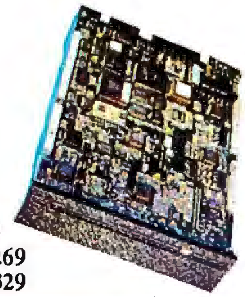

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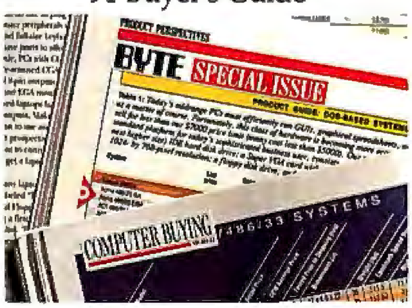


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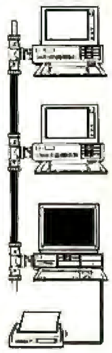

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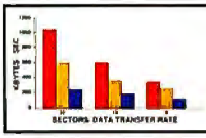


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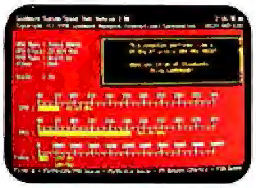

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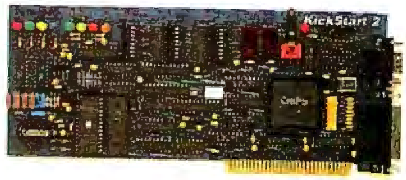

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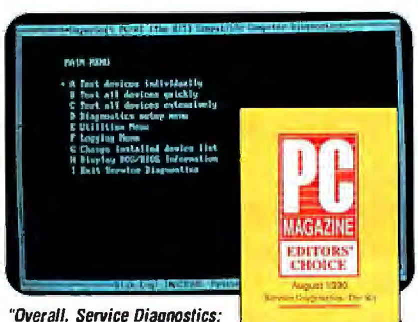


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| Adaptec 1522 KIT | 187.00 |
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| Identity Int. 2400 BAUD modem MNP-5 w/software | 129.00 |
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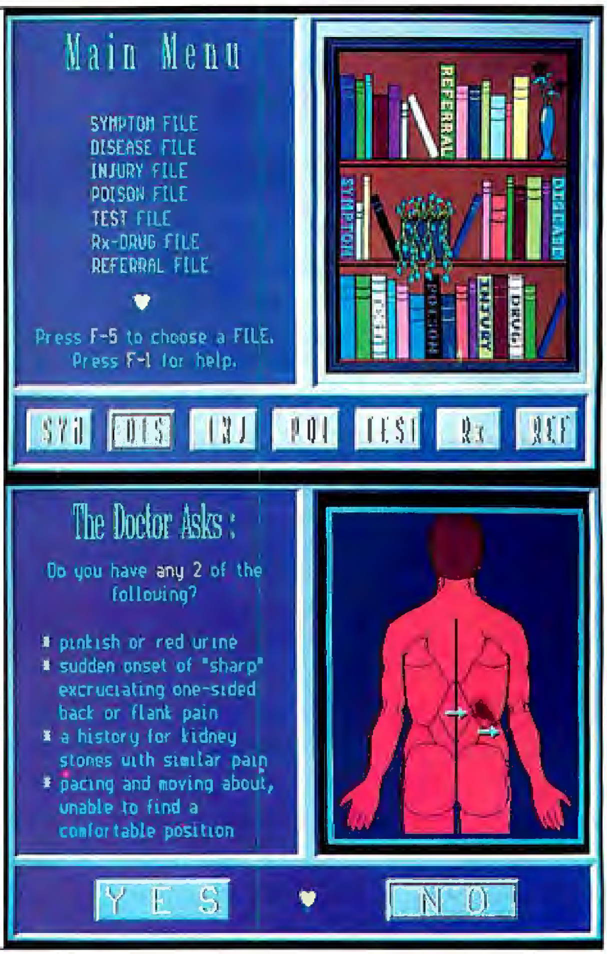


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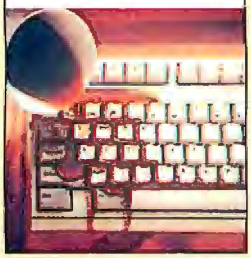

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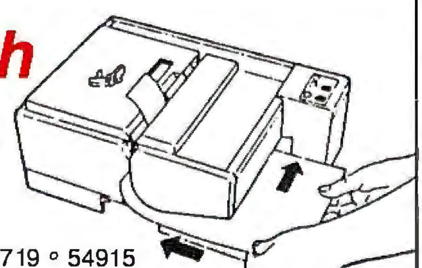

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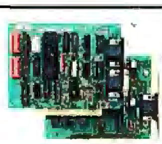

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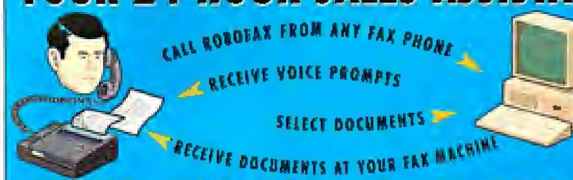


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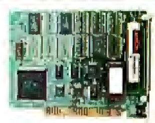

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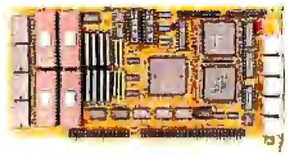

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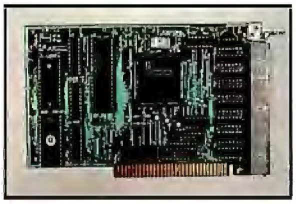

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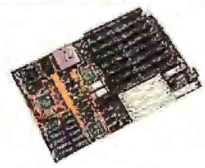

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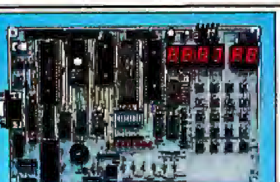

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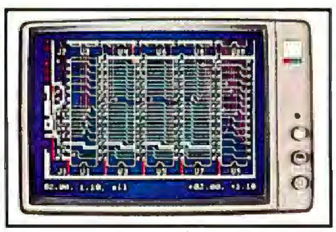

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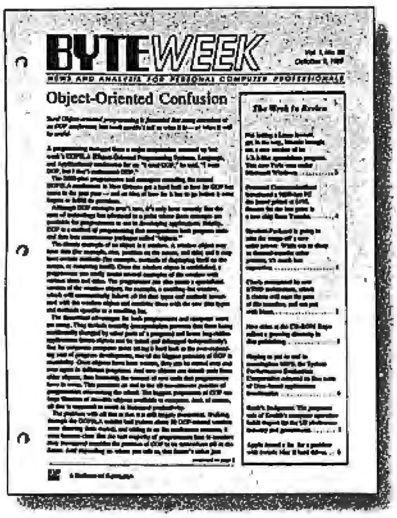



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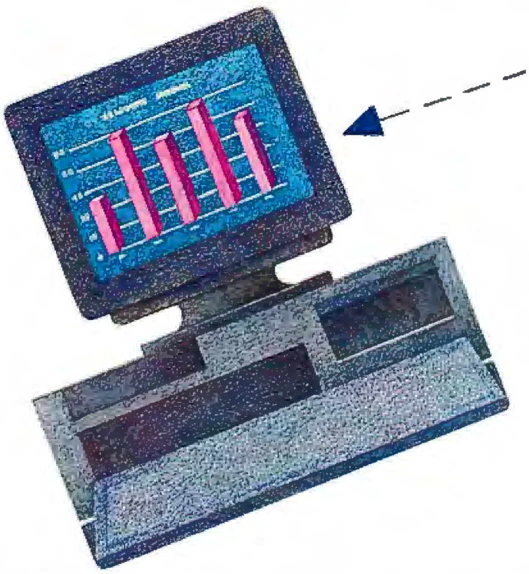

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HUGH KENNER

# Glitzers Anonymous

## Don't let overbearing screen designs mar your programs

I recall a bleak screen that said just, in white on black, "Infile? <RETURN>".... Calling up such a memory, I feel like the oldest inhabitant of computerdom. (Will the last inhabitant please turn out the lights.)

For screens nowadays are glitzy: red backgrounds, cyan borders outlined in blue; up above, a header bar in brown; below, an overlaid emergency bar, black with polychrome borders. Worse are windows, superimposed, strident chromatics clamoring for attention, the whole mess atop a blue background with a double-ruled yellow boundary....

All of which can well drive the computer-innocent back to pencil and scratch pad, a side effect that computer-drunks don't seem to grasp. Yea, colors! Colors we've got! And the more the glitzier! On, Stunner! On, Glitzen! Onward toward HyperGlitz!

A cure? Call it Glitzers Anonymous: a weekend with Edward R. Tufte's *Envisioning Information*, a quietly handsome book in which horrors such as the above utter their silent screams at the bottom of page 88, right across from a cool example of what might just as easily be. A calm white window has gray demarkers, a cyan header, a yellow border. Behind it, another window in two shades of gray, awaiting activation, lies quiet for now. Cyan and yellow may invest it once it's active, and what's now assertive will recede into gray.

For yes, as we oldest inhabitants concede, "color can improve the information resolution of a computer screen." But let us not therefore invoke a rainbow deluge with our eyes shut. Color's first office is to "calm video glare, the effect of staring at a light bulb." Next, "color defines edges"; thus, "for framing fields, the appropriate color should be *light in value*" but also "relatively intense and saturated," so we'll quickly spot the active window. And the only color that meets both requirements is yellow—and don't fussily stick a border of some other color inside it.

Tufte, who teaches "statistics, graphics design, and political economy" at Yale, came to wider notice in 1983 with *The Visual Display of Quantitative Information*, now in its tenth printing. He's (rightly) meticulous enough to have issued both books from his own Graphics Press (P.O. Box 430, Cheshire, CT 06410), to which you send your order. One section of *Envisioning Information* even uses 12-color printing. The quality is, yes, evident—quietly.

Here, on page 83, is an "exuberantly bad example": a U.S. Census Bureau map with colored blobs designating home-heating fuels. OK, except that the map got enclosed in a thick white border atop a blue field, and the one thing that clings to your eye is that thick white border, "the map's dominant visual statement," and it's meaningless.

Worse (page 33), a price-of-diamonds graph, 1978–1982. It came from a Time, Inc., publication and might as well have come from *USA Today*. The graph surged up and down in a way that suggested to someone a seated cutie's leg. Then her legs and thighs got crosshatched (a graph, see?) and she got equipped with a vapid face and a top hat, and it all became (in four colors) a creative concept. Tufte calls it "chartjunk."

"Chartjunk promoters imagine that numbers and details are boring, dull, and tedious, requiring ornament to enliven." But "if the numbers are boring, then you've got the wrong numbers," and, sure enough, the cutie-chart "mixes up changes in the value of money with changes in diamond prices"—this in a time of high inflation. So it says nothing except "See here!"

"No one can write decently," wrote E. B. White, "who is distrustful of the reader's intelligence." Nor can any designer of a visual display grab attention save by assuming that we want to know. For we want to know all we can. Not aware what fatigues us, still we are fatigued by gross simplification, pizzazz. So, "a most unconventional design strategy is revealed: *to clarify, add detail.*" "God is in the details," and may as well be on your screen.

**Short Subjects**

If you're interested in computerized aids to writing but have found Grammatik a tad naive, you may want to look at Editor, which in fact doesn't edit but simply makes suggestions that you compare against a printout of your text with the sentences numbered.

Editor was written "for typical college-level writers...who may be lazy, inexperienced, or weak," and its dictionaries "are based on a long-term study of undergraduate writing." Thus, "many of the words and phrases it flags are not problems when good writers use them." Good writers might conceivably have a use for the word *definitely*, but Editor flags it without any mercy.

Editor's four programs (Fix, Tighten, Polish, and Consider) are menu-based and can be run separately or with one keystroke. They are very fast, and their output goes to a menu-viewable file. Editor sells for $45 from Academic Software Library (North Carolina State University, P.O. Box 8202, Raleigh, NC 27695, (800) 955-8275). ■

*Envisioning Information*, Edward R. Tufte, Graphics Press, 1990, $48, 128 pp., ISBN 0-961-3921-1-8.

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*Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. 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.*

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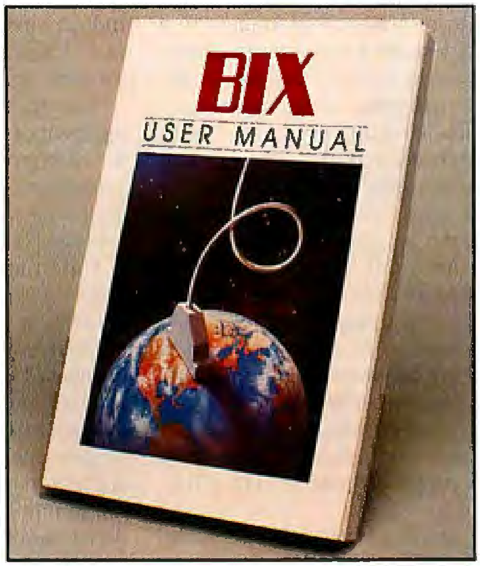


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# STOP BIT

LEONARD LEE

# Computers Out of Control

**Seemingly obscure software bugs can have disastrous consequences**

In 1945, when a team of Navy programmers first used the word *bug* to describe a programming error, they could scarcely have guessed that use of the word would become so ubiquitous. Software errors are an inevitable part of writing programs, but as computers grow more sophisticated, the consequences of bugs are growing at an alarming rate.

The year 1991 may be remembered as the year that the general public first became aware of the software crisis. More than 12 million people lost their phone service in July because of a software error in phone-switching computers. Businesses lost millions of dollars by not being able to reach out and touch customers or branch offices. Take away people's phones, and they'll finally sit up and take notice.

When a Scud missile struck a barracks in Dhahran, Saudi Arabia, during the Gulf War, killing 28 Desert Storm soldiers, the Army claimed that Patriot missiles ignored the Scud because it had broken up in flight. Subsequent investigations showed that a software error had caused the Patriot system to shut down and ignore the incoming Scud.

All this comes as little news to software professionals. They have been aware of the software crisis for years. Anyone who's tried to debug a program or watched a screen full of hard work disappear into oblivion because of a bug knows what I'm talking about.

What's changing is that, as the uses for computers mushroom and their complexity grows, the consequences of these bugs are becoming much more severe. A bug in a navigation system that puts jetliners on collision courses or a tiny software error in a radiation-therapy machine that kills three patients with radiation overdoses is light-years ahead of bugs in simple spreadsheets or word processing programs. Errors in a program flying a 747 or running a medical diagnostic computer can easily endanger lives.

For the first time, people have become aware of how important computer software is when it fails. They've become aware of how much of their daily lives comes into contact with computer software. Software is embedded in car engines, microwave ovens, and VCRs. It runs airliners, air traffic control, Patriot missiles, Stealth bombers, and nearly every business. The need for more reliable computer software has never been greater. The current industry average of one error per thousand lines of code is no longer good enough when modern programs often grow to be millions of lines long.

New technologies have promised to improve the management of large software projects and the reliability of the code produced. Sadly, these promises assumed that the programming community could quickly and thoroughly digest these huge and complex new methods. But the average code error rate has not dropped significantly.

Unfortunately, solutions may have to come from the federal government (although everyone admits that this is far from desirable). But as the world's largest user of software, only it has the clout to mandate sweeping changes. Tighter standards may be needed to ensure that programmers write software using established methods that are proven to write reliable code. In Great Britain, programmers write software for the defense industry according to a standard known as Def Stan 0056.

Programmers understandably balk at the idea of mandated standards for software. No one wants to see more government interference in yet another industry, especially one as rapidly changing as the computer industry. (One would hate to see computers go the way of Amtrak or the Postal Service.)

Still, the time has come to make software engineering a science rather than an art. Software engineering standards must be codified, and programmers must strictly adhere to those standards. Writing software programs is no less important than building a bridge, and it should be treated as such. It is time to recognize that software engineering is no longer the highly individualistic enterprise that it was in the dawn of the computer age.

As computers become more sophisticated, so too must the methods of writing the programs that run them. Failure to do so will only mean more catastrophes. The price we pay for these failures grows every day. ■

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*Leonard Lee is the author of* The Day the Phones Stopped: The Computer Crisis—The What and Why of It, and How We Can Solve It *(Donald I. Fine, 1991). He is a reporter with KSTP-TV in Minneapolis and a former IBM systems engineer. You can reach him on BIX c/o "editors."*

*Stop Bit is a forum for informed opinion on personal computing topics. The opinions expressed are those of the author and not necessarily those of BYTE. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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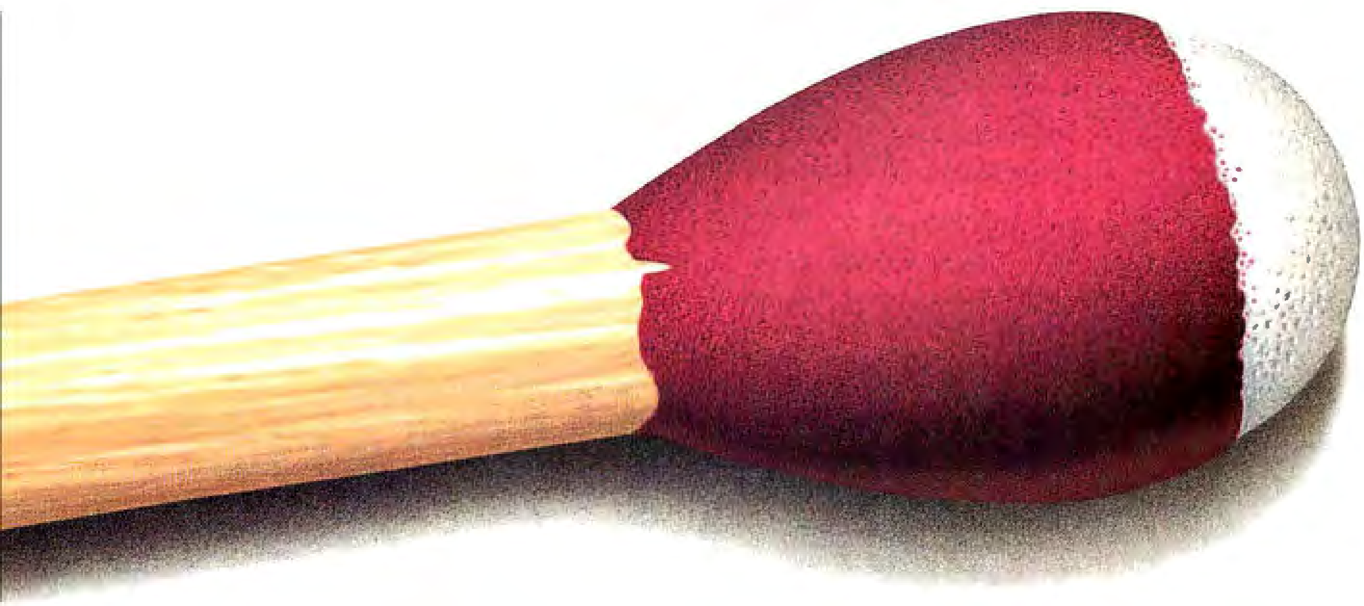

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