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A McGRAW-HILL PUBLICATION

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Introducing Lotu

It's everything a Windows spreadsheet was meant to be.

After listening carefully to what our customers were looking for in a Windows™ spreadsheet, we developed Lotus® 1-2-3® for Windows with three goals in mind.

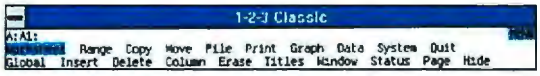
First, make it a full-fledged Windows application.

Second, introduce innovations that deliver a perfect balance of power and simplicity.

And third, make it fully compatible with all of the earlier versions of 1-2-3 that millions of 1-2-3 users are familiar with.

Well, we've done all this. And a whole lot more. Which, no doubt, is why 1-2-3 for Windows was awarded Byte Magazine's *Best New Windows Application* at Comdex/Spring '91.

For starters, the most exciting part of 1-2-3 for Windows is its SmartIcons,™ an innovative "one-click" approach for automating common spreadsheet tasks and fine tuning your working environment for even greater productivity. You'll also find these SmartIcons in all our Windows products, including Ami Pro™ 2.0, our award-winning word processor.



Push the slash key and you'll have instant access to the familiar 1-2-3 menu which will appear in a window on your screen.

You'll feel right at home with our true Windows interface. And you can easily integrate your spreadsheet data with other Windows applications.

Our palette of customizable SmartIcons can be sized and placed anywhere on your screen.

Our interactive graph gallery means you can preview and select by example a wide range of chart and graph types.

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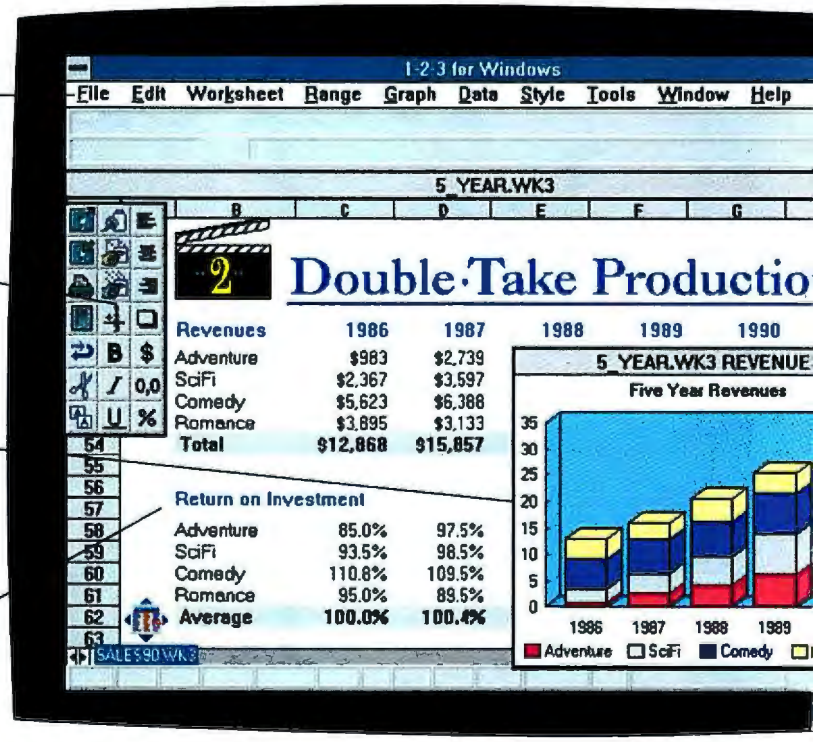

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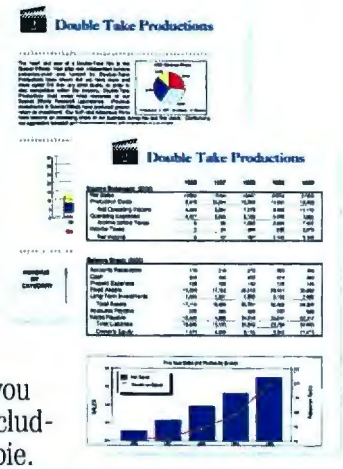

Unlike the Toolbar™ in Microsoft® Excel, 1-2-3 for Windows actually lets you create your own icons for the tasks that are unique to you.

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1-2-3 for Windows Lotus

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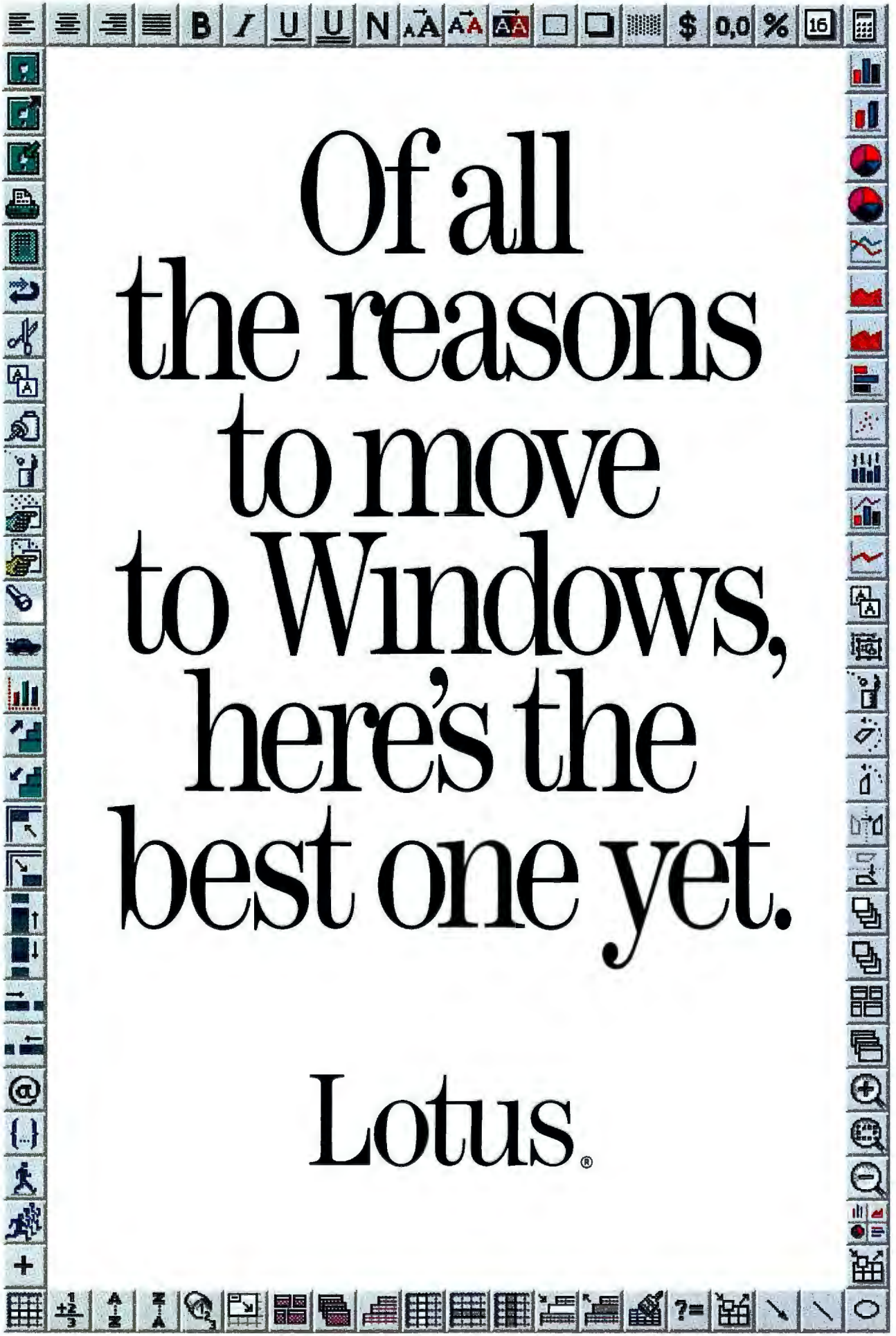
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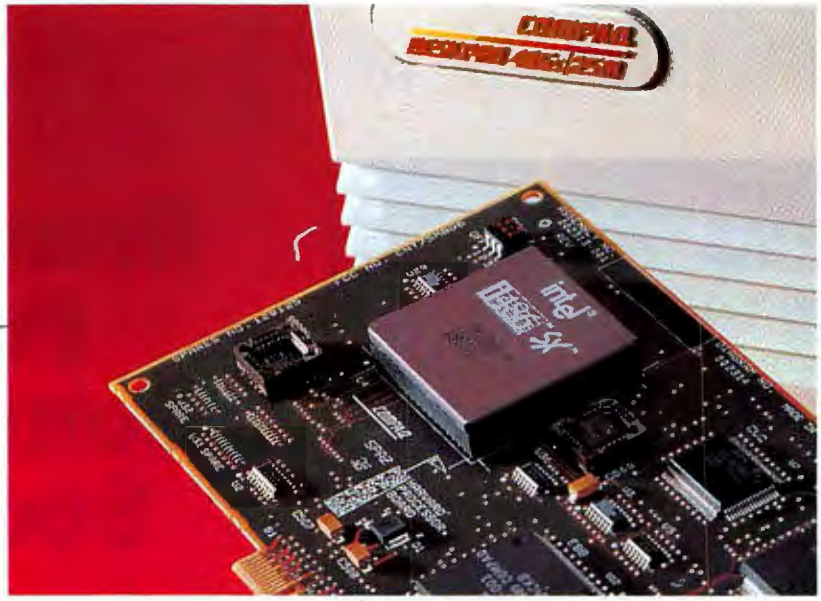

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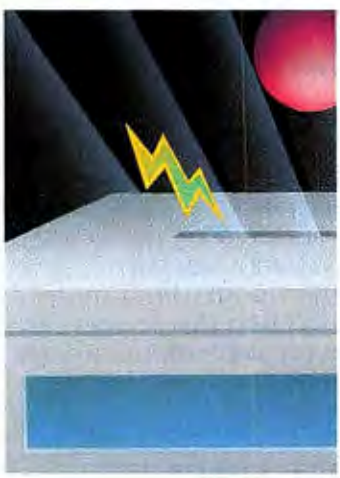

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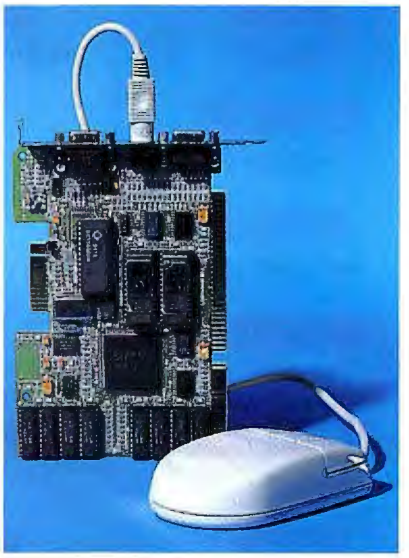

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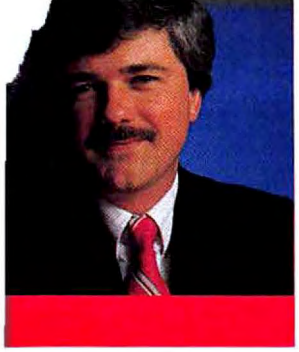


EDITORIAL

FRED
LANGA

DATA LIFEBOATS

I am typing this in a dark room. It should be light out, because it's just midafternoon. But Hurricane Bob is just now passing up the New Hampshire coast. The eye of the storm is about 25 miles from my home, and it's a mess outside.

Although it's not a huge hurricane, Bob is large enough to cause quite a bit of trouble. Trees are down everywhere; I just helped my neighbor section and remove a medium-size tree that had fallen across his driveway. Telephone lines are down—BIX went off-line earlier this morning as the hurricane passed over Massachusetts. And, sure enough, with power lines down all over coastal New England, electricity's gone, with no hope for a quick comeback.

Laptop systems offer more than portability—you might get caught in a hurricane

The power outage has turned my main home computer into a very expensive paperweight. My wife's home computer is likewise sitting in the back room, dark and useless. We've equipped both computers and their modems with fairly hefty surge suppressors to protect them from electrical spikes, surges, overvoltages and undervoltages, and so on. But we've never found it necessary to invest in an uninterruptible power supply.

It's not that UPSes are a bad idea. Quite the contrary, in fact. At BYTE, for instance, all our desktop computers and file servers are protected by a building-wide UPS. That's just common sense. Anywhere that computers are essential to an operation, you need a good UPS to protect the data, the hardware, and the staff's productivity.

But it's harder to justify a full-blown UPS for an after-hours computer. A UPS makes sense if power interruptions happen often enough, or if you're doing so much critical work at home that there's a significant amount of data at risk.

On the other hand, if your after-hours computing is more casual, or if it merely supplements work done in your nine-to-five environment, perhaps all you need at home is a good-quality suppressor/filter to protect your hardware. You can easily and cheaply protect your data with nothing more exotic than a good backup regimen and frequent saves.

However, that does leave you vulnerable to major outages. Imagine what a major outage would do to your plans if you needed to work at home the night before a trip or the night before a major presentation. Saying "the power went out" to your clients or your boss isn't much better than the old "the dog ate my homework" excuse.

Extended outages can cause trouble even in a UPS-equipped office: Eventually, the UPS batteries run down. The largest offices will have backup generators to provide power at times like these, but the majority of medium and small businesses don't have such two-level protection: UPS and generator.

At other times, the backup generators simply don't matter. For example, today's hurricane has shut down most local businesses—including those with heavy-duty electrical safeguards (e.g., DEC and Hewlett-Packard).

Enter laptops. A laptop, kept charged and at hand, can be your data lifeboat. Like a real lifeboat, it may lack the amenities of the larger system it assists, but it gets the basic job done. It keeps you going.

A laptop's inherent portability also means that if there's a problem at your normal computing location, it's relatively simple to move someplace where your work can continue. If you keep your laptop files current with the files on your main system, you can pick up more or less where you left off. Or, if your main system's backup files are on disks your laptop can use, you quickly can get your laptop up to speed with current data.

So, for me, the twin ideals of portability and extra security make it very attractive to have both a desktop system and a portable—a mother ship and a lifeboat.

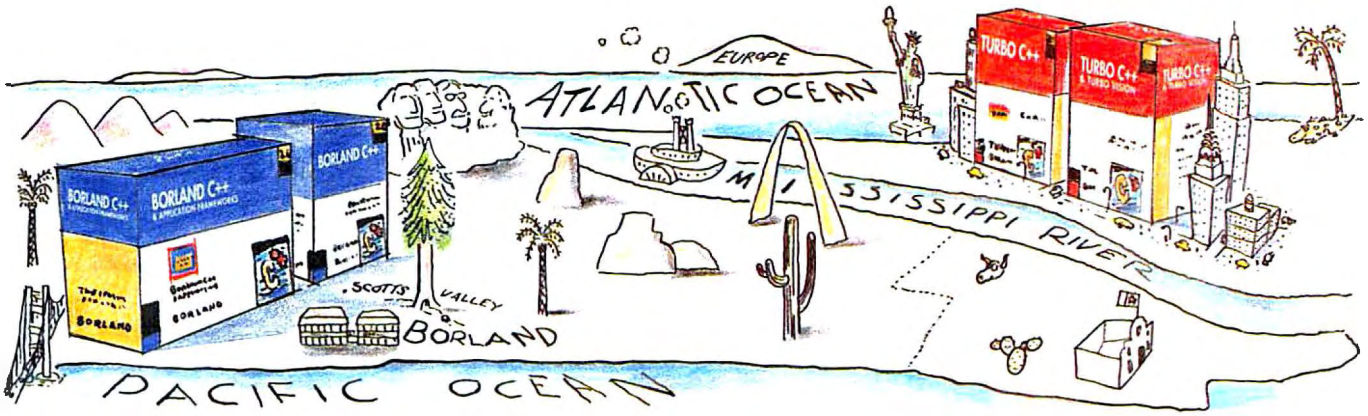
Throw in a battery-powered fax/modem, and you're ready to complete just about any task, no matter what the vagaries of the weather or your power company may be. Laptops don't have to be just for traveling.

This column is a case in point. It's still blowing like crazy outside, and I heard a tree fall behind my house about two paragraphs ago. So far, 2 inches of rain have fallen, with 3 or 4 more expected in the next few hours. A radio report said 750,000 people in the area were without electrical power; eight out of 10 homes in coastal New Hampshire are reportedly dark.

But here, in a room where the brightest light is the screen of my laptop, life—and work—can go on more or less as usual.

Now, if I could only log onto BIX....

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



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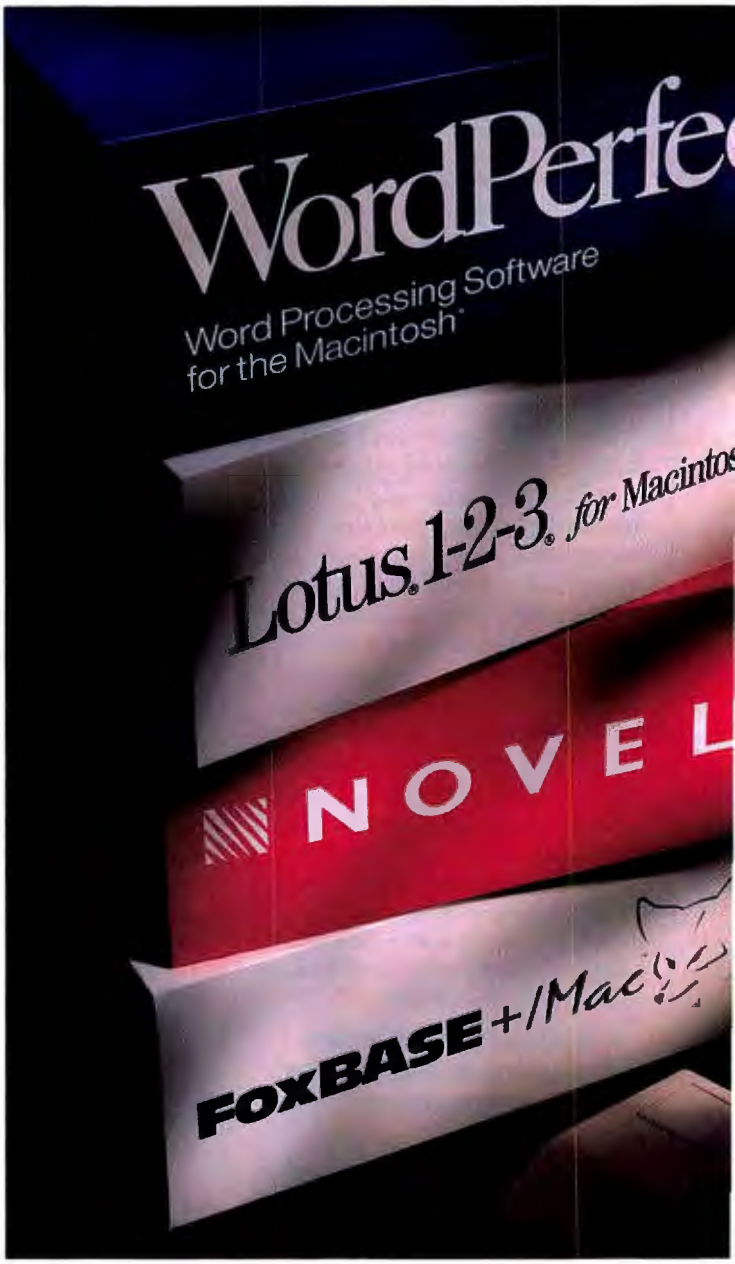

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right into the program. Which means graphic images, charts and sidebars can be added and edited without any reformatting hassles.

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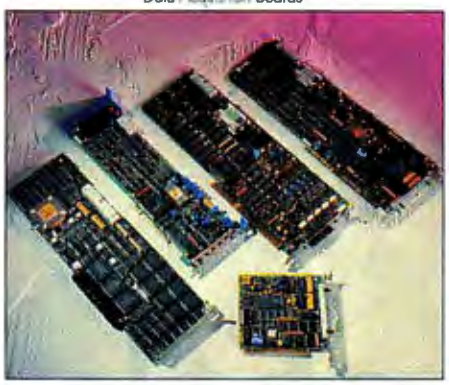

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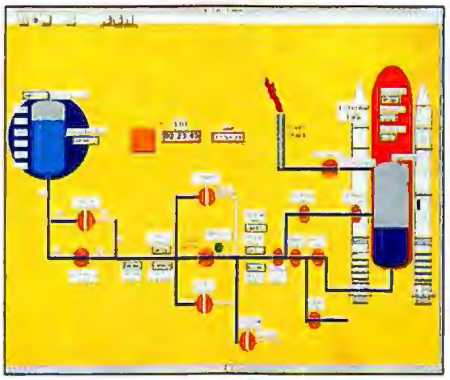

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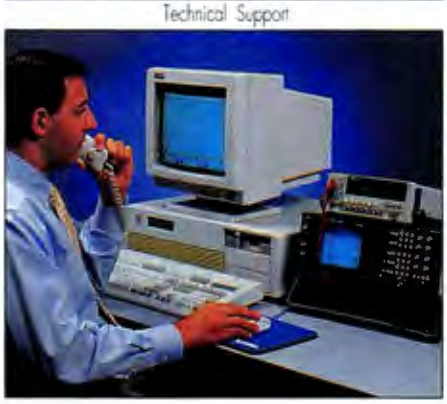

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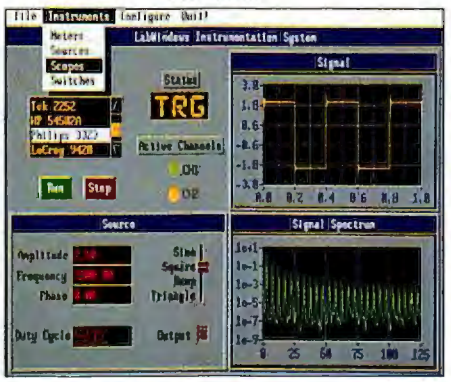

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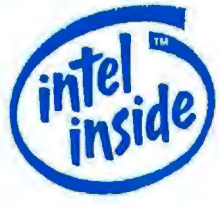

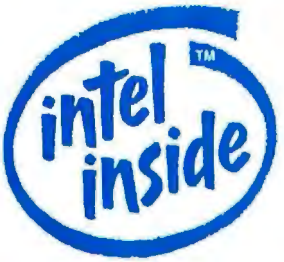

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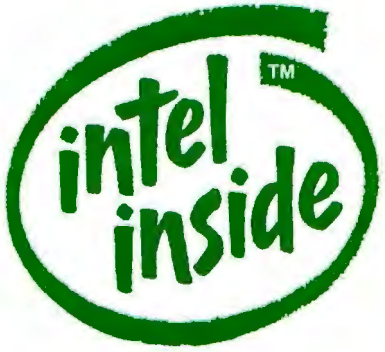

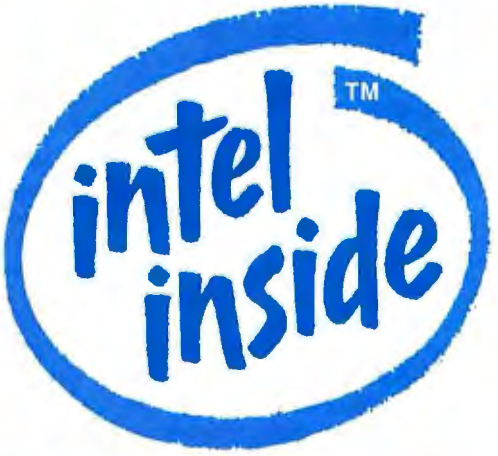

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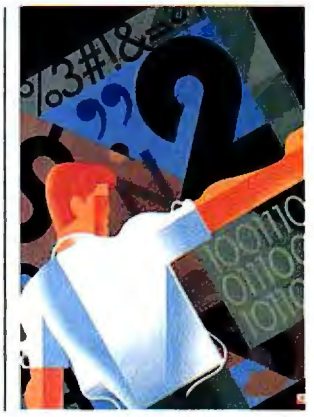

Working Smarter

As the May State of the Art ("Managing Gigabytes") shows, we have recklessly produced too much data and information to cope with. So what is our knee-jerk response? We build bigger storage devices and programs that determine what's important and what's not. In other words, "System, heal thyself."

This is a remarkable state of affairs. We are blinding ourselves with symptoms and ignoring the real problems.

The first step toward solving these problems is to make the word *information* as widely understood as the word *profit*. Next, we must teach people how to be critical thinkers and not just expert function-key pushers. Knowing how to operate a program properly improves efficiency, while knowing how to solve problems (which involves choosing the best tools) improves effectiveness. "Work smarter, not harder," in other words.

But most of us still believe in the imaginary corrective powers of computers, especially when we call them by the pet name *information systems*. We believe that simply using a computer improves the quality of one's performance. This is a silly notion, because everyone knows that a tool (i.e., a computer) does not independently change anything. What should we expect if we train a dummy how to use a computer? A faster dummy.

If we give people the framework and skills appropriate for the information age, watch out! Absolutely everyone benefits. Data leads to information, information leads to knowledge, and knowledge leads to wisdom.

Kevin Stumpf
Kitchener, Ontario, Canada

More on Mac Video

I enjoyed Tom Thompson's informative article "Macintosh Video Revealed" (Some Assembly Required, April). I have been trying to write code that is housed in the configuration ROMs for different NuBus boards.

In his article, Thompson shows the typical configuration ROM structure. Maybe he can give me some hints about good code for the cyclic redundancy check. Apple's books show one algorithm and mention that there should be a CRC patch code in MPW. I have tried the described algorithm against a lot of existing NuBus configuration ROMs, but I have never obtained the same result. I have looked for the CRC patch but have not found it. Does he have some clues?

I thank you again for a very good story and BYTE's in-depth articles.

Leif Gustafsson
Uppsala, Sweden

Most of the information you seek is on Developer CD-ROMs from Apple. There's a folder called Slot Tools on them that has utilities expressly for developers who are designing Mac expansion boards. I assume you don't have access to this source, so I'll supply some information here. The configuration ROM CRC is computed as follows (paraphrasing Apple's documentation):

```
Start pointer at bottom of ROM (top of ROM -
  length)
Initialize sum to 0 (sum will be the CRC value)
@1   Rotate sum left by one bit (with ROL.L #1
       instruction)
     If pointer is pointing to CRC field in format
       header, goto @2 (i.e., don't count CRC field)
     Get a byte
     Add byte to sum
@2   Increment pointer to next data byte
Goto @1 until done
```

There's an MPW application called `crcpatch` *that does this work for you. It is run after the declaration ROM file has been assembled and linked.* `Crcpatch` *first reads the ROM object code file and then computes the code's checksum using the above algorithm.* `Crcpatch` *then lugs this value into the appropriate spot in the ROM code. Another MPW application,* `data`*, then strips off the ROM's code 0 segment and stuffs the code 1 segment into a data file (data fork). The resulting data file is downloaded to a ROM burner.*

Since you seem to be up to the task of writing firmware code, writing two applications to accomplish the above ought to be fairly simple.—Tom Thompson

Roundtable Reaction

I had to respond to the July Roundtable, "Do Computers Save Time?" Gentlemen, are you all going soft in the cranial cavity matter?

Serious people buy general-purpose computers to perform a certain group of specific tasks. These tasks cover a wide range of needs and applications. The adaptability of those computers to service all these needs with minimal compromise is their greatest strength.

As for the distractions that interfere with getting something done, I can only say that it certainly must be nice not to be accountable to finish a project 20 minutes after a user makes a request. Many of us don't have the luxury of time and money to be able to tinker with our systems to the nth degree. We are too busy generating and collecting data to run through our macro-driven spreadsheets, which help us make timely and cost-effective decisions. ■

Mark Wille
Brewster, NY

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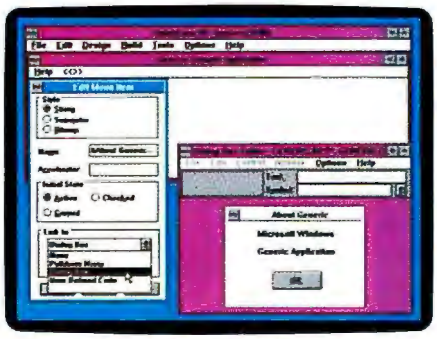
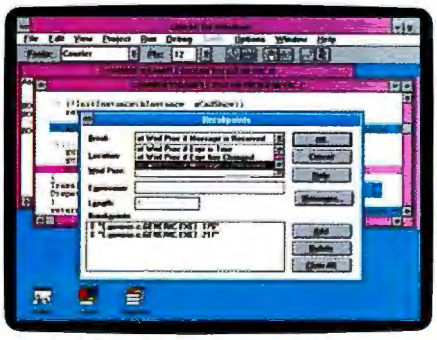
MICROSOFT SOFTWARE DEVELOPMENT TOOLS

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 breakpoints. 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.

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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.
- Syntax highlighting in editor.
- Customizable tools menu allows you to run any Windows or DOS* program from within the QuickC for Windows environment.
- 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

If your idea of 386 is getting "out of mem you don't need

This Manifest memory analysis shows 618K of memory available for DOS programs after running QEMM 6.0. That's enough to avoid the dreaded "out of memory" message.

Here's how you can get more memory. Network drivers, TSRs and other utilities that usually take memory away from your programs have been moved up into high memory, automatically—using QEMM's 'optimize' command.

This example system is a Toshiba, but most 386SX, 386 and 486 IBM® PCs and PS/2s™, and most 100%-compatible 'clones' allow the high memory breakthrough.

QEMM 6.0 Stealth technology 'remaps' ROMs, freeing-up as much as an additional 115K to be used by your favorite programs.

Manifest, our memory management utility, clearly shows you how your memory is being used.

Quarterdeck expanded memory manager—QEMM-386—became the best selling utility in the industry because it does a better job of managing memory.

QEMM solves memory problems smoothly and invisibly. It 'pools' memory so that it's available in whatever form your programs need—expanded or extended. You don't even need to know the difference. QEMM does it all for you. Instantly. All other managers require you to manually allocate memory and re-boot every time you need to change.

Our new version 6 is better still. First, we improved our unique 'optimize' feature. It's still as easy as ever to use: all you have to do is type 'optimize' and QEMM automatically seeks out TSRs and device drivers and moves them out of your PC's conventional memory and into high memory. Now it lets you set up "what-if" scenarios and 'play' with combinations of your own.

Either way, QEMM-386 v6 finds more memory for your programs than any other memory manager. Period.

And QEMM monitors your memory—checking to be sure TSRs and utilities can be moved safely before it does so.

Who'd have thought there'd be another 115K of memory in your PC?

Breakthrough 'Stealth' technology results in a gain of up to 115K of high memory on many PCs by taking advantage of the memory map of most IBM, Compaq and 100% compatible PCs to 'map' ROM into other areas of memory. Only our memory wizards fully understand the technology behind it, but every user can appreciate the huge increase in available memory.

Of course, not every PC has 115K of extra high memory, but every PC can benefit from 'Squeeze'—our new feature to manage all those TSRs that need more memory at start up and less when they're resident. Their memory allocation is temporarily increased at start-up, then squeezed down when it's no longer needed.

QEMM automatically uses idle VidRAM to produce a further 96K gain on EGA and VGA-equipped systems when running character-based programs.

QEMM reorganizes the way your memory is used, filling memory gaps and squeezing every last ounce of performance out of the software you now own.

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/486 performance
ory" messages faster,
ur new QEMM.

QEMM gives you more memory with less pain.

New breakthroughs aside, QEMM does its basic job better than any other memory manager. For example, the DOS 5.0 EMM uses a manual, trial-and-error process to optimize memory while QEMM does it automatically.

And QEMM 50/60 v6 offers these features (except Stealth) and 'loads high' on IBM PS/2 Models 50 and 60. DOS 5.0 doesn't.

QEMM isn't just for power users. It's for anyone who wants to get the most out of the PC. Whether you're using a PS/2 model 50 and DOS 3.3, a 486 with 5.0, or something in between, we can improve the way it works.

PC Computing MVP — MOST VALUABLE PRODUCT 1990 · THE BEST LOTUS MAGAZINE · INFO WORLD BEST IN ITS CLASS Dec. 18, 1989 · INFO WORLD TOP 100 1989

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Prior versions of QEMM have won lots of awards—and become the #1 selling utility in the PC industry.

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QEMM provides an additional 8-24K of conventional memory to Windows 3 enhanced mode—maximizing memory to help make everything run better.

Our new DESQview-386 version 2.4 incorporates the latest memory-maximizing QEMM technology. That means it provides an even better solution for users who want low-overhead, high performance windowing and multitasking.

While DOS 5.0's EMM isn't even compatible with Windows' Standard Mode!

QEMM is the best memory manager to use with any multitasking software on the PC. Period.

Quarterdeck Manifest maps your way to the gold.

Our award-winning memory utility gives you complete and clear understanding of how your memory works.

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Our memory breakthroughs result in real benefits to users with lots of memory demands—especially network users. DESQview-386 lets you run programs in several windows side-by-side while using only about 9K of conventional memory on a typical PC.

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NEWS

MICROBYTES

Quarterdeck X-Tends DOS with Desqview/X

With the long-delayed release of Desqview/X from Quarterdeck, the X Window System finally comes to DOS. X is closely identified with Unix, but the windowing protocol was designed from the outset to offer device independence, and there never was anything inherently Unix-based about X. It already runs on VMS and Macintosh platforms.

Why would DOS users want X? The answer is interoperability. With an X server running on a DOS machine, you can remotely run programs on any machine on the network—including Sun workstations—while interacting with the program using your own DOS machine. And Unix users can remotely run all the character-based DOS programs. You can display Unix/X and DOS applications simultaneously on either platform, and you can copy and paste between Unix and DOS programs. What more could you want?

You would probably like to run Windows 3.0. You can, but only locally, and not in tandem with X applications.

Desqview/X consists of an upgraded Desqview 2.3 with the ported X server and Xlib and Xt libraries. Quarterdeck also includes its own X-compliant Desqview Window Manager. DWM is relatively small (approximately 70 KB) compared to the separately priced window managers based on OSF/Motif (700 KB), Xol Open Look (1.5 MB), and Xview Open Look (300 KB). Support for NetBIOS and IPX is included, with an optional package available that provides support for TCP/IP, DECnet, and PC NFS.

Current Desqview users will find Desqview/X familiar. The desktop has been updated with the new DWM three-dimensional look, but the commands are unchanged. The X version adds some new features, including the ability to customize menus. Desqview/X also provides an icon editor and a new graphical program manager, tentatively called Appman.

A significant feature of Desqview/X is built-in support for scalable fonts from Adobe. The new X desktop will come with Adobe Type Manager, so when you resize a DOS window, the text will stretch or shrink to fit.

X applications are known for their large memory requirements, and Quarterdeck has gone to some trouble to accommodate the memory problem on the DOS platform. Desqview/X is built on top of Quarterdeck's new memory-extending QEMM 6.0. And to reduce the amount of memory that applications require, Desqview/X incorporates a new shared DOS extender and shared libraries from Rational Systems. Programs share a single instance of the DOS extender and X libraries, which are implemented as virtual, shared 16- and 32-bit OS/2-style dynamic link libraries.

—Ellen Ullman

IBM to Scale Down RISC Technology for Low-End Boxes

Whether or not IBM's promised lower-priced RISC workstations use the upcoming single-chip version of the RISC System/6000 processor chip set, the Unix-based computers will probably forfeit some of the functionality of the current, more expensive technology, says Bill Filip, president of IBM's Advanced Workstation Division. Through a process he calls "subsetting," some instructions supported in silicon in the current systems may be left out of the CPU of the low-end machines. Instead, these instructions would be emulated in software.

This means that applications compiled

NANOBYTES

Will the proposed joint-development deal with **Apple**, in which Apple will get to use IBM's RISC processor technology, change **IBM's plans** to build lower-cost RISC workstations? No, says **Bill Filip**, president of IBM's Advanced Workstation Division. In a recent interview with BYTE, Filip said that IBM has long planned to shrink the core RISC CPU down to a single chip and to bring out entry-level systems that would represent "an expansion of our offering, not a shift in focus away from the high end."

Filip projects that OS/2 Presentation Manager and OSF Motif will grow to resemble each other more, and that as Apple's object-oriented Pink technology comes into play, some of its attributes will filter back into OS/2, AIX, and the Mac OS. "Maybe at some point it will all become one thing," Filip said. □

There's a light at the end of the tunnel for the **WordPerfect for Windows** development team—and it's not an oncoming train. The company now says that the long-delayed version of WordPerfect for Windows is finally in beta testing. A company publicist confirmed that WordPerfect (Orem, UT) plans to release the Windows version sometime this month.

Compaq Computer (Houston) lowered the suggested U.S. resale prices of its **LTE** notebook computers. The LTE/286 with a 20-MB hard drive is now $1949, down from $2499. □

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for the entry-level models would run unchanged in the high-end boxes, since their instruction set will be a subset of the current one. But applications compiled for the current RISC System/6000s that make calls to instructions not supported in the low-end CPU would suffer a performance penalty as those instructions execute in software instead of in silicon. For example, depending on the types of applications IBM is targeting, the company might leave some of the floating-point operations out of the low-end CPU.

In any case, Filip indicated that the entry-level systems will use the same Micro Channel bus and add-in cards, the same I/O subsystems (which include industry-standard ports and SCSI connectors), and common peripherals, such as displays and keyboards, as the current models. Because low-end workstations would bump up against the high end of the PC market, IBM doesn't plan to produce RISC systems in the sub-$5000 range or what Filip called the "Sun SLC class."

—Andy Reinhardt

Crescendo Speeds Up Data Transmission Without Fiber

Crescendo Communications has developed technology that could help lower the cost of high-speed data transmission. Crescendo's hardware will let you send data using the 100-million-bps Fiber Distributed Data Interface (FDDI) protocol over standard unshielded twisted-pair cabling instead of more expensive fiber-optic cable. (It was only a few years ago that the top speed over unshielded twisted-pair cabling was just 1 mbps.)

Using copper cable instead of fiber offers several advantages. First, copper cable is less expensive. Second, it is much easier to install. Third, many offices already have surplus twisted-pair cabling put in for future telephone-system expansion—cabling that 10-mbps Ethernet over twisted-pair has already been exploiting.

This new Copper Distributed Data Interface (CDDI) technology should allow for a 100-mbps connection for less than $3000 per port compared to fiber's cost of $8000, according to Marleen McDaniel, Crescendo's vice president of marketing.

Crescendo and its partners in the Unshielded Twisted-Pair Development Forum—AT&T, Apple, Fibronics, and Ungermann-Bass—are not only working on products that support CDDI but taking their technology to ANSI, says McDaniel.

The main factor behind CDDI's ability to transmit data at such rates is the replacement of one FDDI chip with one developed by Bell Labs that uses a coding technology called PR-4. "PR-4 lets you get 500 mbps without having to go to fiber," McDaniel says. PR-4 also requires less electrical voltage and operates at a lower frequency, she says. PR-4 falls within the bounds of FCC Class B transmission, while competing efforts that use shielded twisted-pair cabling still cannot yet qualify for Class B approval, according to McDaniel.

—Sharon Fisher

Latest Word: Windows NT Won't Run OS/2 Programs

Microsoft will not—repeat not—support OS/2 programs in its upcoming New Technology (NT) operating system, company officials have confirmed. Although Microsoft had been denying rumors and reports that it would drop OS/2 support, the latest word out of Redmond is that the software giant no longer has plans to develop the product that had been known as OS/2 3.0. The company instead is focusing on a 32-bit operating system that will be based on an entirely new kernel and will support Windows application programming interfaces (APIs).

OS/2 3.0 was slated to be one of the two operating systems offered for computers complying with the Advanced Computing Environment specification jointly proposed by Compaq, DEC, Microsoft, The Santa Cruz Operation, and Mips Computer Systems. Microsoft says it will continue to develop an operating system for ACE machines, but it won't be called OS/2. It also won't support the Presentation Manager (PM) interface or OS/2 software and device drivers.

The NT operating system, expected

NANOBYTES

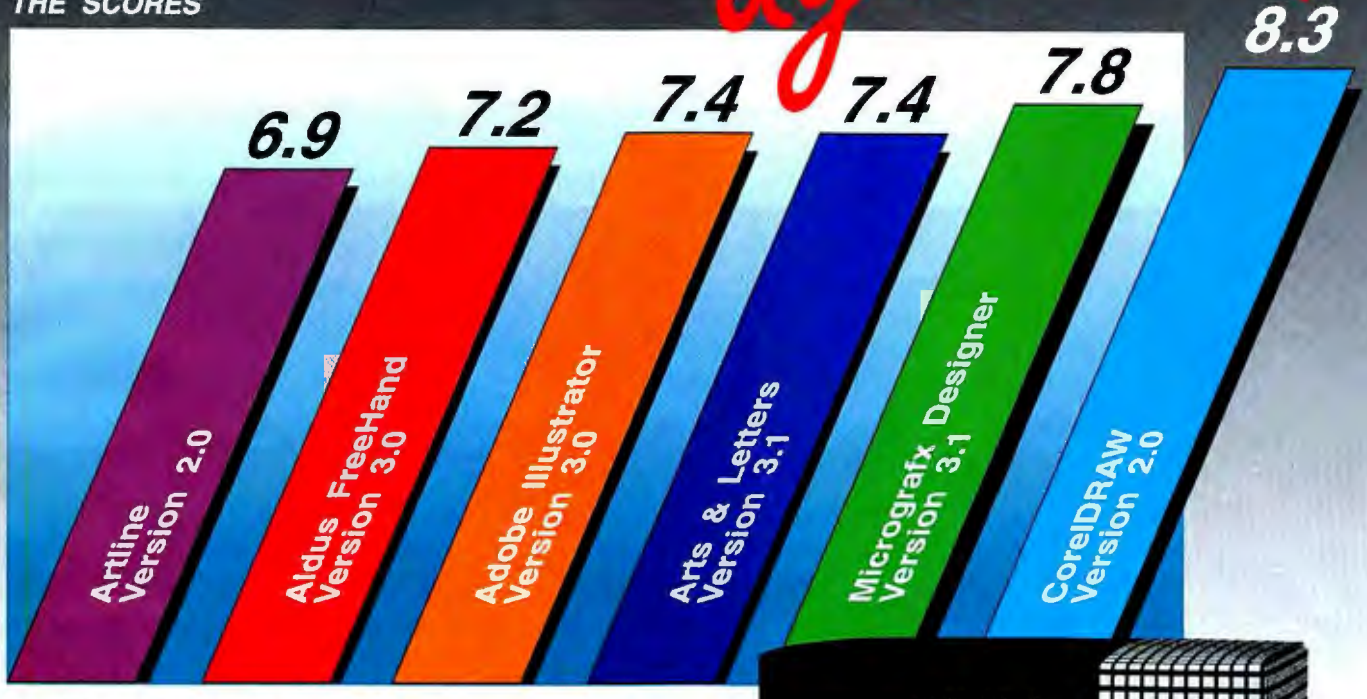
Ultraslim: **Intégral Peripherals** (Boulder, CO) expects to be first to market with the smallest hard drive yet. Intégral's **1.8-inch drive** will initially be available in a 20-MB capacity. Average seek time is

20 ms, the company says. The size of the 1820 drive and its low power consumption make it ideal for mobile, hand-held machines. Intégral is targeting the drives at notebook and pen-based computers and data-collection devices. To fit it in a really thin space, the device can be taken apart like a sandwich, with the head/disk assembly, which stands a whopping 10 mm thin, separated from the drive's electronics, a slice about 5.5 mm tall; the controller part could then be attached as a daughtercard to the motherboard. Intégral expects to have a 40-MB model next year. □

Ray Dream (Mountain View, CA), developer of three-dimensional graphics programs for the Mac, has been demonstrating a **new distributed computing technology** that lets computationally intensive applications—a photo-realistic modeling program, for example—tap into idle CPUs on a Mac network (LocalTalk or Ethernet). When a master machine sends out a task to the slave Macs, DreamNet polls all the Macs on the network for idle CPU time in a way that's transparent to the user of the slave Mac. According to Ray Dream president Eric Hautemont, DreamNet is most suitable for rendering 3-D images on a master machine. "But DreamNet could be used by other products as a distributing engine," he said, including scientific visualization programs, heavy-duty spreadsheet calculations, or database sorts. The company hopes to release a product by the end of the year, Hautemont said. □

PCs beat Macs for Illustration *again!*

THE SCORES



InfoWorld Product Comparison June 17, 1991

CorelDRAW wins InfoWorld Evaluation

Yes, CorelDRAW has done it again! In a pivotal InfoWorld product comparison, CorelDRAW, running under Windows 3.0, beat all leading illustration packages — Macs included!

InfoWorld states: "CorelDRAW combines strong ease of use with a top-notch selection of drawing and editing tools...The program has superior typehandling and tracing utilities...CorelDRAW is applicable to the widest range of drawing uses."* Without a doubt, CorelDRAW speaks for itself as the world's finest graphics software!

*Mike Heck, Doug and Denise Green, InfoWorld June 17, 1991.

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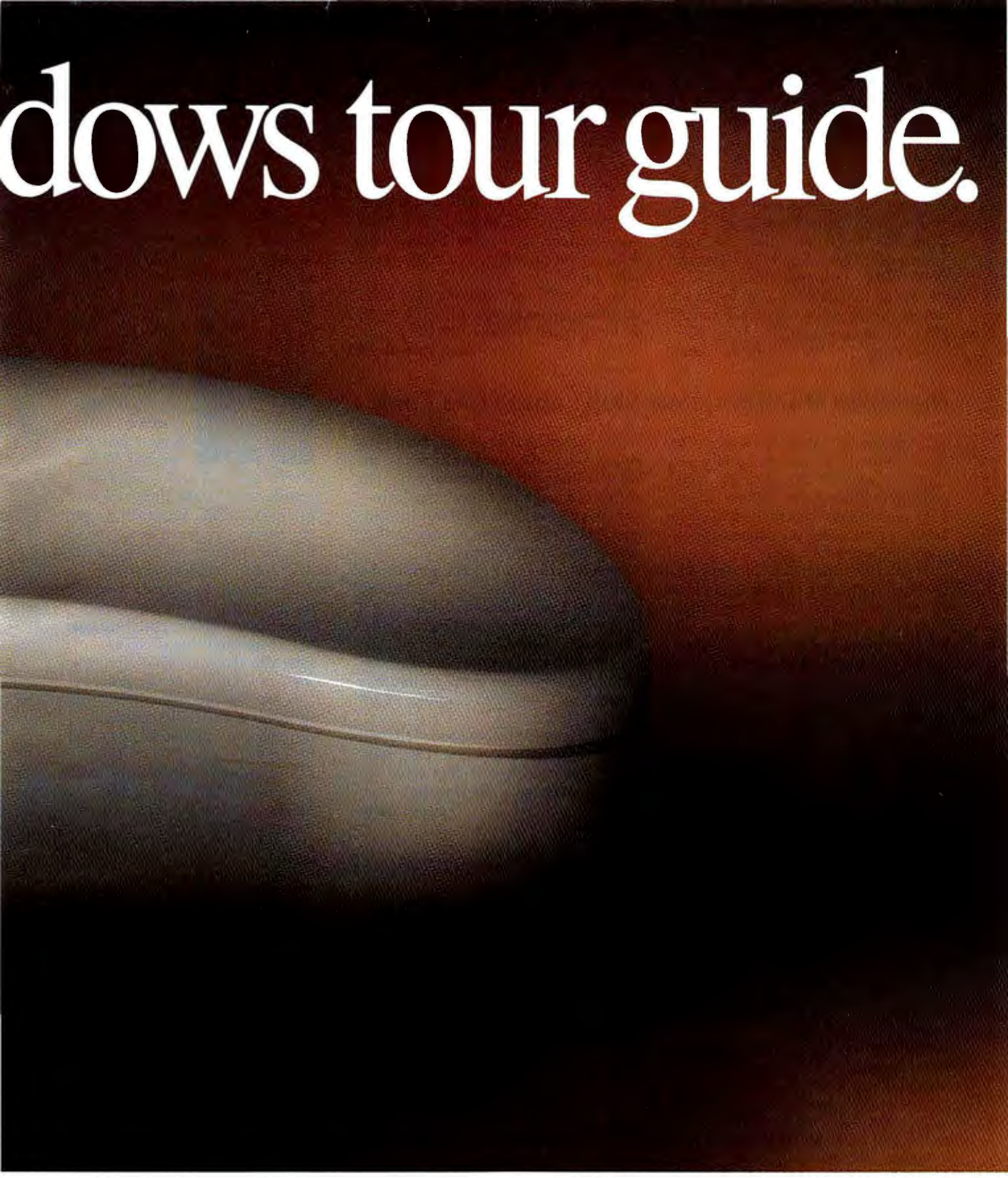

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sometime next year, will fully support Windows binaries and both current 16-bit programs and future applications written to the 32-bit Win32 API, said Microsoft spokesperson Marty Taucher. Unlike IBM's upcoming OS/2 2.0, a 32-bit version scheduled to ship before the end of this year, NT will not support PM. "In our minds, OS/2 3.0 is NT," Taucher said. "We had talked about building OS/2 compatibility into NT," he said, "but it isn't possible now to build an OS/2 subsystem on top of NT. That would require us to work closely with IBM, and at this time, that cooperation does not exist."

For now, PC users looking for a more advanced operating system will have to decide between Windows and OS/2.

—Andy Reinhardt

New Chip Monitors, Helps Fill Laptop Gas Tank

Benchmarq Microelectronics (Carrollton, TX) has designed a new chip that acts as a gas gauge for laptop computers running on battery power. The chip also lets you quick-charge your batteries without risking dangerous overcharging, Benchmarq says.

The bq2001 monitors current, temperature, and other factors to maintain an accurate picture of the battery's state, says John Landau, Benchmarq's vice president of marketing. The device determines the available charge and keeps track of battery capacity, but it can also monitor refueling so that you can quick-charge your batteries without risking fatal overcharging, Landau says.

Because nickel-cadmium and nickel-hydride batteries tend to hold their voltage until they are almost completely discharged, a low-battery warning can come at the point of total discharge rather than giving you a sufficient warning. The solution to this problem, Landau says, is to deeply discharge the battery regularly—something most users don't do. Instead, they shut off the system as soon as they get the low-battery warning.

Benchmarq's chip gets around the problem by letting you put the battery pack through a monitored discharge/charge cycle to restore the battery's capacity. "With the proper connections, our chip allows the system to discharge the battery through a programmable threshold as a preface to charging," Landau says.

The chip, which costs about $10 each in quantities of 1000, is now being sampled. Laptops using the chip could appear at Fall Comdex, Landau said.

—Rick Cook

PenDOS Lets You Write on DOS Applications

Right now, there aren't many commercial applications that will work with a pen-based computer. Communication Intelligence Corp. (CIC) (Redwood Shores, CA) hopes to change that with its new PenDOS, designed to allow existing DOS applications to be used with pen-based computers.

PenDOS has a handwriting-recognition engine that CIC says understands all alphanumeric printed characters. The other main component is a pen-input interface that runs on top of DOS, understands gesture commands, and emulates a mouse; for example, when running PenDOS and Microsoft Word, you could select text by dragging the pen across it and then make a change with a gesture, such as an *X*, to delete the text. Text that you write on the screen is sent to the underlying application as if it were typed.

PenDOS will not work with all combinations of DOS applications and systems, since it requires 330 KB of extended memory to hold the recognition engine and 50 KB of DOS main memory to hold the input and gesture interface. CIC says that it has successfully tested PenDOS with applications such as Lotus 1-2-3, Word, Quattro Pro, Harvard Graphics, and Norton Commander.

—Owen Linderholm

GaAs RAM Chip Offers Speed and Protection

McDonnell Douglas has developed a ferroelectric gallium-arsenide (GaAs) chip that promises a combination of speed and immunity from electromagnetic disturbances. The ferroelectric RAM is readable, writable, and nonvolatile. Although initial applications will be in outer space, FERRAM chips could someday replace the storage devices used in earthbound personal computers.

continued

NANOBYTES

Porting software to the upcoming **Advanced Computing Environment** could be trickier than ACE proponents have let on. According to **DEC** officials in a recent briefing, a developer writing for all ACE platforms will need at least two versions of the source code and four compilers. Source code for the Unix and Microsoft's New Technology operating systems will not be compatible, DEC executives said, and the ACE specification will not address porting strategies between the platforms. Within each operating system, source code will have to be separately compiled for Intel x86 and Mips R4000 processors. In addition, the two processors may require slight differences in source code. In the course of compilation, "there may be incompatibilities," according to **Richard Treadway**, manager of DEC's Western Software Laboratory. Treadway expressed reservations about interoperability between Unix and NT. "No one's told me how you're going to run Unix encapsulated in NT," he said. "We'll know more when we see what NT is." □

Sticky chips: **Dallas Semiconductor** (Dallas) has developed a read/write memory chip that can be stuck anywhere. The new DS199 **Touch Memory** comes in a steel container called a MicroCan that has a peel-and-stick adhesive backing. The metal housing serves as the point of electrical contact. You could use the memory chips in some of the same situations as **bar codes**, the company says, but they offer greater utility than ink on paper. The chips are programmable and can hold up to 4 kb. □

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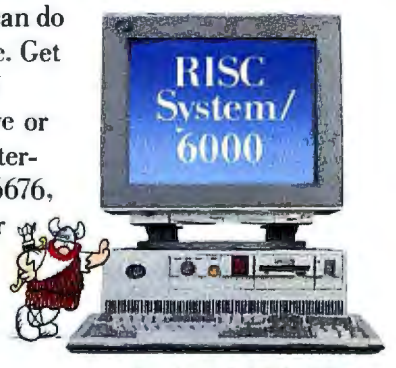

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Researchers recently demonstrated the technology with a 400-cell memory at McDonnell Douglas Electronic Systems' facility in Santa Ana, California. The next step, according to program manager Bill Geideman, is a 4-KB RAM chip, with a 16-KB version this fall. "To go from 4 KB to 16 KB is easy," Geideman says. "To go beyond 16 KB is a developmental step."

The closest analog to FERRAM is probably the old ferrite core memory, which preceded solid-state memory in computers. Like core memory, FERRAM keeps its information even when the power is turned off. Core memory stored information by magnetic polarization of tiny ferrite doughnuts. FERRAM stores information by electrical polarization of even smaller areas of ferritic material deposited, in this case, on a GaAs substrate.

FERRAM is fairly fast, says Geideman, with an intrinsic read time of less than 10 ns. But the big attraction, he says, is its immunity to data-damaging events such as cosmic rays and other stray forms of radiation. Ultimately, Geideman says, megabyte FERRAM chips could become a storage medium for personal computers, replacing both the volatile DRAM and the nonvolatile hard drive in current microcomputers.

—Rick Cook

Honeycomb Keyboard Would Save Strokes and Space

The keyboard of the future may be on the drawing boards today if Dr. Sam Lerman, a physician based in Southfield, Michigan, gets his way. He says that his proposed keyboard could be ideal for tiny computers, because it can pack the functional equivalent of 101 keys in a space just a few inches across. His current design squeezes an array of 61 keys in a hexagon 3½ inches in diameter. The hexagonal keys are smaller than those on most current keyboards, measuring approximately 1 cm in diameter. But that shouldn't be a problem, Lerman says, because the keys are meant to be pressed with a stylus instead of fingers.

According to Lerman, the "honeycomb keyboard" is more efficient than standard models primarily because of the key placement. The layout is designed to make the most efficient use of keystrokes and let you compress as many keystrokes in as little movement as possible; for example, the letter *e*, which is the most commonly used letter in many languages, is smack-dab in the middle. Lerman says that he has grouped the keys so that letters often used together are positioned near each other.

Since you can operate it with a stylus and you don't need to be a proficient typist, the keyboard could appeal to disabled computer users. The stylus merely has to make contact with the key; no physical pressure is required to depress any mechanical moving parts, Lerman says.

Lerman hasn't built a device yet but says he has sent detailed plans to IBM and Hewlett-Packard. He hopes that they'll build his keyboard into future computers.

—Joseph J. Lazzaro

Tera Hopes to SPARC Cheaper Workstations

Tera Microsystems (Santa Clara, CA) has developed a four-chip set that, excluding the main processor unit, provides all the functionality needed for a full-color SPARC workstation. Tera says that the chip set will enable manufacturers to bring out SPARC clones for less than $5000, mainly by reducing the chip count on a motherboard to as little as 19 chips, not counting RAM. Only two of the Tera chips are required to make low-cost monochrome, diskless, or portable SPARC workstations.

Several companies are already in the business of chip sets for SPARC clones. But Tera's approach is to ignore the integer and floating-point processing units and concentrate on the cache, memory management, graphics, I/O, glue logic, and memory-control subsystems. OEMs can purchase the other processors from suppliers such as Cypress, Weitek, Texas Instruments, LSI Logic, or Fujitsu.

Tera's entry-level set, which consists of a system controller chip and an I/O controller chip operating at 25 MHz—sufficient to build a monochrome SPARC system with no SBus expansion—will cost $400 in 5000-unit volume. The full chip set, operating at 33 MHz, will cost $745. ■

—Owen Linderholm

NANOBYTES

It's not the same as the **notebook Mac** that Apple is announcing this month, but the new Notebook

2000 from **Outbound Systems** (Boulder, CO) represents another choice for people who want a movable Mac. Outbound's new clamshell-style machine, which uses genuine Mac ROMs, measures 8½ by 11 by 2½ inches and weighs about 6 pounds. The 10-inch LCD is faster than the one in Outbound's older lunchbox-style system, said chief operating officer Bob Louthon. Starting with a base machine with a 20-MHz 68000 processor, 2 MB of RAM, and a SuperDrive for $2899, you can go to a 33-MHz 68030 with a memory management unit, 4 MB of RAM, a SuperDrive, and a 60-MB internal hard drive for $4299. □

When an **OS/2 developer** recently told Microsoft chairman **Bill Gates** that he thinks IBM's impending **OS/2 2.0** will be something everyone with a 386 box will want to run, Gates said, "That's an interesting comment, but I think you're a little unusual. It'd make us happy if that happens; we make a lot more money when you buy OS/2 than when you buy Windows or DOS. But we don't think that's the way the mainstream is going. We're continuing to add multitasking and other features to Windows to respond to what most people seem to want." Gates added that no matter what happens, the Windows application programming interface is the **strategic target most software developers should aim for**. "We developed special PM [Presentation Manager] versions of Excel and Word. The sales were pretty dismal. One way or another, OS/2 will run Windows binaries." ■

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Pirelli uses Gateway systems in every department. "The engineers in particular love them," Gary commented. "They run Gateway 486 systems as CAD workstations to design products, equipment and plant facilities."

Pirelli people are taking Gateway systems home with them, too. Last year the company hosted a computer fair to give employees a chance to compare various computer brands on the market. "Our factory manager bought a Gateway for home, as did the manufacturing manager, four of the engineers and myself, just to name a few," said Gary. "Even with all the competition at the fair, Gateway 2000 clearly offered the best value."

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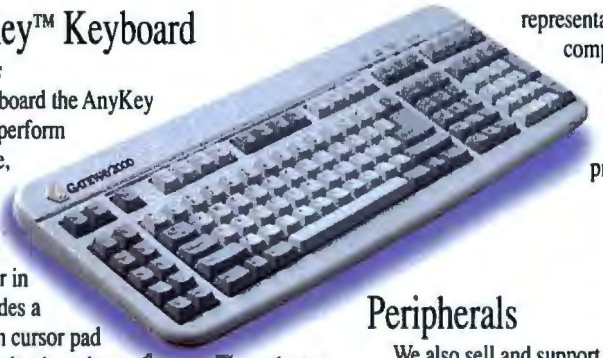

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Compaq Goes Modular

RICH MALLOY

Compaq's new line focuses on modularity, upgradability, and (gasp!) price

Compaq's traditional hallmarks have been high quality and high performance, but the company's new Deskpro/M family of systems steps back from the blistering performance race, where the company had long set the pace, and goes for more modest performance levels. Quality levels remain high, however, and pricing will get very aggressive.

In brief, the Deskpro/M series is composed of four compact EISA-based desktop systems that are identical in appearance. They are all similar to Compaq's older E family of systems, being just an inch wider. The only differences, in fact, among the four systems is a small processor card inside and a nameplate on the front.

Inside each system is 4 MB of four-way associative memory (expandable to 64 MB) on a proprietary plug-in card, a 60-MB hard drive (sizes up to 510 MB are available), and five EISA slots, one of which is taken up by a Compaq high-performance VGA video card. At the front of the system are docks for two half-height drives and one third-height drive, which is occupied with a 3½-inch floppy drive. There is also a 240-watt power supply with an innovative quiet fan.

The Compaq Deskpro 486s/16M, with its upgradable processor card. On the card is the new 16-MHz version of the Intel 486SX chip.

The most interesting part of the system is its processor card, of which four are available. These include the Intel 386/25 with a 16-KB cache at the low end and the 486/33 at the high end. There are also cards for two brand-new versions of the Intel 486SX, running at 16 and 25 MHz. Thus, Compaq—one of the few companies not to introduce a 20-MHz 486SX machine—has quickly leapfrogged in front of (and behind) its competition.

A key design goal for these systems is to be aggressively priced, a characteristic not normally associated with Compaq. Exact pricing information was not available as this went to press, but a Compaq spokesperson said that the prices would be similar to those of EISA systems by ALR and Dell. True or not, even such a suggestion as this is a bold move for Compaq.

Modularity: Feature or Bug?

As you may have guessed, the key to the M family is modularity. Compaq designers have placed the video, the memory, and the processor on separate cards. Even the Intelligent Drive Electronics (IDE) controller and serial ports are on a separate I/O card under the power supply. Although this reverses a general trend in the industry, the design goal here was to "maximize the number of boards; minimize the number of layers." The resulting boards are smaller, simpler, and presumably less expensive to produce.

But besides lower costs, what benefits does this provide for the customer? Perhaps the most publicized advantage of the new system will be its expandability. Compaq says that customers can take out their existing processor cards and replace them with faster cards. Compaq even says that it will give a trade-in allowance for used processor cards. Much of the value of such an upgrade policy depends on the prices that Compaq would charge for the upgrade boards.

Of course, a few compromises are involved in this design. Since the same memory board is used for each system, the memory architecture cannot be customized for each individual processor. As a result, speed may be compromised.

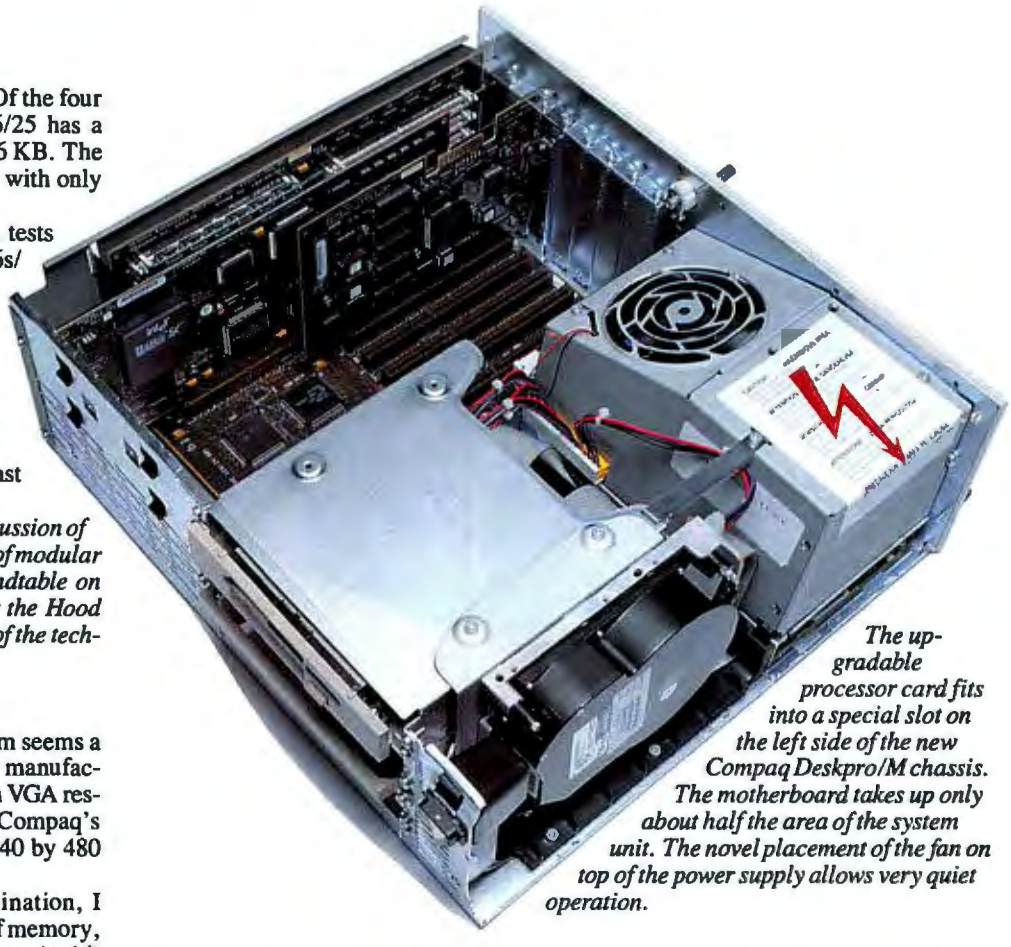
And, indeed, blistering speed appears

PHOTOGRAPHY: S. PARKER / AVIS STUDIO © 1991

not to be a major design goal. Of the four processor cards, only the 386/25 has a memory cache, and it's only 16 KB. The 486 and 486SX cards make do with only their internal 8-KB caches.

The BYTE Lab benchmark tests on an early version of the 486s/25M system bear this out. Although it has a clock speed 25 percent faster than an Everex Step 486SX/20, it had a CPU benchmark only 15 percent better. Still, this new Compaq system is no slouch. It was almost twice as fast as a Compaq Deskpro 386/25e.

[Editor's note: *For a full discussion of the benefits and disadvantages of modular systems, see this month's Roundtable on page 103. Next month's Under the Hood will have a detailed discussion of the technical merits of such systems.*]



The upgradable processor card fits into a special slot on the left side of the new Compaq Deskpro/M chassis. The motherboard takes up only about half the area of the system unit. The novel placement of the fan on top of the power supply allows very quiet operation.

Only One Video Option

At first glance, the video system seems a bit disappointing. While other manufacturers are offering systems with VGA resolutions of 1024 by 768 pixels, Compaq's new video board is still only 640 by 480 pixels.

However, after close examination, I was impressed. It has 512 KB of memory, allowing it to display 256 colors. And it includes a graphics accelerator to speed up software such as Microsoft Windows. In the BYTE Lab benchmarks, this board scored high marks, being beaten only by the Arche 386-40.

On some systems, even the more mundane features are impressive. So it is with the I/O design on the new Deskpro/M family. A separate I/O board slides in horizontally from the side, under the power supply, and connects to the rather small motherboard of these systems. On the board are connectors for two IDE hard drives, as well as for two floppy drives (or one floppy drive and one tape drive). At the rear of the board is a fairly standard set of connectors.

Two 486SX Chips, One Socket

One of the quirkiest aspects of several 486SX designs is the upgrade policy. If you add a 487SX chip to your system, the new chip does all the CPU work, while your original 486SX appears to retire and do nothing.

Compaq is one of the first companies to introduce a new 486SX design philosophy. In this design, the 486SX chip sits in a single "low-insertion-force" socket. When you upgrade to a full 486, you remove the 486SX and insert a 487SX. Your original 486SX still does nothing, but at least you can send it back to Compaq and get a trade-in allowance.

Everyone's EISA?

As someone who has always believed that Compaq systems were on the leading edge of the quality and performance curves, I find the new Deskpro/M series unusual. Obviously, the company is now trying to find a position on the leading edge of the quality and pricing curves. And although it will probably take a bit of time before the street prices of these systems settle down, Compaq will probably succeed in this quest.

The new Deskpro/M family of systems is not quite perfect. For example, it would be nice to have a low-end 386SX version and a 486/50, but these will probably come in the future. The systems will no doubt succeed in their goal, however, which is to be an affordable and rational way for users to step up to Compaq quality and 486/EISA power. And anything that puts more quality systems on more desks is a good thing. ■

Rich Malloy is an executive editor for BYTE. He can be reached on BIX as "rmalloy."

THE FACTS

Compaq Deskpro/M Family of Systems:
386/25M, 486s/16M, 486s/25M, 486/33M
(prices unavailable at press time)

Compaq Computer Corp.
P.O. Box 692000
Houston, TX 77269
(800) 231-0900
(713) 370-0670
fax: (713) 374-1740
Circle 1270 on Inquiry Card.

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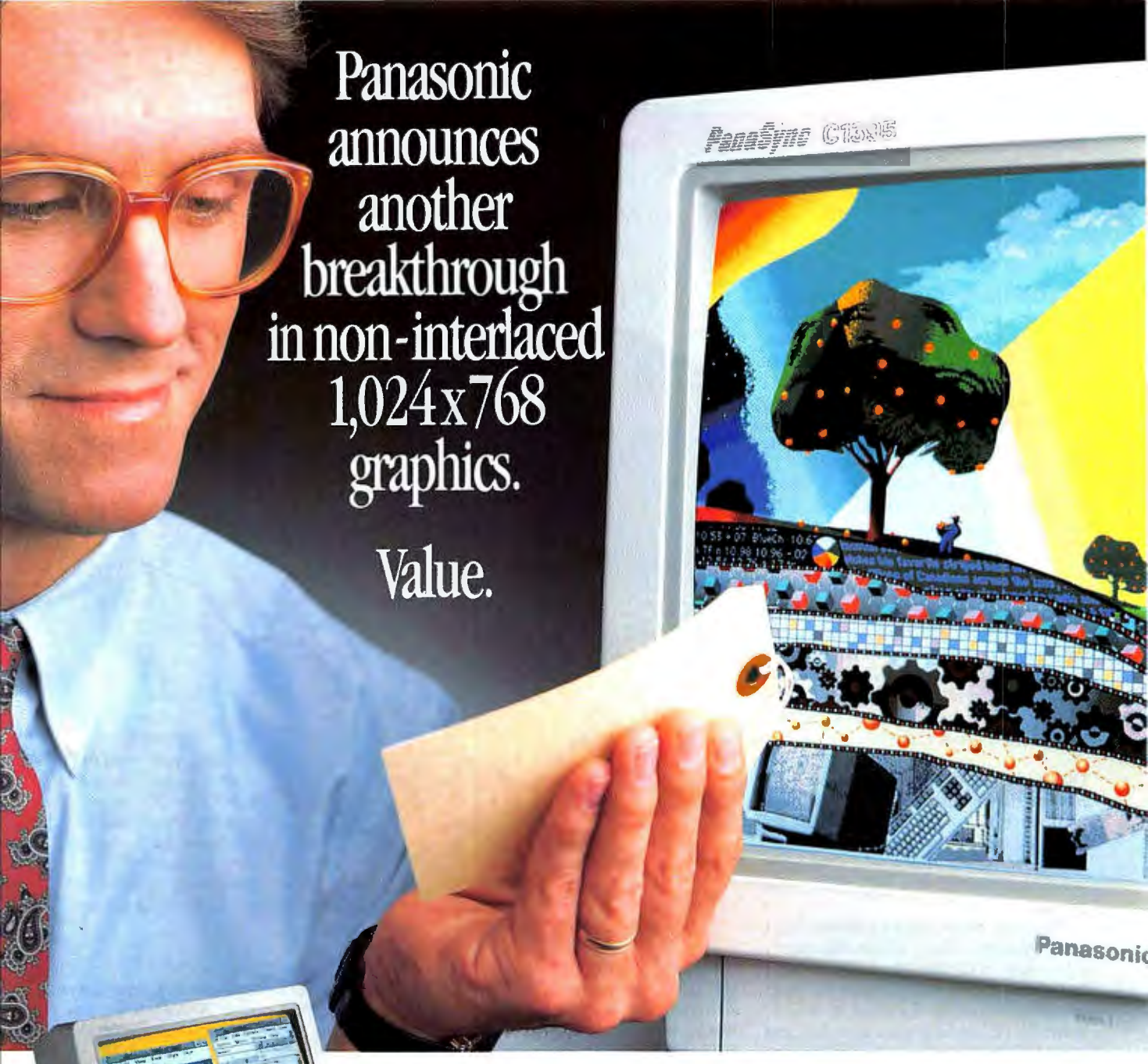

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M4-BY

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Compatibility Is King in 1-2-3 for Windows

ANDY REINHARDT

Lotus walks a fine line between satisfying the gargantuan base of current 1-2-3 users and incorporating new GUI features

Lotus Development faced a daunting challenge in developing a Windows version of its venerable 1-2-3 spreadsheet: With the largest installed base of any application in the world, Lotus absolutely had to provide seamless backward compatibility. Literally billions of dollars have been invested by 1-2-3 users in training, data files, templates, and macros.

The problem is that 1-2-3 is not organized in a way that fits neatly into a graphical environment. The resulting 1-2-3 for Windows (1-2-3/W) is a hybrid that succeeds as an evolutionary step for 1-2-3 but may fall short as a Windows application.

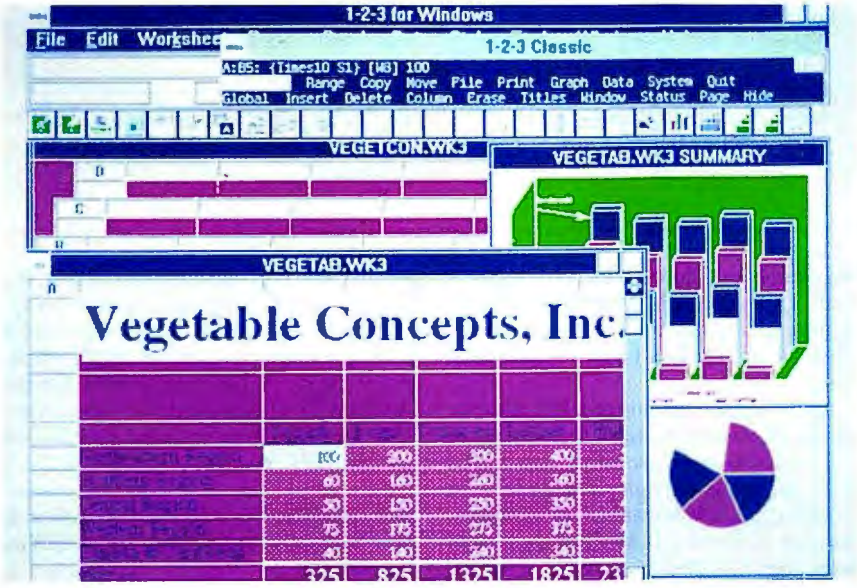
Ultimately, whether you see 1-2-3/W as a triumph or a disappointment depends on how deeply you are committed to 1-2-3. Lotus has kept its promise to users, but new customers may be frustrated by 1-2-3/W.

New Look

Lotus 1-2-3/W doesn't add a lot of new features beyond what is already available in releases 3.0 and 3.1. The most significant change is in the user interface. Instead of the old "slash" menus, 1-2-3/W uses standard Windows menus like File, Edit, and Help. Familiar commands like /Copy, /Move, and /Print have disappeared from the main menu and now reside in the File or Edit menus. To accommodate people who are used to the old commands, Lotus also supports "1-2-3 Classic" menus. As another concession to the installed base, 1-2-3/W supports either 1-2-3's usual action-before-selection method or the selection-before-action technique typical of GUI spreadsheets.

One of the most convenient and powerful features of 1-2-3/W is SmartIcons, a technology used in the Ami Pro word processor and obtained by Lotus when it acquired Samna. SmartIcons is a collection of shortcuts—either menu commands or macros—that are represented in a resizable, customizable palette of tiny icons. The standard configuration includes SmartIcons for setting type in bold or italic, moving up and down a three-dimensional stack of spreadsheets, summing a row or column of cells, or viewing a graph. Dozens of other icons are available, or you can add your own.

New styling and publishing commands let you decorate your spreadsheet with a variety of fonts, colors, shading, and borders. Unlike the WYSIWYG add-ins in releases 2.3 and 3.1, these style commands are integral to the main menu. However, as with the add-ins, the style information is maintained in a separate file from the underlying data values and formulas, so that even a dressed-up spreadsheet can be accessed by an earlier, non-



THE FACTS

Lotus 1-2-3 for Windows release 1.0
$595
Network Server edition, $895
Network Node edition, $595

Requirements:
IBM AT, PS/2, or compatible with 2 MB of RAM, EGA or better graphics, a mouse, 5 MB of available disk space, and Windows 3.0.

Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
fax: (617) 693-1197
Circle 1375 on Inquiry Card.

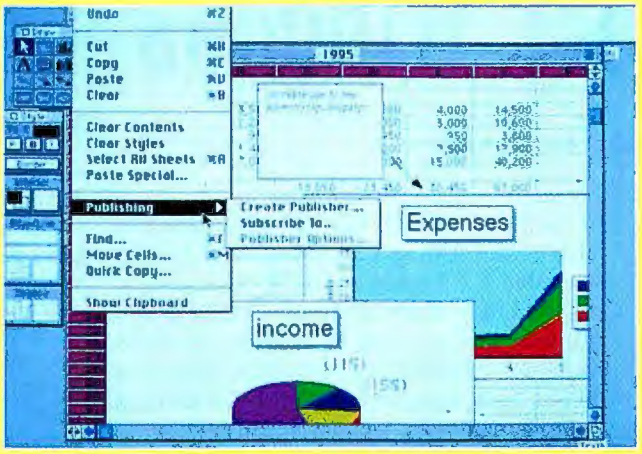
@ Last: 1-2-3 for the Mac

D. Barker

With Lotus 1-2-3 for the Mac, Lotus has done a nice job designing a true-to-Mac interface. Menus are straightforward, and some functions, such as drawing tools, are kept in handy palettes.

Lotus programmers have also ensured compatibility with other versions of 1-2-3. If you've got the right equipment, such as Apple's floppy disk high-density drive (which can read floppy disks from DOS machines) or a Mac-to-PC network connection, you can exchange and open up worksheets done with 1-2-3 releases 2.0 and 3.0 (WK1 and WK3). You can also work with files from Excel 2.2; the translation is quick and painless. (The beta version that I worked with could not translate worksheets from Excel 3.0, but Lotus says that's coming.) In addition, the Mac version of 1-2-3 can run macros from the other 1-2-3 packages. A company official said that the program will be able to convert Excel macros, but I couldn't do that with the beta edition I had.

This is currently one of the few programs that tries to take advantage of System 7.0. I say *tries* because some of the operations ran into gnarly snags. For example, I was able to publish a range of data from one worksheet and then subscribe to that data from another worksheet (all done through menu choices); but later, when I changed the original data, it didn't change in the second worksheet. The Publish/Subscribe mechanism in the beta version got me hosed nearly every time. This is no discredit to Lotus; after all, the package was a prerelease version, and System 7.0 is still young. It was simply disappointing to not see Publish/Subscribe really work, since it is one of the slickest features of the new Mac OS.



Lotus has done a good job of taking a classic DOS program and blending it into the Mac environment. It's not as Macish as something bred for that machine, like Wingz, but for the most part it maintains the look and feel and structure of a Mac program. For someone new to spreadsheets, this one is a lot easier to get started with than its DOS ancestors. But people using other Mac spreadsheets aren't likely to switch over to 1-2-3, even if it is much easier to use in some ways.

People who are in mixed environments should check out Lotus 1-2-3 for the Mac. The program's ability to harmoniously handle worksheets from other platforms is essential for many users and will be one of 1-2-3's big drawing cards.

THE FACTS

Lotus 1-2-3 for the Mac
$495

Requirements:
Mac with a 68020 or higher, a hard drive, 2 MB of memory, and System 6.0.4 or higher, including System 7.0.

Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
(617) 577-8500
fax: (617) 693-1197
Circle 1376 on Inquiry Card.

D. Barker is a BYTE senior news editor. You can reach him on BIX as "dbarker."

WYSIWYG version of 1-2-3.

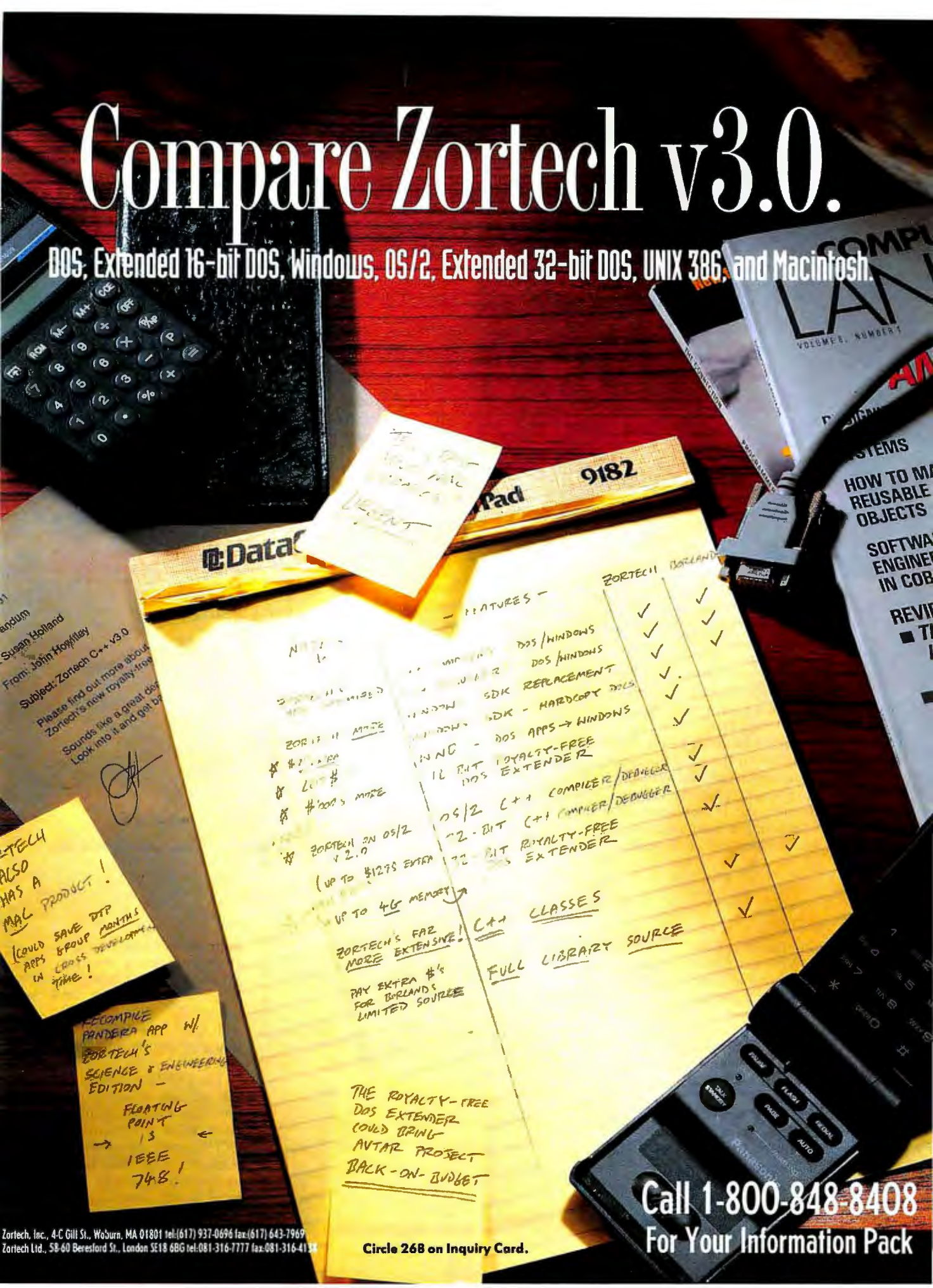
Power users will be pleased to know that Lotus has included in 1-2-3/W the Solver and Backsolver capabilities that were first introduced in 1-2-3/G.

Limits and Objects

One of the design goals of 1-2-3/W was to accommodate networked environments where users of different versions of 1-2-3 could access the same files. The separation of data from styling information is one example of how Lotus achieved this goal. This approach, however, is an advantage and a drawback: 1-2-3/W sometimes sacrifices flexibility for compatibility.

As a Windows version of 1-2-3, it packs all the functionality (and then some) of its character-based ancestors into a GUI package. But as a Windows application in its own right, it is not as rich or as object-oriented as Excel 3.0. Once you get used to the idea that double-clicking on an object in Excel will open up new options, it's hard to go back to the more procedural approach of 1-2-3. Lotus deserves praise for accommodating its users, but until graphical versions of 1-2-3 are freed from the shackles of an installed user base, they will feel like they've been shoehorned into the GUI. ■

Andy Reinhardt is a BYTE news editor in New York. He can be contacted on BIX as "areinhardt."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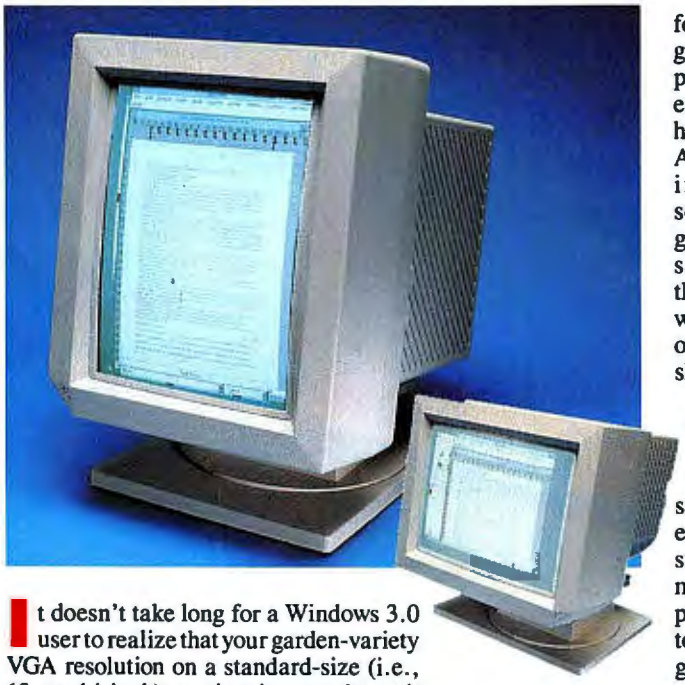
A Monitor to Flip Over



It doesn't take long for a Windows 3.0 user to realize that your garden-variety VGA resolution on a standard-size (i.e., 13- or 14-inch) monitor just won't cut it for serious use. A resolution of 640 by 480 pixels on a small screen offers little more than a small peek at a piece of a desktop.

With the **Full Page Pivot** monitor coupled with the **SVGA MultiView** card, Radius has brought its full-page, full-color display system (which has been available for the Mac) to the PC platform. Like its Mac counterpart, the 15-inch screen is "flippy": Switching it from a standard horizontal orientation (which is perfect for spreadsheets or graphics) to a full-page vertical orientation is a one-handed operation. A mercury switch in the monitor senses the 90-degree shift, and it sends a signal to the graphics card, which causes the on-screen image to shift.

The Radius system is state of the art. The monitor uses a flat-square tube with an etched antiglare surface and 0.28-millimeter dot pitch. It conforms to Sweden's stringent guidelines for magnetic and electrical emissions. The SVGA MultiView card comes with 1 MB of high-speed video RAM, so the graphics performance is speedy. It has standard VGA resolution at the low end, but it supports up to 1024 by 768 pixels (with 256 colors) with drivers. Drivers are included for Windows 3.0, WordPerfect, Lotus 1-2-3, AutoCAD, AutoShade, and Studio 3D.

The software installation is painless and automatic: You can choose either 800 by 600 or 1024 by 768 resolution. All I did was run the installation program and reboot. (There's also a DOS program that flips standard DOS applications, but you won't get a full-page display.)

Full-page displays have been available for Windows before, but they have been monochrome. The Full Page Pivot is the first full-page color display, and it makes working with word processors or desktop publishing programs under Windows a genuine pleasure. At $1698 (with the SVGA MultiView card), it's not inexpensive. However, for serious graphics work, it's essential and worth every penny. My old VGA monitor is now sitting in the corner gathering dust.

—Stan Miastkowski

THE FACTS

Full Page Pivot, $1249
SVGA MultiView, $449

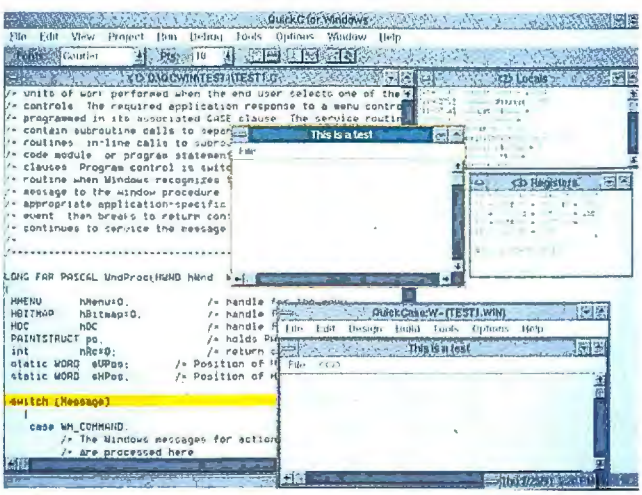
System requirements:
A 386- or 486-based PC running Windows 3.0 or higher.

Radius, Inc.
1710 Fortune Dr.
San Jose, CA 95131
(800) 227-2795
(408) 434-1010
fax: (408) 434-0770
Circle 1197 on Inquiry Card.

QuickC Does Windows

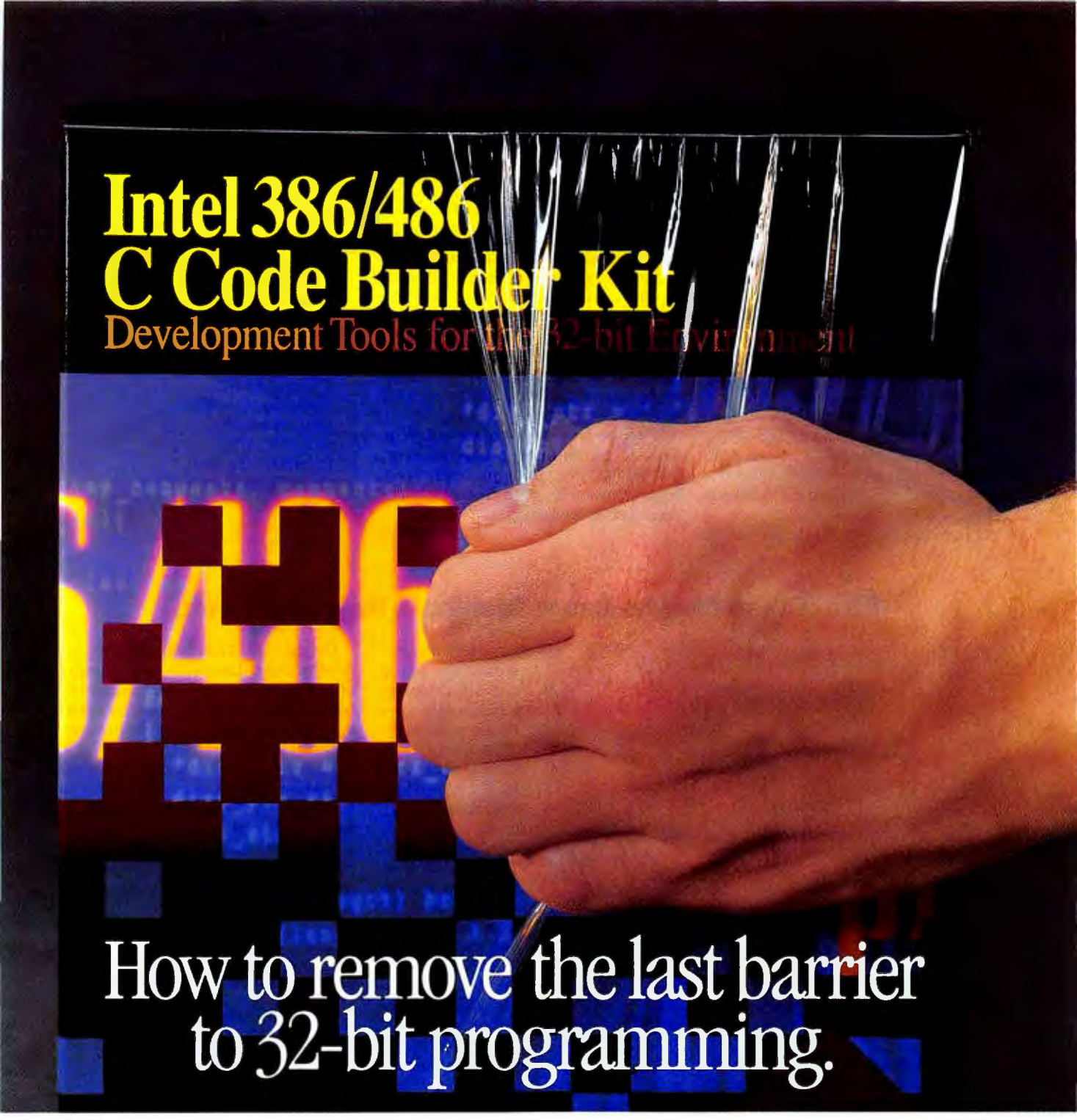
QuickC for Windows (QC/Win) has finally arrived—complete with everything you'd want for producing Windows and DOS programs, except for a help compiler and perhaps the Windows debugging kernels. (Both of these are available separately.)

The core of QC/Win is an integrated Windows programming environment—which is itself a Windows program. No more shelling out to DOS. With QC/Win, you can edit your code; create your dialog boxes, cursors, and other resources; build your executable files; and debug your programs without leaving the Windows desktop. But that's not all: QC/Win is bundled with QuickCase:W, an easy-to-use Windows application generator.



The QC/Win library can get you into Windows in no time. Just list the modules of your DOS program in a QC/Win project, set the project to use the QC/Win library, and rebuild the project. You'll wind up with a working Windows application.

The QC/Win editor lacks



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the power of a professional programmer's editor. It does, however, sport some slick features, including full integration with the QC/Win debugger, multiple document windows, regular expression support, selectable fonts, and syntax coloring.

As you'd expect, the QC/Win compiler produces object code quickly, and it's even easier to use than the DOS version, thanks to the toolbar and dialog boxes. QC/Win is a lot faster than Microsoft C or any other optimizing compiler, but it's not nearly as fast as Borland C++, which can precompile headers.

Conversely, the QC/Win linker takes a disproportionate amount of the total build time. The only faster Windows linker I know of, however, is OptLink from SLR Systems—and OptLink costs more than the whole QC/Win system.

Debugging with QC/Win is easy and doesn't interfere with normal Windows operation. Most of CodeView's functions for Windows are duplicated in the QC/Win debugger but are easier to get at.

If you're looking for a one-box Windows C programming environment, QC/Win has everything you really need. It performs well—even in the beta-test versions I've been using.

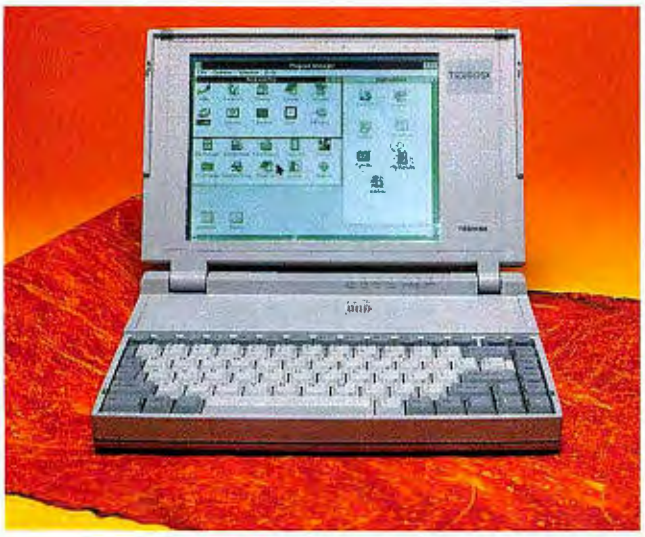
—Martin Heller

THE FACTS

QuickC for Windows
$199;
upgrade from QuickC, $89.95

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 883-8101
Circle 1198 on Inquiry Card.

First Class Weighs Less: Toshiba's New Notebook



The **Toshiba T2200SX** notebook computer is a refreshing addition to the notebook computer industry, not because of any astounding technical innovation, but because of important refinements. I looked at a "commercial sample" of Toshiba's new system and was impressed by the combination of technology and attention to detail that it represents.

The T2200SX is a 20-MHz 386SX-based notebook that weighs merely 5½ pounds, including its nickel-hydride battery pack. Toshiba claims that its AC adapter is the "world's smallest" and adds only 13 ounces to the laptop's "carry weight." The size (11¾ by 8¼ by 1½ inches) represents about a one-third reduction in volume for the T2200SX from the T2000SX. Toshiba achieved these smaller dimensions by using nickel-hydride batteries, a thinner—though larger—VGA-compatible screen (with a 5¾- by 7½-inch viewable screen area), and a thinner 3½-inch floppy drive. The 2½-inch Connor hard drives (40- or 60-MB) have 19-millisecond access times. Toshiba decreased the case thickness and weight by going with a carbon-fiber polymer. Inside, the 0.23-inch-thick motherboard is a six-layer, seven-fold, Toshiba Rigid-Flex design.

A function key lets you toggle between 10- and 20-MHz operation. In the sleep mode, the system slows down to 4-MHz operation and will run for about 100 hours with the standard 2 MB of RAM. Toshiba's AutoResume function remembers where you were when you switch off the power or when the battery runs down. Backup batteries protect your data while you swap nickel-hydride battery packs.

The T2200SX has a slot for a RAM card to expand the system up to 10 MB, a slot for a 2400-bps MNP level 5 modem, a serial port, a printer port that doubles as an external 5¼-inch floppy drive connector, and a 150-pin expansion port for Toshiba's Desk Station IV.

Overall, the T2200SX packs all you need in a small and lightweight configuration. In fact, it has a full 86-key keyboard with full-size key tops, except for the right-edge cursor keys, which are only slightly smaller.

The 640- by 480-pixel sidelit black-and-white LCD measures 9½ inches diagonally. These notebooks can't get much smaller unless we're willing to accept smaller displays and keyboards. We can hope for ongoing weight reductions, though. I recommend taking a good look at this one.

—Gene Smarte

THE FACTS

Toshiba T2200SX
$4499 (with 40-MB hard drive, DOS, and hypertext documentation)

Options:
60-MB hard drive, $300; 2-, 4-, and 8-MB RAM cards, $479, $889, and $1779, respectively; 2400-bps MNP level 5 modem, $359

Toshiba America Information Systems, Inc.
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Removable Hard Drives Break the Storage Barrier

A removable-cartridge drive is a cross between a floppy drive and a hard drive, giving you the convenience of a floppy disk with the speed and capacity of a hard disk. The **SyDOS 88** and Iomega's **Transportable 90** are the latest offerings from the industry leaders.

The unit from SyDOS (a division of SyQuest Technology) came configured as an external drive, complete with an Adaptec SCSI adapter and DOS software. The drive looks and feels like any normal DOS hard drive. To change cartridges, you simply press the release button on the front of the drive. After a moment, a release lever pops out; an easy push on the lever, and the cartridge pops out. To load a cartridge, you simply insert it and push in the release lever.

Iomega's Bernoulli-technology drives have been around for almost as long as the PC itself. The 90-MB removable 5¼-inch drive is read-compatible with the company's earlier 44-MB drives. Cartridges in the drive automatically mount when you push them in. You remove the cartridge by pressing the release button above the drive.

Iomega sells its drives à la carte. The Transportable 90 is a unit designed to be moved from one machine to another.

Both drives performed admirably on the BYTE benchmark tests. From a price standpoint, the drives are almost identical. Which to choose? If you're buying a removable drive to back up and archive data, the lower cost per megabyte and faster access time of the Transportable 90 would be advantages. If you need to exchange large amounts of information from one computer to another (and you can't use a LAN), either would suffice, although you'll have to pick a drive compatible with both computers. Whichever you choose, you'll be buying from a company with a reputation for solid performance and good customer support.

—Howard Eglowstein

THE FACTS

SyDOS 88
$1598 (includes adapter and one cartridge)
88-MB cartridge, $278

SyDOS
6501 Park of Commerce Blvd., Suite 110
Boca Raton, FL 33487
(407) 998-5400
fax: (407) 998-5414
Circle 1200 on Inquiry Card.

Transportable 90
$1149
DOS Interface Kit: ISA, $265; Micro Channel, $399
Mac Interface Kit, $49
88-MB cartridges, $687 for three

Iomega Corp.
1821 West 4000 South
Roy, Utah 84067
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fax: (801) 778-3450
Circle 1201 on Inquiry Card.

Affordable Full-Color Scanning

What? *Another* 24-bit color scanner? Correct. Another big, gray, flatbed contraption that connects to a Mac's SCSI bus, like the rest of the competition. However, the **ScanJet IIc** comes from Hewlett-Packard, a company whose reputation for rugged equipment—from its hand calculators to its 64000 development systems—is well known.

Setting up the ScanJet IIc is simple plug and play. You take the scanner out of the shipping box and unlock the scanning assembly by moving a lever built into the scanner body. Next, you hook up the SCSI cable and terminator and switch on both the Mac and the ScanJet IIc. Finally, you copy some software from floppy disks onto the Mac's hard disk, and you're set.

One odd quirk is that the ScanJet IIc has only one 50-pin SCSI port (instead of two). The other SCSI port uses a DB-25 SCSI connector, like the Mac. The reasoning for this is that you use the same

THE FACTS

ScanJet IIc
Mac version, $1995;
PC version, $2195

Hewlett-Packard
19310 Pruneridge Ave.
Cupertino, CA 95014
(800) 752-0900
(208) 323-2551 (support)
fax: (208) 344-4809
Circle 1202 on Inquiry Card.

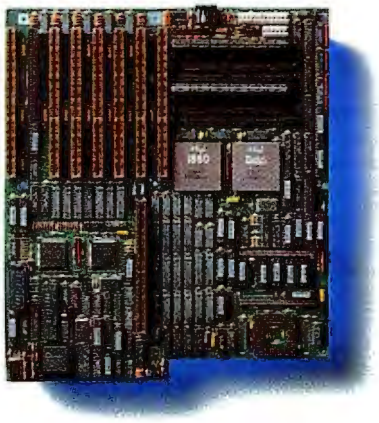
RISC FREE!

NEW!! SEE OUR NEW LINE OF 386 AND 486 MOTHERBOARDS AT FALL COMDEX '91.

Free i860™ Processor and i860/APX Software!
By now, you've probably heard about our industry-first 4860™ MotherBoard that packs the power of the Intel 80486 CPU with the Intel 80860 RISC processor (i486™ + i860 = 4860).

What you haven't heard is that, for a limited time, when you buy a 4860 MotherBoard with 8MB of RAM, Hauppauge will give you an i860 RISC processor and the i860/APX operating system at no additional cost.

Why *give* you this capability? Because you'll enjoy a level of processor performance never before seen in a PC. Our bet is that you'll be so impressed, you'll come back for more!



A PC Revolution: In the PC environment, the 4860 is a 486-based MotherBoard with the new EISA I/O bus. It runs over 2 times faster than 386 computers and delivers mainframe power for applications including CAD, LAN and desktop publishing. This board is fully compatible with DOS, IBM's OS/2, Novell Netware and SCO UNIX. What's more, Hauppauge's 4860 supports up to 64 MBytes of memory *without* a RAM expansion board.

RISC-Y Business: The i860 processor is ideal in complex applications, performing up to 25 million floating-point operations per second. It adds to the power of the 486, so you can run rings around ordinary PCs.

By adapting Intel's APX (Attached Processor Executive) software to our 4860 MotherBoard, we've created a way to exploit the power of the i860 to give you *practical* multiprocessing. In fact, i860/APX provides a base for entirely new applications made possible by the advent of the i860 RISC processor.

Technical Features: 25 or 33MHZ 486/860 • 4 Mbytes of high speed RAM expandable to 64 Mbytes shared between i486 and i860 processors • Socket for optional Intel Turbo Cache 485™ and Weitek 4167 • 7 EISA I/O slots • 64-bit expansion slot for optional high-speed graphic frame buffer • 1 parallel, 2 serial ports and a built-in PS/2-style mouse port.

Enjoy a RISC-free investment. Our 4860 MotherBoard is designed with the world's highest performing microprocessors. So you can have the world's highest performing PCs and workstations.

For more information, call **1-800-443-6284**.

Hauppauge Computer Works, Inc.
91 Cabot Court
Hauppauge, New York 11788
Telephone: 516-434-1600
Fax: 516-434-3198
In Europe (49) 2161-17063
In Australia: (7) 262-3122

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Trademarks: OS/2: IBM • Intel 386, i486, i860 and Turbo Cache 485™: Intel Corp. • DOS and Xenix: Microsoft Corp. • 4860, 4860 MotherBoard: Hauppauge

SCSI cable to daisy chain to other SCSI devices. Whether or not this is a good idea remains to be seen.

The ScanJet IIc has a 400-dot-per-inch charge-coupled-device sensor strip to capture color images in a single pass. It supports scanning modes of 4- and 8-bit gray scale and 24-bit color.

The color data is an actual 8 bits per red, green, and blue component, yielding 16.8 million colors. This is unlike some scanners that actually capture fewer bits of information and, therefore, provide only some thousands of colors.

For my tests, I used a Mac IIfx with 8 MB of RAM and an 80-MB hard drive running System 7.0. The beta DeskScan II application goes about performing its job properly by spooling the image data to a disk file. This lets you capture 24-bit-deep high-resolution scans using only 2 MB of RAM (the shipping application should run in 1 MB). This is much better than some scanning software packages that simply cram the image into memory and thus need 8 MB of RAM or more to do the job.

You can set the image's resolution (from 12 to 1600 dpi) and scale the image (either as a whole or using different scaling factors for the image width and height). Modes for handling line art, halftones, and photos are available, and you can apply color corrections to the image as a whole or only a portion of it during the scanning operation. All the images produced by the ScanJet IIc were excellent, and they were made with a minimum of fuss.

For a high-resolution scan (150 dpi or higher), the scanning head starts tracking back and forth during the scan. This is the scanning head repositioning itself after the computer throttles the data as it saves it to disk.

You would think with such gyrations that image quality would suffer. Amazingly, it doesn't.

As for the additional wear and tear on the scanning mechanism, HP has used all the repair information from its venerable ScanJet line while designing the IIc, so I expect it to hold up for a long time.

—Tom Thompson

BeyondMail Pushes Out the Envelope

As the information glut intensifies, we spend more and more of our time classifying, sorting, and responding to the flood of inputs competing for our attention. If, like me, you'd like to automate some of these chores, take a long and careful look at **BeyondMail**. An offshoot of the Information Lens project at MIT (see "Through a Lens Smartly," May BYTE), BeyondMail adds event-oriented, rule-based message processing to an otherwise conventional E-mail program.

BeyondMail's high price and heavy RAM requirement may look like overkill if you are not drowning in E-mail. Of course, if you take this program seriously—as a platform for groupware applications that streamline your business—your electronic mailbox will see a lot of action.

Like other E-mail programs for DOS-based LANs, BeyondMail relies on Novell's Message Handling Service, a store-and-forward engine. As such, BeyondMail users on a LAN can communicate not only with each other, but (potentially) with users on other LANs reachable through MHS hubs. BeyondMail users can also communicate with users of other MHS-based E-mail programs.

To get started, you install MHS and then BeyondMail. Like other MHS-based programs, BeyondMail provides a tool, NUPDATE, which populates the MHS directory, and its own public address book, with names drawn from the NetWare bindery. When I ran NUPDATE, it would not convert my users' names. Whose fault was it? MHS's. MHS, although a Novell product, can't deal with some perfectly legal bindery names—in particular, those with an underscore.

BeyondMail's character-mode GUI makes quick work of normal E-mail tasks: writing, reading, and filing messages and attachments; creating distribution lists; and managing address books. You can link applications to attached files so that when you mail a spreadsheet, its recipient can instantly launch Lotus 1-2-3 to work with it.

Five message templates (i.e., memo, phone message, request form, meeting, and transmittal memo) create structured modes of communication. A request form, for example, asks someone to approve, act, or decide on something by a given date. These fielded forms do double duty as rule templates.

The documentation showcases some intriguing applications. My favorite, if adapted to BYTE, would handle the faxing of guidelines to prospective authors.

BeyondMail gives us a taste of true office automation. I can't wait for the world to catch up with Beyond's vision. ■

—Jon Udell

THE FACTS

BeyondMail
Server Edition, $695 (includes MHS and a five-user license)
five-node expansion pack, $395
20-node expansion pack, $1395

System requirements:
A 286 or higher running DOS 3.1 with 884 KB of free conventional and extended memory.

Beyond, Inc.
38 Sidney St.
Cambridge, MA 02139
(617) 621-0095
fax: (617) 621-0096
Circle 1203 on Inquiry Card.

"My Dolch 486™ is awesome. . ."

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Introducing two with some of the numbers in

If it sometimes seems that workstation vendors talk too much about specs, maybe it's because they have so little else to talk about.

Not so with Sun's new SPARCstation™ ELC™ and SPARCstation IPX.™ Yes, you'll be impressed with their specs. Really impressed — especially considering the price.

But step away from the hardware a bit, and you'll discover other numbers that are just as powerful.

Consider, for instance, that SPARCstation is the Number One selling work-

1

station family available today. It's a comforting fact in a world of ever-changing vendor alliances, consortiums, and deal-making.

Or that SPARCstation is famed for

4,995

making tremendous power increasingly affordable (our new $4,995 SPARCstation ELC — a 20.3 SPECmark powerhouse — is a good example).

The 475,000 Sun workstations and servers that are up and running make

475,000

ours the industry's third most popular operating system. And since software developers go where the users are, you can imagine how much your company can get done on a Sun.

Better yet, don't imagine. Crack

The new $4,995 SPARCstation ELC gives you more than twice the power of our previous entry-level monochrome workstation: 20.3 SPECmarks from a single 33-MHz chip that performs both integer and floating-point calculations. Load it with up to 64 MB of memory, and up to 5.2 GB of external storage.

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FINLAND: Tel. 358-0-502270 FRANCE: Tel. 33-1-30-67-50-00
GERMANY: Tel. 49-89-46008-0 ITALY: Tel. 39-39-6056337
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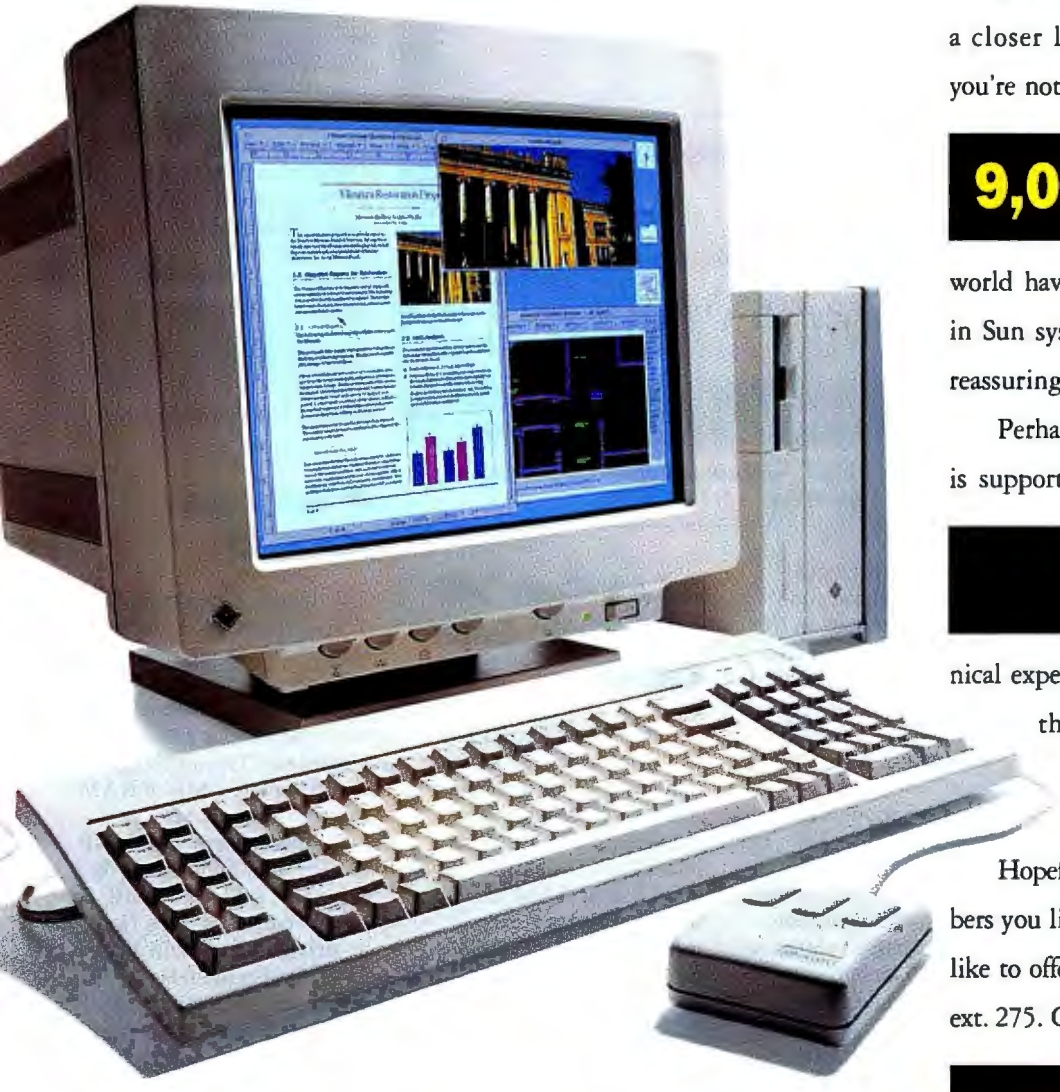
workstations most powerful the business.



The new $11,995 SPARCstation IPX is the lowest-cost accelerated graphics workstation we've ever offered. Its GX accelerator is on the motherboard, freeing up an expansion slot. Its 40-MHz integrated integer/floating point processor performs up to 24.4 SPECmarks. (Color monitor available at additional cost).

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SWITZERLAND: Zurich Tel. 41-1-825-71-11 Geneva Tel. 41 22 64 47 35
UK: Bagshot Tel. 44-276-51440 Camberley Tel. 44-276-20444
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open our latest applications catalog. Lotus® 1-2-3®, Oracle®, and some 3,500

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other solutions give you the UNIX® industry's largest selection of software applications.

Should all this motivate you to take a closer look at our SPARCstations, you're not alone. Companies around the

9,000,000,000

world have thus far invested $9 billion in Sun systems. Honestly, if that isn't reassuring, what is?

Perhaps this: Every system we sell is supported by a force of 16,000 tech-

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nical experts worldwide, through more than sixty service partners. If you ever need help, they can provide it.

Hopefully, these are the kind of numbers you like to hear. In which case we'd like to offer one more: 1-800-426-5321, ext. 275. Call, and we'll send all sorts of

1-800-426-5321

useful information about our new SPARCstations.

Numbers, certainly. But a few more words and pictures, too.

sun microsystems

Circle 211 on Inquiry Card.

Color and Power in a Laptop

The ProSpeed 486SX/C laptop computer sports a Super VGA thin-film transistor active-matrix color screen, a 486SX processor, and a 32-bit EISA expansion slot. Weighing in at 16-plus pounds, the 20-MHz unit measures 14⅘ by 15⅗ by 4⅕ inches.

The ProSpeed's 10-inch screen has a resolution of 640 by 480 pixels in 256 colors. Other features include 2 MB of expandable memory via SIMMs, 120 MB of hard disk storage, and 8 KB of cache memory. Standard operating systems for the unit are Windows 3.0 and DOS 5.0.
Price: $8999.
Contact: NEC Technologies, Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (508) 264-8000.
Circle 1271 on Inquiry Card.

The ProSpeed 486SX/C works in Windows 3.0 and supports 256 colors and Super VGA.

A Tower of Power

A 486 in a tower, the Super-486/33 ISA has a 1.44-KB floppy drive. It includes 4 MB of burst-mode RAM (expandable to 16 MB), 64 KB of ROM, and 64 KB of external copy-back RAM cache (expandable to 256 KB). Hard drive models are available.

With six half-height storage bays and eight expansion slots, the computer has two serial ports, one parallel port, and a Weitek coprocessor socket. Its floppy drive and hard drive controllers are built onto an I/O board that plugs into a 16-bit slot. A 101-key keyboard, DOS 4.01, and GWBASIC are included. The system also supports EMS 4.0 memory.

Hard drive models are available with 100-, 200-, or 300-MB capacity. Each hard drive computer comes with Windows 3.0 in addition to the standard software.
Price: $5595 and up.
Contact: Hyundai Electronics America, 166 Baypointe Pkwy., San Jose, CA 95134, (408) 473-9200; fax (408) 473-9279.
Circle 1272 on Inquiry Card.

A single floppy disk drives Hyundai's Super-486/33 computer.

A Low-Cost 386 with Write-Back Cache

For a 40-MHz 386 at a price under $2000, you may want to consider the ME 386-40 desktop machine. Based on the AM-386DX chip, the ME 386-40 has 4 MB of RAM and 64 KB of write-back cache RAM (expandable to 256 KB). The motherboard holds up to 64 MB of RAM.

Standard features on the zero-wait-state ME 386-40 are a 5¼-inch floppy drive, two serial ports, and one parallel port. You get a choice of a keyboard with 101 keys or a built-in trackball.
Price: Basic configuration, $1949.
Contact: Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705, (800) 642-7621 or (714) 852-1400; fax (714) 852-1225.
Circle 1273 on Inquiry Card.

CD-ROM on a Laptop

The GridCase 1550cd laptop computer includes a CD-ROM drive with 635 MB of storage. The 1550cd also has Isopoint, a built-in printing device, and a SCSI connection. The 17-pound 1550cd has 2 MB of RAM (expandable to 8 MB). It includes a 3¼-inch floppy drive, a 60-MB hard drive, a backlit VGA LCD, and Windows 3.0.
Price: $6590.
Contact: Grid Systems Corp., 47211 Lakeview Blvd., Fremont, CA 94538, (800) 222-4743 or (415) 656-4700; fax (415) 683-9895.
Circle 1274 on Inquiry Card.

A Guileless Notepad

An open-faced computer with a hinged display that adjusts for maximum viewing, the Notepad 386SX comes with a multipocket portfolio case or a stand-alone case. The notebook computer has 2 MB of RAM (expandable to 4 MB), a 2400-bps modem with MNP level 5, a 9600-bps send/receive fax, a 20- or 40-MB hard drive, a 3½-inch floppy drive, and a sidelit VGA LCD. It also includes a serial port, a parallel port, and an external mouse port, as well as a nickel-cadmium battery.

Price: $3595.
Contact: Lighthorse Technologies, Inc., 4105 Tolowa St., San Diego, CA 92117, (619) 270-7399.
Circle 1275 on Inquiry Card.

SBus Expansion in a Deep Dish

Called the "Deep Dish" expansion box, the Model 9100 SBus Expansion Box for the Sparcstation 1, 1+, 2, and interprocess communications provides four master/slave slots. Each slot can perform master DMA functions, including the new-generation burst mode, and slave duties.

You can add as many as three expansion boxes to your host system, which determines the maximum configuration in which you can use the box; each host system must have a single-slot host adapter card for each expansion box. The Model 9100's internal expansion lets you add four SCSI devices.

Equipped with a host adapter card and cables, the Model 9100 does not require host driver software.
Price: $2595 in the U.S.; $2995 internationally.
Contact: Texas Microsystems, Inc., 10618 Rockley Rd., Houston, TX 77099, (800) 627-8700 or (713) 933-8050; fax (713) 933-1029.
Circle 1276 on Inquiry Card.

Portrait Displays for the Mac

A tabloid-page gray-scale display system for Mac NuBus computers, SilverView Portrait features a 21-inch flat-screen monitor with a 72-dpi resolution. It displays up to 256 shades of gray and has a 72-Hz refresh rate.
Price: $3695.
Contact: Sigma Designs, Inc., 46501 Landing Pkwy., Fremont, CA 94538, (415) 770-0100; fax (415) 770-2640.
Circle 1279 on Inquiry Card.

Texas Microsystems' SBus Expansion Box increases Sparcstation capacity. The 9100 is compatible with all DMA-controlled SBus cards, according to the company.

FlexForce Hammers Your Words into Type

The E950 heavy-duty printer takes advantage of Facit's new FlexForce technology, which uses a 24-hammer print head. The hammers utilize stored energy to strike consecutively and are released at a high velocity to form the characters.

Based on a ramp design, the FlexForce print head tilts so that it prints diagonally, letting it print two lines simultaneously at a speed of 320 lpm. For letter-quality 24-pin resolution, the print head tilts still more for vertical printing of just one line.

The ergonomically designed E950's electronics are in a modular, removable controller assembly. Other features include a zero-tear-off capability, automatic loading, paper-thickness adjustments (it prints 8- to 10-part forms), a straight paper path, and 55-dB operation. It is programmable via a setup card.
Price: $3799; new ribbon cartridge, $45.
Contact: Facit, Inc., 400 Commercial St., Manchester, NH 03108, (800) 733-2248 or (603) 647-2700; fax (603) 647-2724.
Circle 1277 on Inquiry Card.

Personal Printing Made Easy

With a vertical design and straight paper path, the IBM Personal Printer Series (PPS) II from Lexmark has a noise level of 55 dB and an easy-to-use operator panel. It gives you a choice of five paper paths, a push/pull tractor, paper parking, and six-part form-printing capability. You can switch from automatic sheet-feed printing to continuous-form printing by flicking a switch.

Available as the narrow-carriage Model 2380 and the wide-carriage Model 2381, the 10-cpi PPS II includes a rip-and-run document tear-off capability. It has four fonts and an 11-KB buffer.
Price: Model 2380, $499; Model 2381, $699.
Contact: Lexmark International, Inc., 740 New Circle Rd., Lexington, KY 40511, (800) 426-2468.
Circle 1278 on Inquiry Card.

Choices and ease of use portray Lexmark's IBM PPS II printer.

CD-ROM as a Workhorse

The TCDR-6000 Workhorse heavy-duty external CD-ROM drive is combined with a keylock to prevent theft of a CD. The Workhorse plugs into your PC with a CD/Link accessory package. The CD/Link is not required for Macs. With a 390-ms access time, the Workhorse has two audio channels, a 32-KB buffer, and automatic lens cleaning.

The TCDR-6000 can daisy-chain as many as eight drives on a single interface card. The unit uses a High Sierra/ISO-9660 CD and has a double-door cartridge compartment.
Price: $805.
Contact: Todd Enterprises, Inc., 224-49 67th Ave., Bayside, NY 11364, (800) 445-8633 or (718) 343-1040; fax (718) 343-9180.
Circle 1280 on Inquiry Card.

Powerful Backup Card Freezes Data

The Powercard 4.0, a programmable internal backup power system, runs at the BIOS level, making it independent of your operating system. The card, which attaches to the motherboard via a short cable, works by freezing data before it safely shuts down your computer. You can use this feature to shut off your computer in the middle of any program.

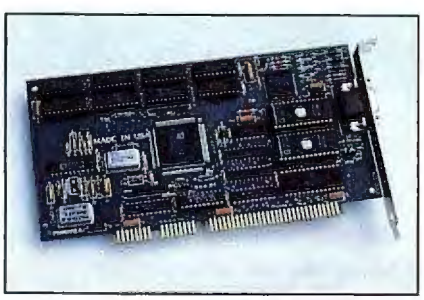
Powercard 4.0 supports dual monitors, letting you work on text and CAD/CAM. It includes an encased external lead-acid battery. The data-protection system supports DOS 3.0 through 5.x, LANtastic, MainLAN, DR DOS, and NetWare. It also works with Windows 3.0, Memory Commander, QEMM, and Desqview.
Price: $299.
Contact: Powercard Supply, L.C., 12231 Southwest 129th Court, Miami, FL 33186, (800) 637-2797 or (305) 251-5855; fax (305) 251-2334.
Circle 1281 on Inquiry Card.

Powercard 4.0 lets you safely shut off your computer.

A VGA Card that Manages Your Graphics

For PCs, Macs, and Suns, the GraphicsManager VGA card displays 32,768 colors in 800- by 600-pixel resolution, 256 colors in 1024- by 768-pixel resolution, and 16 colors in 1280- by 1024-pixel resolution. Its display is 72 Hz and noninterlaced.

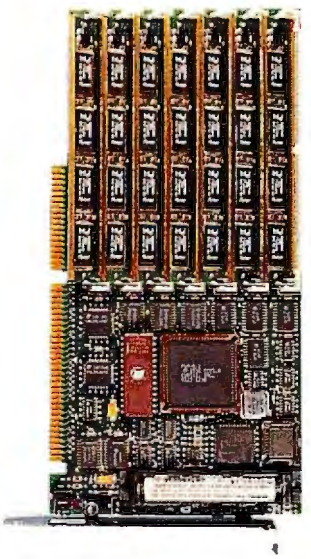
The package includes the 32K VGA GraphicsManager board and GraphicsManager Tools—software that captures Windows screens; manipulates images; and supports GIF, PCX, TIF, TGA, MAC, and RAST formats. Its functions include smooth scaling, rotation, mirroring, and pixel conversion. Compactor, a JPEG-based file compressor, and QuickSend, a full-color image transmission, are also included.
Price: $349; with Tempra Pro, $599.
Contact: Micrographics, 550 West Jackson Blvd., Suite 340, Chicago, IL 60606, (800) 332-0150 or (312) 648-1000; fax (312) 648-1588.
Circle 1283 on Inquiry Card.



The ROMDisk PCF uses solid-state memory to emulate a hard drive.

Solid-State Storage in a Flash

SIMMs let the ROMdisk PCF emulate a high-capacity data disk or dual disks to auto-boot from a floppy drive. The board programs flash memory at 100 KBps and bulk-erases it at 4 MB in 10 seconds.
Price: With one flash SIMM, $895; with one static RAM SIMM, $995.



Contact: Curtis, Inc., 2837 North Fairview Ave., St. Paul, MN 55113, (612) 631-9512.
Circle 1285 on Inquiry Card.

Open the Spigot for Video on Your Mac

A one-slot digital system that captures and plays video on large-screen Mac displays, VideoSpigot Pro uses Apple's QuickTime media-integration system. VideoSpigot Pro lets you capture and convert NTSC or PAL video input to compressed digital form from a VCR, laser disc player, or video camera. The package includes an RS-170 jack and a socket on the Processor Direct Slot adapter for an optional FPU.
Price: $1899.
Contact: SuperMac Technology, 485 Potrero Ave., Sunnyvale, CA 94086, (408) 245-2202; fax (408) 735-7250.
Circle 1282 on Inquiry Card.

EISA Burst Transfers Your Data

The AD11W EISA board gives you a standard interface for applications requiring processor linking, networking, or high-speed continuous data transfers. The board uses a 32-bit EISA-burst DMA transfer mode for sustained system throughput of up to 16 MBps.

Packaged with a file transfer utility, the AD11W board includes C library support for DMA buffer chaining. The board uses a single slot and has EISA automatic identification and configuration.
Price: $1995.
Contact: Analog Digital Technology, 2977 Willow Lane, Thousand Oaks, CA 91362, (805) 371-5761; fax (805) 371-5760.
Circle 1284 on Inquiry Card.

See the Difference.

INFO WORLD ranks Nanao #1

"Using each adapter at VGA, 800-by-600 and 1,024-by-768 pixel resolutions, all test images were displayed crisply."

-- PC Week

"The image is the brightest we've ever seen, even in the brightly-sunlit new CADalyst office."

-- CADalyst

"The intelligence built into this monitor eliminates all of the arm stretching and wheel turning so often associated with video mode changes."

-- PC Magazine

"Nanao thoughtfully places the seven most-used controls on the front of the monitor, unobtrusively tucked below the faceplate."

-- Macworld

See the difference that the industry experts agree has set the **Nanao Flexscan 9080i** apart from other monitors.

The Difference Will Impress You.

Color yourself impressed by the Nanao Flexscan 9080i's multiscanning abilities and high resolution. The 1280 x 1024 non-interlaced resolution increases productivity and enhances graphics applications beyond compare. Its high refresh rate (74Hz) is easy on the eyes. And with sharper text and brighter colors, the 9080i delivers the high quality professionals need...and want!

The Difference Will Excite You.

Get excited about doing what you've always wanted to do with Windows on the 9080i's larger 16-inch screen area. Highly compatible, in compliance with the Video Electronics Standards Association. Convergence & pin-cushioning controls. Dual inputs for two computers or two boards. The little differences that make for an exciting new monitor.

The Difference Will Comfort You.

Sometimes for high performance you need to give up creature comforts. But not with the 9080i. Sit back and relax in front of your Nanao monitor and its convenient front control panel. Almost every adjustment is within your reach. Nanao Flexscan monitors even align themselves with the Swedish MPR standards of low radiation emissions and give you an anti-static coating, fulfilling your ergonomic needs.

See the family of monitors ready for the next step in high resolution. To see the difference for yourself, contact your local Nanao dealer or call us at **1-800-800-5202.**

NANAO®

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Torrance, California 90505
(213) 325-5202

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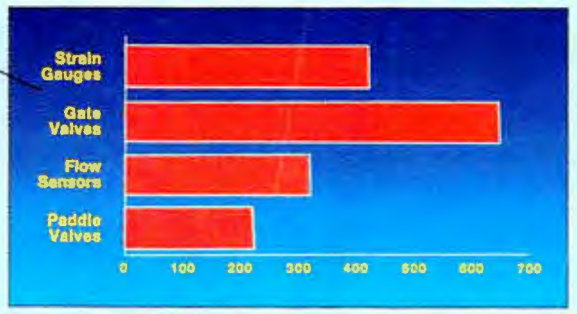
Not only is the Phaser™ II PXi the first thermal wax printer with Adobe's PostScript© Language Level 2 software, it also has HP-GL. What more could you want from a printer?



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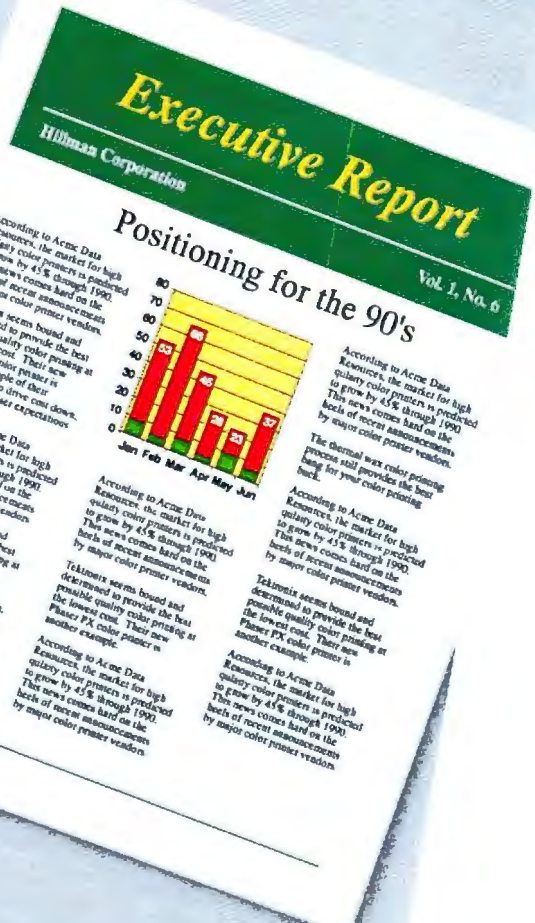
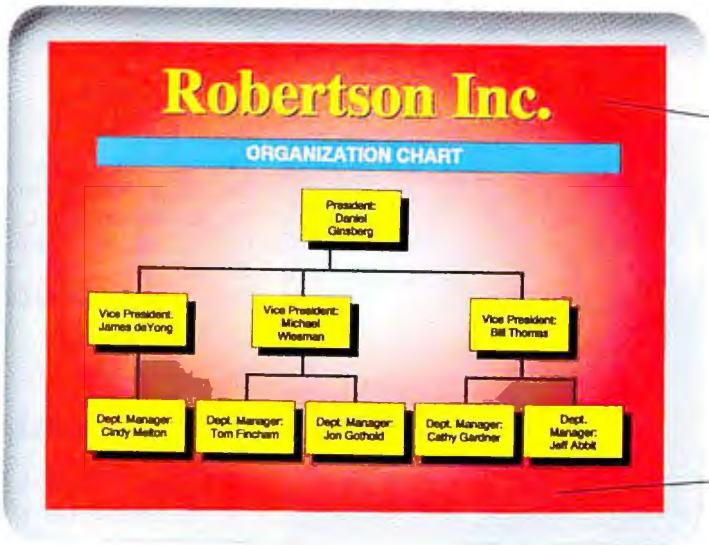


The Phaser II PXi was designed with shareability in mind. So it works with Macs, PCs and workstations simultaneously.



A screaming 24 MHz RISC processor and 6 Mb of memory make the Phaser II PXi the fastest color printer on the market. Really.

The Phaser II PXi delivers 16.7 million brilliant colors at 300 dpi. If you don't believe us, count them for yourself.

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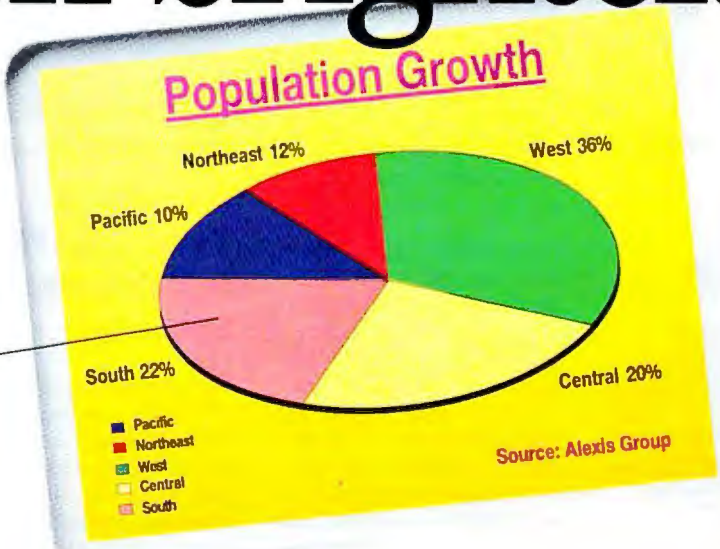

You say you want superior color fidelity? Rest assured the Phaser II PXi is approved by Pantone and features TekColor™ matching.

So you have this great idea. One that'll win an account. Break a sales record. Or simply make you look like a genius. Don't blow it with a color printer that won't do your brainwork justice.

Get the new Phaser II PXi, the thermal wax printer that's flexible, cost-effective and able to produce millions of brilliant colors.

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The pocket-size Dycam Model 1 digital camera lets you capture 32 photographs, store them in solid-state memory, and transfer them to your Mac or PC through its serial port.

Weighing 10 ounces, the Model 1 transfers and displays images in 256 shades of gray with 376- by 240-pixel resolution in TIFF. The camera directly digitizes the image for sharp photos that you can use for halftones and easily incorporate into your document, presentation, or database, Dycam says.

Price: $995.

Contact: Dycam, Inc., 9588 Topanga Canyon Blvd., Chatsworth, CA 91311, (818) 998-8008; fax (818) 998-7951.

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Dycam's Model 1 rechargeable camera digitizes photos for later transfer to your Mac or PC.

Be a SCSI Bus Monitor

When you want to monitor activity on your computer's SCSI bus, the ACI 1085 SCSI Test Bus Monitor may come in handy. The monitor operates transparently and can be installed at any point on the bus.

Three standard connectors (a low-density 50-pin Centronics SCSI-1, a high-density 50-pin SCSI-2, and a 50-pin flat-ribbon header) interface with the SCSI test monitor and adapt to other connector types. Signals are connected straight through to the connectors. You can scope signals on the SCSI bus or connect to a logic analyzer via the panel-mounted header.

Price: $295.

Contact: Applied Concepts, Inc., 5350-H Eastgate Mall, San Diego, CA 92121, (619) 453-0090; fax (619) 453-6715.

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The ACI 11085 SCSI Test Bus Monitor.

Type Your Way to Computer Security

Your style of typing is as unique as your fingerprint. BioPassword, a security system that uses typing style as an identifying characteristic, recognizes your typing cadence to provide or deny you computer access.

BioPassword comprises a half-size PC expansion board and a software support program. When you log onto your computer, the security system develops an electronic-signature record for you. As you repeatedly type your code and password, BioPassword recognizes your individual keystroke dynamics and stores your record in the board's nonvolatile memory.

Price: $495.

Contact: Trove Resources, Ltd., Suite 505, 850 Burrard St., Vancouver, BC, Canada V6Z 2J1, (604) 684-4845; fax (604) 681-5279.

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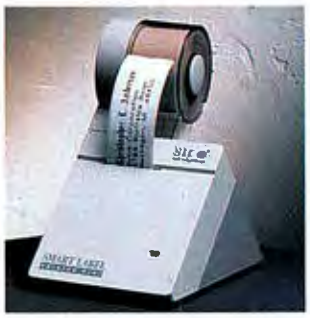
The new Smart Label Printer Plus has 47 scalable fonts, 11 of which are high-resolution. You can design your labels using the printer's WYSIWYG interface, mixing text, graphics, and bar code fonts on a single label.

The label software supports several bar code symbols, including PostNet, Code 39, UPC-A, and EAN 13. A label database lets you design a label, save it by name, and retrieve it later. The software also offers background printing and vertical orientation of the label.

Seiko offers versions for the Mac and the PC. The Mac version runs as a desk accessory. The PC version connects through the serial port.

Price: $249.95.



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486 Modularity for CTOS

A modular workstation/server for CTOS networks, the SuperGen Series 5000 is a 33-MHz 486-based machine that supports up to 32 workstations. The unit uses a Super VGA controller.

Most system components are self-configuring plug-in cartridges, slide-in drives, and slide-on expansion units. The chassis has just one screw. The workstation supports Posix, Oracle SQL, and the XVT GUI portability toolkit.

Sophisticated voice circuitry supports emerging multimedia applications with the ability to program, record, store, and play back voice messages, according to Unisys. A digital signal processor and built-in microphones and speakers provide support for voice mail, voice annotation, and text-to-speech applications.
Price: $13,995.
Contact: Unisys Corp., 2700 North First St., P.O. Box 6685, San Jose, CA 95150, (800) 874-8647 or (408) 434-2599.
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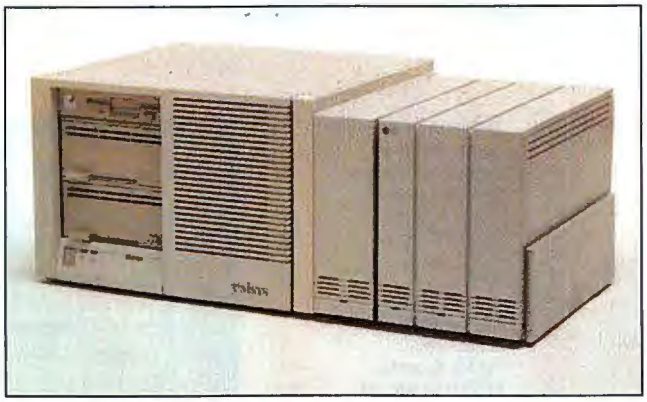

The SuperGen Series 5000 uses self-configuring parts, enabling it to support as many as 32 workstations.

A New Network Archivist

Version 2.0 of the Network Archivist for Novell NetWare adds media management and diagnostics to its previous version. It also preserves and displays the entire 31-character Mac filename and long names for folders.

The media diagnostics in the new version track the percentage of soft errors encountered on your tape medium. If the percentage rises above a threshold that indicates a tape may become unreadable, Network Archivist alerts you and recommends corrective measures. A workstation option lets you back up, archive, and manage local DOS workstations via Novell's IPX protocol even if the workstation is not logged into the network. The new version also lets you retire a tape from the automated rotation schedule.
Price: $995 to $1195; workstation option, $695.
Contact: Palindrome Corp., 850 East Diehl Rd., Naperville, IL 60563, (708) 505-3300; fax (708) 505-7917.
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Network Archivist displays the entire Mac folder and filenames.

Net/30 for Windows

A DOS-based peer-to-peer network, Net/30 for Windows lets you access its networking capabilities through the Windows interface, but it then gives you the option of using either the Windows utilities or the Net/30 utilities. The program lets you multitask by making the Windows-created virtual machines independent of each other. You can connect and disconnect network drives or mapping in one virtual machine without affecting the drives or mapping in other virtual machines.

In addition to using NetBIOS, Net/30 includes TransBIOS, a new high-speed communications protocol. TransBIOS adds the performance of a server/client network to the flexibility, reliability, and ease of use of a peer-to-peer network, the company says.
Price: For 10-Mbps Invisible Ethernet, $369; for Portable Ethernet, $399.
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Expandable Printer Sharing

Lasernet QwikShare III is an expandable, parallel printer-sharing system that lets as many as 32 PCs independently share up to three remote, parallel laser and dot-matrix printers or plotters. The system consists of the printer server with memory and three parallel ports; up to 32 expansion modules, each with parallel input and output ports; and a printer-select switch.
Price: Printer server, $295; expansion module with printer-select switch, $149.
Contact: Western Telematic, Inc., 5 Sterling, Irvine, CA 92718, (800) 854-7226 or (714) 586-9950; fax (714) 583-9514.
Circle 1299 on Inquiry Card.

DOS Goes into the LAN via the Great OS

The Great OS operating system connects PCs into a peer-to-peer or client/server-based LAN. The system supports distributed file sharing, E-mail, system management, security, backup, and access to remote communications products. System software supports MS-Net programming interfaces for multiuser program hooks, disk and device redirection, and node naming.
Price: $495 to $995, depending on the number of users.
Contact: Gateway Communications, Inc., 2941 Alton Ave., Irvine, CA 92714, (800) 367-6555 or (714) 553-1555; fax (714) 553-1616.
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REMARKABLE!

FLYTECH'S NEW NETWORKABLE CARRY-1 COMPUTERS ARE THE PERFECT DESK-CORNER PCS FOR TODAY'S COMPUTER-COMFORTABLE EXECUTIVE, WHO WANTS HIS DESK BACK.

Carry-1 booksize desktop PCs can be at hand wherever you work, whenever you work. Small, yet powerful, they are completely compatible with all DOS and Windows applications. Now our 5000 series adds more versatility with two 16-bit expansion slots. But the essence of the Carry is **to be handy.** It's still small enough to tote to the corner of the desk where the work is waiting.

Get the whole story. For the name of your nearest dealer, call 408-727-7373.

CARRY-1

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Chile: Ingram 56-2-2771516 Fax 56-2-334989
France: M3C 33-1-4827-1976 Fax 33-1-4235-5916

Germany: Macrotron 49-89-420-8233 Fax 49-89-422-863
Greece: Altec 30-1-8832017 Fax 30-1-8816187
Hong Kong: Parkly 852-305-1268 Fax 852-796-8427
Hungary: Minor 361-1224-687 Fax 361-1415-656
Italy: Prima 39-522-518599 Fax 39-522-518599
Israel: MLL 972-3-7516511 Fax 972-3-7516515

India: Unicorp 91-11-6831341 Fax 91-11-6845828
Korea: Mccoy 82-2-7436055 Fax 82-2-7431896
Malaysia: Comtec 60-3-274-8888 Fax 60-3-274-9988
Mexico: Trionica 52-5-2591221 Fax 52-5-2591447
Norway: Secus 47-2-722-510 Fax 47-2-722-515
Netherland: KN 31-20-6584141 Fax 31-20-6597436

New Zealand: TL System 64-9-665805 Fax 64-9-665803
Singapore: Transnko 65-4758408 Fax 65-4713803
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Now your Carry can have a 386 processor, a modem-and-fax card, and still have one extra 16-bit slot for expansion. Ready? Give us a call.

Pretty.

Mission Critical Workstation 1448: 9 option slots and 2 drive bays.

A PC that looks good in your office won't look good for long out in the plant.

Heat murders microprocessors. Dust decimates disk drives. Vibration victimizes video cards.

Any or all can wreck your entire operation.

Texas Microsystems line of rugged, reliable ISA Bus products and systems are specifically engineered for those brutal industrial environments that eat pretty PCs for breakfast.

To ensure maximum reliability we design and manufacture from scratch practically everything that goes into our systems, like passive backplanes which we pioneered for microcomputers in 1983. These backplanes accommodate a full compliment of convenient, plug-in components, all compatible with IBM®. They're why our Mean Time To Repair (MTTR) is a phenomenal 10 minutes.

You won't find passive backplanes — or lower MTTR — in any of the leading office PCs.

We also build industrial-strength option cards to handle myriad functions, in addition to our 286, 386™ and 486™ CPU cards in a full range of processor speeds. Our CPU card designs use Very Large Scale Integrated circuits and programmable array logic devices to reduce component counts by 50-60% which enhances reliability and resistance to physical stress. Ultimately, the design contributes to our remarkably long Mean Time Between Failures (MTBF): 70,000-100,000 hours, calculated against the MIL Standard Handbook 217E.

Ultra-fast 32-bit (80386) AT® equivalent CPU board B386S. Available at 16, 20, 25, 33 MHz.

Mission Critical Benchtop 2003: 10 option slots and 2 drive bays.

You won't find that kind of card selection — or MTBF — among the leading PC makers.

You won't find them torturing their systems like we torture ours, either. Not only do we perform extensive "shake, rattle and roll" tests on each new design, we pretest all our systems before they leave our dock. We burn them in at 55°C/131°F for 48 hours straight just to make sure they can take the heat at your plant.

Pretty reliable.

What's more, we shock-mount our disk drives to stand up to vibrations surpassing Richter scale proportions and we use only high-reliability power supplies that can go 100,000 hours MTBF.

With all that reliability designed into our products, is it any wonder that we guarantee better support than the other leading PC makers? Every system we offer comes with a full one-year, on-site warranty. Theirs don't. We also offer a toll-free number for technical and sales information, a regional network of sales engineers, engineering support for systems integration and a guarantee to meet shock specs. Of the leading PC makers, Texas Microsystems has the longest history of design using Intel microprocessors: 15 years in all. You' ll find our systems hard at work in harsh operating environments at 70 of the Fortune 100 companies.

Granted, the leading office PCs may be prettier than ours, but our industrial-strength systems are designed to be more reliable. That reliability makes our systems look a lot better where it really counts:

Your production line .

Mission Critical Rack-mount 2001: 10 option slots and 3 drive bays.

It's- No- Comparison			
	Texas Microsystems	COMPAQ	IBM PS/2
Passive Backplane	Yes	No	No
100,000-hour MTBF power supply	Yes	No	No
Shock-mounted disk drives	Yes	No	No
Maximized MTBF	Yes	No	No
Positive pressure, filtration	Yes	No	No
Operation at 55°C/131°F	Yes	No	No
48-hour burn-in at 55°C/131°F	Yes	No	No
Maximum expansion slots available	14	5	5
1-year, on-site warranty	Yes	No	No
Toll-free support number	Yes	No	No
Regional sales support	Yes	No	No
"Shake, rattle and roll" testing	Yes	No	No

For technical or sales information, call

1-800-627-8700

TEXAS MICRO SYSTEMS

Texas Microsystems, Inc.

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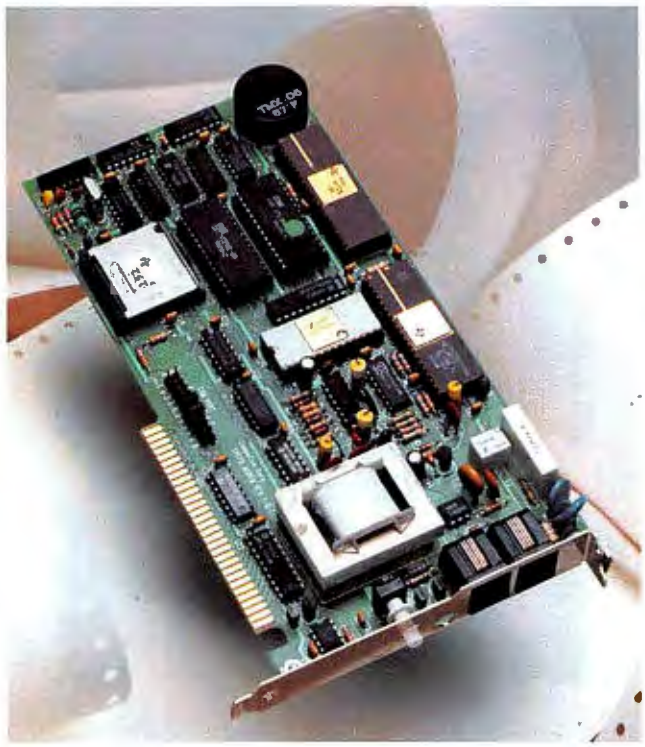
Challenger and Storm Meet Multistandards

Two multistandard modems are available in internal and external versions, as well as with fax, voice mail, and caller ID. The V.32bis Challenger and the V.32 Storm also support CSP, CompuCom's 9600-bps standard.

Both modems include V.42 error correction, V.42bis data compression, and MNP level 5. The fax capability in the Combo versions of the two modems supports the CAS standard and the Electronics Industry Association TR-29.2 interface. They have a separate on-board processor that provides scheduled transmissions, background operation, and the ability to fax documents from within programs.

Price: Challenger, $499 to $629; Storm, $299 to $429.
Contact: CompuCom Corp., 1180-J Miraloma Way, Sunnyvale, CA 94086, (408) 732-4500; fax (408) 732-4570.
Circle 1295 on Inquiry Card.



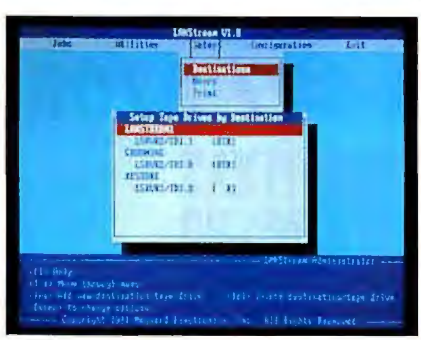
CompuCom's multistandard modem card is easily configured to work with the Challenger or the Storm modem.

Unattended Backups on Your Network

The LANStream client/server data storage and retrieval system backs up NetWare file servers and DOS workstations unattended. Any authorized user on the network can initiate a backup or restore activity.

The tape drives, attached to a dedicated PC that acts as a tape server, let the system work as a shared peripheral. The system operates in the background, freeing your PC for other applications.

LANStream is designed for networks of 1 gigabyte or larger and is available as LANStream DAT and as LANStream 2200HS.
Price: $7495 to $8995.
Contact: Maynard Electronics, Inc., 36 Skyline Dr., Lake Mary, FL 32746, (407) 263-3500; fax (407) 263-3555.
Circle 1292 on Inquiry Card.



The LANStream system.

Remote Diagnostics and a Database

OffSite, a communications program that lets you communicate with, manage, and diagnose a remote computer via a modem, includes a database for storing vital client information. You can use the database to restore a computer's original configuration, including the `autoexec.bat` and `config.sys` files, with one command, Sophco reports.

The program consists of the Commander and the Receiver. With the Commander on your PC and the Receiver installed on the remote computer that you control, you can issue more than 40 commands (e.g., send files, receive files, view current configuration, view a memory map, and scan application environments). You can also run tests, copy files, and execute programs. OffSite lets you configure commands to specify how and when screen data is transferred. The program's script language is based on dBase.
Price: Commander, $295; each Receiver, $95.
Contact: Sophco, Inc., P.O. Box 7430, Boulder, CO 80306, (303) 444-1452.
Circle 1297 on Inquiry Card.

Anywhere Printing on the Network

The M200 NetPrint adapter lets you attach your printers directly to an Ethernet LAN running the TCP/IP protocol. You can locate parallel and serial printers anywhere on the network, minimizing the number of host/server ports and printer cabling required.

With DMA and a 16-bit Motorola processor, the M200 NetPrint's parallel port can sustain data rates in excess of 50,000 cps. One of the serial interfaces also acts as a console port that lets a terminal or PC configure the M200's parameters, load IP addressing, and run troubleshooting diagnostics. The M200 supports SCO Xenix, Unix, and SunOS. The company is developing a 10Base-T model.
Price: $995.
Contact: Microplex Systems, Ltd., 265 East First Ave., Vancouver, BC, Canada V5T 1A7, (604) 875-1461; fax (604) 875-9029.
Circle 1294 on Inquiry Card.

New VEDIT PLUS 3.50

The fastest text editor for programming and editing huge files.

VEDIT PLUS

DOS | QNX | XENIX | FlexOS | UNIX | IBM 4680

- Mouse Support
- Drop-down menus
- Columnar blocks
- 1000 Level Undo
- Regular expressions
- Small 80K size, fast
- Also VEDIT for $69
- Emulate Wordstar, Word Perfect, Brief, vi, others
- Edit text and binary files of any size and line length
- Powerful macro programming language for instant "off-the-cuff" macros
- Also VEDIT Jr. for $29

As a computer professional, you need the best text editor available. The new VEDIT PLUS 3.50 excels as the finest programmer's editor and also for editing huge text and binary files that are becoming commonplace.

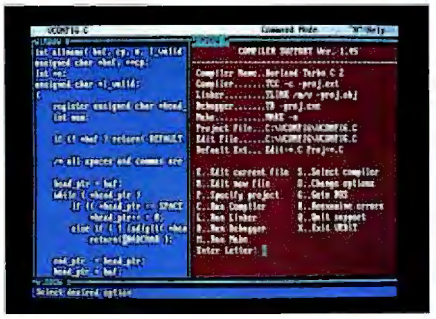
Written entirely in assembly language, VEDIT is small and lightning fast. It's the first programmer's editor that can edit *any* file - 600 megabyte CD ROM files, files downloaded from mainframes, huge postscript and plotter output files, any binary file.

Incredibly, VEDIT is 30 to 100 times faster than other editors on just a 3 megabyte file, and even faster on larger files. You may not need to edit huge files today, but with files getting larger every day, you will soon. And VEDIT is the only editor that can do it.

BENCHMARKS IN 3 MEG FILE

	VEDIT	Brief	Sage
Save and continue	52 sec	3:52 min	1:47 min
Load, modify, save, exit	21 sec	49 sec	1:38 min
Block-column copy (40x200)	2 sec	30 sec	2 sec
Delete one column in file	9:58 min	1:50 hour	1:03 hour
60,000 search & replace	3:18 min	1:44 hour	1:32 hour

VEDIT's breakthrough compiler support runs not only popular compilers, but also your favorite linkers, debuggers and Make programs from within the editor. When shelling to DOS, VEDIT swaps itself and any desired TSRs out of memory, giving you as much as 600K of available memory for compiling the biggest programs with the biggest compilers.



Only VEDIT gives you the advantages of a powerful editor with the convenience of an integrated environment.

An intuitive user interface with drop down menus, hot keys, mouse support, optional scroll bars, context sensitive help, point and shoot file selection, 1000 level undo and a completely configurable keyboard layout with unlimited keystroke macros make VEDIT easy to use, easy to learn.

Just about everything in VEDIT is configurable. The keyboard layout, the screen colors, the way control characters, long lines and window borders are displayed, and much more, is all configured with easy to use menus.

FREE Fully Functional Evaluation Copy
Call 1-800-45-VEDIT

VEDIT PLUS has every advanced feature you might expect. Simultaneously edit numerous files, split the screen into windows, search/replace with regular expressions. Automatic indent, block indent, parentheses matching and block operations by character, line, file or column speed program development. Word wrap, paragraph formatting, justification, centering and many printing options are ideal for text processing.

VEDIT PLUS has the most powerful macro programming language of any editor. It eliminates repetitive editing tasks and lets you create your own editing functions. The macro language includes testing, branching, looping, user prompts, keyboard input, string and numeric variables, complete control over windows plus access to hardware interrupts, memory and I/O ports. Source level macro debugging with breakpoints and tracing.

You can confidently order your copy of VEDIT PLUS today, because it comes with a 30 day money-back guarantee. You will immediately see why VEDIT has been the choice of 100,000 programmers, writers and engineers since 1980.

VEDIT PLUS - DOS single user license: $185; DOS network 5 user license: $295; UNIX/XENIX, QNX, FlexOS/IBM 4680 single CPU license: $285. Multiple user discount pricing is available.

Greenview Data

P.O. Box 1586, Ann Arbor, MI 48106
(313) 996-1299, Fax (313) 996-1308

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* Free evaluation disk is fully functional and can edit small files.

Background photography Dewitt Jones. Screen image simulated

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For the whole sweep of advanced, demanding applications: CAD/CAM, graphic design, desktop publishing, medical and scientific imaging, and Windowing.

Flat square technology and innovative focus system virtually eliminate distortion and flicker and reduce eye strain. Both 17" and 21" monitors offer brilliant color and automatic scanning over wide frequency ranges (30-65KHz). VGA-, 8514A- and Mac II-compatible with resolution up to 1280 pixels x 1024 lines. Smart, compact design with handy controls and easy adjustments.

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At $3499 list the 21" is $1000 less than the competition. At $2100 list the 17" delivers far more monitor than anything else in its price range. Seeing is believing. Try a Toshiba at your dealer's. For more information phone or fax today:

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17" $2100 list ***21" $3499 list***

In Touch With Tomorrow

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Circle 221 on Inquiry Card (RESELLERS: 222).

An Interface Generator for Interbase

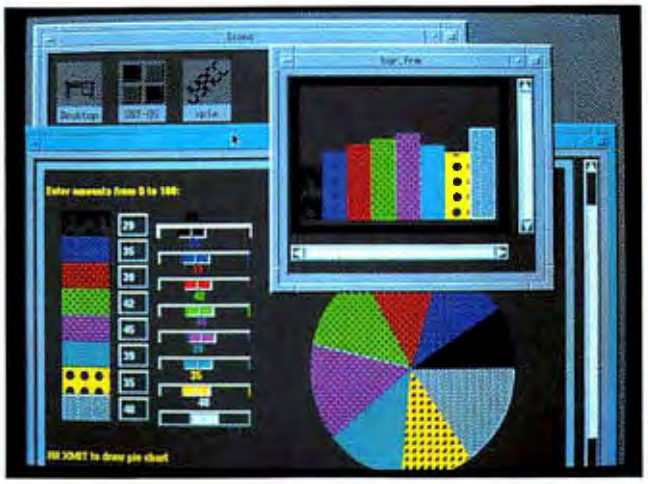
A version of the Jam application development environment is now available for the Interbase relational database that runs across networks of multivendor Unix workstations and minicomputers. Jam provides a screen painter and window manager, an integrated data dictionary, a fourth-generation language, and a subroutine library. JYACC says Jam is useful as an integrating vehicle where you have more than one database technology.

Jam for Interbase is available for Sun, IBM, Hewlett-Packard/Apollo, DEC, Data General, and SCO workstations.
Price: $2925 to $47,850.
Contact: JYACC, Inc., 116 John St., New York, NY 10038, (212) 267-7722; fax (212) 608-6753.
Circle 1328 on Inquiry Card.

Object Windows Library for Image Display

ImageMan, an object-oriented Windows library that lets you add image display and print capabilities to your applications, lets your programs access a variety of image types with the same set of function calls, thus reducing development time.

ImageMan supports TIFF, PCX, EPS, Windows Metafile, and bit-map images. ImageMan is a dynamic link library.
Price: $395; with complete source code, $995.
Contact: Data Techniques, Inc., 1000 Business Center Dr., Suite 120, Savannah, GA 31405, (800) 868-8003 or (912) 651-8003.
Circle 1333 on Inquiry Card.



Jam for Interbase can display multiple data objects, including arrays and geographical data in Motif (shown here) or in character mode. An intelligent emulator lets Jam applications on PCs connect to the servers running Interbase.

Three Add-Ons for Brief

OurSoft and Solution Systems have released three add-ons for the Brief programming editor.

Turbo Brief, an integrated programming environment that enhances Brief, now lets you integrate your own batch-file make. You can launch either your own batch-file make or a Unix-style make with a single hot key.

Turbo Brief 2.0 integrates programming tools, such as Turbo Debugger and CodeView, and a variety of compilers. The environment lets you choose from two key maps: a superset of the original Brief and a superset of the Turbo Integrated Debugging Environment/Turbo Debugger.

An active error window combines error messages and warnings from the mixed-language make and lets you go directly to the correct source file and offending line.
Price: $249.50.
Contact: OurSoft, P.O. Box 6396, Bellevue, WA 98008, (206) 643-0204; fax (206) 869-2837.
Circle 1329 on Inquiry Card.

dBrief, an add-on that customizes the Brief editor for DBMS programming, now supports Paradox. dBrief for Paradox adds Paradox-specific features to Brief and lets you consolidate your programming tools in one work area.

The company also offers Briefor C++, which customizes the programming editor by adding a browser for C++. You can browse according to class hierarchy, member variables, or member functions. The browser can scan multiple files, letting you access all files in your PC, not just those currently stored in memory. The add-in supports Borland C++ 2.0.
Price: dBrief, $129; dBrief and Brief 3.1, $359; Briefor C++, $129; Briefor C++ and Brief 3.1, $339.
Contact: Solution Systems, 372 Washington St., Wellesley, MA 02181, (800) 677-0001 or (617) 431-2313; fax (617) 740-0089.
Circle 1330 on Inquiry Card.

Interactive Design for Multiple GUIs

With XVT-Design, you can design GUI resources (e.g., dialog boxes, windows, controls, menus, and strings) in a graphical and portable manner. The interactive design tool works with XVT Software's library for writing applications that run under multiple GUIs.

XVT-Design can generate native resources for the Mac, Windows 3.0, Presentation Manager, Open Look and Motif for the X Window System, and XVT's own character system. The GUI resource information is stored as a portable binary file that you can transfer across platforms.
Price: $900 to $2500, depending on the development platform.
Contact: XVT Software, Inc., P.O. Box 18750, Boulder, CO 80308, (303) 443-4223; fax (303) 443-0969.
Circle 1331 on Inquiry Card.

Develop 32-bit Applications for Windows

The 32-Bit Windows Application Development Kit, when working with MetaWare's High C compiler, lets you run your 32-bit Windows applications under 16-bit Windows. MetaWare says the Application Development Kit frees applications from the performance constraints of Windows.
Price: $795; introductory fee, $145.
Contact: MetaWare, Inc., 2161 Delaware Ave., Santa Cruz, CA 95060, (408) 429-6382; fax (408) 429-9273.
Circle 1332 on Inquiry Card.

Diving Into C++ Without Raima Object Manager™ Can Be Pretty Ugly

Raima Object Manager is designed to enhance the elegance of your C++ development. The functionality required to store objects is built into the base classes. Development time is decreased. Quality is increased. Plus, your applications gain the performance edge Raima products are known for .

Raima Object Manager is based on the latest object-oriented technology and db_VISTA III's proven database engine. You can add persistence to objects and maintain complex inter-relationships using direct reference, relational, and network database models.

Inheritance is incorporated into Raima Object Manager, yielding greater code re-use and object extensibility. Now you have the tool to more closely model *real world* objects.

All Raima database products are designed for C and C++ programmers, providing a smooth transition from C to C++. Available on MS-DOS, Windows, UNIX, OS/2 and others.

Raima Object Manager prices start at just $395.00. For more information on turning the ugly into elegant call

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(1-800-327-2462) Outside U.S.: 206-747-5570

Raima products offer unique advantages for C and C++ development:

- **Speed** - offers unmatched application performance.
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- **Source Code Availability** - provides total programming flexibility and control.

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Imagine getting twice the Bernoulli for two-thirds the price.

The new Bernoulli 90MB.

BERNOULLI MEANS SECURITY FOR YOUR DATA™

Welcome to the next generation of removable storage, the new Bernoulli® 90 from the leader in removable storage—Iomega®.

At 90 megabytes per removable disk, we've more than doubled our capacity. Yet the new Bernoulli 90 is actually less expensive than our own Bernoulli 44. A lot less. And with a new, 19-msec* effective access time, a lot faster, too.

But the best part is, it's all Bernoulli. Rugged, reliable, endless storage. The new Bernoulli 90 is exactly what storage-intensive users—like Windows users—demand.

More value.

If you need more storage, you'll welcome the Bernoulli 90, since Bernoulli is now comparable in price to a hard disk upgrade. So why not just buy another hard disk? Consider what you *don't* get with a hard disk.

You don't get infinite storage in 90-megabyte increments—hard disks fill up. You don't get 180MB of easy, on-line backup. You don't get the security of removing your data and locking it up. You don't get the ability to safely ship your data anywhere on shock-resistant disks. You don't get a technology that frees you from head crashes. And you don't get Central Point's Backup software.

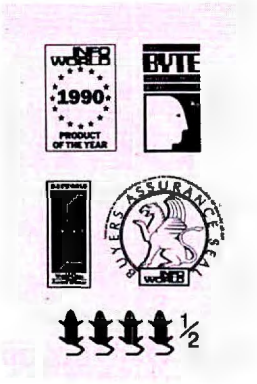
In short, you don't get a Bernoulli.

Bernoulli at a Glance.

Drive Specs.
Effective access time: 19 msec
Transfer rate: Up to 20Mbits/sec
MTBF: 60,000 hours

Disk Specs.
Capacity: 90MB formatted
Warranty: 5 years
Shock tolerance: 1,000Gs
Drop height: 8 feet

Units Sold.
Drives: 700,000
Disks: 4,000,000



More ways to get attached.

The new Bernoulli 90 is a welcome relief from pigeonholing technologies. Bernoulli is compatible with every major operating system, as well as workstations. Just take your pick.

More recognition.

Leading publications have given Bernoulli some welcome recognition, but our biggest supporters are Bernoulli users. In fact, we have a 98 percent satisfaction rate. Perhaps it's due to our worldwide support network, and our 24-hour** drive replacement service.

Welcome to the 90s.

And as if 98 percent wasn't enough, we've designed the 90 to read 44MB disks, and we're instituting an attractive Bernoulli upgrade program to help get every current Bernoulli user into the 90s. And protect your investment.

Call 1-800-777-4084.†

Questions? We don't blame you. There's a lot more you should know about—like our free 90MB disk offer, drive configurations, Bernoulli Technology,® and specific pricing.

So we've prepared a free brochure that you can have by placing a simple phone call. Find out today what a welcome change the new Bernoulli can be. Before the 90s leave you behind.

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Sales Software for the Mac

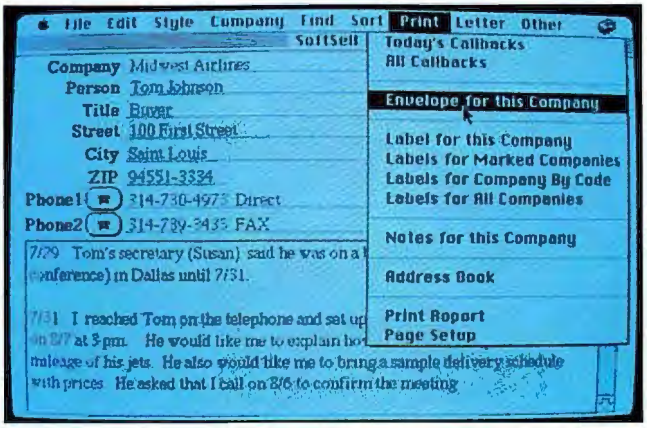
Within 15 minutes of loading SoftSell for the Mac, you can enter and retrieve customer information, print form letters, and tag companies for callback, Business Software says.

SoftSell prints a daily list of customers you need to call back. It identifies callbacks not made and forwards them to the next day until you attend to them. The program supports full text searching and sorting by company, contact, address, callback date, and customer code. SoftSell prints address books with names, addresses, and phone numbers. The program also supports automatic dialing.

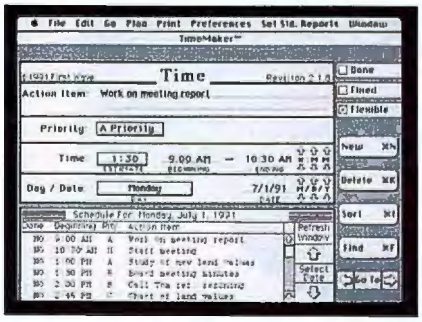
Price: $375.

Contact: Business Software, 701 San Conrado Ter., Suite 5, Sunnyvale, CA 94086, (408) 736-3000; fax (408) 730-5165.

Circle 1334 on Inquiry Card.



With SoftSell for the Mac, you can automatically print a customer's address on a label or an envelope. The program also automatically places the address in the header of a new or existing letter.



TimeMaker schedules your business day based on priorities you assign to tasks.

Manage Time and Contacts on the Mac

TimeMaker offers time and contact management on the Mac, letting you print out a variety of schedules while removing the task of copying and prioritizing unfinished action items from day to day. It can schedule your day automatically, based on priorities you assign to each task and the time you estimate each will require.

Overnight, the program can place completed tasks in an archive, schedule the next day, and print required reports. As you enter names and addresses, TimeMaker can prepare documents based on user-defined categories you assign to a prospect. TimeMaker includes a database of form letters that you can customize and a word processor.

Price: $149 to $249.

Contact: First Wave, 4747 North Seventh St., Suite 400, Phoenix, AZ 85014, (602) 951-3812; fax (602) 266-4285.

Circle 1335 on Inquiry Card.

Gupta Says Don't Fear the SQL

Quest, Gupta's new Windows database tool, lets you access data contained in corporate Structured Query Language databases without requiring programming. Without knowing SQL, you can use Quest to edit and browse SQL tables, issue simple and complex queries, and build WYSIWYG reports.

Quest comes with a single-user SQLBase engine that works on single PCs and LANs. You don't need extra software to use Quest with SQLBase Server, but you will need appropriate Gupta SQLNetwork connectivity modules to use it with other SQL servers. Quest supports SQLBase Server and DB2, and versions are planned for other SQL servers by November.

Price: $495.

Contact: Gupta Technologies, Inc., 1040 Marsh Rd., Menlo Park, CA 94025, (415) 321-9500; fax (415) 321-5471.

Circle 1337 on Inquiry Card.

PC-File Gets an Overhaul and a New Face

A Windows-like interface and better file-search and macro capabilities highlight PC-File 6.0, a dBase-compatible flat-file database. In adding the new features and interface, ButtonWare preserves keystroke compatibility with previous versions. But in a departure from previous versions of PC-File, the program is not available as shareware.

You can modify macros without struggling with complex ASCII codes; the program lets you define up to 27 macro commands, with as many as 1000 characters each. You can invoke a window that provides a description of each macro command and the macro hot key associated with it.

The new version adds a read-only mode. You can modify records directly from a table view, eliminating the need to switch from table to record view when updating. Other features include an undo command, mouse support, better help screens, and 13 optional ready-to-run PC-File applications (e.g., accounts payable, business contacts, and prepay invoicing).

Price: $149.95 (includes two free PC-File applications); LAN version, $449.95.

Contact: ButtonWare, Inc., P.O. Box 96058, Bellevue, WA 98009, (206) 454-0479; fax (206) 454-1838.

Circle 1336 on Inquiry Card.

DBMS Case Study:

Testing The F-15 Fighter

The Challenge

Every time he straps in, a military pilot puts his life on the line. He trusts his aircraft to respond instantly in split-second supersonic maneuvers. Constant testing and re-testing of his jet's hydraulic control systems are essential to assuring success—and survival.

The Application

HR Textron's F-15 STS Test Stand takes the computer-controlled hydraulic system that controls a jetfighter's flaps and ailerons through tests that simulate flight situations. A graphical user interface includes test fail dialogue boxes and menu trees that lead the operator through a complex series of diagnostic procedures. Limit-testing, self-calibration and archiving of results are handled by the test stand's integrated database.

The Solution

The system software for the test stand was developed using the db_VISTA III DBMS from Raima. Rich Rutkowski, Director of Engineering for the project, looked at the relational database products available and determined that they fell short of the design specifications. "Only db_VISTA III handled the complex data relationships, and also provided the speed and portability necessary for this application. We're not close to using all the power and flexibility db_VISTA III has to offer."

Over 90,000 missions were flown in the recent Persian Gulf conflict. Allied forces lost only five aircraft to mechanical failure — an incredible record made possible in part by exhaustive, thorough performance testing.

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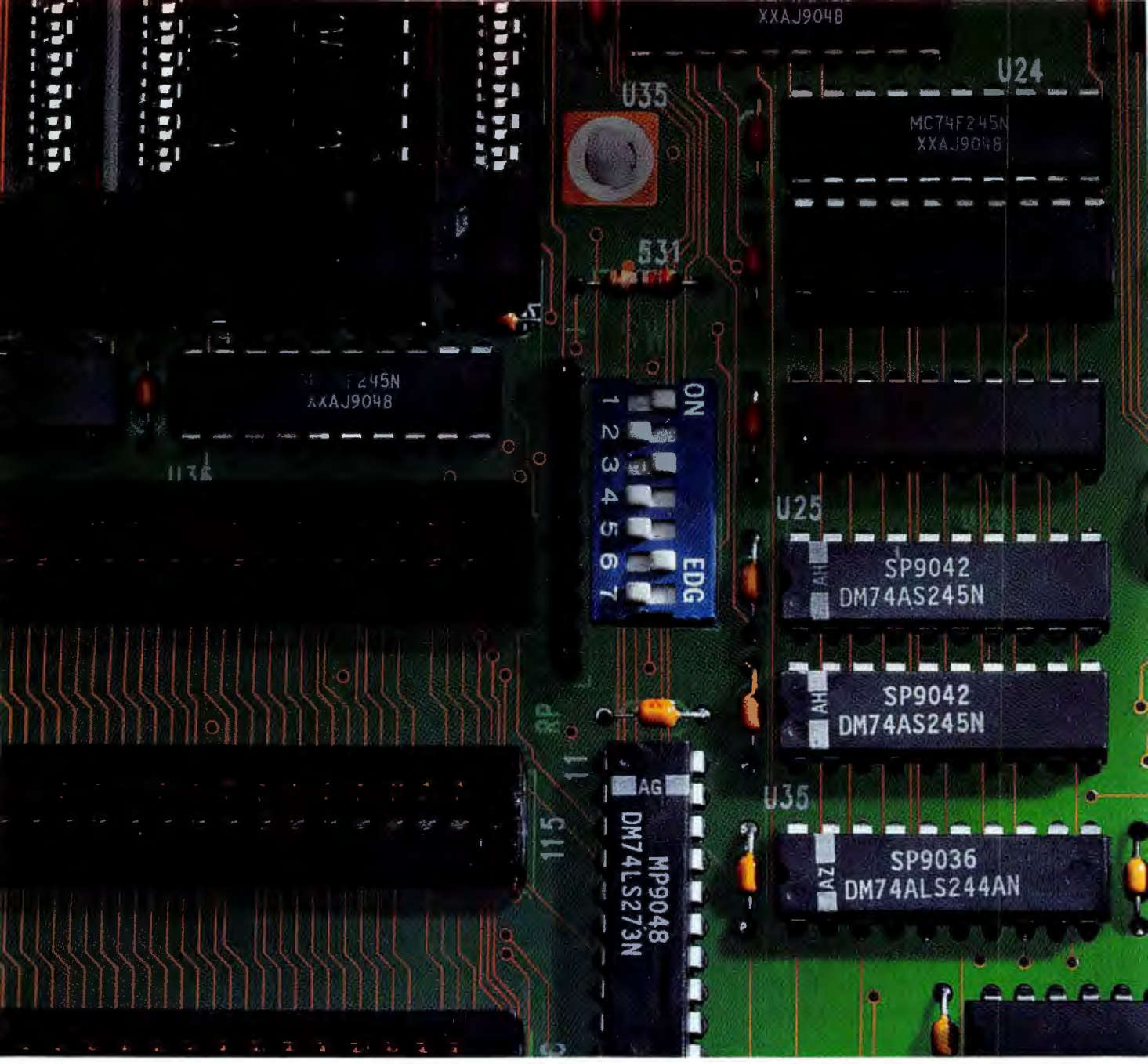

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If you need a math coprocessor to speed your power applications, ask yourself this question: Which would you rather have sitting next to your Intel microprocessor — an Intel Math CoProcessor or something you may know nothing about? Because if you don't specify Intel, that's basically what you're getting — a big question mark. With Intel, however, there's simply no question. You're getting quality.

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AFD-Plus 3.0 Supports PLL Analysis

The AFD-Plus 3.0 program for active hardware-filter design on PCs now supports phase-locked-loop analysis for the synthesis and analysis of PLL systems. With AFD-Plus 3.0, you can design filters of low pass, high pass, band pass, band stop, and all pass types to twentieth order.

Version 3.0 adds an automated macro recorder and new user-definable file features that include math functions and calculated pole/zero locations. Multiple configuration files let you tailor the program to particular applications, and a command-line option lets you include the name of a filter data file for AFD-Plus to load at program execution.

With the new PLL feature, you design the filter to be used as the loop-filter function. The program then creates the PLL function as an open loop, a closed loop, or an error function. This function is available for frequency- or time-domain analysis.

Price: $895.
Contact: RLM Research, P.O. Box 3530, Boulder, CO 80307, (303) 499-7566; fax (303) 499-0877.
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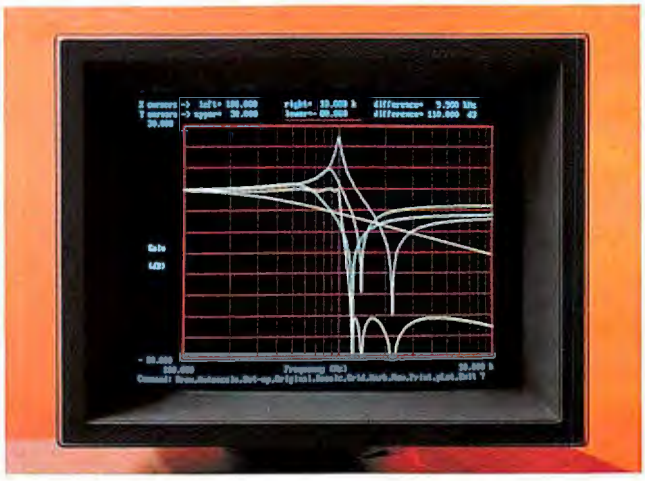

AFD-Plus 3.0 lets you explore multiple design alternatives, create complex filter prototypes, and revise existing active-filter designs.

Don't Let Your Circuits Overheat

As circuit board designs call for faster operation in a smaller area while offering better functionality and the same component count as previous designs, the risk increases for circuit board failure due to heat. But a new program called The Circuit Board Thermometer (TCBT) for Windows offers electronic circuit board thermal analysis for double-sided, multilayered circuit boards.

The program provides a display that can be configured for the simultaneous viewing of the junction and case temperatures of sides 1 and 2 of a design. It also displays temperature profiles and heat flow for the individual layers of the circuit board. TCBT supports continuous graphical updating.
Price: $299.
Contact: Lakeview Software Corp., Laurel Lakes Executive Park, 8377 Cherry Lane, Laurel, MD 20707, (301) 317-0726; fax (301) 317-0587.
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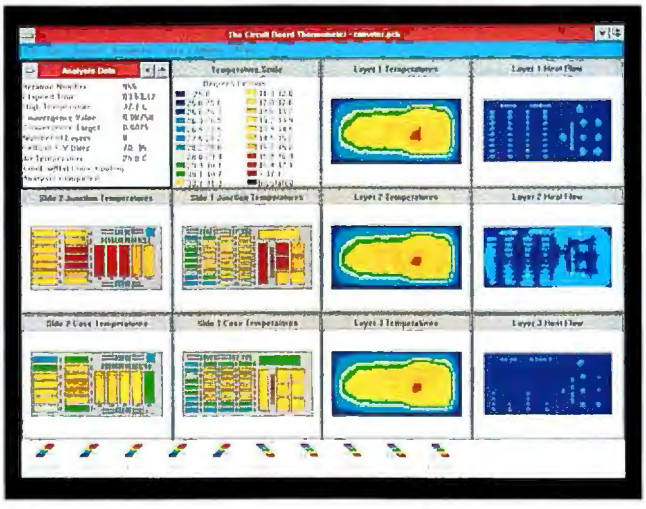

The Circuit Board Thermometer for Windows shows a completed circuit-board thermal analysis. The program supports multiple viewing of data.

Model Synchronous Designs

The first major upgrade of TimingDesigner, the program for Windows that automates the design and analysis of timing diagrams, has new features that make it easier to model synchronous (clock-based) designs and develop and use timing libraries. Chronology says the most important new feature of version 1.2 is the ability to automatically detect and analyze situations where two timing paths are derived from the same signal. These situations are known as reconvergent fanout.
Price: $1495.
Contact: Chronology Corp., 2849 152nd Ave. NE, Redmond, WA 98052, (206) 869-4227; fax (206) 869-4229.
Circle 1342 on Inquiry Card.

A PC Program for Contractors

Carpenter's Dream, the program that makes all those complicated calculations when you're trying to cut wood to fit a complex space, has been expanded into a program for contractors.

Contractor's Dream estimates the materials needed to complete projects (e.g., roofing, decking, and drywall) and then calculates material and labor costs. It also calculates the dimensions of rafters, trusses, stairs, windows, and doors. The program supports what-if modeling.

Contractor's Dream gives you four choices of bid sheets: an editable summary sheet, individually priced materials and labor with totals, materials and labor with totals only, and a materials list.
Price: $275.
Contact: Workhorses, Inc., 805-B 14th St., Golden, CO 80401, (800) 777-2477 or (303) 279-8551; fax (303) 278-4029.
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NEWS

WHAT'S NEW • OTHER SOFTWARE

Taking Color Images to the Streets

Streets on a Disk, the PC road-mapping program for motorists, bankers, and salespeople, lets you attach photographs, floor plans, or 256-color images to selected spots on a street map. Each location can have as many as 100 lines of descriptive text, according to Klynas Engineering.

You can also run outside programs to combine map information with existing database information and slide-show software.
Price: $225; street maps, $40 to $225 each.
Contact: Klynas Engineering, P.O. Box 499, Simi Valley, CA 93062, (805) 529-1717; fax (805) 583-1457.
Circle 1343 on Inquiry Card.

Zip from DOS to Unix

Uni-Zip, a PKZip-compatible file archiver, is now available for 386 Xenix and 386 Unix System V release 3.2 or higher. Archives made by DOS PKZip and Uni-Zip are interchangeable, simplifying file transfers among DOS- and Unix-based systems, Precise Electronics reports.

Uni-Zip implements all the major features of PKZip, the company says. Uni-Zip archives are typically 10 percent to 30 percent smaller than tar/compress, ARC, or ZOO archives. You can add, delete, and extract individual files without decompressing the entire archive.
Price: $149.
Contact: Precise Electronics, 31 Englewood Ave., Brookline, MA 02146, (617) 566-6867.
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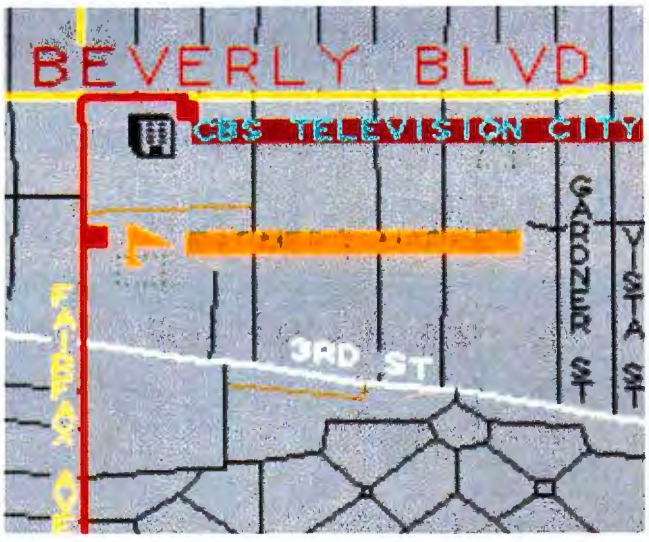

Streets on a Disk can find the fastest travel route from one location to another. The program works with various optional street maps, including TIGER files. An optional batch programming interface lets you run repetitive tasks at night.

Make Multimedia Legal

Clip art collections are plentiful for desktop publishing applications, but what about the emerging field of multimedia? It's easy enough to grab a scene or two off the TV using a video-capture board, but this is illegal. The same problem exists for background music.

The Publishing Factory offers Clip Video and Clip Audio, two products for use in desktop video publishing with video-capture boards and programs like MediaMaker and FilmMaker. The company distributes the programs on VHS videocassettes and standard audiocassettes, making them machine independent. Both products are copyright free, the company says.

The first volume of Clip Video, called Potpourri, contains a selection of cutaways and other general-interest episodes. Some of these include metaphors such as money blowing away, interstate highway scenes, sports scenes, and airport scenes.

The audiotapes (seven in all) include segments of the works of Debussy, Chopin, Mozart, and Schubert, as well as the old traditional song "On Top of Old Smokey."
Price: Potpourri, $89; audiocassettes (about 30 minutes of music each), $15.
Contact: The Publishing Factory, 310 Dover Rd., Charlottesville, VA 22901, (800) 835-5547 or (804) 973-8254; fax (804) 978-1629.
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SPREAD THE WORD

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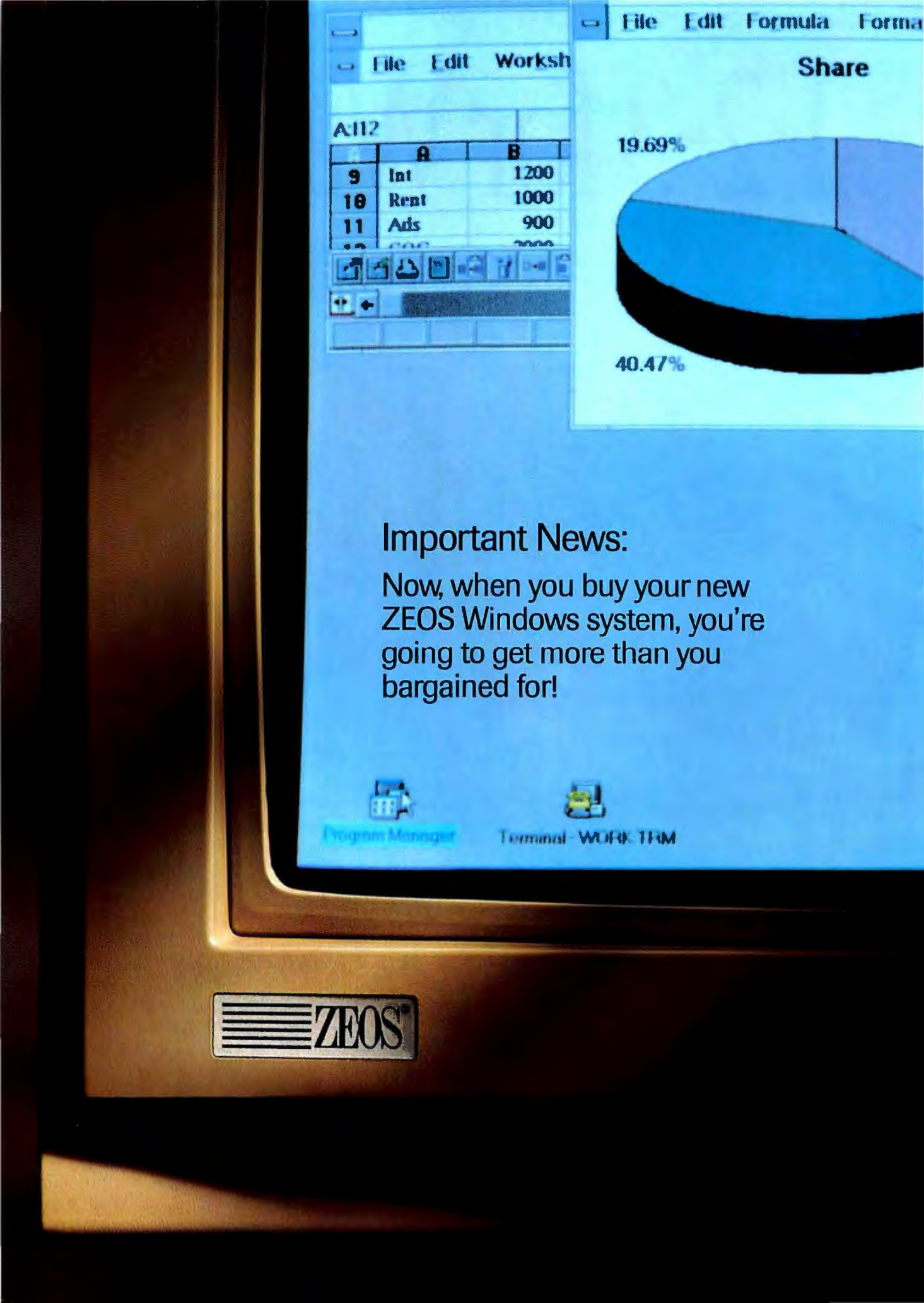
Interactive Authoring for the Amiga

Foundation, the Personal Software Authoring System, lets you create applications and interactive presentations on the Amiga even if you don't know how to program. Foundation comes with a variety of modifiable stacks (e.g., phone/address; calendar; and the MediaBase animation, sound, and picture database). By adding buttons to the stack, you can print reports, access telecommunications services, and simultaneously launch and communicate with other programs.

You can use Foundation to automate the entire desktop, freeing the multitasking Amiga for other uses. You can also use the program to create front ends to control laser discs, VCRs, and CD-ROM devices.
Price: $250.
Contact: Impulse, Inc., 6870 Shingle Creek Pkwy., Suite 112, Minneapolis, MN 55430, (800) 328-0184 or (612) 566-0221; fax (612) 566-1822.
Circle 1345 on Inquiry Card.

Plot Fonts That Are Big, Big, Big

A new version of Plottergeist lets you plot TrueType fonts up to 4 feet tall. Plottergeist 2.0 takes advantage of System 7.0 to render TrueType fonts. It has also been enhanced to produce vinyl signs using sign cutters from Roland and Ioline.
Price: $395.
Contact: Palomar Software, 2964 Oceanside Blvd., Suite D, Oceanside, CA 92045, (619) 721-7000; fax (619) 721-4758.
Circle 1347 on Inquiry Card.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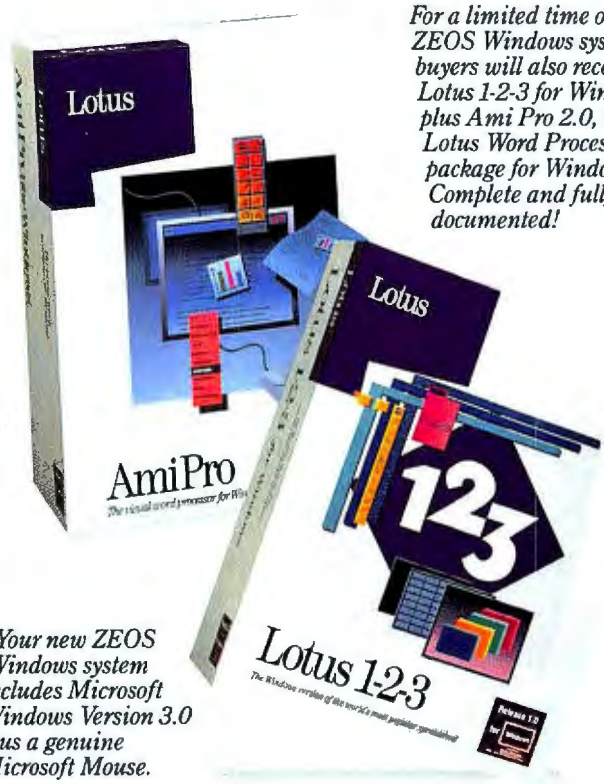

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These are not some scaled down versions or trial disks either. They are the *complete* and *fully documented* editions of Lotus *1-2-3 for Windows* and Lotus *Ami Pro 2.0* for *Windows* provided to you by special arrangement between ZEOS and Lotus. This is one incredible value that no one else can offer. You're going to love it, too.

Because nothing else brings out the power of the most powerful software like your blazing new ZEOS system. And when you strap your-

plus AMI Pro 2.0!

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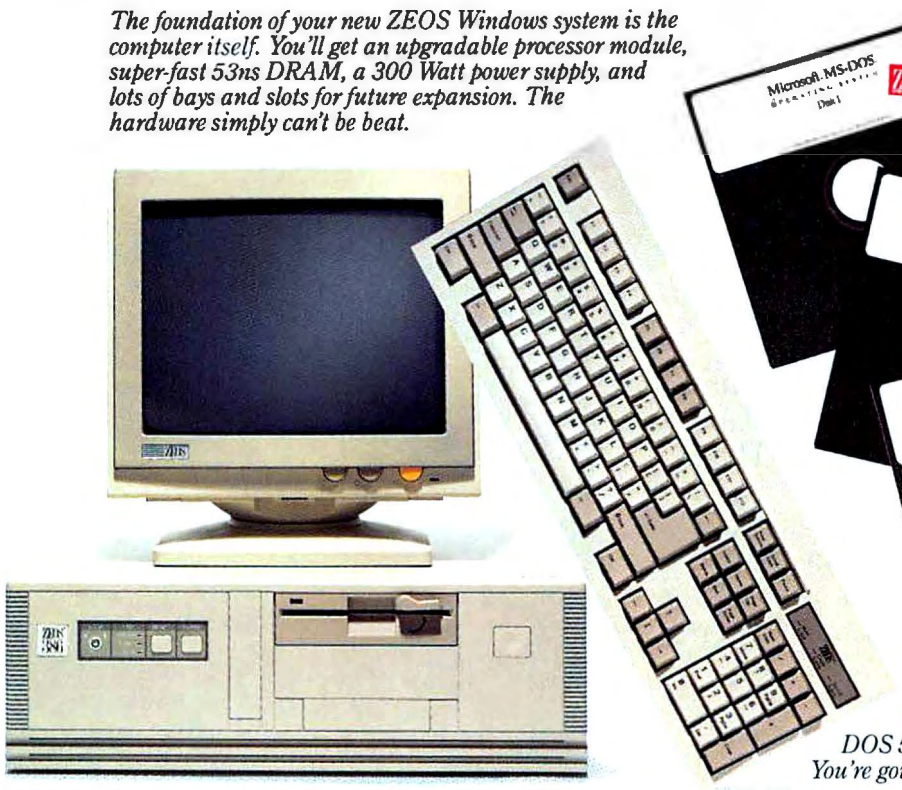

Wrap your Windows system up with the latest and greatest DOS version, Microsoft DOS 5.0! Fully featured and fully documented. You're going to love it!

self in and fire up *Windows* with Lotus *1-2-3* and *Ami Pro,* you're in for the ride of your life!

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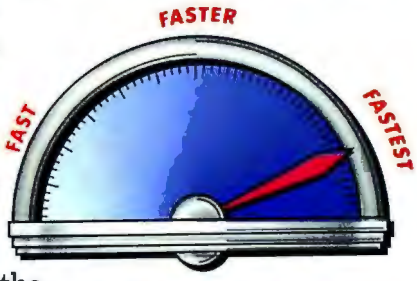

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To help you select the processor option that's right for you, we have developed the Z-Meter. *The* Z-Meter *shows you the relative performance gains achieved by moving from one processor module to another—fast, faster, fastest! No matter which system you select you can be sure of one thing*—these babies are Hot!

So if you're looking for a high speed, upgradable, rock solid system supported like none other *and* you want incredibly low prices, you've found your company. And your computer. Read on!

This ZEOS ad reviews each of four money saving upgradable system packages based on processor type. For a limited time only, every ZEOS Windows system includes Lotus 1-2-3 for Windows and Ami Pro 2.0 at no additional charge!

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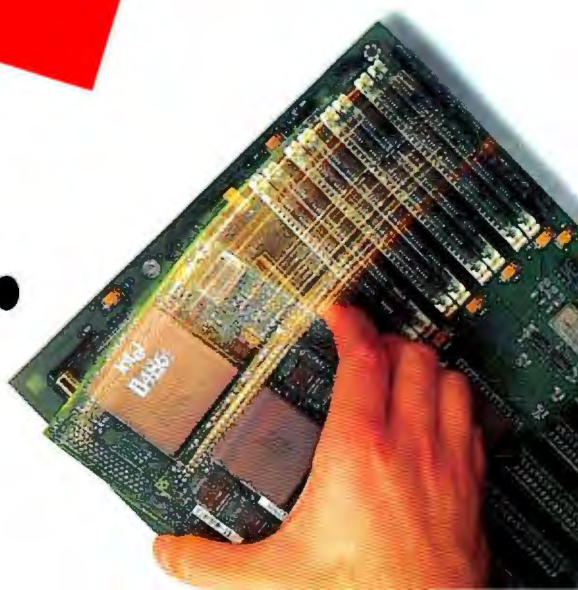
and '486 systems!



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Harnessing the ZEOS power and value you want is easy. Pick your processor then your package. Package #1 gets you up and running for a very reasonable price. To add even more options *and* savings select from Packages 2, 3 or 4.

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And that's just for starters. Because *inside* your new ZEOS system rests the very latest advancements in surface mount, high integration technology. As an example, we have freed two normally occupied expansion slots by placing our high speed IDE hard drive and floppy drive interfaces right on the main board. Then, we put the high speed serial, parallel and game ports on the motherboard too. The result?

Eight expansion slots, *seven* of which are available for your future use! After all, expansion and non-obsolescence are what these great new ZEOS systems are all about. We've built in some other very important expansion features for you as well.

Like our *300 watt* power supply. Providing you with all the pure clean power you'll need right now, your ZEOS 300 watt supply also provides you with plenty of power for the future as well. Plenty of slots, plenty of power. How about space? This is where ZEOS has performed something akin to magic.

It's your new ZEOS SpaceSaver case! Complete with *seven drive bays,* this incredible case is actually *smaller* than many cases offering only five bays. We've also added *a second whisper quiet cooling fan.* Why? Because whether you expand your system or not, the cooler it

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- Two Serial, one Parallel & one Game Port built right onto the motherboard.
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- Rugged ZEOS SpaceSaver case with twin cooling fans for added reliability and product life.
- Seven drive bays and our custom 300 Watt power supply for your future expansion!
- Includes ZEOS 24 Hour a Day Toll Free Technical Support and Customer Satisfaction package.

PACKAGE #1

486-33 $1795
486SX-20 $1595
386-33 $1495
386-25 $1395

INCREDIBLE ZEOS PACKAGE #2

We take Package #1 and upgrade your ZEOS Modular System to include:

- 2 full Megabytes of Rip-roaring 53ns DRAM.
- Our incredible 85MB IDE hard drive with its own built in cache.
- Both the Teac® 1.2MB *and* 1.44MB floppy drives.
- The awesome Diamond SpeedStar Plus VGA graphics card Complete with 1MB DRAM.
- ZEOS 14" High Res VGA Mono Monitor with Tilt & Swivel base.
- Lotus 1-2-3 for Windows, *plus* Ami Pro 2.0, *plus* Microsoft Windows and DOS 5.0, *plus* a genuine Microsoft mouse!

PACKAGE #2

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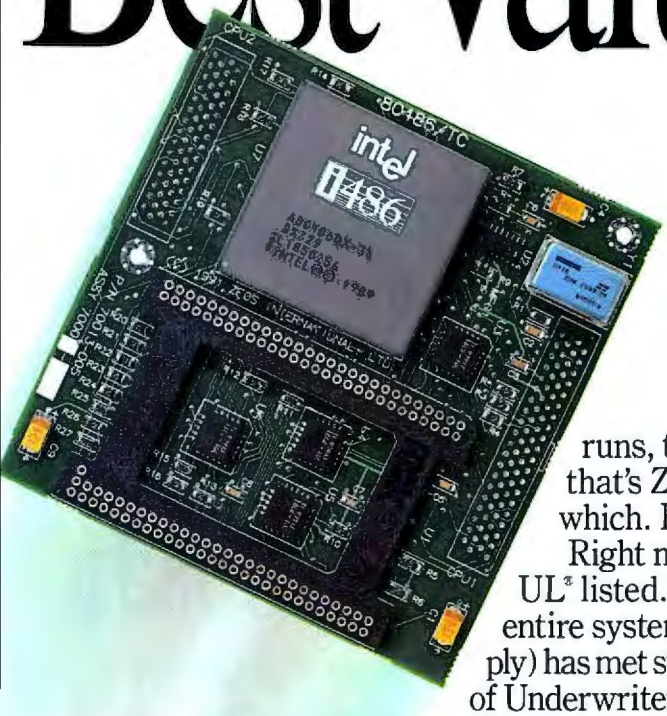
486SX-20 $2195
386-33 $2095
386-25 $1995

Best Value!



486-33 $2895
486SX-20 $2695
386-33 $2595
386-25 $2495

runs, the longer it will last. Now that's ZEOS *value*. Speaking of which. How about UL® listings? Right now every ZEOS system is UL® listed. This listing means your entire system (not just the power supply) has met stringent safety requirements of Underwriters Laboratories. We believe UL® listings also say a lot about quality. And UL® safety listings are something many of our competitors simply don't (or can't) provide. At ZEOS quality and safety are important to us. *You* are important to us.

Price. Performance. Quality and Support. There are *many* reasons to buy your new ZEOS upgradable system. Plus, your ZEOS advantages include *24 Hour a Day Toll Free* Technical Support, our 30 Day Money Back Guarantee and ironclad warranty, just to name a few (for more ZEOS advantages see the section entitled *"Why ZEOS is Your #1 Choice"*).

486-33 $3395
486SX-20 $3195
386-33 $3095
386-25 $2995

Selecting the new ZEOS system that best fits your needs is easy. Choose from any of the money saving packages shown here. Or let your friendly and knowledgeable ZEOS Systems Consultant help you configure exactly what you want from our huge selection of upgrades and options. Whatever you select, one thing is for certain.

Buying your new ZEOS system is perhaps the best purchase decision you'll ever make! So why not pick up the phone and give us a call right now. Incredible ZEOS power awaits you! *Call now Toll Free, 800-423-5891.*

For Complete Processor and Package Pricing, simply turn the page!

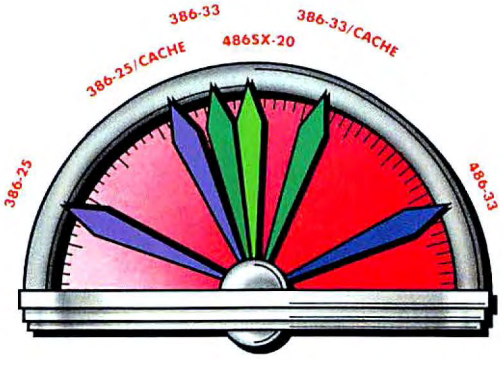
Pick You Package

Or Let Us Custom Build to

Now, ZEOS lets you pick the power you want for the price you want to pay! Not only that, every ZEOS Windows System (Packages 2, 3 and 4) includes not only Microsoft *Windows*, *DOS* and a mouse—we're also including Lotus *1-2-3 for Windows plus* Lotus' new Windows word processor *Ami Pro 2.0!*

And with your new ZEOS modular system, the computer that's right for you today is also the computer that's right for you tomorrow. In the future, you can upgrade to even more performance with a new '386 or '486 processor module.

And that's only the start of your many ZEOS system advantages. But what more could there be than dazzling performance, incredible prices and upgradability? From ZEOS there's lots more.



Z•SPEED METER

Let the "Z-Meter" help you pick the processing power that's right for you. The comparisons are easy to make. Fast, Faster or Fastest!

Because your new ZEOS system is not only fast, it's absolutely *loaded with features.* Like our *300 watt* power supply, eight expansion slots, twin cooling fans (for even more reliability) and our unique seven bay SpaceSaver case. And, *every ZEOS system is UL®* listed.

r Power, & Price!

Your Exact Specifications.

PACKAGES 2, 3 AND 4 INCLUDE LOTUS BUNDLE!

	Pkg. #1	Pkg. #2	Pkg. #3	Pkg. #4
386-25	$1395	$1995	$2495	$2995
386-33	$1495	$2095	$2595	$3095
486SX-20	$1595	$2195	$2695	$3195
486-33	$1795	$2395	$2895	$3395

Add $200 to any price for a 128K cache.

In addition to all of these standard ZEOS advantages, you're also receiving our legendary ZEOS Technical Support, *24 Hours a Day, 365 Days a Year.* Plus, our 30 day Absolute Satisfaction Money Back Guarantee and more!

So pick your Power, and your Price *then give us a call!* Your expert ZEOS Systems Consultant is ready to answer any questions you may have. Why not give us a call right now, Toll Free at 800-423-5891.

Call to confirm current pricing, product specifications and configurations, all are subject to change without notice. Purchase orders subject to approval. Lotus, 1-2-3, Ami Pro, Classic and SmartIcons are trademarks of Lotus Development Corporation; Windows and Microsoft of Microsoft Corporation; Z-Card, SpaceSaver, and ZEOS of ZEOS International, Ltd., 530 5th Avenue NW, St. Paul, MN 55112 USA © 1991.

INCREDIBLE ZEOS PACKAGE #3

Add even more memory, a larger drive. And more Savings! You now receive:

- **4 full Megabytes of Ultra High Speed 53ns DRAM.**
- **Our fast 130MB IDE hard drive with built in cache.**
- **Both Teac® floppies, the 1.2MB *and* 1.44!**
- **Your Diamond VGA Plus card with 1MB DRAM.**
- **ZEOS 14" 1024x768 VGA Color Monitor w/Tilt & Swivel.**
- **Lotus 1-2-3 for Windows, Ami Pro 2.0, Microsoft Windows, DOS 5.0 *plus* a Microsoft mouse!**

PACKAGE #3

THE ULTIMATE ZEOS PACKAGE #4

Now, Memory goes to 8MB and the drive to 210MB. The ultimate Power User's Dream Machine!

- **8 full Megabytes of High Speed 53ns DRAM.**
- **Your screaming 210MB IDE hard drive with its own built-in cache.**
- **Both Teac® floppies, the 1.2MB *and* 1.44!**
- **The Diamond VGA Plus card with 1MB DRAM.**
- **ZEOS 14" 1024x768 VGA Color Monitor w/Tilt & Swivel.**
- **Lotus 1-2-3 for Windows, Ami Pro 2.0, Microsoft Windows, DOS 5.0 *plus* a Microsoft mouse!**

PACKAGE #4

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Why ZEOS is

Now, your ZEOS modular system allows you to upgrade from one CPU to another as your computing requirements change. Obsolescence is virtually obsolete!

You may choose between a variety of '386 and '486 processor options, both cached and non-cached.

Made in USA! Your new ZEOS system boards are designed and manufactured by ZEOS, right here in the USA.

ZEOS has utilized the very latest in highly integrated surface mount technology. Faster, cooler, more reliable systems for you!

Every ZEOS modular system comes standard with incredibly fast *53 nanosecond DRAM.*

Plus, you may expand your system with up to 32 megabytes of memory right on the motherboard.

Your new system features the *exclusive* ZEOS seven bay desktop case, smaller than most five bay cases yet plenty of room for future expansion.

Two whisper quiet cooling fans move more cool air thru your system increasing reliability and component life.

CHECK YOUR EXCLUSIVE

If you're deciding which new computer to buy, there are many important considerations.

Here, we've gathered together a number of these considerations for your review. Some are of obvious importance,

ZEOS. Eight Times Editor's Choice.

Your *entire* system is UL* listed (not just the power supply). Few others offer this security; we wonder why.

Eight slots, one for the video, seven more open providing plenty of room as your system requirements grow.

Two high speed serial ports, one parallel port and one game port.

Our top quality 300 watt power supply provides you with plenty of power for your present *and* future needs.

ZEOS uses *only* genuine Teac* floppy drives. Accept nothing less.

Monochrome TTL systems feature Genuine Hercules* brand graphics controllers. Only the best for you.

Your #1 Choice!

ZEOS ADVANTAGES:

while others are subtle yet critical to your ultimate satisfaction. We'll go over them here with you one by one.

Please feel free to use these as a basis for comparison with other system vendors. We believe you will come away with the conclusion that *ZEOS is indeed Your #1 Choice.*

☑ VGA color systems feature the high-res ZEOS 1024x768 monitor with the incomparable SpeedStar Plus card complete with One Full Megabyte of memory!

☑ Special package savings are available incorporating our most popular upgrades. Many packages include Microsoft® DOS plus Windows and a Mouse!

☑ For a limited time every ZEOS Windows system also comes with Lotus *1-2-3 for Windows* plus Lotus' incredible new Windows word processor *Ami Pro 2.0!*

☑ *PC Magazine* said ZEOS offers "more options than even the most configuration hungry hound could possibly need." Let us build whatever you require.

☑ Everybody loves ZEOS' 24 Hour a Day Toll Free Technical Support. You can call for advice any time of the day or night, 365 days a year!

☑ ZEOS systems have been selected by *PC Magazine* as *Editor's Choice, Eight Times!* These, along with many other consumer and industry awards attest to ZEOS' consistent and outstanding value.

☑ Your new system is backed by our 30 Day Absolute Satisfaction Money Back Guarantee, One Full Year Limited Warranty and our Express Replacement Policy.

☑ Buy with confidence. ZEOS is a strong and rapidly growing public company (NASDAQ Symbol: ZEOS). We've been around since 1981. We'll be around for a long time to come as well.

☑ ZEOS offers you a wide variety of payment options including MasterCard, VISA, Discover, American Express plus our own Z-Card, the ZEOS credit card featuring low consumer rates. Credit terms are also available along with very attractive leasing programs to qualified corporate customers.

☑ Friendly, knowledgeable ZEOS Systems Consultants are available 24 Hours a Day by calling 800-423-5891. You can call any time.

When you add it all up, there's nothing like buying from ZEOS. There is certainly nothing like these new ZEOS systems!

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Here's how it works. We have these incredible ZEOS '386 and '486 color VGA systems pre-built and ready to ship. While supplies last, we will ship any of these systems to you *the day you order* subject to these conditions:

1. Your order must be received by 1PM Central Time M-F.
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Yes! We can ship your new ZEOS system Right Now! Place your order by 1:00 PM Central Time and we'll ship today. Guaranteed!*

***OUR GUARANTEE TO YOU:**

If we accept your order for immediate shipment and fail to ship your system under the conditions outlined, we will ship it at *our expense* as soon as it is ready.

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- Lotus 1-2-3 for Windows, *plus* Ami Pro 2.0, *plus* Microsoft Windows and DOS 5.0, *plus* a genuine Microsoft mouse!
- Shadow RAM and EMS support for enhanced performance.
- ZEOS/RS 101 key SpaceSaver keyboard.
- High Speed ZEOS I/O with two Serial, one Parallel & one Game Port built in.
- 7-16, 1-8 bit expansion slots. Math coprocessor support for '386.
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ZEOS® INTERNATIONAL LTD

A Smarter Ami Pro

Ami Pro release 2.0 for Windows offers an outliner, power fields, master documents, and a scientific and equation editor. The new version of the word processor has improved SmartIcons, which automate tasks such as centering a paragraph or boldfacing text.

Previously, SmartIcons were monochrome and resided only on the left side of the screen. Now they are in color, and you can move them anywhere, including outside the document window. AmiPro ships with 120 SmartIcons, and you can add others.

Price: $495.

Contact: Lotus Development Corp., Word Processing Division, 5600 Glenridge Dr., Atlanta, GA 30342, (800) 831-9679.

Circle 1205 on Inquiry Card.

Ami Pro's dialog box lets you modify chart attributes such as chart type, colors, or axis values. You can access C:Mail from inside Ami Pro, and the program supports workgroup editing.

Sift and Search Through Documents

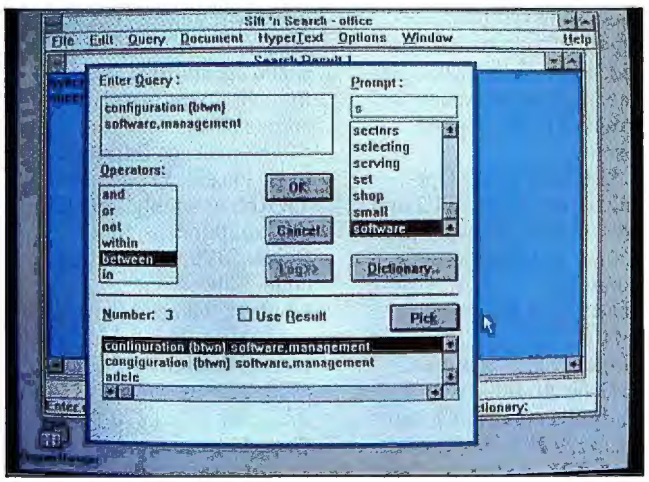
Sumak's new Sift 'n Search document retrieval program for Windows lets you import documents in various formats, index the documents, and organize them in bins. You can organize bins along the lines of a business's operation, such as sales. You can also establish links between bins, documents, and pictures.

Sift 'n Search supports a number of indexing methods. When searching for documents, the program supports proximity and Boolean searches. The program stores the results of all queries. You can further refine the results of queries with new queries. Hypertext linking lets you browse among related topics. Simple queries can act as gateways to other concepts.

Price: $295.

Contact: Sumak Enterprises, Inc., 39 Dawson Dr., Sudbury, MA 01776, (508) 443-5970; fax (508) 443-5895.

Circle 1209 on Inquiry Card.



Sift 'n Search supports a variety of searches, including queries that can act as gateways to other concepts.

Personal Folio Lets You Tap Others' Work

Folio Views, a text retrieval and hypertext authoring system for the PC, is now available in a Personal Edition that lets you search, annotate, edit, group, and link information in a commercial infobase. An infobase lets you manage free-form electronic information.

Price: $295.

Contact: Folio Corp., 2155 North Freedom Blvd., Suite 150, Provo, UT 84604, (801) 375-3700.

Circle 1208 on Inquiry Card.

Ventura Markets Database Publisher

A marketing agreement between the U.K. developer of DataBase Publisher and Ventura Software has resulted in the release of a database publishing program in both DOS/GEM and Windows editions. Called Ventura DataBase Publisher, the program lets you publish catalogs, price lists, directories, and other documents based on database information. The information can be stored in DBF or ASCII format in dBase, FormBase, Paradox, and FoxBase, according to Ventura.

Price: $895.

Contact: Ventura Software, Inc., 15175 Innovation Dr., San Diego, CA 92128, (800) 822-8221 or (619) 673-0172; fax (619) 673-7672.

Circle 1206 on Inquiry Card.

Nisus Adds System 7.0

Paragon Concepts' Nisus 3.05 word processing program for the Mac now supports System 7.0 through an add-on package called Nisus XS. Nisus XS expands the word processing program by adding sound and interapplication communications.

Using AppleEvents, another application can simultaneously share files with Nisus and instruct the program to perform editing tasks, including macro execution.

Price: Nisus XS, $75; Nisus 3.05, $395.

Contact: Paragon Concepts, Inc., 990 Highland Dr., Suite 312, Solana Beach, CA 92075, (619) 481-1477.

Circle 1207 on Inquiry Card.

NEWS

One Application, Many Platforms with Jam

The Jam/Presentation interface (Jam/Pi) tool for Windows eliminates the steep learning curve associated with GUI programming while letting end users access the same application under several GUIs. The application, and the interface you create, can run under Motif or Windows or on terminals in block- or character-based mode.

The fourth-generation language tool lets you build Windows applications that support the multiple-document interface, extended memory, dialog boxes, and other Windows features. Forms that you draw in Windows and save on a file server can be accessed and used by character-based systems without any reconfiguration. In all, Jam/Pi is portable to over 100 platforms and 10 operating systems. A version is planned for Open Look.

Price: Jam/Pi for Windows, $395.

Contact: JYACC, Inc., 116 John St., New York, NY 10038, (212) 267-7722; fax (212) 608-6753.

Circle 1210 on Inquiry Card.

Real-Time Data Acquisition Drivers

The DriverLinx series of products for Windows 3.0 gives developers of custom applications a high-level interface to PC data acquisition hardware. According to Scientific Software Tools, DriverLinx can insulate you from the complexity of interfacing with boards from Keithley Metrabyte, Advantech, Computer Boards, and Soltec as you port your applications into Windows. The company has added support for the Industrial Computer Source ATO-16 16-channel board and plans to add others in the future.

The package provides you with more than 70 services for creating foreground and background tasks for performing analog I/O, digital I/O, time and frequency measurement, event counting, pulse output, and period measurements. The company says the package overcomes the limitations of drivers that provide a high-level interface but impose software limits on the data collection. DriverLinx supports multitasking, multiple users, and up to six boards and 10 concurrent tasks.

Price: $400.

Contact: Scientific Software Tools, Inc., 30 East Swedesford Rd., Malvern, PA 19355, (215) 889-1354; fax (215) 889-1630.

Circle 1212 on Inquiry Card.

The Jam/Presentation interface tool for Windows is the second addition to JYACC's family of fourth-generation language development tools. It lets you develop applications for several graphical and character-based platforms.

Squeeze Your Code into Smaller Spaces

The Optlink/Compress 3.0 linker for DOS provides compressed, single-level overlays, letting you put more code into a smaller space. According to SLR Systems, the linker provides disk-space-saving features while running from four to 10 times faster than Microsoft's Link.

SLR's linker produces self-extract-to-run .EXE files. When a file is executed, an automatically embedded decompression routine kicks in to expand the program to its original form.

SLR also offers Optlink/2, for 16-bit OS/2 and Presentation Manager programs, and Optlink/Windows.

Price: Each program, $350.

Contact: SLR Systems, 1622 North Main St., Butler, PA 16001, (412) 282-0864; fax (412) 282-7965.

Circle 1211 on Inquiry Card.

EZ-Install Automates .INI File Updating

EZ-Install 4.0, a toolkit that helps you simplify the installation process of your application, can now automate the modification and updating of Windows initialization (.INI) files. EZ-Install 4.0 makes these changes to your system automatically. You specify what needs changing in the .INI file. At installation, EZ-Install does all the updating.

EZ-Install runs as a DOS application. Versions are available for OS/2.

Price: $249.

Contact: The Software Factory, Inc., 17610 Midway Rd., Suite 134-222, Dallas, TX 75287, (214) 490-0835; fax (214) 306-4552.

Circle 1214 on Inquiry Card.

Graphics Toolkit Lets Your Images Go Boom

The newest member of the GX Development Series of graphics programming tools for the PC lets you add fade, wipe, roll, slide, spiral, and explosions to your graphical images. GX Effects adds animation and sprite capabilities. More than 50 image dissolves are supported.

The package interfaces to C, Pascal, BASIC, FORTRAN, assembly, and Clipper compilers.

Price: $199; with source code, $399.

Contact: Genus Microprogramming, 11315 Meadow Lake, Houston, TX 77077, (800) 227-0918 or (713) 870-0737; fax (713) 870-0288.

Circle 1213 on Inquiry Card.

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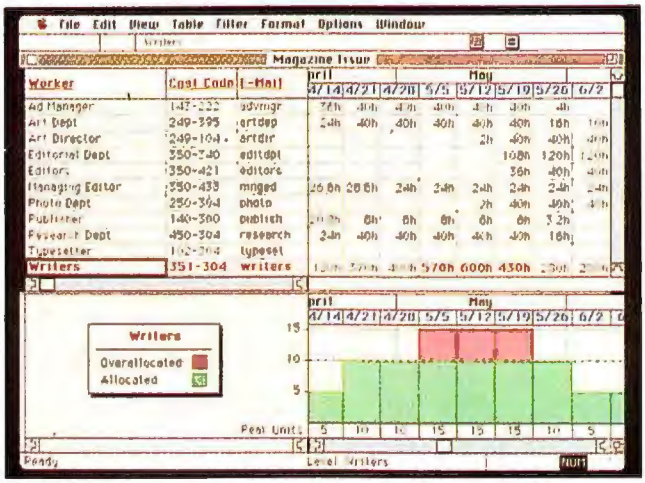
Circle 564 on Inquiry Card (RESELLERS: 565).

Manage Projects on the Mac

Microsoft Project 1.1 for the Mac is fully compatible with Microsoft Project for Windows, letting companies with mixed platforms standardize on one project management program. The two programs read and write in the same format, letting you share information and complete work initiated in another department or on another personal computer.

You can add information to the program through various means, but the spreadsheet view (called the task view) of rows and columns lets you start with a general to-do list that you can update as the project develops.

You can assign resources on a partial basis and level resources selectively to balance workloads across projects. Large projects can be divided into subprojects.
Price: $695.
Contact: Microsoft Corp., 1 Microsoft Way, Redmond WA 98052, (206) 882-8080; fax (206) 883-8101.
Circle 1215 on Inquiry Card.

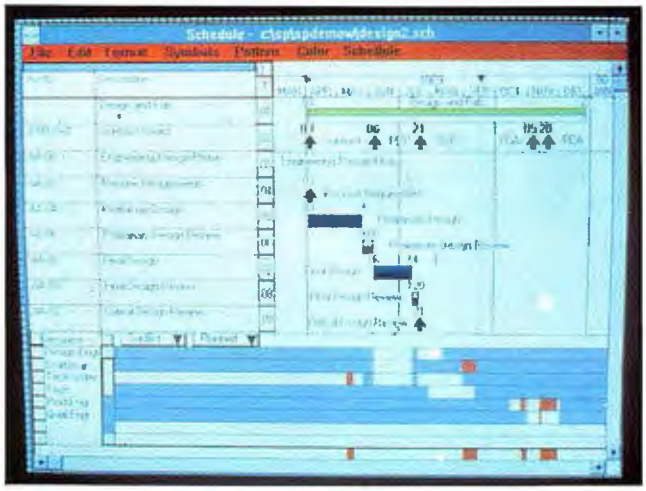


Microsoft Project 1.1 for the Mac lets you manipulate data in Gantt, PERT, and histogram charts, resource usage tables, or the task view. Changes made in one view are updated in the others. Unlike the Windows version, the Mac version offers print preview.

Projects on the Mac and PC

Lucas Management Systems (formerly Metier Management Systems), developer of high-end mainframe project management programs, now offers project management programs for the Mac, Windows, and DOS/GEM environments. Called Artemis Schedule Publisher, the program combines schedule, resource, and cost processing while constantly updating the Critical Path schedule as you move activities.

Along with updating the Critical Path, the program continuously recalculates resource loadings and associated project costs. The program provides a set of standard reports, or you can import reports created in drawing packages such as Canvas, Corel Draw, and Presentation Team. Artemis Schedule Publisher interprets the graphical report layout and publishes its data to the imported report.
Price: $2000 per platform.
Contact: Lucas Management Systems, Inc., 12701 Fair Lakes Circle, Suite 350, Fairfax, VA 22033, (703) 222-111; fax (703) 222-8203.
Circle 1216 on Inquiry Card.



Lucas Management now offers project management for the Mac, Windows, and GEM platforms. Translation functions provide links to high-end systems within the Artemis product family.

Primavera Quantifies the Odds

Primavera Systems has acquired all rights to Log/An's Promap V Monte Carlo simulation software for use with the Primavera Project Planner and Finest Hour project management and scheduling programs. Renamed Monte Carlo, the program is a simulation model for dealing with uncertainties, such as weather, material shortages, technological risks, inflation, and labor availability, that affect projects.

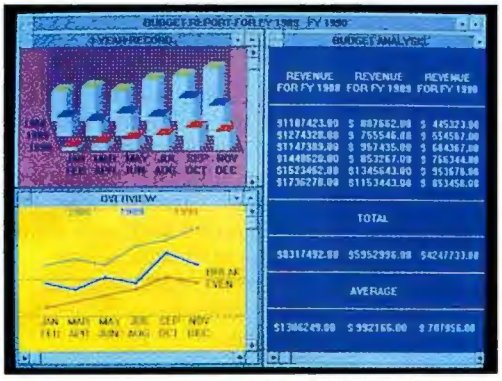
Monte Carlo can use project information from Primavera's programs and determine confidence intervals, criticality indexes, risk envelopes, contingency requirements, and delivery date ranges, the company says.
Price: $5000.
Contact: Primavera Systems, Inc., 2 Bala Plaza, Bala Cynwyd, PA 19004, (215) 667-8600; fax (215) 667-7894.
Circle 1217 on Inquiry Card.

Integrated Estimation and Planning

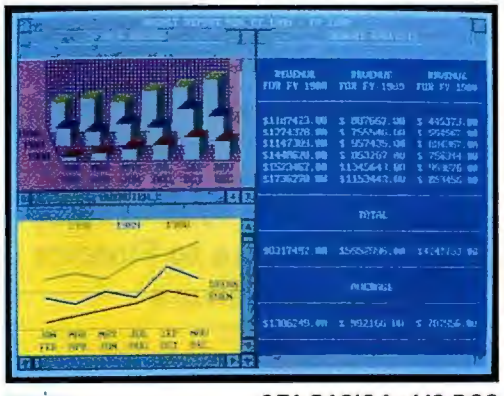
A new utility for the ProjectBase 4.0 life-cycle management, planning, and estimating tool lets you export task-based plans and estimates directly into Microsoft Project for Windows.

With ProjectBase, you can tailor a comprehensive plan from its life-cycle knowledge base. Using historic-effort data, human resource profiles, and task dependencies, ProjectBase generates realistic task effort, duration, and cost estimates, the Center for Project Management reports.
Price: $2950.
Contact: Center for Project Management, 18 Crow Canyon Court, Suite 290, San Ramon, CA 94583, (415) 837-0397; fax (415) 837-0593.
Circle 1218 on Inquiry Card.

Only one programming language lets you cross develop for Windows 3.0 and MS-DOS without rewriting code. Introducing GFA-BASIC.



GFA-BASIC for Windows



GFA-BASIC for MS-DOS

```
main
PROCEDURE main
  set_database
  bar_graph
  line_graph
  budget_a
  stop_program
RETURN
> PROCEDURE set_database
> PROCEDURE bar_graph
```

With GFA-BASIC you use the same commands and functions whether you are developing for Windows 3.0 or MS-DOS.

GFA-BASIC gives you a simple, but powerful, language for developing sophisticated, state-of-the-art Windows 3.0™ and MS-DOS™ applications. Write a program with either the DOS or Windows version of GFA-BASIC and port it to the other platform, maintaining a common look and feel.

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Both versions of GFA-BASIC include 500 system and mathematical commands and functions to facilitate software development. At the same time, common commands and functions enable you to develop and maintain a single set of source code for each program.

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Another 400 commands and functions in the Windows version simplify the development of a complete GUI interface, including clipboard, DDE, DLL's, and dialog boxes. And, you don't need any additional libraries or the SDK.

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What's more, routines you've already developed in C or Assembler can be bound into a compiled GFA-BASIC program. And, GFA-BASIC supports arrays larger than 64K as well as the use of EMS in DOS.

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GFA-BASIC for Windows 3.0	$ 495.00	$ 295.00
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Add it all up and you have a very low-cost, easy-to-use structured language for developing Windows and MS-DOS applications[1]. To see for yourself how powerful GFA-BASIC is, just ask for our free demo disk. Call 1-800-766-6GFA, or write GFA Software Technologies, Inc.; 27 Congress St.; Salem, MA 01970; Fax (508) 744-8041.

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[1]UNIX and OS/2 versions of GFA-BASIC available in 1992.
Windows 3.0 and MS-DOS are trademarks of Microsoft Corporation.

Circle 560 on Inquiry Card.

Geographic Information for System 7.0

Atlas Pro for the Mac, the desktop mapping system that combines database analysis and presentation graphics, fully supports System 7.0 and lets you establish live links between data and graphics, whether data files are stored on your Mac or on a database server.

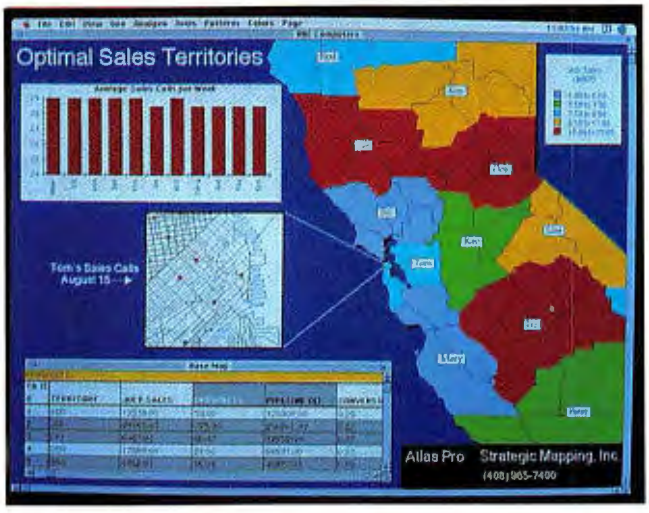
Atlas Pro has its own internal database, but it can also take data from external databases or spreadsheets and match geographic variables (such as a ZIP code) against a digital map. The program lets you query Structured Query Language databases.

Atlas Pro supports street-level address mapping. The program includes a starter kit of data and boundary files and demographic data from the 1990 census.

Price: $795.

Contact: Strategic Mapping, Inc., 4030 Moorpark Ave., San Jose, CA 95117, (408) 985-7400; fax (408) 985-0859.

Circle 1219 on Inquiry Card.



Atlas Pro combines database analysis and presentation graphs on the Mac running System 7.0.

Executive Information with Stock Tracking

The new version of the LightShip executive information system for Windows 3.0 offers greater data access capabilities, including support for Dynamic Data Exchange. DDE makes the program suitable for tracking real-time data such as stock quotes.

The company has also developed LightShip Lens, which uses dynamic link libraries to let you point and click your way to data in applications such as dBase, Paradox, Microsoft SQL Server, and Oracle Server.

Price: LightShip 3.0, $795; LightShip Lens, $195.

Contact: Pilot Executive Software, 40 Broad St., Boston, MA 02109, (800) 944-0094 or (617) 350-7035; fax (617) 695-1265.

Circle 1220 on Inquiry Card.

If standard LightShip 3.0 reports and graphs aren't what you want, you can use the program to make use of meaningful images, as in this map of Massachusetts.

MarketPlace Rises from the Ashes

MarketPlace Business 1.1 combines software technology and CD-ROM-based business data from Dun & Bradstreet Information Services to let you target prospects, analyze markets, and create prospect lists. The Mac program is offered by former employees of Lotus, which dropped the product after concerns about privacy issues. To avoid similar problems, MarketPlace Information will not issue a consumer database.

Price: $695.

Contact: MarketPlace Information Corp., 1 Canal Park, Cambridge, MA 02141, (617) 225-7850; fax (617) 225-7860.

Circle 1126 on Inquiry Card.

Manage Your Prospects and Customers

DataSel Gold for the PC lets you collect and track contacts and consolidate all the data. Among the program's features are a calendar for keeping track of all appointments, a word processor, mail merge and letter generation, and auto-dialing.

Price: $179.

Contact: DataSel Software, Inc., 12780 High Bluff Dr., Suite 260, San Diego, CA 92130, (800) 322-6160 or (619) 793-2950; fax (619) 755-5644.

Circle 1127 on Inquiry Card.

3-D Spreadsheet Links to Finance Software

The new ProCalc 3D spreadsheet program performs 3-D computations by stacking multiple pages of data, thus forming a Workcube that adds depth to information that's normally displayed in horizontal rows and vertical columns. The program displays information in a 2-D format while automatically calculating data in three dimensions.

The program supports over 100 @ functions. ProCalc 3D imports and exports in WK1, DBF, DIF, and ASCII formats.

Price: $89.

Contact: Parsons Technology, 375 Collins Rd. NE, P.O. Box 3120, Cedar Rapids, IA 52406, (319) 395-9626; fax (319) 395-0217.

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PCTronics 1420 E 78th Street Minneapolis, MN 55423

XTree Grows with Unix

The XTree for Unix program introduces file-manipulation capabilities similar to those of the DOS version of the utility, letting you organize your directories with one- and two-keystroke commands. The utility lets you view files in a tree-like graphical representation. Its commands include `global`, `showall`, `autoview`, `prune`, `graft`, `split screen`, `tag/untag`, and `filespec`.

The utility's level logging feature lets you view your system at the level with which you're most comfortable. A NODE command lets you break the system tree down into one or more logical branches. The GOTO command lets you type the first few letters of a filename to retrieve the file—no more scrolling lists, the company says. Rather than grappling with grep, the Unix command that searches files for patterns (e.g., every occurrence of a word in a file or files), XTree for Unix lets you tag groups of files and automatically search for the specified text.

A COMPACT command can, in some Unix implementations, remove directory entries for deleted files, thus cutting size, search, and access time for those directories.

The XTree for Unix utility won't override any security established by an administrator. It takes advantage of built-in console functions such as color, line-drawing characters, and keyboard functions. The utility works with SCO Unix V/386 release 3.2, SCO Xenix 386 release 2.3.2 and higher, and Interactive Systems Unix V/386 3.2.

Price: $295.

Contact: XTree Co., 4330 Santa Fe Rd., San Luis Obispo, CA 93401, (805) 541-0604; fax (805) 541-8053.

Circle 1133 on Inquiry Card.

Prepare for System 7.0

Pharos Technologies is offering a free System 7 Readiness Kit to all registered users of Status*Mac. Status*Mac lets you rapidly and remotely gather accurate information about hardware and software components within your domain on a network. Information contained in Status*Mac profiles is automatically imported into the Status*Mac Master Database for in-depth analysis, reporting, or exporting.

The new readiness kit includes the Status*Checker utility for analyzing System 7.0 compatibility for all user configurations in a Status*Mac 2.0 database. It lets you determine if the Mac is System 7.0 ready without having to physically visit each Mac. The System 7.0 Readiness Kit addresses RAM size, hard disk space, application memory, the paged memory management unit, MultiFinder usage, RAM cache, and other configuration details.

Price: Status*Mac 2.0 for networks of 25 users or less, $449; unlimited users, $1199.

Contact: Pharos Technologies, Inc., 4243 Hunt Rd., Cincinnati, OH 45242, (513) 984-9273; fax (513) 984-1653.

Circle 1135 on Inquiry Card.

Make Windows More Aware

E'vent Manager acts as an agent for Windows 3.0 by watching for events that normally occur in a PC's operation and comparing them to a set of conditions that you specify. When an event occurs that meets your criteria (e.g., an application execution or a lapse of time with inactivity), E'vent Manager executes your predefined commands.

A point-and-click approach to programming lets you build error-free English statements that describe the conditions that E'vent Manager should monitor. You also use this programming approach to specify commands that E'vent Manager should execute when certain conditions are met.

Price: $179.99.

Contact: Merasoft Corp., 384 East 720 South, Suite 204, P.O. Box 1918, Orem, UT 84059, (801) 225-9951; fax (801) 225-9984.

Circle 1136 on Inquiry Card.

Add Power to Your Windows Icons

IconDraw Plus combines three programs to let you replace your standard Windows icons with colorful and descriptive images and select a combination of files to launch from a single icon. It also offers six dynamic link libraries for a total of more than 400 premade icons.

The IconDraw portion of the program lets you create new icons for your applications or select from an included library of icons. LibView adds the six icon libraries in categories of Windows applications, DOS applications, utilities, games, cartoons, and generic. AutoLaunch lets you combine the functionality of several .EXE, .COM, .BAT, .PIF, and other files under one icon.

Price: $69.95.

Contact: WinSoft, 18742 142 Ave. NE, Woodinville, WA (800) 275-7638 or (206) 485-7329; fax (206) 485-7488.

Circle 1137 on Inquiry Card.

Help for Mac Configuration Problems

Help is on the way for Mac users who need to analyze their hardware and software and detect potential or actual problems. Teknosys's problem-solving utility offers solutions to detected problems, including incompatibilities with Apple's System 7.0 operating system. Help also generates publication-quality reports.

The utility checks for problems using an expert system to compare your configuration against a knowledge base of information. The company offers update subscriptions to keep up with the latest conflicts, hardware, and software. A yearly subscription, which includes at least four updates, costs $75.

Help will detect start-up document conflicts, incompatibilities between system software and hardware, multiple system folders, insufficient memory, and damaged files.

Price: $149.

Contact: Teknosys, Inc., 3923 Coconut Palm Dr., Suite 111, Tampa, FL 33619, (813) 620-3494; fax (813) 620-4039.

Circle 1134 on Inquiry Card.

Fix

The correct phone number for AutoSight (What's New, August) in Melbourne, Florida, is (407) 242-5865. The company reports that it recently lowered the price of Access 3.0 to $299 for a single user and $899 for a five-user license.

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- 64-Gray Scale

Memory Expansion Chips:
- 80ns ZIP-type DRAM

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- 1 External Keyboard Connector
- 1 External CRT Port for Color VGA Monitor
- 1 RS-232 Port
- 1 External FDD and RS-232 Pack Connector
- 1 Bus Expansion Pack Connector

Expansion Compartments:
- 2 Expansion Compartments for Battery and Optional Function Packs

Disk Storage:
- 1 Internal 3.5" 1.44MB Diskette Drive
- 1 20MB or 40MB or 60MB Internal Hard Disk Drive

Keyboard:
- 83 Keys - Function Keys 1 - 12

Power Supply:
- 2 Battery Packs
- Autoswitching 110 V/220 V AC
- Adapter/Battery

Physical Dimensions:
- Width: 12"
- Length: 9"
- Height: 2"

Weight (including 2 battery packs):
- 7.7 Pounds

Software:
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- Windows 3.0
- Video Utility
- Power Management Utility

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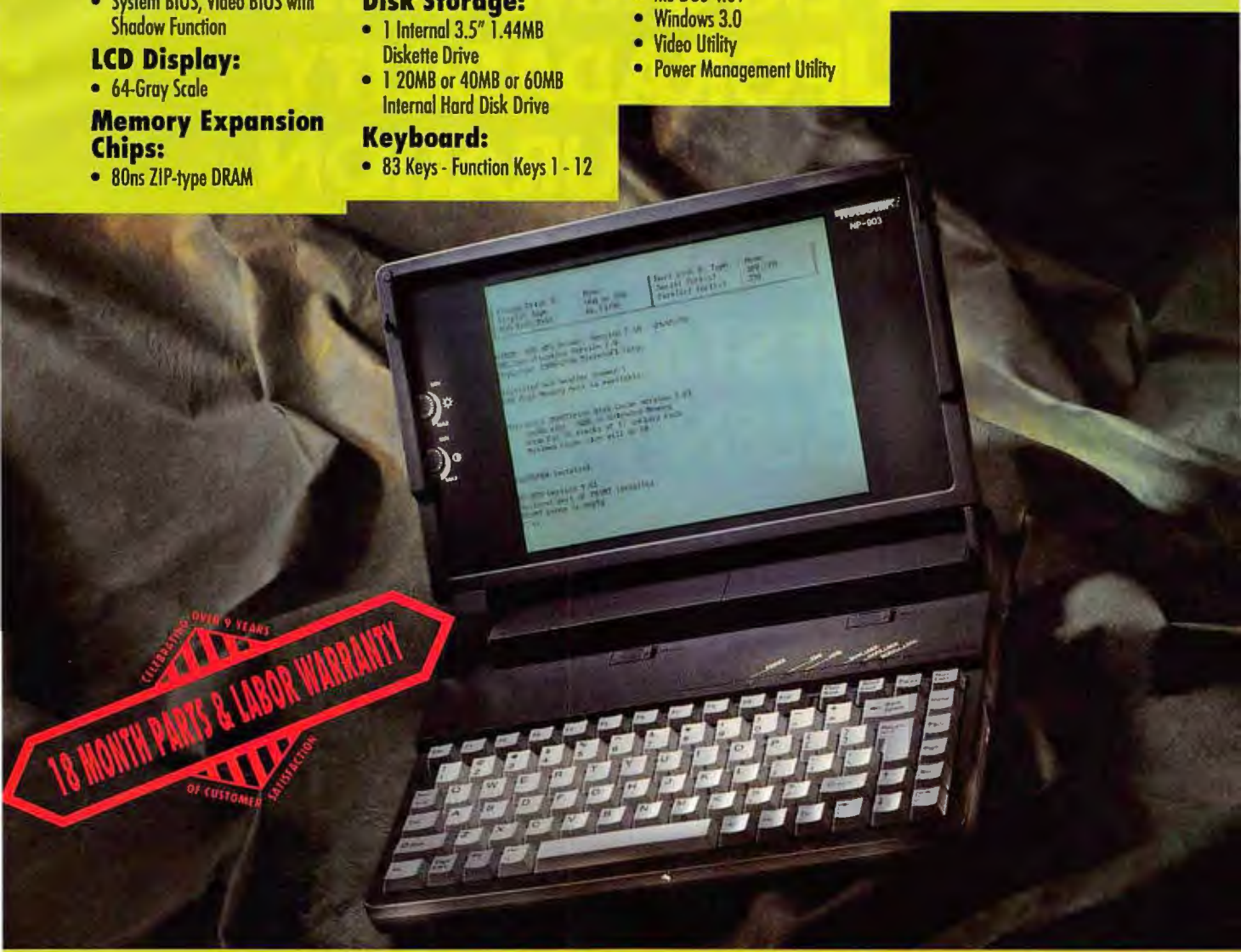

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NEWS

Terminal Emulation with Many Lives

The Meow terminal-emulation program for the PC lets you connect to systems running Unix, Ultrix, Xenix, VMS, and TCP/IP. The program, which is distributed on one floppy disk, lets you run up to 20 simultaneous TCP/IP sessions and provides VT100 and VT220 terminal emulation. It also supports Tektronix 4014 graphics, providing zoom and pan, mouse, and screen-capture capabilities.

With keyboard mapping, you can store keystrokes for frequently used commands. Meow supports Kermit, XMODEM, and YMODEM file transfer in serial sessions and FTP and RCP in network sessions.

Price: $395.

Contact: Robbins-Gioia, Inc., 209 Madison St., Alexandria, VA 22314, (800) 322-6369 or (703) 739-7360; fax (703) 739-6129.

Circle 1128 on Inquiry Card.

The Meow terminal emulator supports up to 20 simultaneous TCP/IP network sessions.

From WordPerfect to OfficeVision/400

WordPerfect Loader will automatically convert files from WordPerfect to OfficeVision running on the IBM AS/400 minicomputer. With the program, you won't have to remember to save your WordPerfect documents in Document Conversion Architecure or use special commands to view the documents from within OfficeVision. With WordPerfect Loader, you can view WordPerfect documents stored on an AS/400 from OfficeVision, even if you're using a nonintelligent terminal.

Price: $7500 to $20,000 per site license.

Contact: Data Conversion Laboratory, 184-13 Horace Harding Expwy., Fresh Meadows, NY 11365, (718) 357-8700; fax (718) 357-8776.

Circle 1131 on Inquiry Card.

Windows LAN Remote Control Gets Faster

Remotely Possible 3.0, the latest version of the program that lets you control a PC running Windows 3.0 even if you don't have Windows, offers a performance increase of two to three times over version 2.0, Avalan Technology says. Version 3.0 contains a Windows dynamic link library that interacts with the Windows 3.0 Graphics Device Interface library. Remotely Possible achieves its performance increase by intercepting GDI function calls from Windows applications.

Version 3.0 allows remote control over LANs of Windows 3.0–equipped PCs running in real, standard, and 386 enhanced modes. It supports networks running NetWare 286/386, Microsoft LAN Manager, Banyan Vines, and other NetBIOS-compatible networks.

Price: Eight-user license, $299; 1024-user license, $2299.

Contact: Avalan Technology, 116 Hopping Brook Park, Holliston, MA 01746, (800) 441-2281 or (508) 429-6482; fax (508) 429-3179.

Circle 1129 on Inquiry Card.

Catapult Over the Mainframe Barrier

A new program called Catapult provides PC-to-midrange and PC-to-mainframe connectivity while converting host files into more than 40 PC programs. Catapult lets you access files on System 36, System 38, AS/400, DEC, Hewlett-Packard, NCR, and other systems. It extracts needless formatting characters and control codes and then converts ASCII files into popular PC application formats. For PC-to-PC interconnectivity, the company offers Avenue, which converts among more than 25 different file formats.

Price: Catapult, $495; Avenue, $369.

Contact: Tangent Group, Inc., 18702 North Creek Pkwy., Suite 205, Bothel, WA 98011, (800) 526-4843 or (206) 486-5629; fax (206) 486-2470.

Circle 1132 on Inquiry Card.

WeatherBrief Shows Lightning Strikes

WeatherBrief 4.0, the software that links to WeatherBank's on-line weather service, provides up-to-the-minute weather satellite data, graphs, and photos, including the display of national U.S. real-time lightning strikes. Other new features include iso-graphics (weather charts of surface and upper-air conditions), advanced hurricane/storm tracking, color satellite display of weather fronts, and overlays of highways. The program can now generate output for NTSC video.

You use the WeatherBrief software on a VGA- or EGA-equipped PC to call the WeatherBank service at up to 9600 bps. The company offers a toll-free number that you can use anywhere in the U.S. or Canada. Access charges range from 15 cents to 45 cents per minute, depending on what you download and what access number you use. Because the graphics are generated directly from satellite photographs, they are accurate up to the minute, according to WeatherBank.

Price: $49.95.

Contact: WeatherBank, Inc., 5 Triad Center, Suite 315, Salt Lake City, UT 84180, (801) 530-3131.

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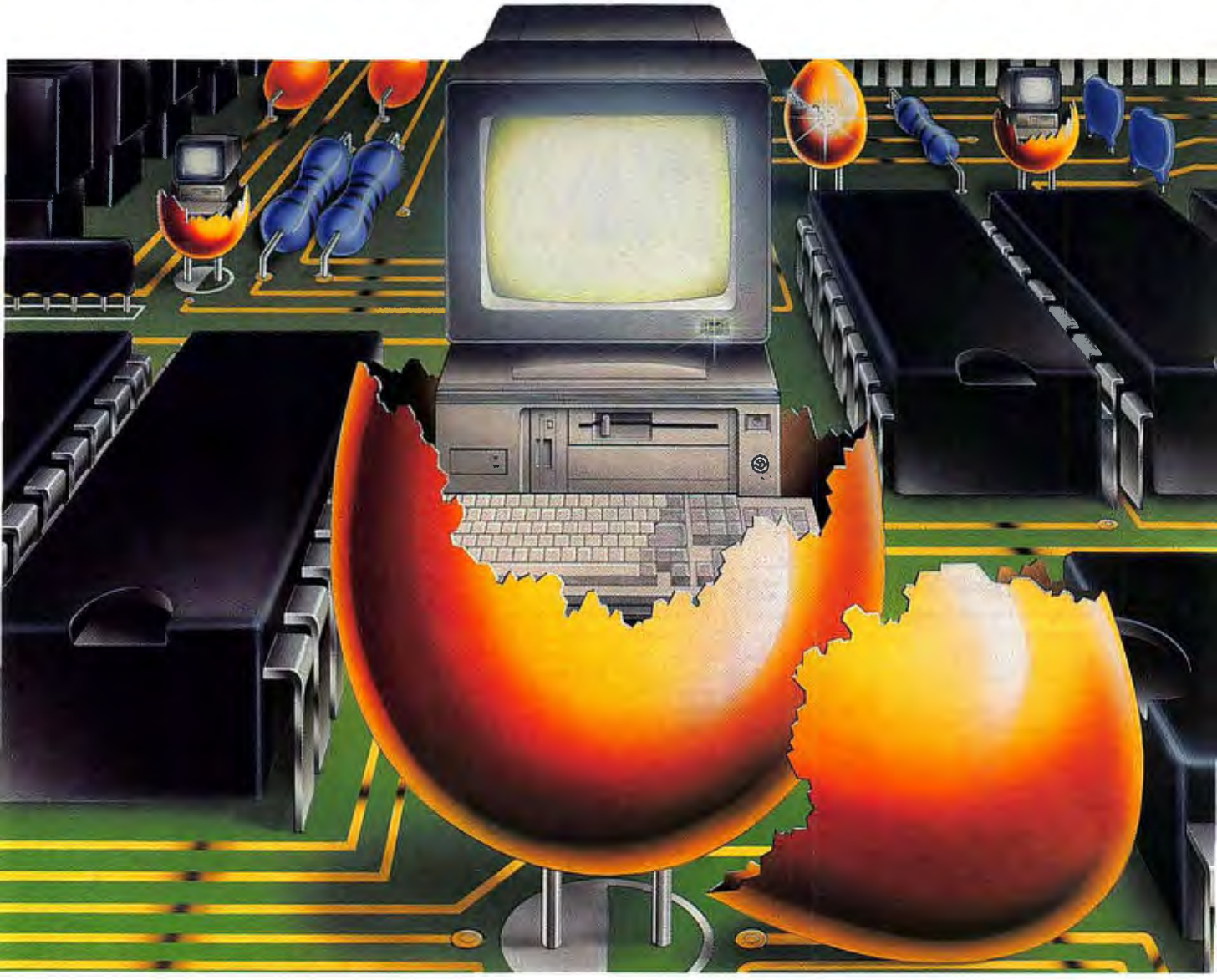

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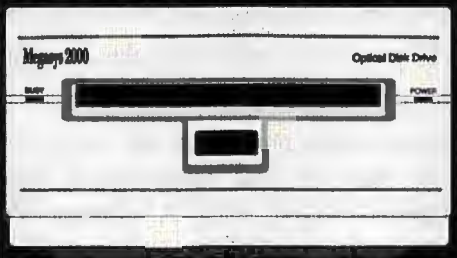

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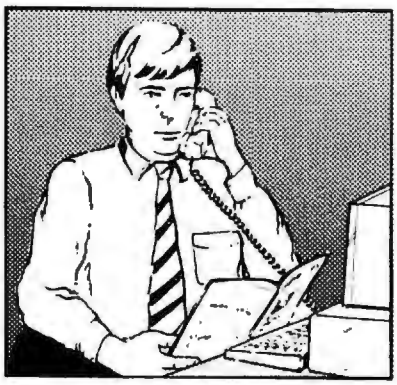

In an effort to make your telephone purchasing a more successful and pleasurable activity, The Microcomputer Marketing Council of the Direct Marketing Association, Inc. offers this advice, "A knowledgeable buyer will be a successful buyer." These are specific facts you should know about the prospective seller before placing an order:

Ask These Important Questions

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Reputable computer dealers will answer all these questions to your satisfaction. Don't settle for less when buying your computer hardware, software, peripherals and supplies.

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- *Confirm that the price is as advertised.*
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- *Make a record of your order, noting exact price including shipping, date of order, promised shipping date and order number.*

If you ever have a problem, remember to deal first with the seller. If you cannot resolve the problem, write to MAIL ORDER ACTION LINE, c/o DMA, 6 E. 43rd St., New York, NY 10017.

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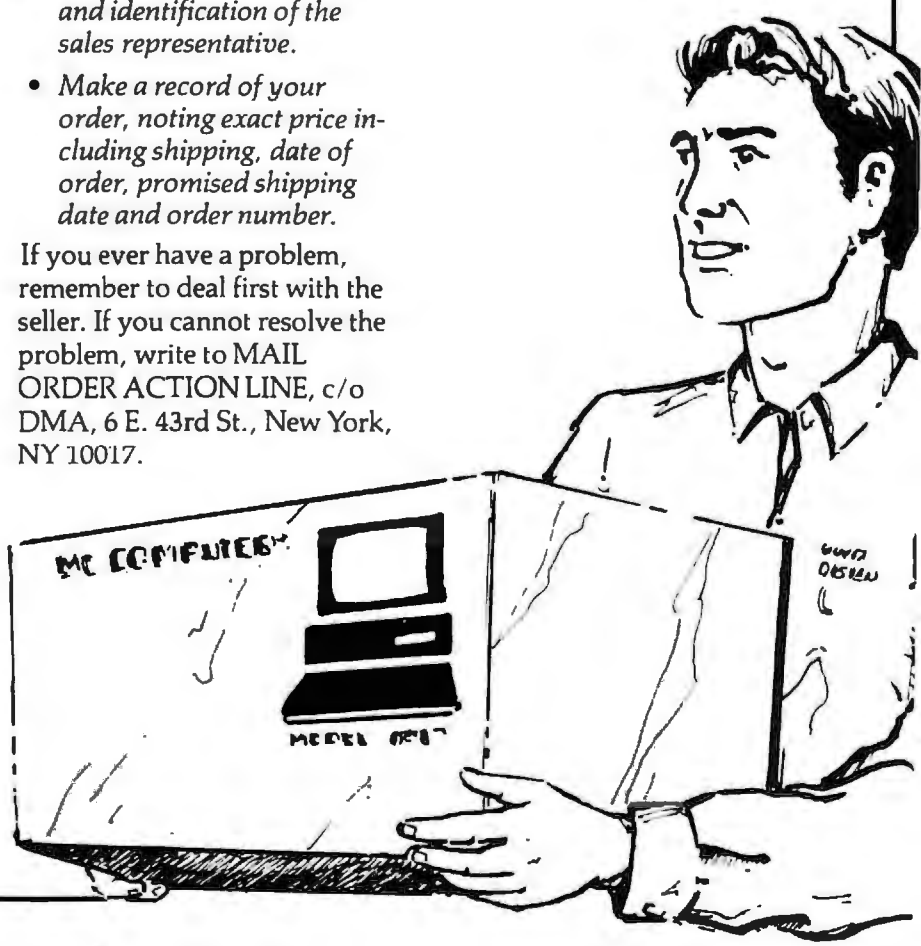

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Circle 572 on Inquiry Card (RESELLERS: 573).

Interact with CAD Drawings

CADMax TrueSurf for the PC now supports sphere and torus surface entities, adding to previous versions' support of plane, cone, and cylinder types. Version 4.6 offers the automatic elimination of double lines and a new depth-picking function.

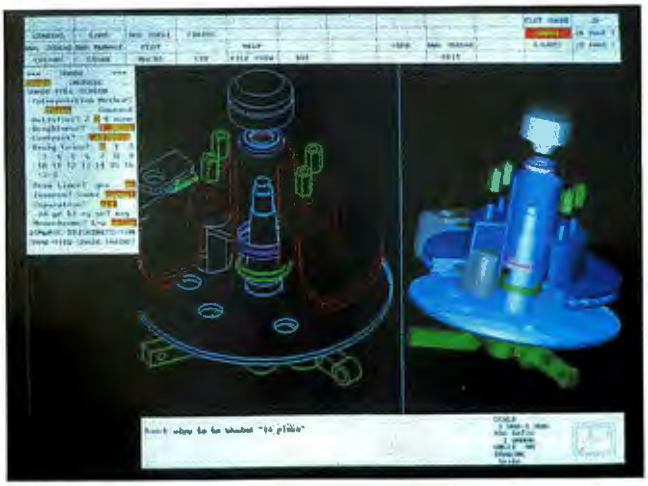
CADMax TrueSurf lets you automatically define all five surface types from wireframe geometry, eliminating the time-consuming process of explicitly defining surfaces. The program doesn't require a postprocessing procedure to generate a static hidden line or shaded design.

The depth-picking feature helps when you need to identify specific geometry and surfaces.

Price: $5900.

Contact: Vector Automation, Inc., Village of Cross Keys, Baltimore, MD 21210, (301) 433-4200; fax (301) 433-0305.

Circle 1138 on Inquiry Card.



With CADMax TrueSurf, you can interact with hidden-line and shaded views instead of 3-D wireframe models. Version 4.6 adds two new surface entities that let you create more complex drawings than with previous versions.

Convert to AutoCAD Release 11

Convert 2.0, an HPGL-to-DXF-to-DWG file conversion program, supports AutoCAD release 11 formats, along with most other versions, AutoSight says. The upgrade supports batch conversions of files.

AutoSight's HP2DXF 1.3, for converting HPGL plot files to DXF format on Hewlett-Packard Unix systems, now supports HPGL-I and HPGL-II.

Price: Convert 2.0, $199; HP2DXF 1.3, $995.

Contact: AutoSight, Inc., P.O. Box 362086, Melbourne, FL 32936, (407) 242-5865; fax (407) 255-1052.

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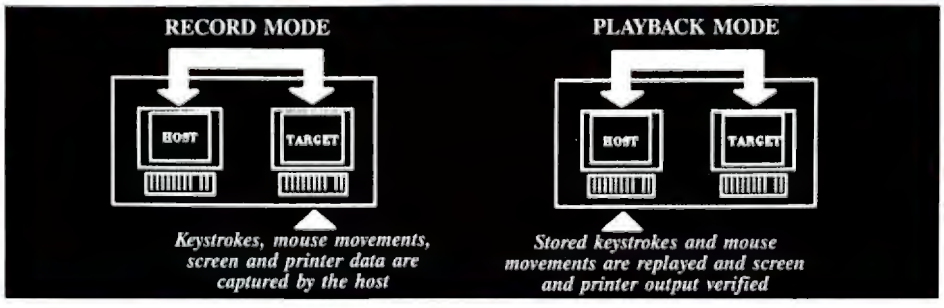
AUTOMATED SOFTWARE TESTING



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5251 Terminal Emulation for Windows

IdeaComm 5251 for Windows, a terminal-emulation program, includes a new version of Idea's file transfer software, rewritten for Windows, that supports automated file transfer. IdeaComm 5251 for Windows provides communications to AS/400 and System 36 and 38 midrange computers.

The program is compatible with Idea's 5251 communications card.

Price: Software and card, $395.

Contact: Idea, 29 Dunham Rd., Billerica, MA 01821, (508) 663-6878; fax (508) 663-8851.

Circle 1140 on Inquiry Card.

IdeaComm 5251 for Windows provides communications to AS/400 and System 36 and 38 midrange computers.

Filing and Printing for MS-Net, Unix

Two new client/server software packages from Micro Computer Systems (MCS) provide filing and printing services for DOS-based LANs that support the SMB protocol and are MS-Net-type systems.

MCS Server/PC lets client PCs use the server's shared disk and printer devices as though they were locally attached to the client machine. Features include dedicated and nondedicated operation, simultaneous multiple-client support, sharing of up to three printers, the ability to share servers' hard or floppy drives, and a date- and time-setting service for client computers. It offers transparent device redirection for applications.

Client/PC provides connectivity options to the MCS SMB/ix Server, a Unix application program that lets SMB-compliant network operating systems, such as PC LAN and LAN Manager clients, transparently use Unix filing and printing services.

Price: MCS Server/PC, $595; MCS Client/PC, $79; MCS SMB/ix Server, $995.

Contact: Micro Computer Systems, Inc., 2300 Valley View, Suite 800, Irving, TX 75062, (214) 659-1514; fax (214) 659-1624.

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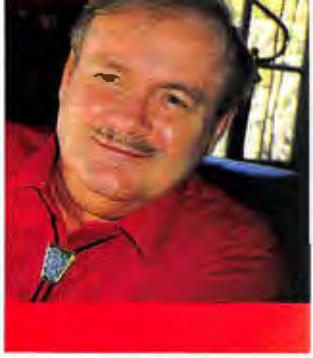

JERRY POURNELLE

AN EXERCISE IN LOGISTICS

The good news is that both *Fallen Angels* and *Go Tell the Spartans* hit the best-seller lists, albeit not as high up as I would have liked. Even better, *The Moat Around Murcheson's Eye* is coming along nicely, and it ought to be finished about the time you read this. I do seem to be turning out books.

Of course, that leads to the bad news: as usual, I'm in a fearful rush. I keep wondering when these little computers are going to save me some time I can use for myself. I understand that I couldn't accomplish a quarter of the work I do without my computers, but it does seem that the little suckers take away as much time as they give back. Ah, well. But the bottom line is, it's short-shrift time again: a number of products that ought to be featured will be lucky to be mentioned at all.

As it happens, I've been neglecting whole boxes full of new and useful stuff that will never be advertised but you ought to know about. Here goes.

Index, Anyone?

Bindex from Esc is a keyword index to BYTE. It's updated quarterly and is available for 1990 and 1991. If you need this, you need it bad. If you think you don't need it, you may be right, but think about it: a way to find just about everything you ever wanted to find in BYTE—letters, columns, articles, you name it—by title or by subject matter. The retrieval software is simple and easy to use.

And it's guaranteed. If you don't like it, return it for a full refund. Recommended.

Poor Man's Systat

InStat from Graphpad Software is a program of instant "cookbook statistics" for those who have forgotten most of what they were taught about statistics but still have to put statistical stuff in their work, academic or otherwise. It's very good as that sort of thing goes, and, used carefully, it can be extremely useful.

The problem is that if you don't know what you're doing, you can do some odd things with statistics. Garbage in, gospel out, and so forth: which is to say, you can use the cookbook exactly correctly, but on defective or inappropriate data. The results will still look impressive, but they may not mean a thing. On the other hand, amazing numbers of people don't know what they are doing with statistics, and that doesn't seem to slow them down. At least with InStat you'll get the right answers and good advice.

Of course, InStat doesn't guarantee that you've asked appropriate questions, which is the most important thing in statistics. If I seem a bit nervous here, it's because I've seen an awful lot of odd—even weird—stuff published in the social science and education fields that makes me recall the words of Dr. Jane's song:

"You take a big statistic, an undefined statistic, then remove it from its context, so it fits into your pa-aper. Oh, oh, oh, no, sci-ence! Drivel, she come down!" (If you don't know about Dr. Jane's science folk song tapes, ask in the dealer room at the next science fiction convention you get to. They are wonderful.)

Jerry copes with a gaggle of word processors and looks at new products

I still recommend Systat for serious statistical analysis, but InStat is a good program for those who don't have the time and background to go the full Systat route. With that warning, recommended.

Knowledge Acquisition Series

It all started when Jim Ransom and I got to discussing the new moon programs that he's writing for The Lunar Society, and I had to confess I had forgotten how to use English units: I couldn't remember the exact definition of a slug. I figured I'd show off by accessing Inductel's Knowledge Acquisition Series (KAS), which has on-line versions of the McGraw-Hill physics and chemistry dictionaries. I also have their other products: a dictionary of 26 foreign languages, the Funk & Wagnalls dictionary, a biology dictionary, and a computer dictionary.

For one reason or another, I hadn't used the KAS system for a while. It isn't totally intuitive, and the manual is less than illuminating, but I didn't figure it would take me long to look up *slug*.

It didn't work. It seemed to be working, but it just

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wasn't letting me access the information, and the error messages made no sense. After a while I gave up, but it annoyed me. I wondered if I had done something wrong in using it. I hadn't used the KAS system for a while because I haven't needed scientific dictionaries the past few months. On the other hand, I didn't remember it was *that* hard to use.

It's comforting to know I have all that data when I need it, and I wanted it working again. So the next day, I called Inductel. It turns out that the reorganization of my hard disk was to blame. I had the earliest version of KAS, and in it, the exact path to the dictionaries is specified in a non-ASCII data file the program accesses. I'd moved KAS from the D drive to the K drive, and the bad news was that I'd have to reinstall. That's bad news indeed, because the installation program is a bit of a dog's breakfast.

The good news was that there was a new version that made installation easier, and they'd send it. At least I thought that was good news.

Years ago I invented the description "infuriatingly excellent" for programs like this one. This one is excellent, because once you understand it and get it working properly, it really is wonderful, and if you need instant access to scientific information, you get to wondering how you lived without it. It's infuriating because the installation routine assumes you know how to use the program, and so does the manual, and much of it's simply not intuitive, at least not to me.

The good news is that persistence pays. Although some of the problems I had made me think it was due to copy protection, that wasn't true: there isn't any copy protection. There's just a counterintuitive installation routine and a nonintuitive user interface. Be persistent. Once you get it working and understand how to use it—really less than an hour's work—it is excellent: physics, chemistry, biology, 26 languages with a limited but fairly large vocabulary, a mechanical design dictionary, and computer terms. All on-line, all easily available, and, truth to tell, easy enough to use once you get the hang of it.

A slug, incidentally, is either a pulmonate gastropod (biology) or the mass that experiences an acceleration of 1 foot per second per second when a force of 1 pound acts on it (approximately 32.174 pounds mass). And did you know that a snake is *zmija* in Serbo-Croatian, but *ular* in Indonesian?

Now that I've got the system running properly, I expect I'll use the KAS dictionaries a lot more. Recommended.

Taming Desqview

Tame is wonderful. If you use Desqview, get it. It's available as shareware or directly from the publisher, and you won't know how you lived without the time you'll save.

Tame is a fairly small (6 KB) TSR program that you run in a Desqview—or VM/386, DoubleDOS, or Windows 3.0—window along with the program you want in that window. Tame then notices if your programs are accomplishing nothing—for instance, polling the keyboard device. If so, Tame will switch the CPU's attention to what's going on in another window. This may not sound like much, but the improvement in performance is very noticeable.

Example: I usually put Norton Commander in my first Desqview window. Unfortunately, if I leave that program active in the background, the performance of other programs is degraded considerably, even though Commander isn't doing anything. As a result, I've always had a separate Desqview window for "Norton Mail," which is nothing more than Commander given access to a serial port and told to run in the background; and yet another, "Norton Active," which is Commander with no serial port but active in the background so that it can do big file transfers and copy operations. When the latter two cease to be active, I close their windows.

Tame lets me leave the Norton Commander window running in the background, so I don't need Norton Active at all; and for that matter, no great harm is done if I leave a tamed Norton Mail open. The one thing you should do with Commander active in the background is turn off the Screen Saver feature. Screen Saver writes to the screen, and Tame doesn't know that's what's happening; the result is that Commander can be stealing more cycles than you like—enough to make your mouse vanish in a game window—when all it's doing is "saving" a screen to which it isn't really writing at all....

Tame also lets you leave Info Select (or its older brother Tornado) open in the background, tames WordPerfect and other editor programs (although I don't ever leave editor programs open in the background anyway), tames Lotus 1-2-3 and other spreadsheets, and so forth. If it has any cost other than the 6 KB of memory it eats, I haven't found it yet.

That's Desqview. I confess that I have *not* run this with Windows other than to see that it does seem to work; but I have no reason to doubt that the effect on Windows will be at least as dramatic as it

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is with Desqview.

The manual is a bit dense, but the program is easy enough to use; and if you have questions, there's a BBS. This does not cost much, and if you multitask, I'm sure you'll like it. Recommended.

Q&A 4.0

If you use Q&A—and I do, even though I have every conceivable rival to the program—you should get this update. It doesn't fix all the quibbles I had with Q&A, but it takes care of a lot of them.

Q&A isn't the fanciest database available, and it isn't the most powerful. If you really need a full relational database capable of doing complex operations on big files, and a powerful programming language to control it, Q&A isn't going to do you any good. On the other hand, I don't need that kind of capability. I have to keep track of my books and contracts, and that does sometimes get complex enough that I can wish I'd set up something in Paradox and been done with it. But the fact is, I get along nicely with Q&A. And for keeping up with mail and correspondence, and generating letters to be sent to selected lists, and that sort of thing, Q&A is not only plenty powerful, it's easy to use.

Easy to learn, easy to use, even if you don't use it every day; that's why you get Q&A. Not to mention that the Write program is much the same, easy to learn and easy to use, powerful enough for everything I do. The main failure of Q&A Write is in printing very large documents or stuff with a fancy layout. There's no widow and orphan control (i.e., a way to make sure that there isn't a page break after one line of a paragraph or one word before it ends), and I'm still not happy with the method for linking files to be printed in consecutive order with continuous page numbers. No matter. They're minor problems compared to the invisibility of Q&A Write for doing creative writing, pounding out letters, sending form letters with mail merge, and all the other stuff I do frequently, and the ease of use of the integrated database.

As an example of its ease of use, you really need to know only three keys: F1 is help, Esc is "don't do it," and F10 is "do it." With these three keys, even a complete novice computer user can compose and send letters in a half hour's time. Contrast this to the "WordPerfect is a way of life" school, where days are needed to become halfway competent.

Q&A 4.0 incorporates mouse support. There's a print preview feature for use with proportional fonts, so you get something more WYSIWYG than with the old Q&A. The database interface is improved. Better menus, better documents, just all around better. Q&A 4.0 isn't a "Windows application," but it runs just fine under both Windows and Desqview. (In fact, it comes with a program information file for Windows.) When people tell me PC software is too difficult and they're going to have to get a Mac, I point them at this. Clearly recommended, since it's what I use.

Logistics

Go Tell the Spartans has been out for several months and on the best-seller list a good part of that time. We haven't had any complaints about the print quality, so I guess the story can be told. The book was typeset in-house at Baen Books. A story goes with that.

This was a very collaborative work. The characters are mine. Its universe,

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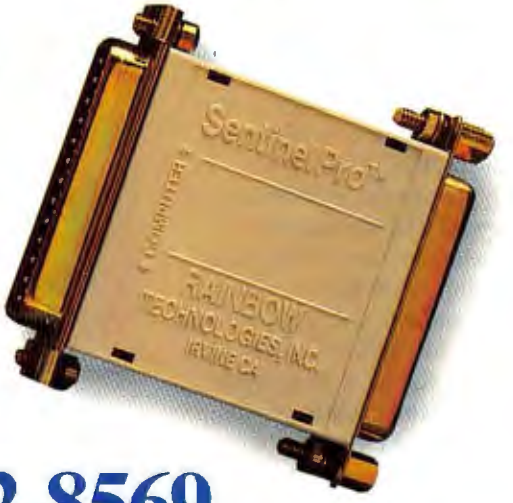

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the world of Falkenberg's Legion, is very popular, but lately I haven't had much time to write that kind of fiction. Falkenberg's Legion exists in the world of the CoDominium, in which the U.S. and the U.S.S.R. get together to share influence and make sure that no other country would ever be a superpower. I wrote that about 20 years ago, and now things are catching up. Jim Baen, who both edits and publishes the series, wanted more CoDominium stories. He suggested that I work with Steve Stirling.

Go Tell the Spartans was the result. I did the plot. Steve did a first draft. I didn't like some of what he'd done, rewrote some, added new scenes, and tore the rest apart. Steve rewrote, and we went through that process once more. It was pretty good this time. Finally, I put his final work into my machine and went through it all, rewriting in some places, adding to scenes or building new scenes, and generally making it the way I wanted it. Everyone seems to like the result.

Of course, the original notion was that I'd do a lot less work than I did, but it wasn't too big a surprise when that didn't work. I've found over the years that most collaborations require considerably more than 50 percent of the effort to be done by each party. When I am working with Larry Niven, we both do about 90 percent of what we'd do if we were working alone. *Go Tell the Spartans* I'd estimate was about 75 percent for me and 90 percent for Steve. (One of Jim Baen's best turns as an editor is to keep convincing me that collaborations do not involve much work for me.)

The interesting part was the logistics.

Start with word processors. Steve likes WordPerfect. Jim likes XyWrite. In both cases they tend to put everything in one enormous file, one far too large for Q&A to access. That almost shot the project down right there: I found I was spending the time I'd intended to use working on the book just trying to get it up on my screen so I could read it.

That part took several iterations, and it included my trying to learn XyWrite. I did learn it well enough to use for breaking book-length files into chapter-size chunks, and in the process I got to understanding why those who like XyWrite like it a lot. I also decided I wasn't going to become a XyWrite user. (As Baen is fond of saying, XyWrite just out of the box is a do-it-yourself word processor kit.) I also decided I wouldn't switch to WordPerfect.

The next part saw us working with Word for Word, which is a pretty nifty file format–translation program. Alas, Q&A Write uses a very sophisticated—one might say needlessly complex—header. The rest of the file is ASCII, but if you don't get the header right, Q&A Write won't read it properly. Mind you, Q&A Write reads ASCII just fine; for journalistic work, I generally use ASCII with double spaces between paragraphs. That one's real easy. So is WordStar format: Q&A Write reads that fine, and for complex formatted file transfer, WordStar 3.3 is really hard to beat.

Alas, Word for Word didn't always translate WordPerfect files into proper Q&A Write files. Another round of frustrations, resulting in my telling Baen I was going to abandon the project. It was just eating too much creative time in logistic details.

One more attempt. This time, Baen read the WordPerfect files into his XyWrite; this was complicated by the fact that Word for Word handles WordPerfect 5.0 just fine, but WordPerfect 5.1 files

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PC MAGAZINE

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PC Magazine, 1/15/91

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can't be converted. Once Jim had them in XyWrite, he made some margin adjustments to keep the line lengths below 70 characters and used Word for Word to convert those to Q&A Write. The Q&A Write file was then compressed with PKZip and sent to me over BIX.

That worked. Sort of. That is, Q&A Write could *read* the file all right; but any attempt to page through the file would result in the program crashing, requiring that I close the Desqview window containing Q&A Write. But I could read in the file, reformat the page to my standard (left margin of 8, right margin of 72, 66 lines per page, total page width of 78), and *that* was just fine. I could read and edit that, and save and recover it as I do with any other file.

Once we figured that out, it was simple enough. Jim Baen wrote a macro that would do the job at his end; I'd get the new chapter, PKUNZIP it, and leave it in a work subdirectory. Then I'd change Desqview windows to the Q&A Write window, read in the file from the work subdirectory, press my macro key to reformat the page for Q&A Write, and save it into the \QW\SPARTANS subdirectory. Come time to send it back to Jim, I'd simply PKZip my QW file and BIX it. Jim's Word for Word has no trouble at all translating Q&A Write files for XyWrite, and it gets the boldfacing and underlining and italics right first crack.

That was phase one.

Pretty Print

Phase two: Baen put the entire book into one enormous XyWrite file, did what copy editing he thought was necessary (really careful spelling checking, scanning to see that minor character names didn't change spellings, checking for continuity, and so forth), and fed that into Ventura Publisher. Then he'd do page layouts. If he noticed anything wrong, he could do minor copy editing in Ventura. But for major corrections, it was easier to hike it all back into XyWrite and do it there. Ventura isn't a really good vehicle for copy editing.

Eventually he had that to his satisfaction and printed it in Baskerville typeface on a Hewlett-Packard LaserJet III. The galley proofs were merely the printed output on good-quality 8½- by 11-inch paper in landscape mode (i.e., two book pages side by side on the sheet). Those galleys were great: enough margin to mark things up on, very clear, and easy to read. Indeed, in the early phases of the book, when I was still unhappy with some of it and tearing things apart, I could mark up on paper, rewrite my

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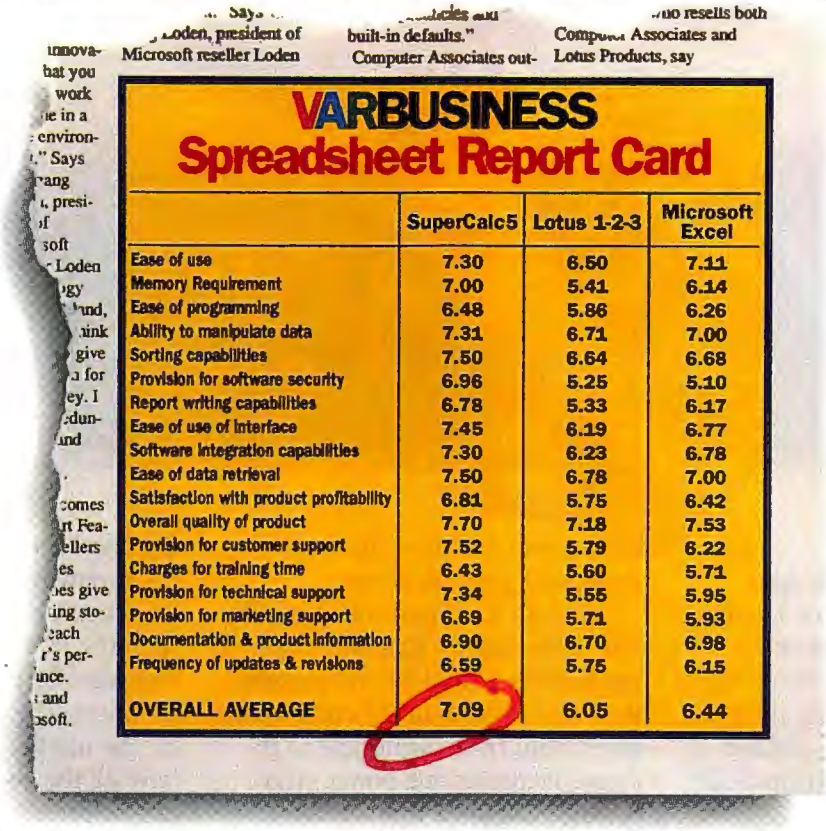
The Pros Rate SuperCalc5 Higher Than Lotus 1-2-3 And Microsoft Excel.



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	SuperCalc5	Lotus 1-2-3	Microsoft Excel
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Memory Requirement	7.00	5.41	6.14
Ease of programming	6.48	5.86	6.26
Ability to manipulate data	7.31	6.71	7.00
Sorting capabilities	7.50	6.64	6.68
Provision for software security	6.96	5.25	5.10
Report writing capabilities	6.78	5.33	6.17
Ease of use of interface	7.45	6.19	6.77
Software integration capabilities	7.30	6.23	6.78
Ease of data retrieval	7.50	6.78	7.00
Satisfaction with product profitability	6.81	5.75	6.42
Overall quality of product	7.70	7.18	7.53
Provision for customer support	7.52	5.79	6.22
Charges for training time	6.43	5.60	5.71
Provision for technical support	7.34	5.55	5.95
Provision for marketing support	6.69	5.71	5.93
Documentation & product information	6.90	6.70	6.98
Frequency of updates & revisions	6.59	5.75	6.15
OVERALL AVERAGE	7.09	6.05	6.44

Recently, *VARBUSINESS* conducted a survey of some people who know more about spreadsheets than anyone.

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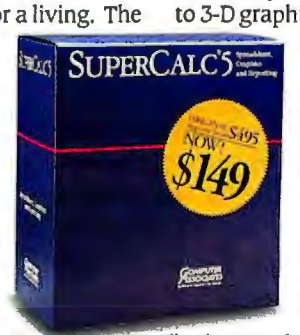

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Premium II 386SX/20

Premium II 386/33

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Circle 29 on Inquiry Card (RESELLERS: 30).

Q&A file, send that, and have new page proofs back in a few days. It really sped things up.

And finally we had the book the way we wanted it. It was long past time it could be sent to a typesetter; so the master copy was printed on Jim's LaserJet III, and a photoreduction of that was what was actually printed. I think it looks fine, as good as *Prince of Mercenaries*, which was set in the usual way.

The implications here are obvious. Among others, authors can experiment with fonts and typefaces. Niven and I used a variety of font changes in *Oath of Fealty*; they indicated different kinds of events, such as BLOCK CAPITALS TO INDICATE A COMPUTER SPEAKING OVER A LOUDSPEAKER, small capitals to indicate computers speaking quietly and directly into a character's mind, *italic to indicate internal dialogue*, and so forth. I think that works, and I'd like to do more with it.

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The bottom line is that I'm going to get a LaserJet III. (I may actually—urk!—*pay* for it.) I probably won't do my own page layouts, but it's sure nice to know I could if I wanted: that I could submit camera-ready copy to a publisher, giving me absolute control of what is printed with my name on it.

Pioneer Does It Again

The Pioneer six-pack CD-ROM Minichanger is great. We've had it in operation for the best part of a year now, on a number of different systems. At present, it's daisy chained with Pioneer's read/write multipurpose optical disk drive, run by a Corel SCSI board, on an Arche Legacy 486 running DR DOS 5. But it has been on a number of other machines, with different SCSI cards and DOS varieties from 3.3 through 5.0. It has always performed flawlessly. I've had three different CD-ROM programs open in three different Desqview windows and jumped back and forth among them; no problems, and as I said in the original review, it changes drives a lot faster than you'd expect it to.

The other day a mysterious package arrived from Pioneer. No cover letter, no PR hype, no press release. Just a card from a Pioneer engineering supervisor, a plastic tube containing two very large ROM chips, and a single sheet of instructions on how to take the Minichanger apart and replace the old ROM chips with the new ones.

That change took about 10 minutes, because the ROM chips are big and we bent the pins inserting the first one. After I straightened them and got out the Stabilant 22 contact enhancer and connector lubricant, we didn't have any more problems. We put the machine back together again, loaded it with some highly visual intensive CD-ROMs like the wonderful Impressionist disk, and tried it out.

It's really fast. It may not be faster than the newest Hitachi CD-ROM player, but it's not noticeably slower. Accesses that used to take many seconds are now nearly instantaneous. Accesses that took over a minute now take a few seconds. I always did like the Minichanger, even though it was slower than the Hitachi. Now it's even better.

Incidentally, the Pioneer Minichanger will work just fine with a Mac.

CD-ROMs

There are so many new CD-ROMs it's impossible to look at them all, much less review them. One good one is the Civil War, which is part of the American Wars

— Circle 189 on Inquiry Card.

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MICROSOFT WINDOWS.

PC MAGAZINE EDITORS' CHOICE September 13, 1988 Watcom C, Version 8.5

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Highlights

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series from Quanta Press. So far I have Korea, Vietnam, and the Civil War; there may be others, and certainly there will be more in the future.

The Bureau of Electronic Publishing, meanwhile, has its Revolutionary War CD-ROM and is busily putting the *Monarch Notes*—apparently *all* of them—onto CD-ROMs. Remember them? The bright red and black booklets that have saved more than one collegiate career. The Bureau would have that CD-ROM done if it weren't for the volcano in the Philippines (that's where the data entry is done). It should be out about the time you read this.

Pioneer has a six-pack of CD-ROMs that includes Countries of the World (with maps and recordings of national anthems), U.S. History, Shakespeare, and a Potpourri disk that includes the King James Bible, a movie database, and other stuff; it sounds a lot like the old Between Heaven and Hell disk.

And Drew Kaplan, one of the founders of Priority One but now the CEO of DAK, sells scads of CD-ROM packages as well as reasonably priced drives; also, Radio Shack has their MultiMedia series featuring not only reasonable prices but CD-ROM drives with speeds comparable to that of the Hitachi and the new and improved Minichanger.

The CD-ROM of the month is Quanta's Civil War.

The CD-ROM of the Month is Quanta's Civil War: lots of good stuff on that.

A Visit from St. Niklaus

Longtime readers will recall Dr. Richard Ohran, who while at ETH (the Federal Technical University in Zurich, often known as the Swiss MIT; Einstein got his Ph.D. there) did most of the hardware design on the Lilith computer. Lilith was designed to use Niklaus Wirth's Modula-2 as its internal machine language and operating system. Wirth, who is at ETH, wrote ALGOL-68 and Pascal and is a major light in computing.

The other day, Dr. Ohran called to say he was driving Dr. and Mrs. Wirth to the L.A. Airport, where they would be catching a SwissAir plane to Europe; would it be convenient if they stopped by Chaos Manor for a couple of hours?

Convenience hardly mattered. I had a most enjoyable visit with Wirth at the Institute for Computer Systems in Zurich a few years ago (that was when I had to file my column from Liechtenstein by printing it on what amounted to adding-machine tape; the editorial assistant who had to retype it has never forgiven me), and I'm flattered that Wirth reads this column. I hastily changed my schedule.

Dr. Wirth's latest project is Oberon, a language that goes beyond Modula-2; more on that in later columns.

Richard Ohran has a new Transputer Education Kit. This is a package of software and a PC board that will let you experiment with transputers as coprocessors. Being a transputer, it comes with occam, the parallel-processing language developed by Inmos with the transputer

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in mind. There's also a Modula-2 compiler that lets a PC with a transputer board work very much as the old Lilith did. My memory of the Lilith with Modula-2 is that it was the best programming environment I've ever experienced.

The beast comes with a workbook and complete instructions; not surprisingly, it would drop right into a parallel-processing university course.

Computer System Architects will probably have to have a transputered Oberon environment one of these days, too. A lot more on all this in later issues.

Dr. Wirth seemed to enjoy Chaos Manor, but the high point for me was when Roberta photographed him gaping at Wing Commander on the 19-inch Hitachi monitor driven by the Cheetah 486. The game is a really good demonstration of just what small computers can do, what with graphics and keeping track of all those spaceships and missiles and even shots from guns, and doing it at really high speeds; it's also gorgeous to watch. But there is a certain satisfaction in seeing one of the top computer scientists in the world fascinated by a space war game....

I think you're going to like Oberon, and the Transputer Education Kit looks to be a great hit. Stay tuned.

Winding Down

The game of the month is Martian Dreams. This uses the Ultima games engine to present a science fiction story: what if Jules Verne's cannon really could fire you not merely to the moon, but to Mars, and an expedition led by Percival Lowell went there in 1893 to find that Mars was very much as Lowell imagined it to be, complete with canals, mostly extinct Martians, wild animals, and lots of stuff like that?

Fair warning: the early stages of the game are frustrating, since you spend a lot of time bashing monsters, and until you build up enough hit points through experience, this can be both time-consuming and threatening. Also, this isn't a game you can expect to finish in a day or two: it's going to take a long time to solve all the puzzles, which include getting the Martian power plants operating again, melting the ice caps to fill the canals, and curing the madness of many expedition members, including Lowell and George Washington Carver. Loads of fun, actually, once you get past the early stages.

There are several books this month. One by Shay Addams, *Railroad Tycoon: Master Strategies for Empire Builders* (Osborne/McGraw-Hill, 1991), is precisely what it sounds like, a book about how to play Railroad Tycoon. Worth reading, too: I'd have bought it if they hadn't sent a review copy. Alex and I kept quoting new wrinkles to each other from it; this after a year of playing the game. Incidentally, Railroad Tycoon now runs on the Mac, and all reports are that it works fine.

The serious book of the month is by Paul Johnson, *Birth of the Modern: World Society, 1815–1830* (HarperCollins, 1991). Like all of Johnson's work, it's very thorough, interesting, and thought provoking. Fair warning: it's a *big* book.

The computer book of the month is actually a book and a program: *Display Mate Video Display Utilities* (Sonera Technologies, P.O. Box 565, Rumson, NJ 07760, (908) 747-6886) will tell you as much as you ever wanted to know about optimizing your video display. Do your eyes get tired from staring at video screens? There are things you can do that may help. The manual is worth reading just for the information.

Now I'm headed for Baja to see the eclipse. I've got the Magellan Satellite Navigation receiver set up, I have the U.S. Naval Observatory book on where the eclipse is, and, with luck, I'll be within 3 meters of the exact center of the path of totality. You'll hear all about it next month. ■

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

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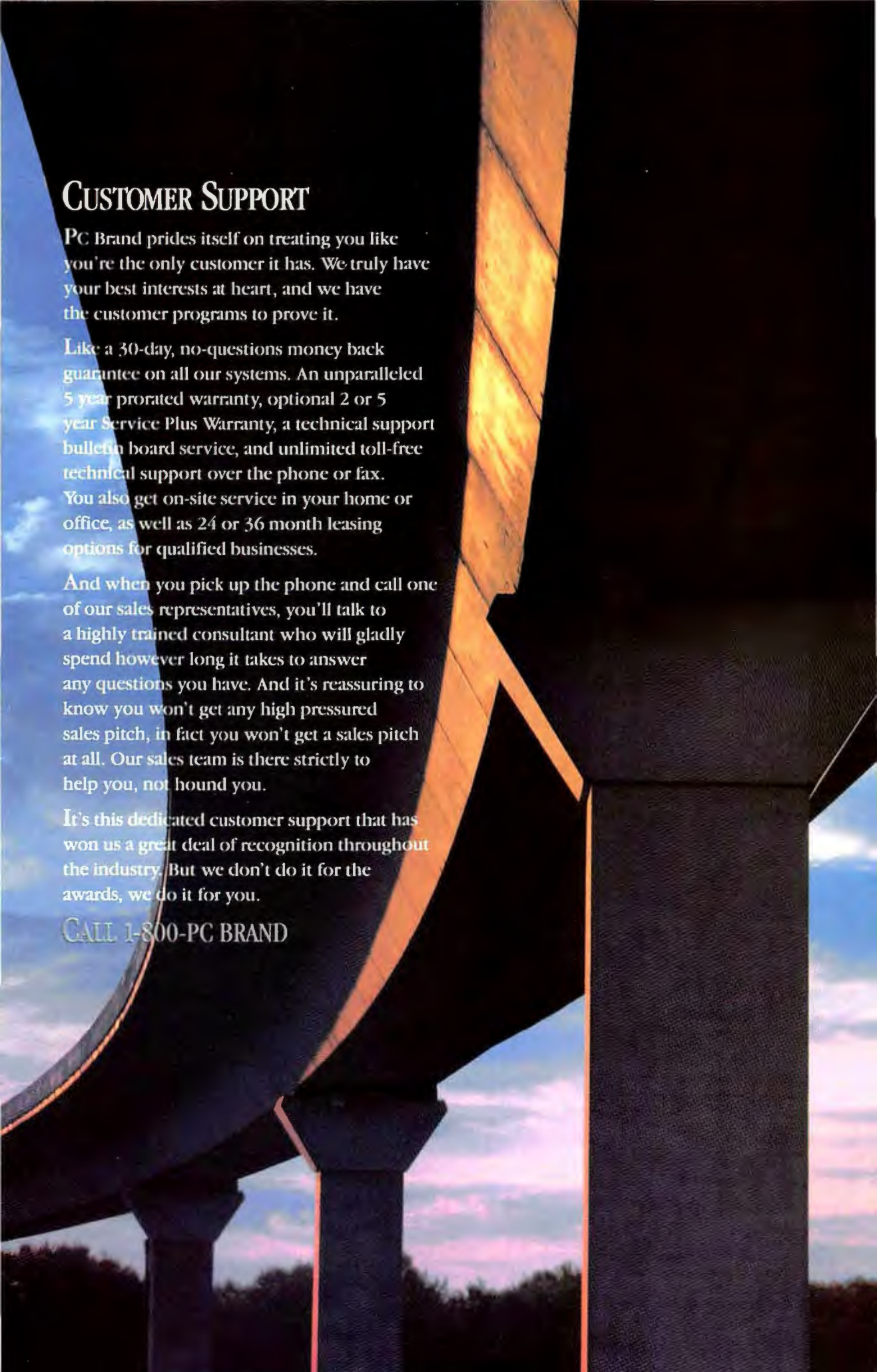

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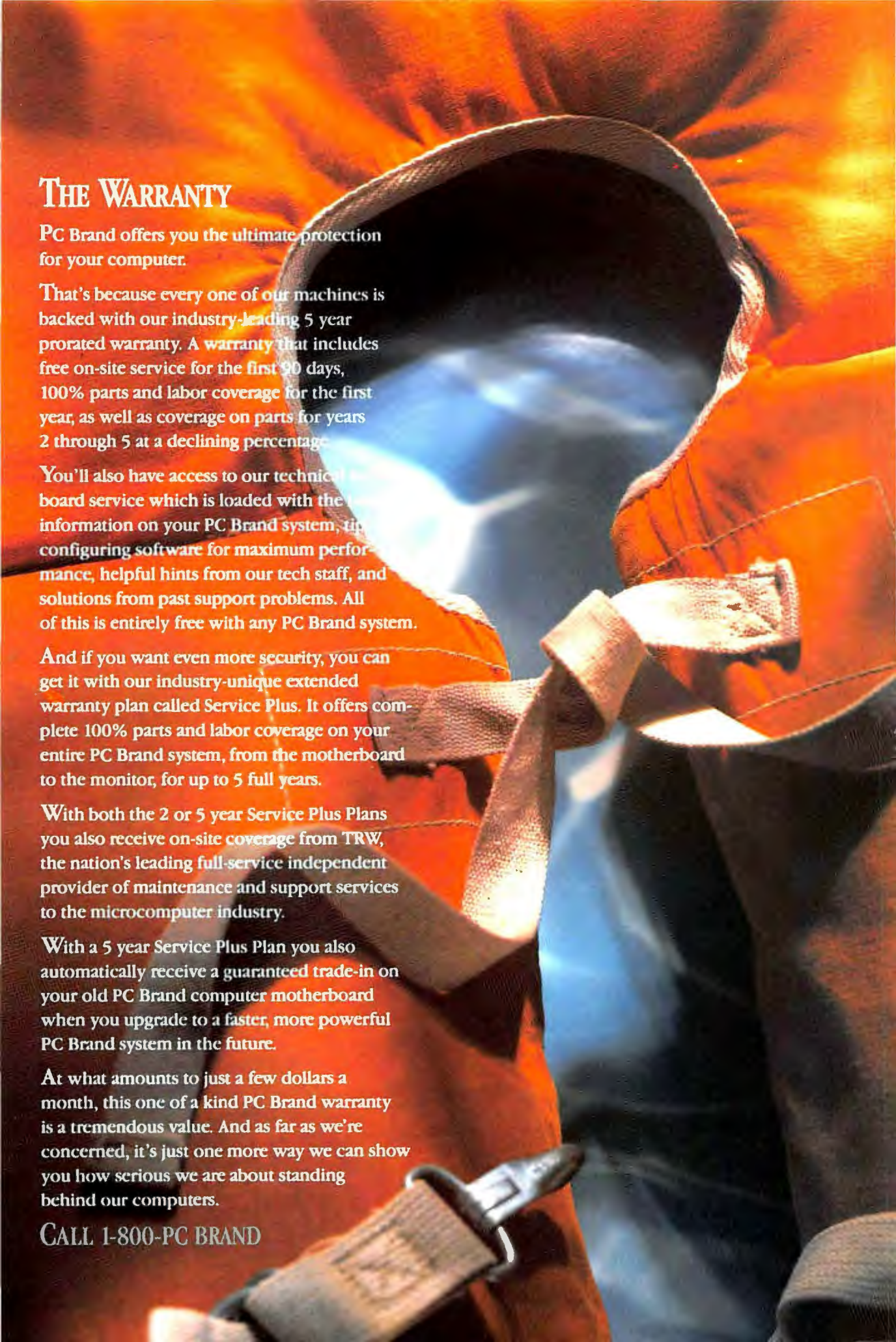

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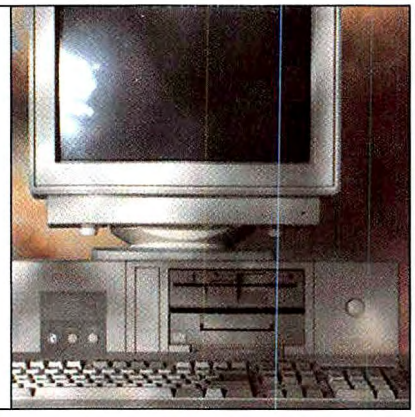

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DEFENDING YOUR LAN

For the last couple of months, I've discussed the preliminary stages of LAN design from the manager's viewpoint. That was for a reason: You now have some of the background you'll need to defend yourself in staff meetings after you make the decisions I'll talk about this month. You're about to enter the dangerous territory of network operating systems and protocols.

You'll note that I didn't say that the process of choosing network operating systems and protocols was necessarily difficult, nor that some technical mystery was involved, because it's not. Instead, this is the area in which everyone in the company will try to second-guess you or preempt you. Compared with choosing between Ethernet and Token Ring, for example, the executive-suite battles about the annual budget or corporate strategy are trivial. When something really important emerges, such as a choice between NetWare and LAN Manager, entire staff-decades can be lost on the decision process.

Why Does It Matter?

The sad part about these boardroom battles is that they need not happen at all. For the majority of all LANs, there isn't any significant difference between the capabilities of Ethernet and those of Token Ring. Likewise, the choice of LAN operating systems won't matter significantly to most users. In other words, for most LANs, the choice is easy because technically it simply doesn't matter very much.

This is not to say that there aren't differences, because there are. Some of the differences are important and, in a few cases, can have critical impacts on the choices of protocols or network operating systems. Most of the time, though, the differences are more economic than technical, and often the choices are made more for political reasons than technical reasons.

Since it's often easier to lose your job for political infractions than for technical errors, the differences between LAN choices are important. What's also important, though, is to know when there's a good reason to fight for a particular selection and when there's not.

Hard Choices

A few years ago, IBM salespeople were trained to tell their customers that Token Ring (which IBM used) was vastly superior to Ethernet (which it isn't). This was in the days when Token Ring had a data transmission rate of 4 Mbps, and Ethernet moved data at 10 Mbps. IBM sales literature claimed that Ethernet really didn't work as fast as Token Ring, even though it had a faster data rate. This was, of course, hogwash.

Now, IBM sells Ethernet, and the claims about its inferiority have disappeared from the literature. Besides, now Token Ring runs at 16 Mbps, so it's clearly faster, right? Well, actually, no. In the real world, it's not correct to say that either protocol has the edge over the other, because too many other variables affect network speed. You can prove that either Token Ring or Ethernet is faster, depending on the benchmark you use.

The nontechnical issues may be the most hotly debated when you're selecting a LAN

Besides, it doesn't matter anyway. Regardless of which personal computer you are using, you're not going to be able to handle data at anything like the rate at which the network runs. A good analogy would be to imagine hooking up a garden hose to a sewer pipe. It doesn't matter much whether you're using a ½-inch or a ⅝-inch hose, or whether the sewer pipe is 34 inches across or 36 inches across; you are not going to exceed the capacity of the sewer pipe with that garden hose. In short, the capacity of the LAN so exceeds the capacity of any of the PCs that the capacity of the network is rarely a problem.

That does not mean that there aren't important considerations that might mandate one protocol over another. You might find, for example, that you have to provide a path to the company mainframe, which is an IBM 3090. In a situation like that, it's a safe bet that at least part of your LAN will be Token Ring, since controllers with Token Ring capability are vastly more common in the IBM mainframe world than controllers with Ethernet cards.

Likewise, if you have to provide access to the company VAX or one of various Unix machines, then you can assume that you'll need Ethernet in part of the

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LAN, because VAXes and Unix boxes usually support only Ethernet. In fact, you might find yourself having to deal with a Datapoint system and find that your LAN must support ARCnet.

As it happens, LANs that need to be bridged to a LAN of a different protocol tend to show performance degradation for the traffic that must cross the bridge. This means that if you can avoid such a bridge, you'll probably see slightly better response time, all other things being equal. To avoid such a bridge, use the same protocol throughout the LAN.

Unfortunately, you can't always use a single protocol throughout a LAN. Suppose you have several types of computers, including something in a VAX and maybe something else in an IBM mainframe. You may well find yourself with a LAN that has to support both Token Ring and Ethernet. At that point, you can solve any problems of second-guessing by announcing that you are going to select both protocols.

Cost used to be a major deciding factor in choosing a LAN protocol, but that difference has nearly disappeared as well. While you can still buy a network interface card for Ethernet at a much lower cost than for Token Ring, this makes little difference in the cost of the whole LAN. The reason is that users are embracing the new 10Base-T standard that uses twisted-pair wiring for Ethernet instead of coaxial cable. This also requires the use of active hubs, effectively raising the price so that it's nearly as expensive as an equivalent Token Ring LAN.

Soft Choices

There was once a time when choosing a network operating system was relatively simple. If you were an IBM shop, you went with either LAN Server or LAN Manager because that's the IBM way. If you weren't, you went with NetWare. Now, everything has changed. IBM has embraced NetWare. Microsoft is aiming beyond LAN Server. NetWare works better with Macs. LAN Manager works on Unix servers. Meanwhile, what about Banyan Vines?

In fact, for most office users on moderate-size LANs, the network operating system makes remarkably little difference from the user's viewpoint. Users want to share data, send E-mail, and use their scheduling program. They really don't care if the file server is running OS/2, Unix, or something proprietary, as long as it works. Fortunately, all the major network operating systems work.

Since they all work, does it make a difference which one you select to support your corporate LAN? Well, yes, it does, but the reasons are more business-related than technology-related. For example, if you already have a specific network operating system running in your corporate environment, then it makes sense to use the same one if you can. After all, you might need to connect them at some point. If you need to connect your LAN with existing LANs right away, then you must select something that is compatible, unless you're prepared to change the other network to match yours.

There's also the matter of applications software. If you need to use a specific application, and it requires a specific network operating system, then you need to use that operating system. You don't have a choice. This is often the case with database servers and applications that support them, since some of them can be pretty picky about the network operating environment in which they reside.

Beyond these considerations, selecting a network operating system is likely to depend on a specific feature that you require. Because the top network operating systems each have unique features, there are factors that can make you choose one system over the other. Below is a list of some major systems and features you might want to know about.

Novell NetWare

If you're worried about hardware or software support, NetWare is your choice. This is because Novell owns between 60 percent and 70 percent of the LAN operating system market, which means that Novell always gets support first. In addition, NetWare has excellent Macintosh support, and the NetWare loadable modules for NetWare 386 provide support for a vast array of other networks.

NetWare is a bit faster than the other market leaders, although a lot depends on whose benchmarks you use. It has the advantage of excellent security, and you will more easily find people who know NetWare than those who know other environments, again because of Novell's market position. On the other hand, NetWare 3.11 is hideously expensive at 12 grand a pop, and you'd better hope you buy from a dealer who knows the business, because Novell expects you to get service from the dealer, not from Novell.

LAN Manager (and LAN Server)

Microsoft's LAN Manager has improved greatly from its rather shaky beginnings. Its problem with spontaneous crashes has been licked. Microsoft has also improved the system's security and boosted the performance so that some users claim

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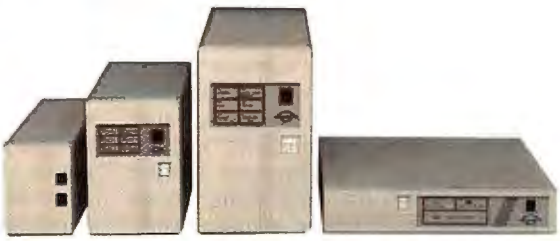

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it's just about as fast as NetWare. Because LAN Manager and IBM's LAN Server are nearly identical already, and because the two network operating systems are growing closer, the IBM clout also provides clout for Microsoft.

While it's possible that IBM's move to include NetWare in its universe may have an adverse effect on LAN Manager, it's not likely. In fact, the stated intention of IBM to create a link between LAN Manager and NetWare is a plus for LAN Manager. LAN Manager, meanwhile, provides security features such as the ability of the network operating system to perform file server mirroring, which NetWare can't do. LAN Manager also supports OS/2 workstations much more cleanly than does NetWare, although Novell says it's working on that.

On the other hand, LAN Manager and LAN Server still don't have Macintosh support, and they can't support TCP/IP except with a third-party product. These shortcomings will probably be fixed in a little while (IBM says by the end of the year), but in the meantime, if you need these capabilities, you're out of luck.

LAN Manager is also beset by some odd pricing, which means that you get a choice of two sizes: five users and more than five users. Because LAN Manager doesn't have a stated upper limit on licensed users, you need to compare prices between LAN Manager and NetWare according to the actual number of users. The differences in either direction can be astonishing, although no matter what you do, LAN Manager isn't going to cost you 12 grand.

Banyan Vines

Despite its small installed base of LANs, Banyan has long been a favorite of large companies and large agencies with large LANs. Much of this is due to the Vines software and its transparent support for multiple file servers on a network. If you have the network set up properly, you can log onto the Vines network from any workstation in exactly the same way, and the network will figure out how to route your connection to your home server.

This feature is so powerful that Microsoft has incorporated something called Domains that works similarly, and Novell has created its Directory Naming Services to do the same thing. In the meantime, the Banyan solution works well for users and administrators alike, while the jury's still out on the other two.

Vines has built-in communications support and will support gateway and bridge installation in the file server itself. TCP/IP support is built in as well, probably because Vines uses Unix as its native operating system. This makes Vines a natural for use in a large enterprise network, while its low price makes it a natural for small networks.

Banyan's biggest problem is the fact that it's not the biggest. Estimates of the company's market share place it in the 5 percent range, which means that hardware and software support for Vines may arrive later than for Novell and Microsoft or, in some cases, it may not arrive at all.

ITEMS DISCUSSED

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Making a Choice

With the exception of Macintosh support, most technical issues that differentiate the major network operating systems are negligible. All three will work with Windows. MS-DOS 5.0 comes with drivers already in place for NetWare, LAN Manager and LAN Server, and Banyan Vines, as well as several other network operating systems. MS-DOS 5.0 will arrange to load the network workstation software into high memory, so the relative memory requirements no longer matter as they once did.

At this point, you're down to some simple technical decisions, specifically whether or not you need support for the Mac or for TCP/IP. If you do, you might as well plan on using either NetWare or Vines. If you don't, you can consider any of them. Of course, there are other factors, including the choice of Structured Query Language database servers and server security, but those are normally not of critical importance.

What this all means, therefore, is that despite the advertising claims to the contrary, it really doesn't matter which network operating system or protocol you use as long as it supports the software and hardware you want to use. For most users, other factors outweigh either of the two items that usually generate the most heat. Of those other factors, the most significant is the choice of the vendor, whether that vendor is presented as a LAN installer, a consultant, or a computer store. The second most important factor is the economics of the total installation.

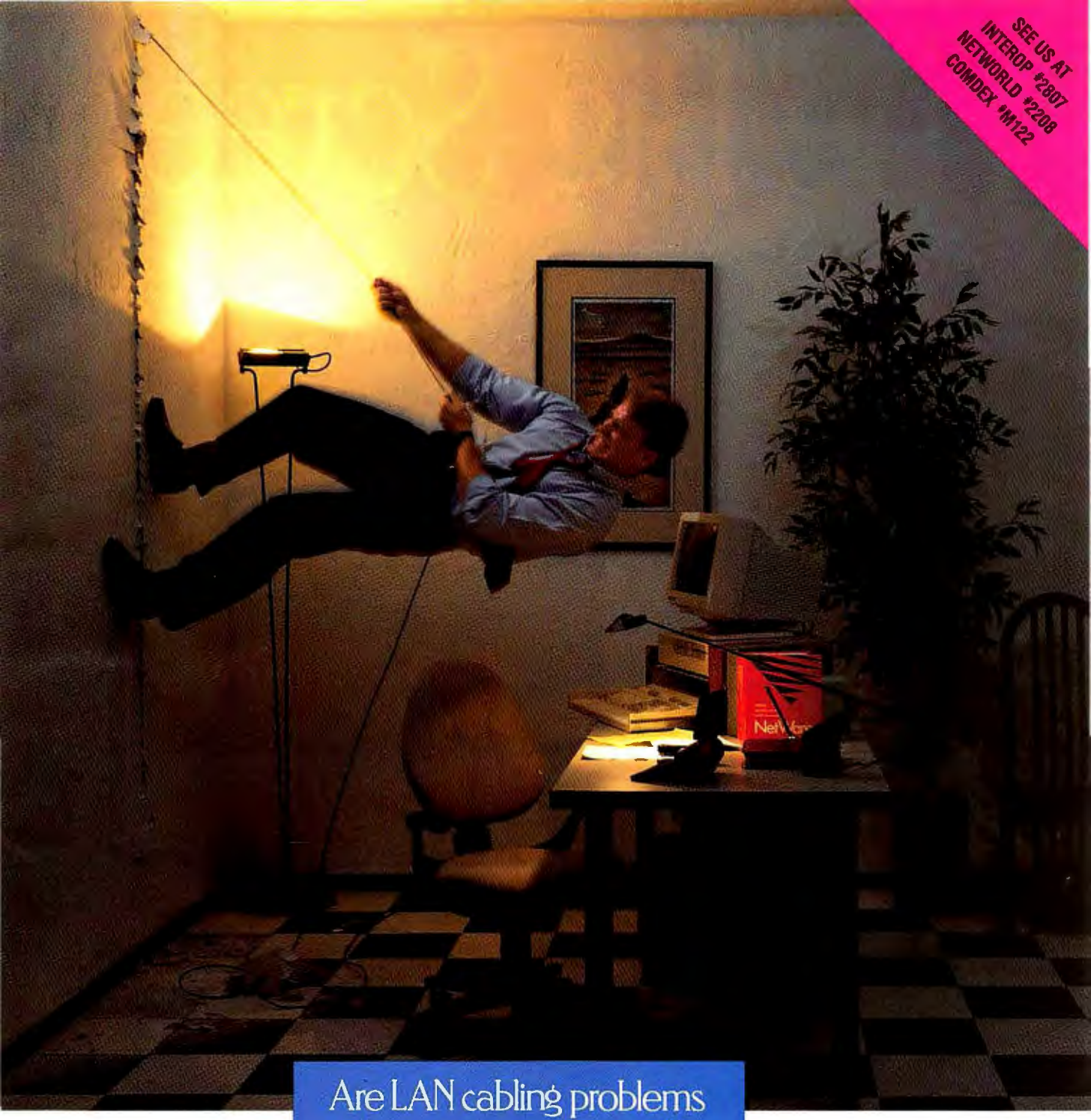
The choice of vendor is crucial because it makes little difference which LAN you select if it's not installed and configured properly. Compared with other factors, including price, the choice of vendor may finally be expressed as a choice between a LAN that works and one that does not. Simply put, it doesn't matter how inexpensive a nonworking LAN is, because if it doesn't work, it's too expensive.

Given that a LAN will work the way you want it to, the next factor is that it meets your company's cost objectives. If it doesn't, you need to reexamine either your cost objectives or your requirements, because one of them is out of sync with reality. Large LANs especially are neither inexpensive nor simple, and you can't expect them to cost as if they were.

There. I've done it. I've let out one of the great secrets of the LAN industry. For most users, the choice between Token Ring and Ethernet and the choice of LAN operating system (as long as it's from a major vendor) simply don't matter very much. You'll hear from the partisans of one brand or another that it matters a lot (I'm sure I will hear from them), but for most users and most uses, the partisans are wrong. There. I feel much better. I hope you do, too. ■

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 columnists, staff, and contributors debate the issues

WHAT PRICE MODULARITY?

Roundtable is a forum in which BYTE editors, columnists, and contributors 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.

KEN SHELDON: At the PC Expo in New York, I was struck by the number of system vendors playing up "modularity" and "expandability" as a theme. Companies have been selling "CPU cards" that let you upgrade from one chip to another for some time now. At the show, Tandon was showing a series of systems that lets you change processors by plugging in an external cartridge without opening up the case.

Is expandability a real feature that buyers need, or is it just a marketing ploy, a gimmick in search of a problem? Do people really buy 286 systems expecting that they might someday want to upgrade them to 386s or 486s?

DON CRABB: I doubt that people really buy 286 systems expecting that they might someday upgrade them to 386s or 486s. At this point, 286 systems are commodity computers, bought to fill basic needs for the fewest dollars. Are these customers all that concerned about performance? I don't think so. And when they do become concerned about performance, they often just retire the old iron in favor of a much faster 386/486 system that also gets them a new power supply, keyboard, monitor, disk drives, and so on.

While the companies selling modularity may honestly think they are offering upgrade alternatives for their customers, the whole thing seems pretty nebulous to me when you look at the bottom line. If 386 machines were more expensive, I might believe the expandability argument for modular 286s, but 386s are dirt cheap at this point.

MARTIN HELLER: I think the "expandable" thing is a marketing gimmick more than anything. It's a little like price protection—people want it, it makes them feel better, it helps close the sale, and nobody uses it.

On the other hand, I've been upgrading my nonexpandable PC a lot. It amounts to swapping motherboards and adding some cache memory, and it takes 15 minutes to install. Is it worth a steep premium to cut that 15 minutes to 5 minutes for a plug-in board installation?

MICHAEL NADEAU: Yes, it's a gimmick in many ways. But I had the opportunity to discuss expandability with several analysts, consultants, and MIS types recently. At many large PC installations, it is usually cheaper and easier to get approval for upgrades rather than buy new systems. This is currently most often done with a motherboard swap. Those organizations that do routinely upgrade systems—and many of them are doing it by the hundreds and thousands at a time—would welcome a modular design even if it meant paying a little more for the system and paying a small performance penalty.

For the small-business or single user, buying a modular system probably does not make sense. For larger installations, economies of scale kick in and it pays off.

ROGER ALFORD: Having worked in system design at the circuit level for many years, I have an intimate feel for how closely the main memory subsystem has to be designed according to the timing of the CPU. Making a system with a modular CPU board, and a memory system that can survive any of a number of faster CPU alternatives, automatically means compromises in the design and operating efficiency of the memory subsystem.

For example, the ubiquitous 386 requires two clock cycles for a standard no-wait-state memory-access operation. The 486 reduces that to one cycle and throws in a block-mode transfer feature to boot. Unless the

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West Coast Bureau Chief

memory subsystem is designed around the substantially different timing requirements of the 486, the system will not perform optimally. Some vendors will argue—with some merit—that having a cache on the replacement CPU card will minimize the impact of the slower main-memory interface. But that is only partially true, and, depending on the application being executed (since the efficiency of any cache system is application-dependent), the slower memory interface can quickly negate the benefit of the faster CPU.

RICH MALLOY: Bear in mind that many companies producing modular systems now are doing so because their customers have requested them in focus groups. With the wide array of Intel-compatible processors available—or soon to be available—it is quite understandable why some customers would not want to be locked into a single one.

FRED LANGA: You're right, Rich, and I've wondered about that. If you buy the right machine in the first place, then by the time you have outgrown the CPU, you've probably outgrown the disk drive, too. If not just for more space for those disk-hogging applications you want to run on the new CPU, then for faster accessing of disk-intensive software.

Let's see. If you're upgrading to run new CPU-intensive software, then there is a good chance it's graphical, and you will probably want a faster video system, too, so the display can keep up with the monitor. If it's a faster video board, then it probably supports higher resolutions than your older, slower board. Why have those high-resolution modes if you can't use them? So, get a new monitor.

If you've had the machine long enough to outgrow its major subsystems, I'll bet the keyboard is pretty grungy. Better replace that, too. And the mouse sure has a lot of miles on it. Just to be safe, let's get a new mouse. They're cheap.

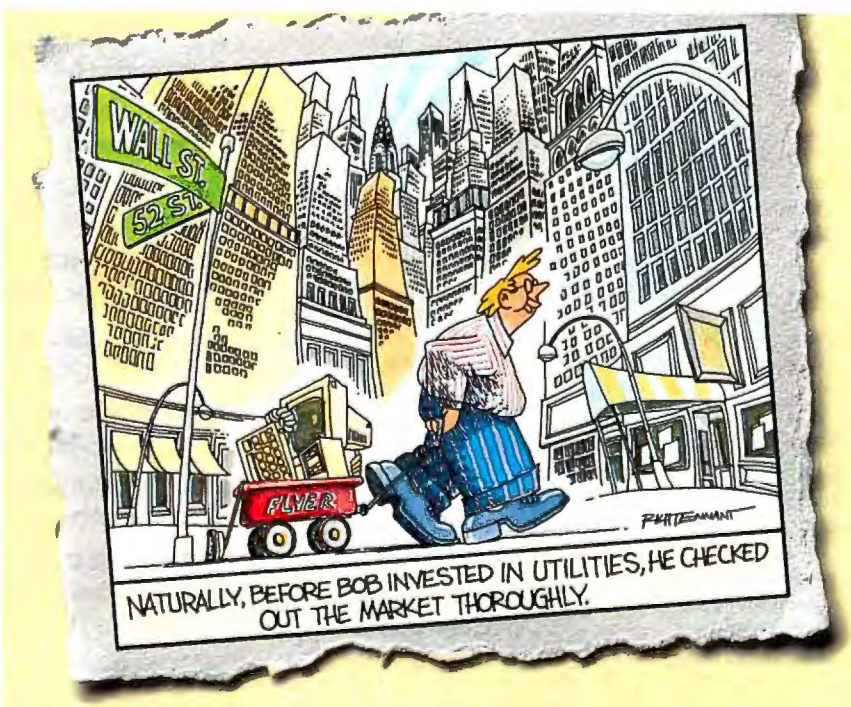
With all that new hardware in the box, upgrading to a new power supply might be wise, too. Why risk frying something vital? By the time you're done, all that's left of the original machine is the steel shell and your mouse pad. Which is why, each time I've upgraded my home computer, I've bought a new system outright. I think the appeal of modular upgrading is vastly different from the reality.

JERRY POURNELLE: One of Pournelle's Laws was "Iron costs more than silicon"; meaning in those days that you ought to buy a modular expandable machine. But that was in the S-100 days, and I meant get a really good box, and then you can add boards and change them as needed.

It is pointless to upgrade most modular machines. That does not mean you do not want slots. You will probably want some kind of coprocessor board like the Intel Satisfaxion to handle communications in the background, and you may well want sound boards, and suchlike. But when it comes time to upgrade your computer system, you will almost always be better off getting a new machine.

In other words, Pournelle's Law still holds, but the applications are different. Silicon is cheaper than iron, but iron's getting pretty cheap, too.

ALFORD: I think many users have gotten simply overwhelmed at the fast pace of the electronics industry—most notably in



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how fast their PC becomes not very fast. A computer with an expandable CPU seems like a great thing, because it's the one feature of every system that gets the greatest amount of ink in the press and clearly represents the performance of the system. Never mind that all those other, auxiliary, things in the system (unbeknownst to most) actually also play a critical factor in the overall effective performance of the machine—things such as the hard disk subsystem, video interface. . . you get the idea.

ROB MITCHELL: I went around to the major clone vendors at a recent show, asking how many of their customers upgraded to new CPU modules. The answers were all the same. From AST to Acer to Everex, everyone said that they came out with the modular design because it had become a "checklist item" for many large customers. But, they added, only 2 percent to 5 percent of all customers ever buy an upgrade module.

Some vendors claim that customers will buy more upgrades as products like OS/2 2.0 and the 32-bit version of Windows begin shipping. I have my doubts. Most PC managers worth their salt will buy a machine that's capable of supporting what their users need for three years (i.e., the time over which the cost of the machine can be amortized). The cost difference between processor types just isn't big enough to make a buyer go with a slower machine just so he or she can upgrade later. Sure, modular upgrades are more attractive in that you can expense them instead of amortizing a whole new machine and adding it to your capital equipment budget. But so what? If, 18 months down the road you decide that you've got to upgrade 100 systems from 16-MHz 386SXs to 20-MHz 486SXs, you probaby didn't plan well in the first place.

Modular systems are a great marketing idea. They make buyers feel good. But most buyers probably won't use the upgrade option and may be able to find a faster nonmodular machine for less money. Given equal performance and price, I'd take a modular CPU-expandable system over a standard PC any day. But given the low probability that I'd ever do an upgrade, I'm not willing to pay much extra for that privilege.

ANDY REINHARDT: I would like to suggest an entirely different justification for modular designs that has little to do with performance: serviceability. I met not long ago with Amkly Systems. The approach that Amkly is taking is to make its systems extremely modular, not just in the interest of expandability, but also to make systems more easily repaired. This is apparently something that corporate PC managers have been asking for. Everything about the Amkly machines is cleverly thought out: The hard drives are in a cage that snaps out, the processor complex is removable, and even the BIOS is in flash EPROM so that it can be updated from a floppy disk.

I think the point that Amkly wants to make is that absolute performance does not make nearly as much difference to buyers as other factors such as service costs. The productivity differences between a 25- and a 33-MHz 386 aren't as tangible as the time spent removing a broken power supply or whatever.

POURNELLE: Serviceability is the only reason I'd pay for modularity. That is worth something. ■

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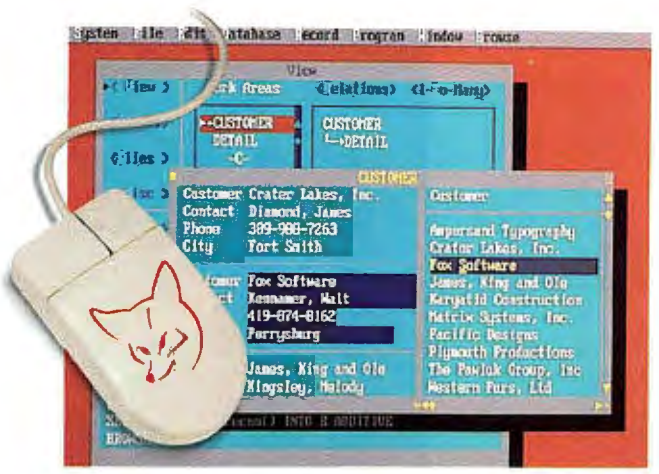

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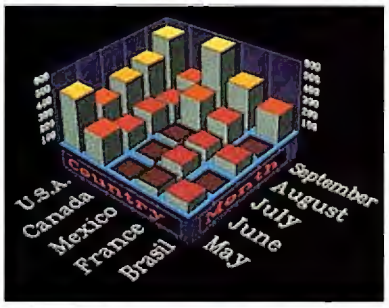

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FEATURE

Expert Networks

An emerging technology marries expert systems and neural networks to provide the best of both worlds

MAUREEN CAUDILL

Your supervisor calls you into her office and says, "Jones, upper management has decided that this plant needs to be on the cutting edge of technology. Besides, we're losing too many of our senior people to retirement. I want you to build an expert system to control the production line. But don't go hassling any of our senior people for help, and don't even think about hiring somebody from outside the company."

You protest and complain, but the order sticks. You're supposed to build an expert system without any help from an expert. Glumly, you face doom and destruction, not to mention the probable loss of that raise you were counting on. How are you going to manage this feat?

The Problem with the Solutions

One of the problems with expert systems is embedded right in their name: You have to have an *expert* to build an *expert system.* This requirement can be a huge drawback in situations where an expert isn't available or is too expensive. How can you do a good job as the knowledge engineer of an expert system if you have no expert to interview?

BYTE ACTION SUMMARY

Expert networks combine expert systems and neural networks to provide solutions that neither system alone can provide. Here are four ways to create expert networks for applications that need fast, accurate responses and rules to explain their answers.

Knowledge engineering is a slow, time-consuming task that demands a rapport between an engineer and an expert—a rapport that just doesn't develop instantly. And even if you have an expert readily available and can afford the time needed to develop a good relationship, it's not necessarily true that experts can explain how they solve problems.

If an expert system isn't the answer to a problem (see the text box "Explaining the Experts" on page 111), what about a neural-network solution? This methodology certainly has possibilities, because building a neural network just needs lots of examples. Unlike an expert system, a neural network doesn't require that you define

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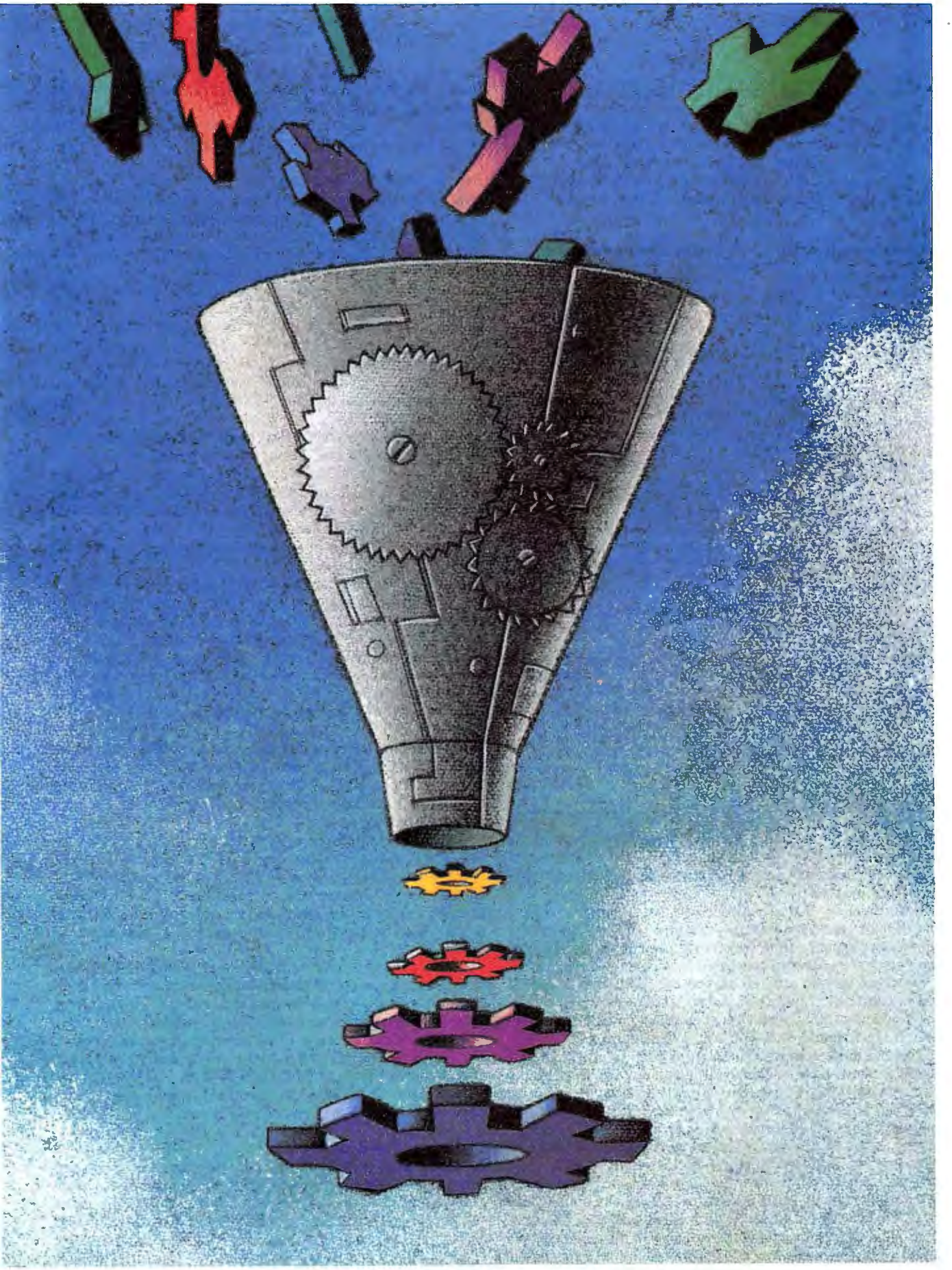

RULE-BASED VS. NEURAL-NETWORK SYSTEMS

Before you go through the effort of building an expert network for your application, weigh the inherent strengths and weaknesses of neural networks and expert systems. If you need the combined capabilities of both technologies, an expert network may be your answer.

Rule-based systems	Neural-network systems
Excellent explanation capability.	Little or no explanation capability.
Requires an articulate expert to develop.	Requires many examples, but no expert is needed.
Many turnkey shells are available.	Few turnkey shells available; most must be customized for your application.
Average development time is 12 to 18 months.	Development time is as little as a few weeks or months.
Preferred system when examples are few and an expert is available.	Preferred system when examples are plentiful or an expert is not available.
Many successful, fielded systems are available for public reference.	Few successful, fielded systems are available for public reference.
Large systems can be unwieldy and difficult to maintain if not carefully developed and designed.	Large networks can't be built today; smaller networks can be hierarchically linked for more complex problems, making them more maintainable.
Systems built through knowledge extraction and rule-based development.	Systems built through training using data examples.
Accepted validation procedures for completed system.	Validation of completed system is dependent on statistical analysis of performance.
Works fine on ordinary digital computers.	For all but the smallest networks, best performance comes from use with accelerator-assisted or specialized parallel chip boards.

specific rules for the network to use in solving a problem; the network discovers its own rules as it learns the examples you provide. It sounds like neural networks can do what expert systems can't, doesn't it?

Unfortunately, neural networks are not a panacea, either. One of their greatest problems is that they require a substantial number of examples from which to learn and generalize. You can't just train a network on a half-dozen cases and assume that it will come up with accurate responses. Furthermore, even if you do construct a highly capable neural network for a particular problem, you are faced with another not-so-nice characteristic: It can't explain what it does or how it does it.

The end user of an expert system is usually a person, and people are not noted for their willingness to take a machine's word for anything. People have a nasty tendency to want to know why an answer is correct. Unlike a rule-based expert system, which has well-defined, meaningful rules that govern its actions, a neural network generates its response to a problem automatically—with the unreasoning skill of an eyeblink.

A neural network has no rules; it doesn't even have a specific, easily extractable set of features that you can point to and say, "This is why the answer is 47." What a network knows is distributed across the network—not neatly pigeonholed and sorted. This difference means that obtaining an explanation from a neural network is about as frustrating as getting one from a four-year-old: "The answer is 47 because it's 47, and that's that." (See the table for a summary of the characteristics of rule-based and neural-network systems.)

Dealing with the Dilemma

Here, then, is the dilemma: You have to build an expert system to solve a problem, but you have no available expert. You've thought about using a neural network, but you also need to have an explanation capability so that your users have some confidence in the answers the system provides.

Now is the time to break new ground and build an expert network. An *expert network* is a combination of an expert system and a neural network that has the capabilities of both systems while minimizing the problems of each. You can combine these two apparently opposed systems and come up with very nice, complete solutions to difficult problems. (For background information, see the text box "Solving the Unsolvable," page 284, January BYTE.)

The trick in constructing such a hybrid system is to stop thinking of yourself as a "neural-network person" or a "knowledge engineer" and to start thinking of yourself as a "purveyor of solutions." You should consider both rule-based systems and neural networks as tools that you use as you need them. With this attitude firmly in mind, you can take advantage of the best features of both kinds of solutions and use them to construct your own expert network.

Rule-based systems are a good choice when you have only a few data samples, when you have experts that are readily available for consultation, or when you find that an explanation for answers is essential. Neural networks are the best choice for all kinds of pattern-matching problems when you have hundreds of examples on hand, when you lack experts to consult, or when the experts that are available are not articulate. It is when these situations cross that you should consider the combined capabilities of a blended solution.

For example, a large utility company is developing an expert network that uses a neural network to monitor power-plant performance; the network defers to an expert system for possible operator intervention whenever the actual performance doesn't meet the expected values.

One proprietary expert network predicts stock market futures with astonishing accuracy; for obvious reasons, the developers are reluctant to disclose details of its operation. Still another hybrid system uses a neural network to determine whether credit card applicants are too great a risk, and a rule-based system to decide what to do about those whom it puts in that category.

Other such applications are beginning to creep into the real world, but they tend to be kept highly proprietary by the developing companies—mostly because they are so accurate and because they provide those firms with tremendous competitive advantages. Commercial tools for building expert networks are also scarce, although you can often combine expert-system and neural-network tools to build such systems (see the text box "Tools to Build Bridges" on page 114). Figure 1 illustrates some of the ways you can build such a system.

Divide and Conquer

One of the simplest methods of combining neural networks and rule-based systems is to break a large problem into pieces. Suppose you have a complex problem, such as scheduling large numbers of delivery trucks on a daily basis. Each day you must determine what packages should be combined on each truck and what the most efficient route is for that truck to follow for

Explaining the Experts

A neural network is an information-processing system based on how we believe the architecture of our brain is structured. (For more information on neural networks, see "Time to Get Fired Up," August 1989 BYTE.) A neural network consists of a large number of simple processing elements, or *neurodes*, connected with weighted links. Each neurode receives many incoming signals along these connections but transmits only a single output response to that net input signal. That output signal is conveyed to many other neurodes in the network or to the outside world.

The neurodes are simple nonlinear processors that react to their net weighted input signals; typically, all neurodes in a network are identical. The network's critical components are the connecting links between the neurodes. Some links are excitatory with positive weights; others are inhibitory with negative weights. A signal arriving over an excitatory connection increases the receiving neurode's output signal; one arriving over an inhibitory connection decreases that output.

A neural network normally starts with random weights on the connections. During training, however, input signals are presented to the network (usually with the corresponding desired output response). The strengths on the connections within the network are changed in a systematic fashion until the network's output is acceptable. The rules for the weight adjustments are called *the learning law*. The learning law determines how the network learns to perform a task, but it has nothing to do with the task the network performs.

The basic operational sequence of a neural network is one of stimulus-activity-response. A stimulus pattern is presented to the network, the neurodes become active to a degree that is dependent on the connection weights leading to each, and, as a result, each neurode generates an appropriate response signal to the stimulus. This stimulus-activity-response action is true at the level of individual neurodes or for the network as a whole and is fundamental to the network's operation.

You can experiment with a sample neural-network simulator called `backprop.C`, which is available for your use on BIX and Demolink (see page 5 for details). The simulator uses the most common learning model, backpropagation. With this program, you can watch a network learn to recognize pixel images of characters and reproduce the appropriate ASCII codes. Backpropagation networks modify their weights by passing errors backward through successive layers of neurodes after each training pattern. You can inspect the C source code for algorithm details. The README file tells you how to run the program.

Rules of the Expert-System Game

In contrast to neural networks, rule-based experts use a symbolic computational approach to automating intelligence. (For more information on expert systems, see "The Real-Time Expert," January BYTE.) A rule-based expert system consists of three key parts: an inference engine; a collection of IF... THEN rules, called a rule base; and a collection of known facts and beliefs about the world, called a knowledge base.

The IF...THEN rules of the rule-based system provide it with a set of actions to take when the perceived state of the world matches the conditional clause of the rules. For example, a rule might be, "If it is raining outside, then take your umbrella." Thus, whenever the system perceives that it is raining outside, this rule may fire, causing you to take your umbrella.

The knowledge base contains the facts about the world as they are known to the system. Not all facts are absolutely true; most have a belief or certainty factor associated with them. The proper adjustment of these certainties as the world changes is an ongoing area of research, and many techniques have been developed to deal with this situation.

The inference engine is the heart of the production-rule system. Its primary task is to match the conditional clauses of the rules with the known state of the world in the knowledge base. From the collection of matching rules, a single rule is chosen, and the system executes that rule. This action probably changes the state of the world, so a new set of matching rules must be developed. The operational cycle of the rule-based system is thus one of match-select-fire and not the fetch-execute-store cycle of an ordinary computer program.

all its stops. No general-purpose algorithm has ever been designed that can deal with this knotty problem.

The key to developing a solution, as researchers Joseph Bigus of IBM and Keith Goolsbey of the University of Texas at Austin found when they tackled this problem, is to divide the problem into smaller blocks. One task is to group the packages into the trucks, and the second is to determine the best delivery route for each set of packages.

General rules of thumb do exist for grouping the packages, and, therefore, Bigus and Goolsbey could successfully use a rule-based approach. On the other hand, route scheduling presents far too many possibilities for a rule-based system to cope with. As a result, the researchers used an optimizing neural network to find an efficient path for each truck. The final system worked very well indeed.

The division of effort on this problem is enlightening. Assigning packages to individual trucks is a problem that dockmasters have dealt with for a long time. As a result, many experts exist who can assist in the development of a rule-based approach. On the other hand, the number of rules needed to determine an efficient route gets unwieldy almost immediately because of the enormous number of possible delivery sites. And while the neural network cannot explain how it developed a particular route, in this instance such an explanation is really unnecessary. The route is its own explanation.

You can use the divide-and-conquer approach to your problems if you remember to apply each kind of solution to the parts of the problem it can best solve. Don't try to teach rules to a

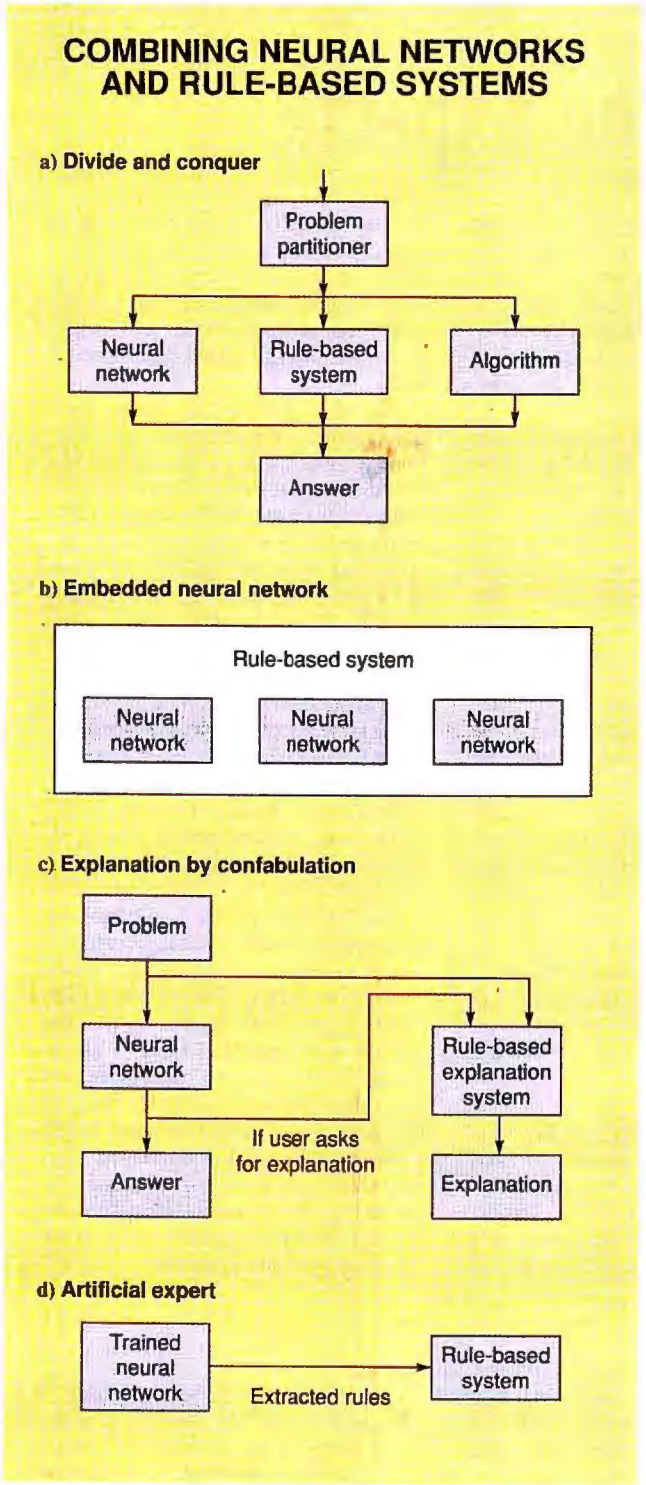

Figure 1: *You can combine neural networks and rule-based experts in a number of ways. In* **(a)**, *you partition the problem into subtasks and use the most appropriate method for each. You can also embed neural networks within a rule-based system, as in* **(b)**. *Parallel neural networks and rule-based systems in* **(c)** *provide the network with an explanation capability. In* **(d)**, *a trained network acts as the expert in developing a rule-based system.*

neural network, and don't try to train a rule-based system using patterns.

The Embedded Approach

Another way of combining a neural network with a rule-based system is to make the network a part of the rule-based system. Consider how a typical production-rule system works. An inference engine compares the state of the world with the IF clauses of the various rules in the rule base. It identifies all the rules that match the state of the world. It then chooses one of those rules, executes it, and begins the whole process all over again. This match-select-fire process is the basic mode of operation of rule-based systems.

Consider the process of matching the state of the world to the IF clauses of the rules. This task is inherently one of pattern matching—one of the applications in which neural networks shine. Why not use a neural network to implement the portion of the inference engine that does the matching? In fact, why not also use a neural network to select the rule to fire?

In explanation by confabulation, the system confabulates (or invents) a reason when it is asked; otherwise, it doesn't bother.

Several neural networks respond with a single-best-response category—the Kohonen and adaptive resonance networks are obvious examples. If the responding category represents a specific rule to fire, the inference engine (at least with regard to the match-select operations) can easily perform its task by using such a network.

This process may substantially improve execution time due to the neural network's inherent parallelism. And, since the rules still fire in a logical sequence, the rule-based system's explanation capability is unimpaired. (Other inference-engine tasks, such as updating certainty factors and inferring new rules, must still be implemented separately.)

Other ways exist to embed neural networks within a rule-based system. You can use a trained network as a kind of subroutine to the THEN clauses of some rules. In this role, the network is called to perform some specific action whenever the rule fires. The action can be a pattern-matching operation, or it can control a device, a process, or any other appropriate function. The network can pass a response back to the rule-based system (e.g., for pattern matching), or it can simply perform the particular desired action (as in applications such as robot-arm control).

Explanation by Confabulation

Another hybrid system can be called *explanation by confabulation*. In this mode, you construct and train a neural network to solve the problem. As long as you don't ask the system for an

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Tools to Build Bridges

Peter Immarco

Groups in expert-system and neural-network camps each claim to have the best technology for obtaining accurate answers, solving problems, and addressing issues. Neural-network followers claim that expert systems are too inflexible and that their abilities are limited by the expertise of the knowledge engineer. Expert-system people claim that neural networks are too unreliable because their decision-making process is opaque to the user.

A hybrid technology has been developed that combines the best features of expert systems and neural networks. It is called an *expert network*. (See the main text.) At the moment, however, there are few commercial expert-network tools available.

You have very little choice if you want to obtain a tool that has built-in expert-network capabilities. HNC's KnowledgeNet provides a means of determining "confidence factors" for a neural network's responses. The technology behind KnowledgeNet is patented and somewhat mysterious, which may lead you to have only shaky confidence in the derived confidence values.

Also, you need to keep in mind that first-generation products may not meet your application needs, so you should investigate them carefully before you decide on one. Other companies supposedly have expert-network products currently in development.

An alternative strategy is to work with any of the many fine expert-system shells that provide the capability of linking to external routines. One of these may be an ideal choice, for example, if you want to use embedded neural networks for your application. You can set up rules that call external neural-network routines written in C (or another language) to implement an appropriate action as needed. Many expert-system shells have the ability to call such external routines, including Neuron Data's Nexpert and Micro Data Base Systems' Guru, both of which are available for a wide variety of computers.

Several commercial C subroutine libraries can serve as the basis for writing your own simulator program. Two of the most popular are HyperLogic's Owl package, which includes some graphical I/O routines, and HNC's NeuroSoft, which is primarily used as an interface to the HNC accelerator card.

Users who don't wish to write their own neural-network simulator in source code generally begin with one of the various commercial simulators that are now available. These include NeuralWare's NeuralWorks Professional II, Cognition Technology's NeuroSmarts, and HNC's ExploreNet. Among the other products available are California Scientific's BrainMaker and Neurix's MacBrain.

These products, except for MacBrain and NeuroSmarts, are available in versions for the PC; MacBrain and NeuroSmarts are Macintosh-only products; and NeuralWorks Professional II is available on a variety of platforms, including PC, Macintosh, and Sun.

Some of these simulators—such as NeuralWorks Professional II, with its optional utility module—can convert a network into C source code for linking to an expert system. For instance, NeuralWorks can create and train a neural network to recognize risky credit-card applicants. NeuralWorks can then convert this network to C source code. A Nexpert expert system can link to this routine and use rules to make a final decision on the application. Furthermore, since Nexpert can communicate with major database programs, an Oracle knowledge base can supply needed training and production-rule data.

As time passes and more sophisticated and user-friendly tools enter the market, combining rule-based systems and neural networks will become easier. We are still a long way from having a Lotus 1-2-3–friendly expert-network supertool. But one may be evolving right now.

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explanation, the network works at solving the problem, and all is well. If you do ask for an explanation, the network's output plus the initial input that generated that response are fed into a parallel, and rather simple, rule-based system.

This system is not powerful enough to solve the problem itself. But it is capable of backward chaining from the network's answer to the input, producing an acceptable justification (you might even say "rationalization") of the network's answer.

In essence, the system confabulates (or invents) a reason when it is asked; otherwise, it doesn't bother. This process is closer to the way human experts actually work than any of us would like to think. Most true experts at a particular task probably do not solve problems by reasoning; instead, they more likely recognize patterns in each problem, and their experience allows them to react appropriately to those problems.

Even in such a cerebral task as playing chess, grand masters do not test every move. Instead, they recognize patterns of pieces on the board and respond to those patterns. This may be why experts find it so difficult to articulate the rules they use to solve problems: They probably don't use rules at all.

The Artificial Expert

Yet another way of combining neural networks and rule-based systems is by using a network as the expert. This method can be extremely helpful if you need to have a rule-based system for some reason but have no human expert readily available. In this case, you train a neural network to solve the problem acceptably well and then analyze it to extract a set of rules from the trained network. The rule-extraction process is tedious, and the results may not be quite what you expect, but it is possible to perform. The resulting rules form the basis for a rule-based system, perhaps after being refined or extended with human inputs.

continued

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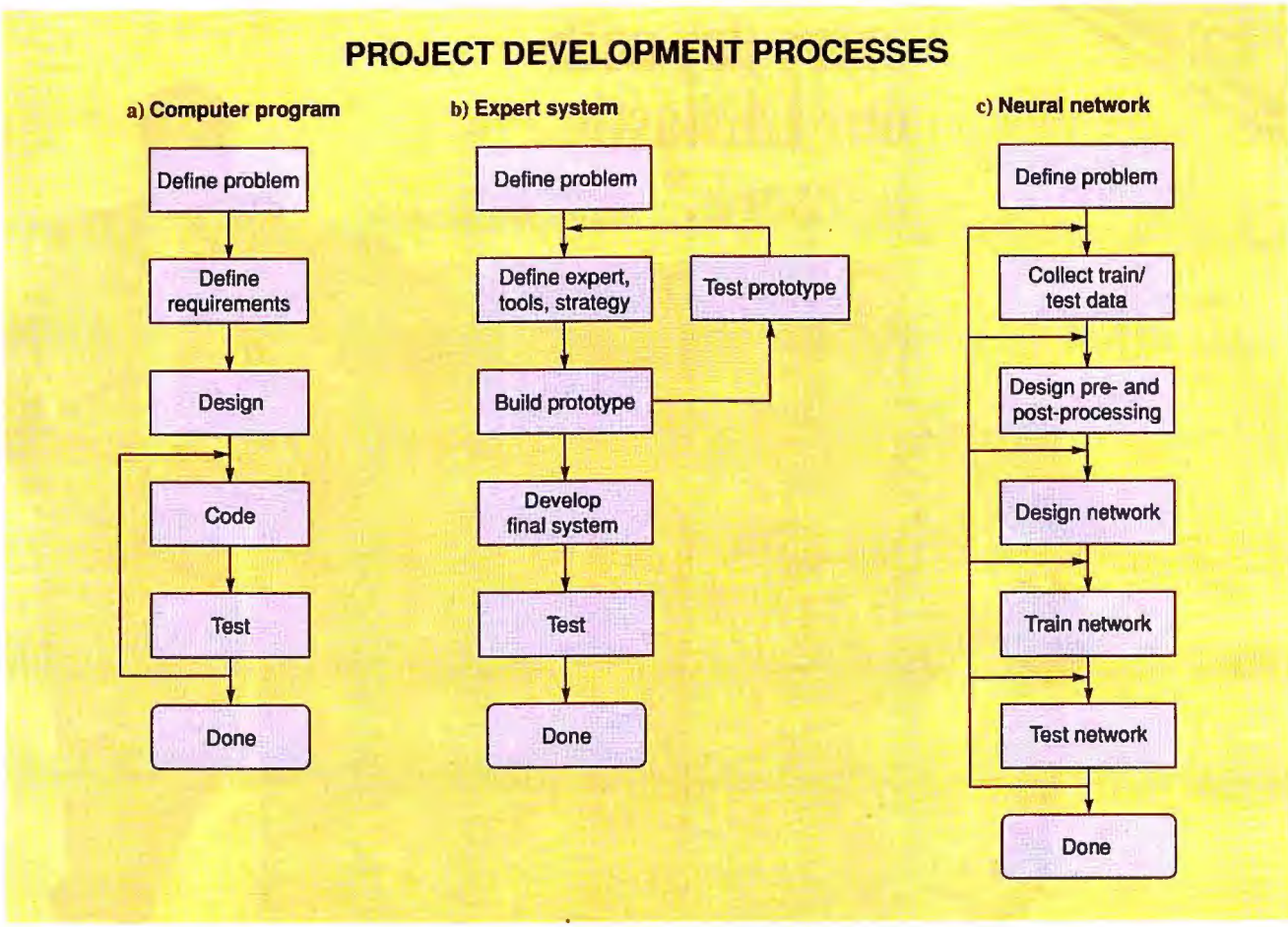

Figure 2: *You develop computer programs, rule-based expert systems, and neural networks using quite different procedures. Rule-based development generally follows a rapid prototyping model. In a neural-network application, you spend more effort collecting data and determining the correct preprocessing technique.*

These last two approaches demand that you build both a neural network and a rule-based system. You might think that the double effort involved would make such approaches impractical. In fact, a neural-network expert often can be developed in a matter of weeks or a few months, compared to the average expert-system development time of 12 to 18 months. Thus, you can train a neural network using a problem and perform a rule extraction on the network in less time than you can perform a normal knowledge-engineering process with a human expert.

You might, then, want to use an expert (if you have one available) to refine and modify the rules the network generated. This process may dramatically reduce the cost (in time and money) of using experts if all they must do is modify or adjust rules that you propose. And when building an explanation by the confabulation system, the rule-based system doesn't have to be nearly as complete as it would if it actually solved the problem. It needs to be just good enough to give you a reasonable justification of the network's answer.

Building an Expert Network

If you are interested in how to go about constructing an expert network, in essence there are four possibilities. You can write your own code, you can use a commercial simulator shell, you can use an accelerator card (either with your own code or with a commercial simulator), or you can use one of the new neural-network chips that are now reaching the market.

No matter which one of these possibilities you choose, however, you must realize that the neural-network development process is quite different from that of a regular computer program, and different again from rule-based system development. Figure 2 illustrates the differences in development processes in the three cases.

Generally, the majority of the effort in neural-network development goes into collecting the data examples and preprocessing them appropriately. Once that feat is accomplished, training and testing the network is relatively easy.

You probably have less experience with neural networks than with regular computer programs. Therefore, expect to perform many more iterations on all aspects of developing the trained network than you would with a more traditional solution, and expect to make more mistakes. After all, you have to train your own biological neural networks to use this technology appropriately. And, as with any other neural network, that process takes a lot of training passes to achieve. ■

Maureen Caudill is an author and consultant on neural networks. Her latest books are Understanding Neural Networks: Computer Explorations *(MIT Press, 1991) and* In Our Own Image *(Oxford University Press, 1992). She is based in San Diego, California. You can reach her on BIX c/o "editors."*

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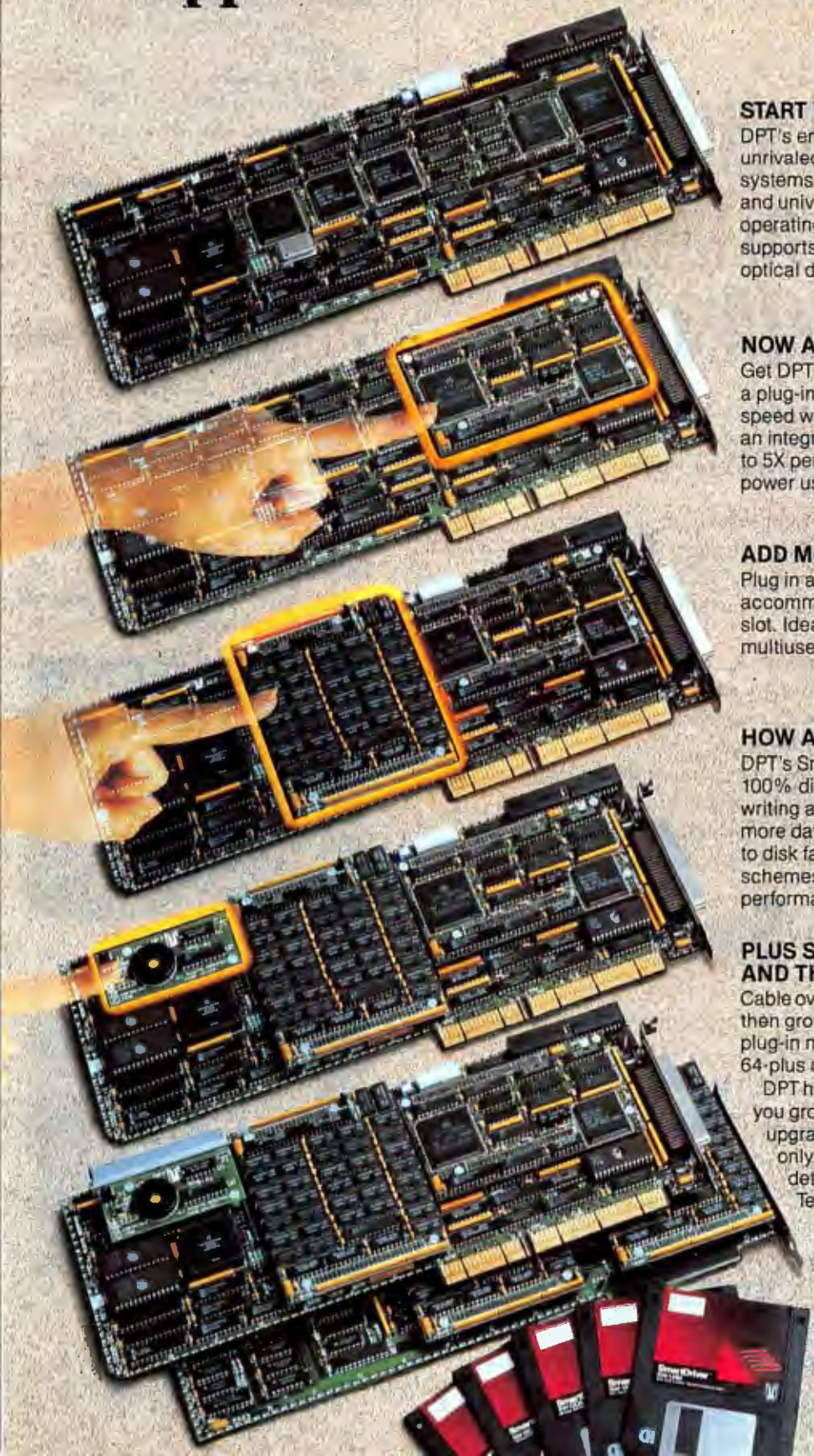

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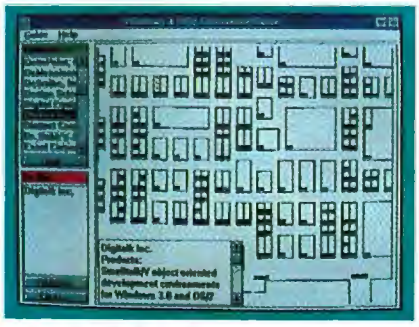

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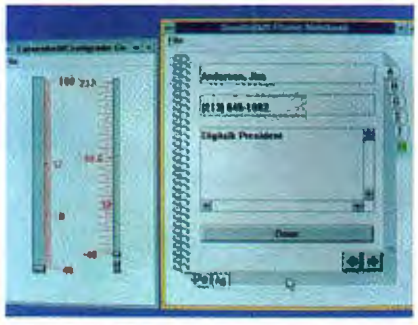

Smalltalk/V PM applications are used to develop state-of-the-art CUA-compliant applications—and they're portable to Smalltalk/V Windows.

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FEATURE

Health and Safety First

Ergonomic issues have taken a backseat to performance, resulting in a growing tide of computer-related injuries. Change is needed—now!

DAVID A. HARVEY

For most of human history, designing and using tools was a highly individualized process. Tools were treated as extensions of the body—things that fit the natural shape of the hands and were easy to use. However, as humans progressed into the machine age, tools began to fit the manufacturing process more than they fit people. Today's personal computer is largely a product of mass-production methods, which emphasize ease of manufacturing, not the health and comfort of the human body that interacts with them.

Office ergonomics have taken a backseat to performance issues. The result has been a growing tide of computer-related injuries. People have only recently begun to accept the notion that greater attention to ergonomic design could make using a personal computer a safer and more productive experience.

Heightened awareness of the importance of the physical human-machine interface brings with it a resurgence of interest in adaptive technologies and software-interface design. The industry is moving toward designing products that improve user—rather than machine—productivity.

Dateline: San Francisco

Formal interest in computer safety began when a group of journalists sued Eastman Kodak (Rochester, NY) over alleged physical and psychological damages incurred while using their Atex system. These suits fed public concern over computer safety, which reached a peak last December with the passage of VDT legislation in San Francisco.

The San Francisco bill was the first to mandate ergonomic guidelines for VDT operators. Governmental proscriptions on health and safety in the workplace are nothing new, but this legislation marked the public sector's first acknowledgment that something is wrong with how people use computers.

When I first began researching this article, my reaction to notions of extremely low frequency (ELF) emissions, very low frequency (VLF) emissions, and even the whole question of electromagnetic fields (EMFs) was one of nonchalance. Ditto for my thoughts on repetitive-strain injuries (RSIs). I'm pretty typical in this respect. Most of us know better, but we just haven't done anything about it.

My computing station is as nonergonomic as you can get: My table is about 30 inches from the floor, I slouch in a high-backed chair, and the 20-inch monitor I've been using is positioned directly in my line of sight. I'm a walking

ILLUSTRATION: JOSÉ CRUZ © 1991

magnet for just about every computer-related injury in the books. And the more I research this issue, the more my hands begin to hurt and my eyes start to blur.

Now, I'm not about to go out and spend a couple thousand dollars customizing my workstation. But I am going to make a few changes that will push my place of work toward a design that embodies sound ergonomic principles.

Tunnel Trouble

RSIs were the first tangible symptoms of the injurious potential of the computer. Broadly speaking, most RSIs fall into the categories of upper-limb and postural disorders. They began showing up first in two specific groups of computer users: journalists and data-entry clerks.

Unlike a typewriter, a computer does not require that you move your hands to change pages, adjust ribbons, or perform any of a dozen similar tasks, so you tend to type for extended periods of time without resting. Created in the 1860s, the standard typewriter keyboard layout (QWERTY) was reputedly designed to *impede* typing speed so that fast typists would not jam the typewriter's keys. However, the combination of constant repetitive motion and inefficient finger movements that QWERTY requires is the ticket to the most well-known RSI, carpal tunnel syndrome (CTS), a form of entrapment or compression neuropathy.

A compression neuropathy is similar in effect to a bend in a garden hose. When the hose is bent, water can't get through. When a nerve is compressed, its impulses are blocked and cannot get through, often with disabling results.

CTS results from the compression of the median nerve, which transmits sensory and motor signals to and from the thumb and first three fingers. It is the architecture of the carpal tunnel—through which a number of ligaments, blood vessels, and the median nerve pass—that is responsible for the problem (see the figure).

During normal finger motion, the ligaments passing through the tunnel slide easily past each other. However, when the wrist is bent, finger motion generates friction by rubbing the ligaments against one another. Prolonged friction can cause those ligaments to swell and eventually press against the median nerve. In addition, the neuron itself can become irritated and swell, resulting in the loss of fine motor control and numbness. Swelling can also cause misfirings that lead to pain and tingling.

The ultimate result of a compression neuropathy can be a condition known as ischemia, in which the neuron begins to degenerate from a lack of blood flow. Degeneration progresses in a retrograde (toward the spine) and an anterograde (toward the extremities) fashion.

Fortunately, retrograde degeneration usually doesn't progress past the point of compression. Better yet, even if the nerve is severely damaged, the disability will, in all likelihood, not be permanent. Peripheral nerves, of which the median nerve is one, tend to regenerate, a process in which the stub of a nerve reinnervates muscle tissue.

Even in mild cases of CTS, recovery is a long and painful process. At the lowest level of damage, a wrist splint and rest from the irritating activity will usually result in near-complete recovery. More serious cases may require surgery.

All this adds up to time away from the job and expensive medical bills. For the company, the costs mount up in terms of increased insurance and worker's compensation costs; for the individual involved, the condition can lead to a catastrophic loss of income.

There are a host of other RSIs related to computer use. The most prevalent are tendinitis, the swelling or irritation of a tendon; tenosynovitis, the swelling of the sheath surrounding the tendon; thoracic outlet syndrome, a compression disorder of the nerves and blood vessels between the neck and shoulders; and ulnar neuritis, a nerve inflammation that is caused by pressure on the ulnar nerve in the elbow. Like CTS, the base cause of these injuries is computing at unsafe angles.

What You See Is What You Feel

Your body is led by your eyes. Although you may be unaware of the process, you frequently adjust your postural position so that you can see better. Even if your posture is as neutral as Switzerland (that is, creating no bodily stress), poor lines of sight can cause you to move in ways that can lead to RSIs. (A good neutral posture is one in which the shoulders, neck, and arms are relaxed; the elbows and hips are bent at a 90 degree angle; and the thighs are parallel to the floor.)

The problem is further compounded by reading glasses, which may not focus correctly at the distance most people sit from their monitors (between 18 and 24 inches). The result is that you tend to crane forward to see the monitor, stressing the neck and shoulders. And with bifocals and trifocals, the motion of the head required to shift between the different levels of magnification can also cause stress.

The eyes are also subject to a number of stressors in a computing environment. Some research indicates that people who use CRTs for more than 4 hours a day are subject to both eyestrain and fatigue. Our eyes were not designed to focus on one object at one distance for that amount of time.

Eyestrain can also result from low-refresh-rate monitors. Back in the time of text-only displays, most screens consisted of either an amber or a green foreground and a black background, a color scheme that is ideal for reducing eye fatigue. With the GUI, however, many of us have attempted to match our displays to the coloration of the printed page. Unfortunately, a standard VGA monitor has a refresh rate of only 56 to 60 Hz, which generates visible flicker in graphics modes. This flicker forces the neurons in the eye to continuously readjust and can lead to headaches and blurred vision.

The Killing Fields

As if the concrete dangers were not enough, an invisible threat has also materialized. EMFs have long been suspected of being potentially dangerous—they've been blamed for everything from cancer to psychosis. But it wasn't until recently that hard data began rolling in on the subject.

A computer monitor produces ELF and VLF radiation (the effect is somewhat stronger at the backs and the sides of the

BYTE ACTION SUMMARY

To date, office ergonomics have taken a backseat to performance. People have only recently begun to accept the notion that greater attention to ergonomic design could make using a personal computer a safer and more productive experience. The office of the future is evolving before us. Health and safety factors are shaping it, and so are issues of cost and productivity.

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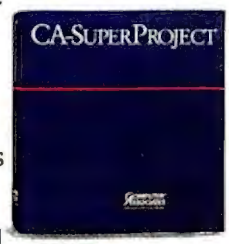

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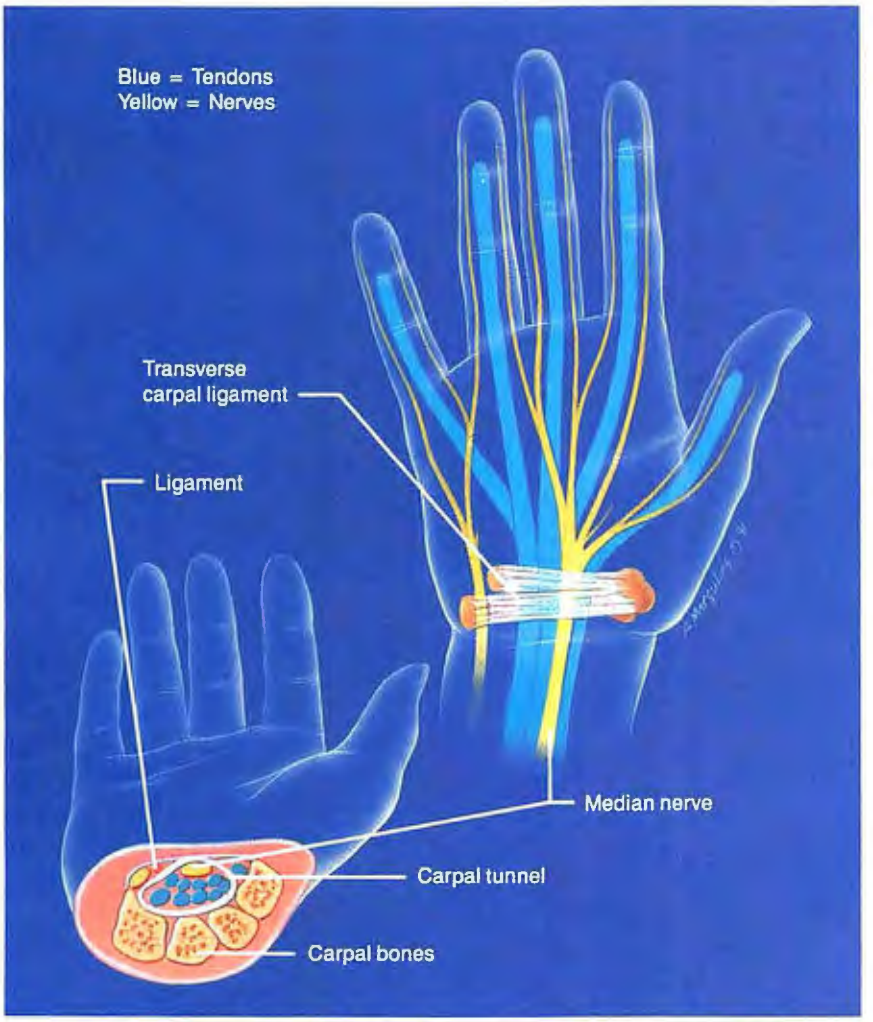

Carpal tunnel syndrome is a painful condition resulting from compression of the arm's median nerve. Repetitive finger motion causes the ligaments to rub against one another. When this is prolonged, it can cause the ligaments to swell. In the confined space of the carpal tunnel, this swelling eventually puts pressure on the nerve. Results can include loss of fine motor control, numbness, tingling, and pain.

cabinet). The culprit is the flyback transformer. This device drives the electron gun, which continuously sweeps across the screen illuminating the pixels.

Despite the ever-widening public debate over whether VDT emissions cause health problems, there is a frustrating absence of hard data. Louis Slesin, editor of *VDT News*, finds it "quite extraordinary that we've come this far in the public debate without a study that explicitly targets VDT emissions."

Although a number of studies have been done on VLF and ELF emissions—they have come up with some alarming results—none has specifically dealt with VDTs. The consensus that ELF and VLF emissions do pose a potentially significant threat to health is growing—so much so that a number of European Economic Council countries have adopted stringent standards regulating the use of VDTs in the workplace.

Despite the fact that concern over radiation has focused on VDTs, other peripherals may be greater sources of electromagnetic radiation. Slesin is concerned that "this whole idea of developing wireless LANs is introducing a new source of EMFs into the office, one that has not really been investigated. On one hand, we have industry scrambling to introduce low VLF and ELF emission monitors, while on the other hand, we're introducing these new sources without checking them out. Imagine what will happen to the office environment if five years from now, when all these technologies are prevalent, people start recognizing that they're a source of dangerous emissions. We don't seem to learn from history."

The lack of conclusive evidence on the dangers of ELF emissions should not deter us from viewing such emissions with suspicion. We need to recognize that computing devices and the ways in which we interface with them are potential sources of injury. Basic research on the effects of electromagnetic radiation must be performed—research that addresses VDTs and other peripherals.

Worker's Compensation

Although a personal computer certainly isn't engineered for injury, lack of attention to the human-machine interface is a disaster waiting to happen. Another potential problem lies in the precedents set by the San Francisco ordinance and the suit against Eastman Kodak. If the industry fails to heed these early warning signs, it could find itself in a morass of lawsuits and regulations that make the medical-malpractice mess look small. Furthermore, with the increase in the number of home offices and their separation from companywide training and equipment-design initiatives, many people may find themselves physically unable to do their jobs.

The economics of the situation call for an immediate response. Not only would the individual benefit from a more comfortable and pleasant computing environment, but companies, too, would find cost savings, in terms of fewer sick days and more productivity. Moreover, given the cost of treating a computer-related injury like CTS, a company that implements an ergonomically correct computing environment will find additional savings in lower insurance and health-benefit costs.

Ergonomic Convergence

According to Anne Tramposh, vice president of R&D at Advantage Health (Kansas City, MO), "the design of the workstation needs to be such that people are maintaining neutral postures, and for each individual that varies some. Each individual needs to be able to adjust the workstation so that the back is neutral, the shoulders are down, the wrists are straight, and the elbows are resting on padded surfaces."

Another benefit to adjustable workstations is that they allow you to vary your working position. The key to most mechanical injuries is repetitive strain, and varying how you work—from moving the keyboard to your lap to standing up or lying down—goes a long way toward reducing continuous stress on any one part of your body.

continued

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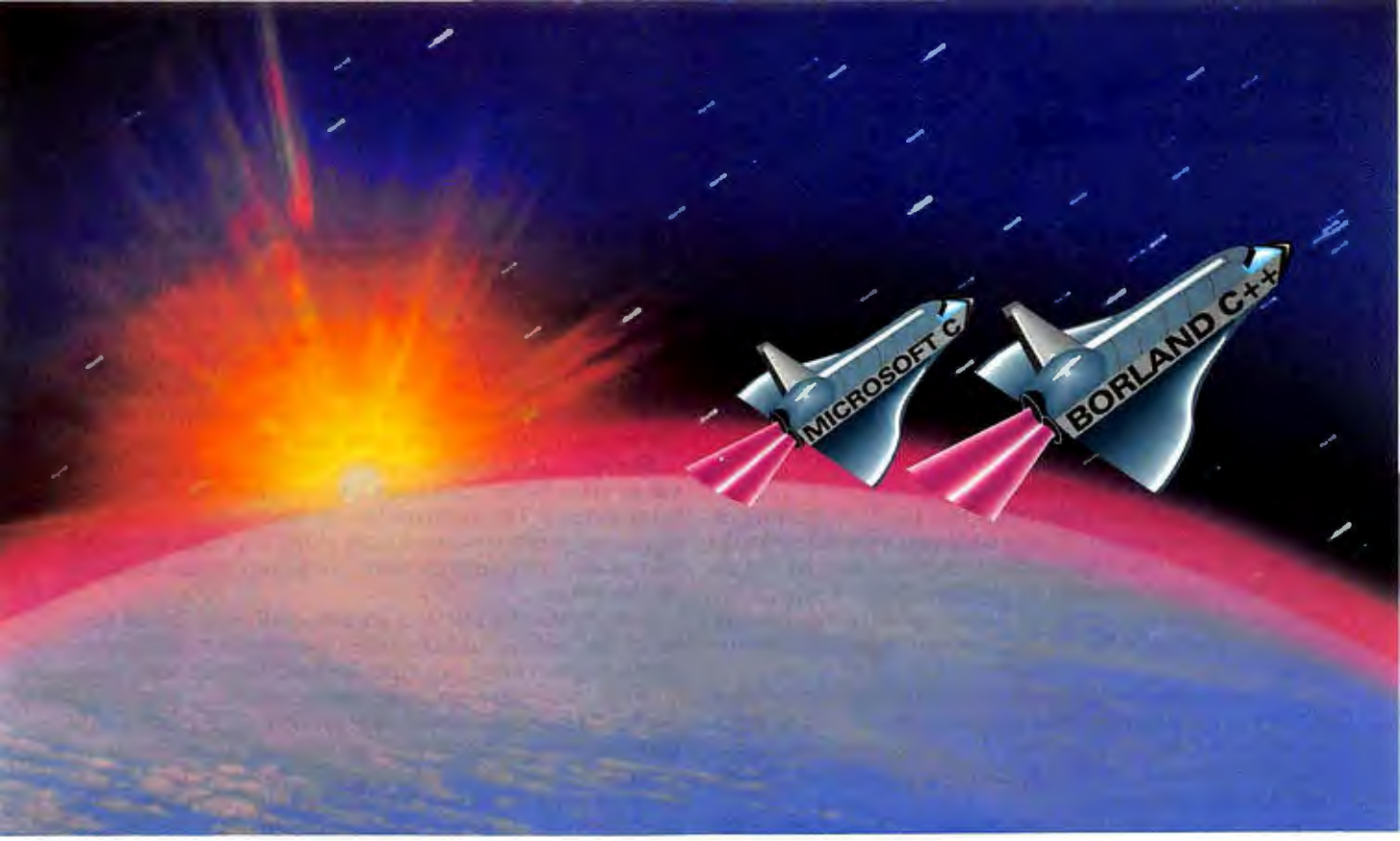

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Aesthetics, too, are important in reducing stress. As simplistic as this may seem, researchers are beginning to identify environmental stress as a key factor in the development of work-related injuries.

The human-machine interface of tomorrow will be composed of three parts: the machine, the receptacles for both the machine and the person, and the person. The major changes in personal computer design will be related to console devices (e.g., mice, keyboards, and monitors).

Let Your Fingers Do the Walking

What will the keyboard of the future look like? For one thing, it will fit your hands better. If you extend your arms out naturally in front of you, you'll notice that your palms turn inward, in what Ward Bond, president of InfoGrip (Baton Rouge, LA), calls the "handshake" position. Because of this natural inward turning of the hands, the flat keyboard will eventually become passé.

Another important consideration in future keyboard design is keeping the fingers parallel to the forearms to reduce stress on the wrist. There are a number of leading contenders for the shape of tomorrow's keyboard, including pyramid, two-piece, and boomerang layouts.

A workaround that will make existing keyboards safer is the addition of wrist-support pads, such as those manufactured by CompuRest (San Diego, CA). These devices attach a pillow to a base plate that slides underneath the front of the keyboard. You don't rest your hands on the cushion; rather, by keeping your hands above the pillow, your wrists remain straight.

Another issue new keyboard designs will address is the actual layout of the keys. The QWERTY keyboard is inefficient and leads to a great deal of unnecessary motion. Whether future keyboards follow the Dvorak scheme or some as-yet-undesigned layout, a large number of workers will continue to use QWERTY keyboards because they are comfortable with them.

You won't have to wait long to ease your troubled tunnels, either. Several ergonomically correct keyboards are on the market today, and others are in the later stages of design.

The Wave, a keyboard made by Iocomm International Technology (Hawthorne, CA), takes a fairly conservative approach to ergonomics. This standard 101-key keyboard has a front lip that curves gently downward in the shape of a wave. By resting your palms on the lip of the wave, you greatly reduce the strain on your wrists.

Even more futuristic is a cordless gull-wing-shaped keyboard that is designed to fit across your lap and that incorporates a graphics tablet and a non-QWERTY layout. Such an innovation solves the problems associated with laptop and notebook keyboards, as well as many of those associated with stationary computers. Moving the keyboard to your lap is already recognized as a good way to vary your working posture, to reduce physical stress, and to allow you to move farther away from the VDT. The most radical redesign of the keyboard to date is the Bat, a two-piece chording keyboard manufactured by InfoGrip.

Whatever shape it takes, the personal computer keyboard is in for a major redesign. Not only will you accrue the benefits of safer, healthier computing, but a more ergonomic keyboard

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will translate into real gains in productivity.

These benefits would be even more pronounced if hardware and software designers would work together to make programs and personal computers more ergonomically cooperative. Tramposh identifies "left- and right-handed software" packages, which cause you to use one hand more than the other, as an ergonomic hazard.

Computing Without Keyboards?

Pen-based computing, too, offers some relief for typists, although it will not replace the keyboard for inputting large amounts of data. But combining a pen-based operating system that includes optical character recognition with a keyboard will help you reduce repetitive stress by further varying your positions and movements.

The jury is far from in when it comes to mice and trackballs. Avid fans swear that trackballs saved their hands. And for each one, you'll find another who swears that a mouse did the same thing. Joysticks and digitizing tablets have similar devoted advocates.

Like the new left- and right-handed mice from Logitech (Fremont, CA) and the Dove Bar design from Microsoft (Redmond, WA) before them, trackballs and mice will continue to shape themselves to our hands.

A few interesting twists on the mouse have cropped up recently. They include the following:

- a hand-held gravity mouse, which is manipulated from a distance by moving your arm as if you were painting
- a zero-gravity combination mouse/joystick used in the RED information system, a portable CD-ROM reader outfitted with a Private-Eye display and audio capabilities produced by Reddy Information Systems (Berkeley, CA)
- the tadpole, a page-turning device used in the extremely ergonomic Cornucopia CD-ROM/DVI system from Empruve (Knoxville, TN)
- pointers that emulate mice
- mouse-like touchpads

Ergonomics are inherently bound to individual styles of work, personalities, and body types. As a result, the more choices you have, the greater the likelihood that you will be able to find an input device suited to you and your needs.

The Eyes Have It

The ideal and ergonomically correct monitor would display text and graphics at the same resolution as a printed page. This would mean a display capable of at least 300 dots per inch, an effective resolution that is not likely to be achieved soon. To improve the readability of displays in the near term, designers need to concentrate on display-adapter technologies.

Real breakthroughs in display adapters are occurring in antialiasing technologies. These are evident in products like Crystal Fonts from ATI Technologies (Scarborough, Ontario, Canada) and Continuous Edge Graphics from Edsun Laboratories (Cupertino, CA), which smooth out jagged edges on straight and curved lines, creating a virtual resolution approaching the magic 300-dpi level.

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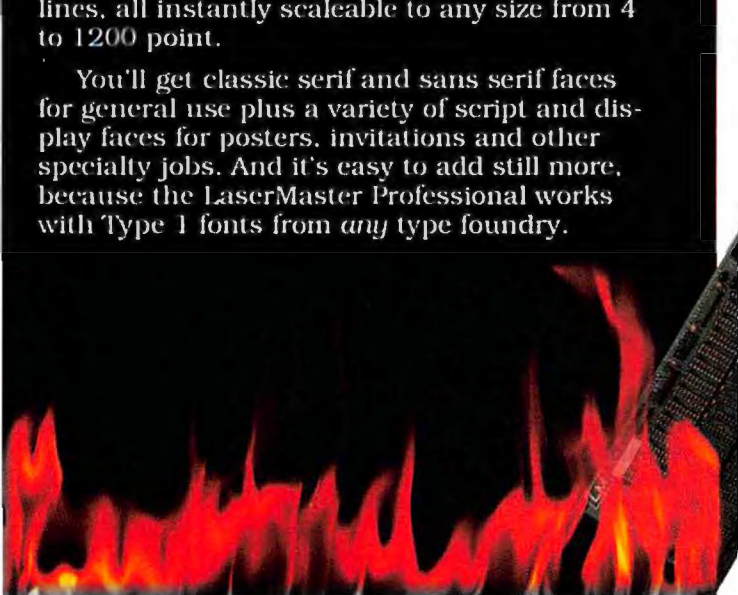

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In addition to improving screen resolution, adapters and cards must support refresh rates of 72 Hz or better. European standards already call for high refresh rates, and many European manufacturers, such as Phillips NV (Eindhoven, The Netherlands) and Olivetti (Ivrea, Italy), are already producing high-refresh-rate cards and monitors. A number of U.S.-based manufacturers are following suit.

With the expected endorsement by the Video Electronic Standards Association of a 70- to 72-Hz refresh rate as standard, it is only a matter of time until the older 56- to 60-Hz refresh-rate monitors become obsolete. Along with higher refresh rates, noninterlaced displays will also become an industry standard for monitors and video cards alike.

Shielding against ELF and VLF radiation, which is also mandated by European standards, is fast becoming commonplace. The 20-inch Flexscan 9400i from Nanao (Torrance, CA) on my desk is shielded against VLF and static emissions. At Spring Comdex, Magnavox (Knoxville, TN) introduced a monitor that meets the stringent standards of the Swedish National Board for Measurement and Testing. Many other manufacturers are also producing low-radiation monitors, and Slesin thinks that by the end of 1992 all new monitors will be low-ELF- and low-VLF-emission models.

The emissions problem lies with monitors now in use that do not provide radiation shielding.

The real emissions problem lies with the millions of monitors currently in use that do not provide high refresh rates or radiation shielding. Because the normal lifetime of a monitor is extremely long, it's unlikely that every desktop will have a thoroughly ergonomic monitor anytime soon.

While several companies have produced aftermarket radiation shields, most of them only cover the front of the monitor, leaving the potentially higher levels of radiation at the back and sides unchecked. Luckily, EMFs decay rapidly over distance. (According to most experts, the EMFs will decay within an arm's length of the screen and within 3 feet of the sides to below 2 milligauss, which is considered safe.) As for combating low refresh rates and interlacing, you can select dark backgrounds and avoid displaying highly dithered images.

Of course, you can get rid of monitor emissions altogether if you get rid of your CRT-based video display. The most promising development on the horizon is the thin-film transistor used in active-matrix LCDs. Currently cost-prohibitive for desktop implementations, TFT displays are the most likely replacement for the CRT. Not only do TFTs eliminate the EMF problem, but they also produce less heat, take up less space, and are capable of greater speed, higher resolution, and more brilliant colors than conventional monitors.

User, Heal Thyself

As much as the human interface and the furniture may change, ergonomic advances won't make much difference unless you

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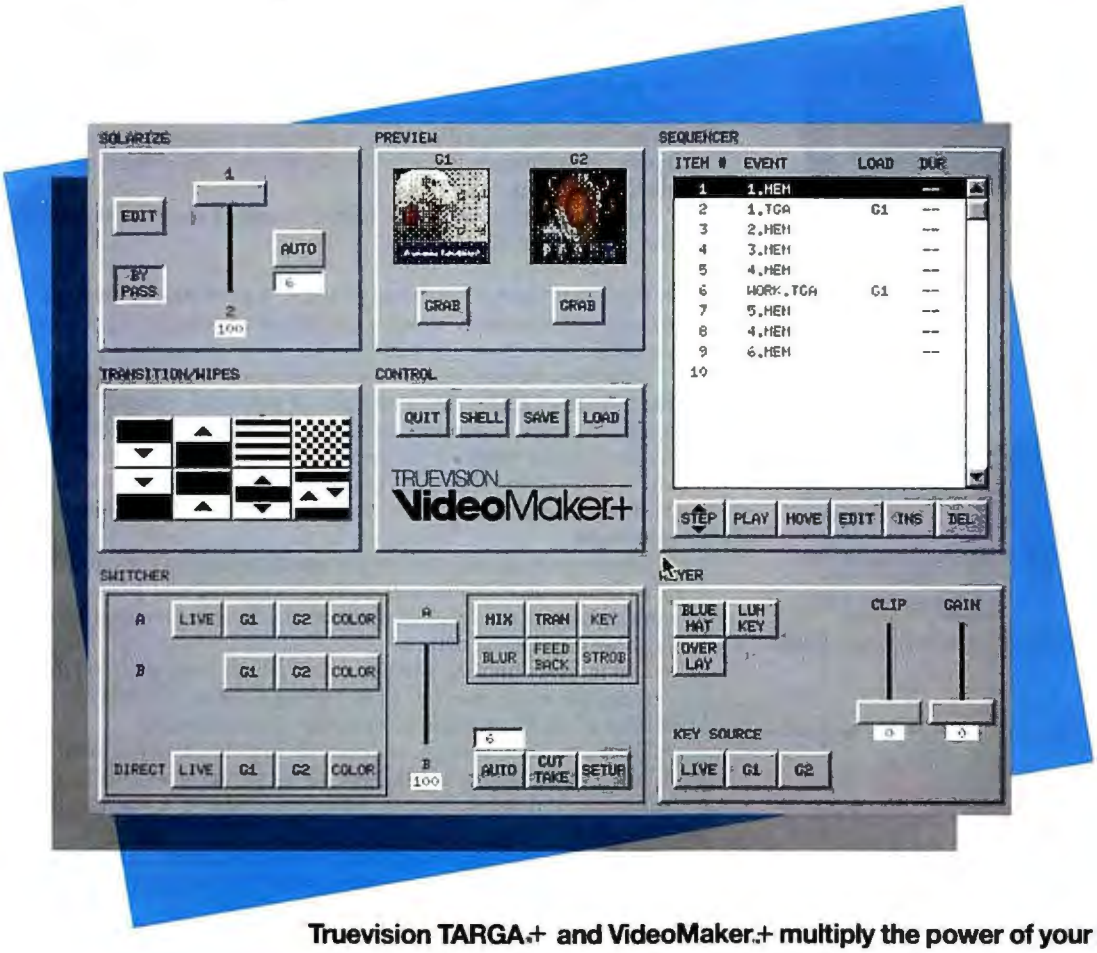

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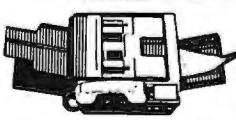

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adjust your work habits. Poor posture is one of the primary causes of RSIs. Working in a contorted, nonneutral posture will destroy the benefits of even the most state-of-the-art ergonomic design.

From adjusting chairs to taking breaks to selecting colors, many people need to be taught how to make computing a safer and healthier experience. According to Tramposh, the first thing Advantage Health does when helping to establish an ergonomic environment is train people to take full advantage of their equipment.

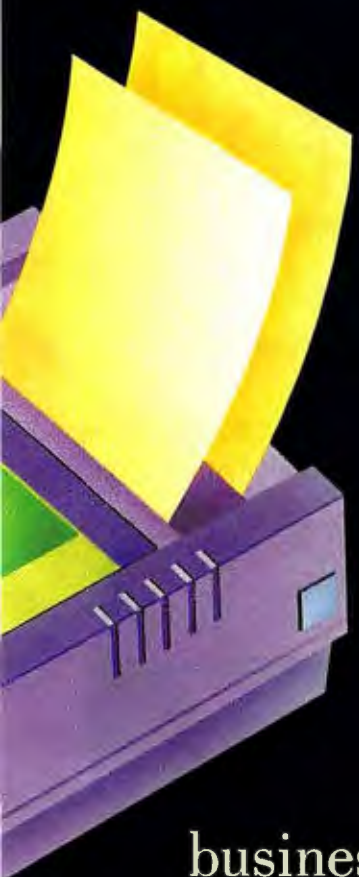
Most experts agree on the following rough set of guidelines for safe computing:

- Place your body in a neutral posture. A good rule of thumb is to make all your body's angles (joints) as close to 90 degrees as possible.
- Sit at least an arm's length away from your monitor to combat the effects of EMFs and eyestrain. If you wear glasses, especially trifocals, make sure that their plane of focus is adjusted to the distance between you and your monitor. American Optical's TruVision Technica is a progressive power lens that allows you to change your visual point of view without moving your head.
- Situate your monitor so that the top of the screen is even with your forehead. To avoid neck strain, you should also place your copy holder at eye level so that you don't have to swivel your head while entering data.
- Use indirect lighting whenever possible to avoid glare on the screen, but make sure that your lighting system can fully illuminate surfaces that hold information you need to see.
- Take frequent breaks, at least 15 minutes every 3 hours. While you are on a break, get up from the desk, do some stretches, and move around. Reducing stress is a key to safe computing.
- Make sure that your equipment is fast enough to run your applications. Waiting for a computer to catch up with your train of thought can add to your general stress level.
- Use adjustable furniture. There's no hard-and-fast rule for the proper elevation of a keyboard or a monitor, although most experts agree that the keyboard should be 26 to 28 inches above the ground and that the center of the screen should be 20 to 30 degrees below eye level.
- Try to vary your work situations. The simple act of moving to another table to talk on the telephone, read, or write longhand can help to vary your motions and reduce stress on your body. Some people have said that alternating between sitting and standing can be helpful; others pull their keyboards onto their laps; and still others compute while lying prone. The key is variation. Any activity that takes place over an extended period of time and is performed from one position is likely to be harmful.
- Personalize your office space. Environmental stressors (e.g., noise, clutter, and perceptions of either smallness or ugliness) can contribute greatly to stress, which translates to musculoskeletal discomfort.

The real key to safer, healthier computing is common sense. We spend a large part of our lives working. Paradoxically, while we often go to great lengths to turn our homes into safe, pleasant environments, we rarely do the same for our workspaces. We should. The dividends are many. ■

David A. Harvey is a computer journalist who lives in Houston, Texas, and specializes in optical and multimedia technologies and software. You can contact him on BIX as "daharvey."

Managing Technology: A Small Business Survival Guide



The 90s technology will be the great equalizer, enabling thousands of small and medium-sized businesses to match the expertise and professionalism of larger corporations.

If Any Ribbon Is O.K., Why Did You Buy An IBM® Typewriter?

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Why All PCs Are Not Created Equal

PHOTO COURTESY OF IBM

IBM's PS/2 Model 70 386.

This is America, where bigger is still better, more horsepower is the enduring thrill for car enthusiasts and seldom is heard a discouraging word about the latest, greatest technological advancement. Unless you're the one footing the bill.

More than ten years after the start of the personal computer revolution, most small businesses can easily purchase all the computing power they require, and then some, without busting the budget. But not every department requires state-of-the-art computing power; and hardware/software needs often vary widely from company to company, and even department to department, depending on the task at hand.

With a few notable exceptions — Commodore's Amiga line of PCs for some multimedia applications and Sun Microsystem workstations for CAD/CAM among them — equipment purchase managers still face two basic decisions: should my company buy an Apple Macintosh-based system or one built by IBM or the legion of IBM-compatible PC makers. The recent cooperative agreement between IBM and Apple may one day eliminate the angst from that decision, but don't expect to see tangible results from that pact for at least the next two years.

Equipment purchase managers still face two basic decisions.

Apple's chief selling point for the Macintosh has been ease of use because of the graphic user interface — standard from one software package to another — as well as the graphics-oriented nature of the Mac. It's no coincidence that, despite the progress made by MS-DOS software publishers, the Mac remains the platform of choice for many small ad agencies and other companies where graphics-intensive desktop publishing is a core application.

Apple executives are also fond of quoting independent studies from the Gartner Group and other market researchers showing users are more productive on the Mac than they are with other systems. And they note that the typical Mac user works with almost twice as many software packages as an IBM-compatible user.

Apple has also been able to whittle away at the chief fear of would-be Mac users: incompatibility with IBM-based files and programs used by the vast majority of companies in the business world. All Macs built in the last three years have disk drives capable of reading MS-DOS files and there are several software packages, Insignia Solutions' AccessPC and Farallon's PhoneNET among them, that will translate Macintosh files into the MS-DOS format, tie IBM-compatibles into AppleTalk Local Area Networks and otherwise bridge the communications gap between the two computer formats.

IBM adherents, on the other hand, cite the thousands of software packages written for IBM-compatibles, particularly for vertical applications — doctors' accounting programs, legal packages and the like. And the advantage Apple has held because of its user interface grows less formidable every day. First, Microsoft's Windows 3.0 and then IBM's OS/2 2.0 now provide the same type of user interface as the Mac, to the point where there's very little difference between working with Microsoft Word on the Mac or an IBM PC.

The difference is, all programs written for the Mac are designed around that user interface, while MS-DOS

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Seems we've been here before. Once again, the most powerful PC you can buy—in fact, the most powerful in existence—comes from Compaq.

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Who's it for? Designers and engineers longing to stretch CAD/CAE to its limits. Software developers who want compilation

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room.

without limitation. Scientists who seek accelerated analysis. Anyone who wants to push Windows wide open and watch graphics-based applications fly.

What's good for one power user is also ideal for a group. Exceptional processing speed, expandability, and practically limitless storage (more than 20 GB) make it an extraordinary network server and multiuser host.

But doing something this new and exciting isn't new to us. Compaq has a history of building the top-performing PCs in their class. With the highest standards of reliability (to save you money) and compatibility (to save you headaches). And outstanding support.

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COMPAQ

It simply works better.

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When All You Want To Do Is Write.

Sometimes a personal computer, though, is technological overkill for a secretary or department that just needs something to handle basic correspondence.

Enter the dedicated word processor. Essentially, these are personal computers with only one function, word processing, though a few of the latest models also incorporate a basic spread sheet and sometimes a modest database program.

Typical of the category is the IBM Wheelwriter 70 Series II built by Lexmark, which manufactures the typewriters, printers and word processors sold under the IBM brand name. The Wheelwriter 70 Series II incorporates a display, printing mechanism and keyboard, a complete word processing program, a spell checker and 80 kilobytes of RAM.

And both Panasonic and Smith-Corona sell laptop personal word processors. About the same size and weight of lightweight laptop PCs, the Smith-Corona and Panasonic laptop word processors have built-in LCD displays and work with companion printers. Cost: under $1,000 for the package.

publishers are still upgrading their packages to work with Windows 3.0.

The release this fall of OS/2 2.0 might have confused the software industry and delayed the spread of Windows-compatible programs, but the upgraded version of the original OS/2 will run any Windows-compatible program — as well as any MS-DOS program regardless of which version. "It's a superset of the Windows environment," says Winnie Briney, IBM Personal Systems marketing director, though she notes the two environments "are competitive."

A final point in favor of IBM-compatibles. Unlike Apple, which remains the only supplier of Macintosh-compatible computers, IBM has a legion of compatible competitors, everyone from

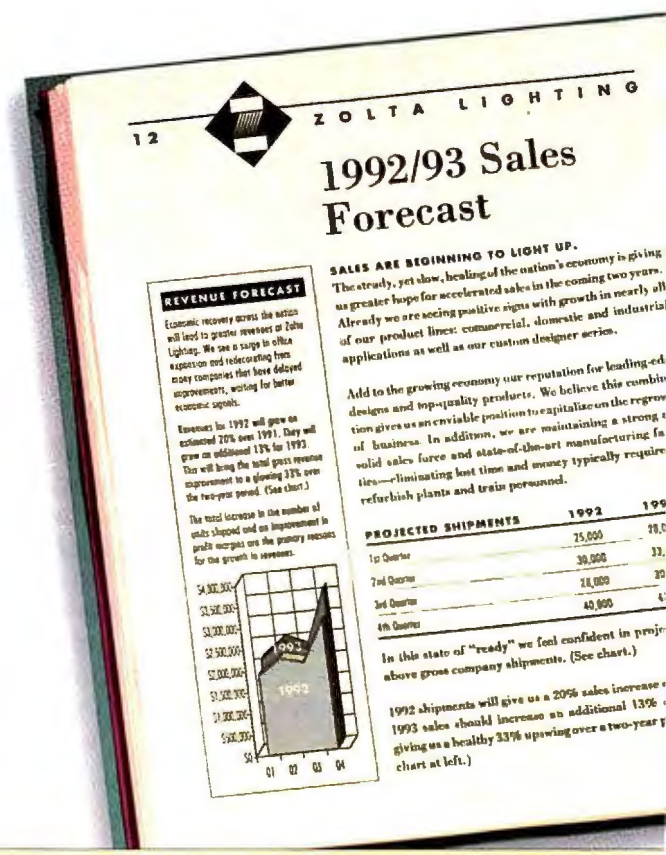
You could be a genius and do this on a word processor.

Layout and design software for the PC and Macintosh.

It'll take more than brains to create this on your word processor. It'll take some old-fashioned cutting and pasting. And it won't look nearly as good.

On the other hand, you could do the smart thing and create it on Aldus PageMaker® 4.0 for Windows. In the process, you'll save yourself a great deal of frustration, and plenty of your precious time.

You see, PageMaker has many capabilities not found in a word processor. All of which makes creating reports, proposals, brochures, catalogs, or manuals quick and easy. Not to mention eye-catching.



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high-profile manufacturers such as Compaq, Epson and Tandy to less well-known but equally competitive brands, such as Advanced Logic Research, Gateway 2000, AST Research, Packard Bell and Dell. And those brands continue to force the cost of IBM-compatible computing down, with no end in sight.

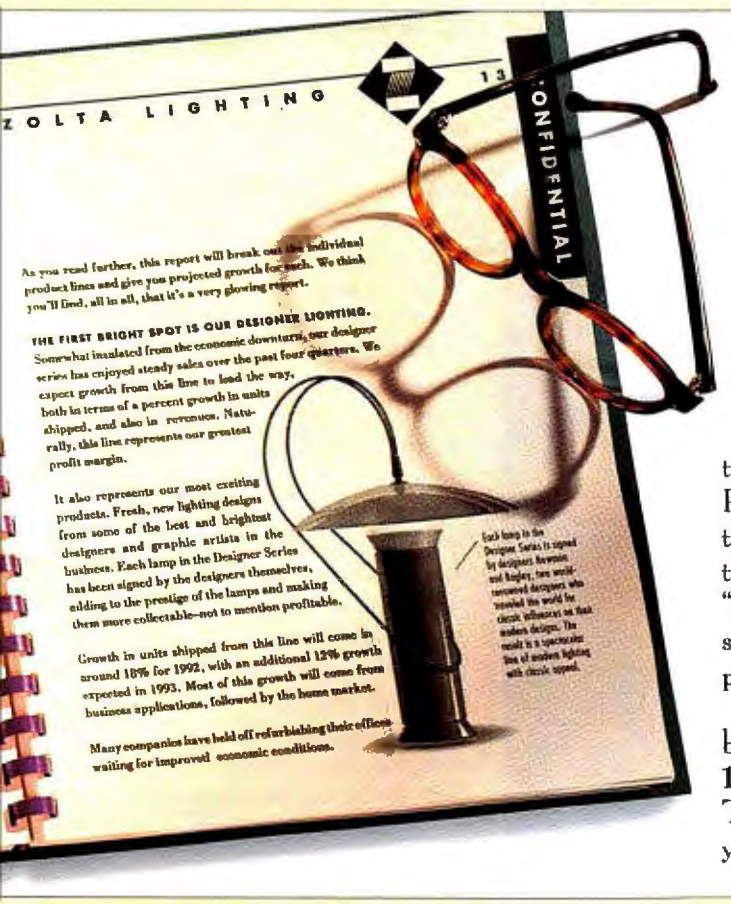
As anyone with more than passing experience with personal computers already knows, choosing a basic hardware platform is only the start of an increasingly thorny process. Can an IBM-compatible user live with a 386-based machine when 486 hardware is available from most vendors? And why buy a Mac Classic when the Mac IIsi beckons with so much more raw computing power?

PHOTO COURTESY OF APPLE COMPUTER, INC. / WILL MOSGROVE

Mac IIsi with 13" RGB Display Monitor.

Add in the hundreds of software packages, printers and other peripherals and related equipment, and it's easy to see why many companies buy on blind faith, or the opinion of salespeople and consultants. It often seems that half the purchasers are afraid of buying too little computer power, while the other half are wary of technological overkill. And either mistake costs money.

"You talk about any high-end product and there's a segment of the market that will buy it at any price," says Eli Hertz, president of the New York-based IBM-compatible personal computer company bearing his name. He argues, for example, that very few companies need the computing power of 486-based PCs. "I tell people to look first at the software applications they plan to use, and what they require, and then consider what they might need if they grow a bit." ■



Or use PageMaker for Windows and just look like one.

Special features pull together multiple files of text, graphics, spreadsheets, tables, or databases. PageMaker's precision layout and typographic tools then effortlessly give them a professional polish. In fact, to quote the March 1991 issue of *PC Computing*, "PageMaker 4.0 proves you don't have to sacrifice ease of use for sophisticated, professional page-makeup abilities."

To find out more about the benefits of desktop publishing, call **1-800-685-3507** for a free booklet. Then get ready to show everyone your true brilliance.

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Printers: If You Look Good, They Look Good

Few clients care whether your project proposal was produced on an Apple Macintosh, IBM 386 33MHz PC — or a dedicated word processor from Lexmark or Panasonic, for that matter. All that concerns them is how it reads — and how it looks.

Buyers face three basic choices in picking a printer: laser, inkjet or dot matrix. Each system comes with its own advantages and disadvantages, and what you buy depends on the task at hand — and the budget.

Nothing has changed the nature of personal computing so much in recent years as the advent of low-cost laser printers — now down to $700 to $800 at retail. Without them, desktop publishing would not be the phenomenon it is today, and small companies would not be producing reports, brochures and proposals with the speed and quality common to much larger competition efforts.

Who needs a laser printer? First, anyone who will be producing documents for outside clients, and in general, any company that is concerned about the appearance of its paper documents.

"Studies we've done verify that print quality matters to clients," says Bill McGlynn, Hewlett-Packard Hard Copy Group marketing manager. "The presentation of a (printed) proposal can win or lose a job."

That doesn't mean an $800 laser printer will suit the needs of every business producing documents for outside scrutiny. There are tangible rewards for stepping up in class.

H-P, IBM, Panasonic and other laser printer manufacturers offer greater speed and improved print quality in more expensive laser printers, as well as more flexibility. All H-P series III laser printers built since last March incorporate resolution enhancement circuitry that effectively brings the 300 × 300 dpi print quality to near 600 dpi.

There are other advantages to more expensive — $1,200 to $2,000 — laser printers. An $800 (street price) H-P IIP laser printer will produce four pages of typed copy a minute with limited type options. But a high-end laser printer from any of the major suppliers can double and quadruple that output, with near-professional printer quality using PostScript-compatible fonts.

"Inkjet technology, in fact, is the most likely candidate to bring color printing to the masses."

But not all small businesses need even a low-end laser printer. For many companies that only occasionally produce documents for outside eyes — mainly correspondence — inkjet printers offer a cost-effective alternative. With some inkjet models in stores for under $500, the technology is fast approaching mass market pricing.

Inkjet printers work essentially as it sounds; a series of fine nozzles spray ink on paper to form letters, numbers or graphics.

Inkjet technology, in fact, is the most likely candidate to bring color printing to the masses. Four-color inkjet printers are available now for about $1,300, and by next year, they may well fall below $1,000 at retail.

The workhorse of computer printers, though, remains the dot matrix.

Purchase orders, UPS shipping documents and other NCR (no carbon required) forms require the impact printing style of a dot matrix. And with dot matrix printers now available for well under $500, the technology represents the most cost effective choice for many small businesses.

No one will ever mistake the print quality of even a 24-pin dot matrix printer for a laserjet — or even inkjet — printer. But manufacturers are making progress. Epson, for example, has developed scalable fonts for its dot matrix line to reduce the "stair stepping" look of curved characters. ■

PHOTO COURTESY OFPANASONIC COMMUNICATIONS & SYSTEMS COMPANY

Panasonic KX-P2624 Quiet 24 Pin Dot Matrix Printer.

"Aren't they that Swedish country rock band?"

Okay, so some people don't know exactly who ALR is. But ask any PC industry expert, and they'll tell you that ALR is an award-winning manufacturer of high performance personal computers.

It's time you get to know US

In fact, the ALR® BusinessVEISA™ recently beat both IBM® and Compaq® for *PC/Computing*'s prestigious Most Valuable Product Award.

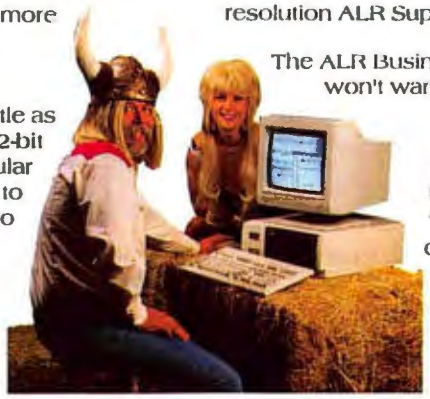
As pioneers in value and performance enhancing technology, we have a history of winning top industry awards. No wonder, in a recent *PC World* survey, 94% of all ALR customers said they would buy ALR again. That's more than AST® (85%), NEC® (77%), or Dell® (73%).

The BusinessVEISA delivers the latest in technology at an affordable price. For as little as $1,995, you get the advanced power of 32-bit processing *and* EISA. Additionally, a modular CPU upgrade path provides a gateway to higher future performance. You never have to worry about outgrowing this system because you can easily and affordably

"Just Upgrade the CPU!."™

	ALR	Compaq®
Manufacturer	ALR	Compaq®
Model	BusinessVEISA 386/33™	Deskpro 386/33L™
CPU	33-MHz i386DX™	33-MHzi386DX
Upgrade Path	25- & 33-MHz i486DX™	33--MHz i486DX
Bus Architecture	32-bit EISA	32-bit EISA
RAM standard	1-MB (**5-MB w/PowerPAK**)	4-MB
	Model 101 **$1,995**	
PowerPAK with	4-MB RAM and	
	SuperVGA adapter	VGA adapter
	(800x600) **$299**	(640x480)
	120-MB Hard Drive $1,095	120-MB Hard Drive
	Suggested list price **$3,389**	**$6,199**

And for a limited time, we've made this great value even better. Purchase any of our BusinessVEISA Model 101s, and get the ALR PowerPAK for only $299. The PowerPAK adds 4-MB of performance boosting memory and a high-resolution ALR Super VGA adapter while saving you $350.



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THE MOST USE
TO COME ALONG

A few months ago we brought you the world's most useful computer—the Toshiba T2000SX.

That computer symbolized what we call "the next generation in personal computing." A computer that not only allows you the freedom to work where, when, and how you want to. But is so precisely engineered—from its superior keyboard to its easy-to-read VGA screen—that you'll actually enjoy using it.

Well, thanks to the incredible speed of modern technology, here we are once again.

This time to present the new Toshiba T2000SXe.

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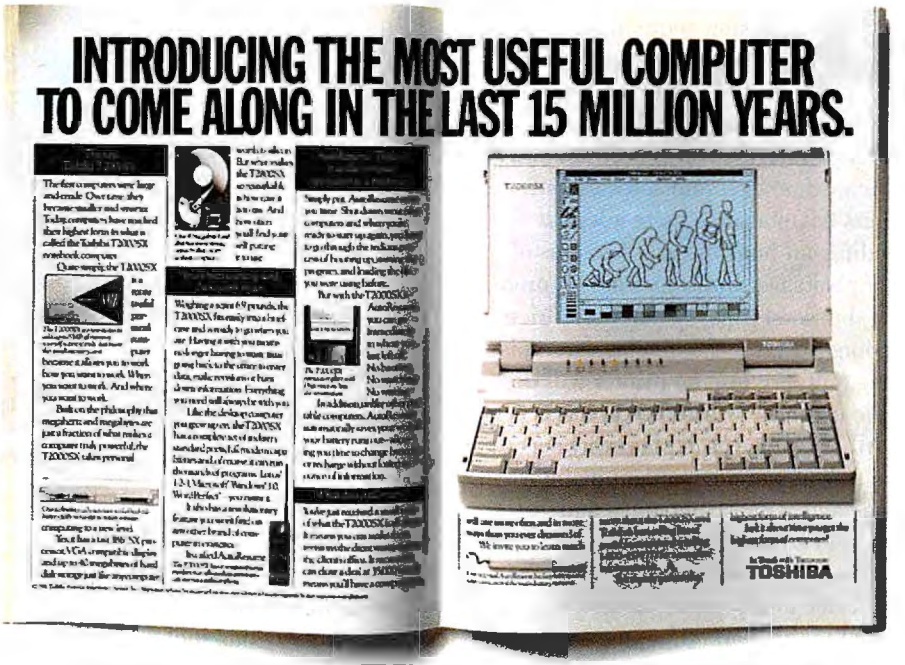
FUL COMPUTER SINCE FEBRUARY.

THE E STANDS FOR EXTRA POWER.

Like the T2000SX, the T2000SXe weighs a minuscule 6.9 pounds, it boasts a 386SX processor, and it supplies up to 60 MB of hard disk storage space. But, and here's the news, the T2000SXe gives you a bigger dose of speed (20MHz) and more memory (2-10 MB RAM).

Of course, the T2000SXe also offers Hypertext, a VGA screen, full modem capabilities (including available cellular and fax accessories), full-size sculpted keys on its keyboard and a host of additional benefits that make other notebooks look more like memo pads.



After testing eight of the top notebook computers on the market, Byte Magazine said, "Buy the Toshiba T2000SX." Wait'll they try the T2000SXe.

A LONGER LASTING BATTERY.

The most useful computer isn't of much use if its battery doesn't last long.

That's why the T2000SXe, like the T2000SX, is armed with a Nickel Hydride battery. Nickel Hydride is proven to deliver 22% more power per ounce than the NiCad batteries found in other portable computers. In fact, according to Byte magazine, the battery on Toshiba's T2000SX lasted well over three hours on a 90-minute charge. Outlasting every other notebook they tested and lasting twice as long as some.

To get even greater battery life, the T2000SXe offers Toshiba's highly acclaimed AutoResume. A special feature that allows you to shut your computer down and start up precisely where you left off. Without the hassle of rebooting, restarting applications and reloading files.

NOW THERE ARE EVEN MORE CHOICES.

At Toshiba, we've always believed that no one computer is right for everyone. That's why we've also added a more affordable notebook to our line called the T2000. Featuring a 12MHz, 286 processor, it's designed for people who don't need all the power of the T2000SX or the T2000SXe.

If you'd like to learn more about the world's most useful notebook and portable computers, please call us at **1-800-457-7777.**

Well, that's the latest. Three incredible notebooks that fit your needs, your briefcase and now your budget.

Isn't technology wonderful?

In Touch with Tomorrow
TOSHIBA

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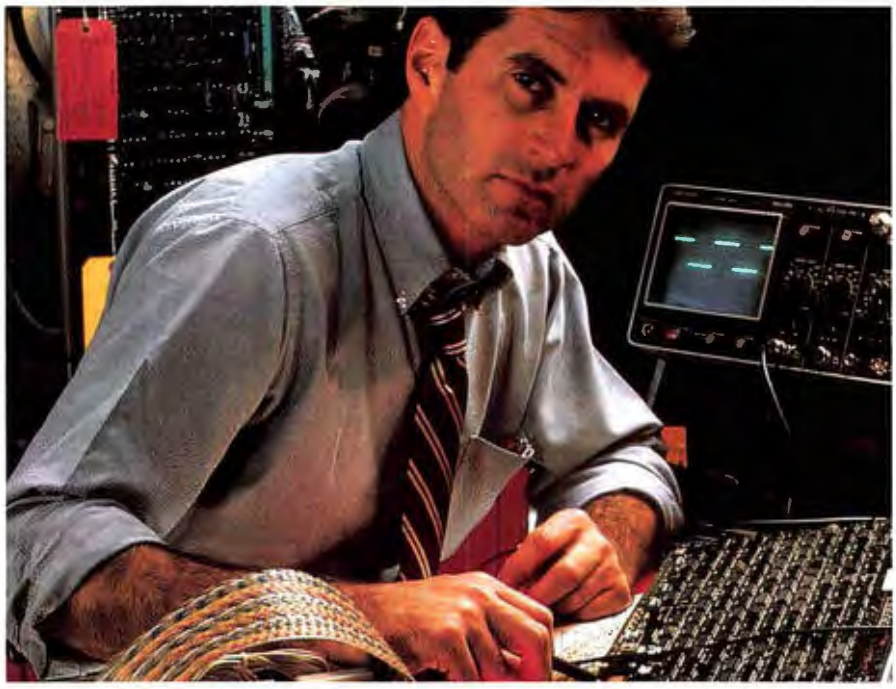
When Your PC Goes Bump in the Night



GABE PALMER/THE STOCK MARKET

Service and support are deciding factors in purchase decisions.

Anyone with more than a passing acquaintance with personal computers knows that it's never a question of IF a PC system will break down. It's a matter of WHEN. Hardware reliability is better than ever and software publishers have become more adept at weeding out bugs in early versions of their packages. But sometime — probably the worst time — that hard drive is going to crash, the display screen is going to freeze up, the printer will die or the database will refuse to load.

All of that helps explain why service programs, independent maintenance and repair companies and technical support hotlines have become a big business.

Service and support, in fact, were central to the marketing program designed by IBM for its PS/1 line of personal computers. The PS/1 is aimed in part at "tiny businesses," those with fewer than 10 employees, according to Skip Gladfelter, manager of PS/1 marketing. "We interviewed literally thousands of potential buyers and when we got to service and support, we found an expectation that virtually no one was filling."

Nothing hurts a computerized operation so much as when a hard disk drive, crammed with vital data, crashes.

In addition to opening on-line support through the Prodigy information service, an electronic bulletin board, IBM's response was to design the PS/1 as a modular series of so-called Customer Replaceable Units that can be removed and replaced without major surgery.

Most hardware and software suppliers, in fact, are paying more attention to their service and support programs. With a package representative of what many PC makers are supplying, Packard Bell, for example, offers a one-year warranty that includes a disk-based tutorial and support program, an 800 telephone support number — currently generating 30,000 calls a week — and on-line support through the Prodigy information service and Packard Bell's own electronic bulletin board.

For more serious problems, the company offers both carry-in service and, for six months to a year depending on the model, on-site service.

It can take 24- to 72-hours to get a technician on-site through that program, though, and for many small companies, that's too much lost productivity. Filling in the gap — for a price — are dozens of third-party service centers.

Computerland, for example, offers four levels of service response: 4-, 8-, 24- and 48-hours. Service is based on an hourly rate and/or an annual contract. Hourly costs typically run from $75 to $90 an hour, depending on location, and contracts vary widely depending on the computer and configuration.

Nothing hurts a computerized operation so much as when a hard disk drive, crammed with vital data, crashes. Unless a company backs up its computerized data on a daily basis, hard drive crashes can bring its operations to a screeching halt. But even when a hard drive dies, most of the data can be retrieved by service companies that specialize in data recovery.

"We average 95 percent data recovery on hard drives," says Rob Harrell, a sales representative with Ontrack Data Recovery, based in Eden Prairie, MN.

Ontrack, like other data recovery operations, typically will diagnose the problem, determine what data can be recovered and present the customer with a cost estimate. Ontrack charges $200 to diagnose the drive and between $200 and $800 to recover the data. ■

Just OK.

HP®LaserJet® IIP

$1295

Printhead warranty: 1 year
Conventional laser printhead
14 fonts, 2 typefaces
50-sheet paper tray
Curved paper path
Height: 8 ¼"

Okidata OK!™

Okidata OL400

$999

Printhead warranty: 5 years
Okidata-built LED printhead
(no moving parts)
17 fonts, 4 typefaces
Fully compatible with HP
Series II software emulation
200-sheet paper tray
Straight-line paper path –
feeds envelopes, labels,
heavy stock without jamming
Low profile: 5 ½"

At $999 list, there's no lower priced page printer on the market than the Okidata OL400.* Yet it offers many features you won't find on the $1295 LaserJet IIP.

Our solid-state LED printhead, for example, has no moving parts. It's so reliable, it comes with a 5-year warranty – longest in the industry (plus 1 year parts and labor on the printer itself).

Okidata's simpler printhead costs less to manufacture, and results in a simpler design overall–a major reason for the OL400's low cost. Yet when PC Magazine compared both printers, they wrote, "...we judged (the Okidata) to have the best graphics and text quality." The OL400 also comes with more typefaces and fonts, and a high-capacity paper tray–all standard.

And the OL400 has one more unique feature–the Okidata OK! It's our promise that every printer we sell will deliver not merely acceptable performance and good value, but outstanding performance and exceptional value.

So before you settle for a page printer that's merely OK, visit your authorized Okidata dealer and ask about the printer that's Okidata OK!–the Okidata OL400.

For further information, please call 1 (800) OKI-DATA.

OKI OK!

OKIDATA OK!

We don't just design it to work. We design it to work wonders.™

*Manufacturer's suggested retail price. Dealer prices may vary. HP and LaserJet are Reg. T.M. of the Hewlett Packard Corporation. P.C. Magazine, 6/12/90 issue. Okidata is a Reg. T.M. and Okidata OK! is a T.M. of OKI Electric Industry Co., LTD. "We don't just design it to work. We design it to work wonders." is a T.M. of OKI America Inc.

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You'll Never Need a Phone Booth Again

Much as some business executives would like to leave the turmoil of company headquarters behind when they hit the road, the call of the office is often just too strong to ignore. That, more than anything, helps explain why more than seven million Americans will own a cellular phone by the end of this year, and why, depending on the market forecast, anywhere from 20 to nearly 31 million Americans will be using cellular phones by 1995.

Many of them will use a cellular phone to turn their car into an extension of their office. The image, after all, of the busy executive — one hand on the steering wheel, the other holding a phone — is what drives many people to buy a cellular phone in the first place. But all of that is prelude to a sweeping change in communications that over the next three to five years will provide all of us with part dream, part nightmare technology: the truly personal phone that will keep us connected, no matter where we are, no matter what the time.

Anywhere from 20 to nearly 31 million Americans will be using cellular phones by 1995.

In what has become an accelerating game of oneupmanship among cellular phone manufacturers, Motorola this past summer introduced the industry's smallest and lightest handheld model to date: a 7.8-ounce hand held cellular phone that will provide between 50 and 60 minutes of talk time, between charges, with a standard battery. That's an improvement over their ground-breaking pocket cellular phone introduced only two years ago, and a hair's breadth better than a competing model unveiled by Fujitsu.

Although they cost between $700 and $1,500 — several times the prices charged for car cellular phones — compact, lightweight handheld cellular phones from Motorola, Fujitsu, Mitsubishi, Audiovox and a growing legion of competitors are fast taking over the cellular phone industry. By some reports, those models will account for 60 percent of the more than two million cellular phones that will be sold this year.

There are still reasons to buy a car cellular phone, though, and handheld models, no matter how good they are, still can't provide all the power and flexibility of car models.

For starters, car cellular phones have a higher power output, 3.0 watts, compared to the 0.6 watt ceiling set, for safety reasons, for handheld models. That means in fringe and other difficult reception areas car models will generally provide better reception. And because a car cellular phone runs off the car's power supply, there's little danger of the phone going dead in the middle of an important conversation.

But the real breakthrough towards a portable, personal telephone will begin to emerge next year as the first so-called Personal Communications Network systems go on-line around the country. PCN phones, based on a new telecommunications standard set by the Federal Communications Commission, can be considered "micro-cellular" phones. They will be even smaller and lighter than conventional handheld cellular phones because they require a lower power output to reach a more tightly strung network of transmitters. ■

COURTESY OF MOTOROLA

Cellular phones are getting smaller and lighter.

Martin Levine has written about computers and high-technology for national consumer and business publications over the past 12 years. He is the former editor of ***Consumer Electronics*** *magazine.*

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B

FEATURE

CLASSIC LANGUAGES, PART 2

COBOL

A large body of programs and trained programmers have kept the Common Business Oriented Language alive and kicking

DORIS APPLEBY

If you read enough computer magazines, you can easily find articles about the agedness of COBOL: what to do with all your old COBOL code, whether COBOL is still a viable programming language, and so on. And yet, more than two-thirds of mainframe users cite COBOL as their top programming language. The reasons are not hard to find. In American corporations today, there are working programs estimated at 70 billion lines of code, developed and maintained by an established (some would say *entrenched*) cadre of COBOL programmers.

But COBOL gets a bad rap from two sources. The first is the computer science community, largely resident in universities and research laboratories. This may be largely due to the different professional styles of the business and scientific communities. The world of business and government does not report its findings in well-documented journals, nor does it publish text books and well-written manuals. Although the Backus normal form (a formal method for describing languages) was developed before COBOL, COBOL's description was not written in it, so the language did not conform to established practice among computer language theorists. In addition, computer scientists aren't interested in business applications anyway.

The second group of detractors advocates an integrated systems approach and believes that fourth-generation languages such as Focus, Nomad, Mantis, and Natural are better suited for this purpose. This group claims that a 4GL facilitates user-written programs, is quick and easy to learn, and has common applications built in. These 4GL enthusiasts estimate that a 4GL application can be written in from ⅕ to 1/300 the number of person hours that it takes to complete a comparable COBOL program. Writing in *Journal of Systems Management* ("The Good Old IS Days Are Gone," April 1991, p. 9), A. McClanahan and J. Perotti stated that COBOL programmers "cannot extricate themselves from their background, because they cannot see beyond it." In such situations, users try to make end runs around the MIS department, where the applications backlog may be from nine months to nine years.

Other reports have been more measured, documenting modest productivity gains as well as costly 4GL failures. The most notorious report was on the effort of the New Jersey Division of Motor Vehicles to connect more than 1000 widely separated terminals to a common database and to process thousands of transactions daily. The project used an untried 4GL, which ground to its inevitable halt. The system was redesigned, at great expense to the New Jersey taxpayers, by consultants from a top accounting firm using COBOL.

Studies of 4GL failures and successes indicate that the outcome depends on the application. Plugging a 4GL into a system to prototype an application (i.e., to try an experimental model) or to generate code (possibly COBOL) seems productive, but systems with large transaction volumes and a lot of concurrent users seem unsuitable—or, at least, are largely untried.

It will be interesting to watch the success of ARKLA Gas, which recently converted, at a cost of $70 million, its entire database from IMS to ADABAS, and its application programs from COBOL to the 4GL Natural, a product of Software AG. Jimmy Jordan of ARKLA Gas reports that the

BYTE ACTION SUMMARY

COBOL is far from dead. Despite the language's age, COBOL applications can be fast and durable. Porting an application to a fourth-generation language system is often expensive and risky. Updating an application to a newer version of the original language may involve less risk (and expense) than converting it to a 4GL system. As for new applications, prototyping in a 4GL may be a good path to COBOL development.

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company was motivated by the superiority of the relational ADABAS over any database supported by COBOL, and by the ease of programming in Natural. Software AG, in business for over 25 years, has a good track record. Other converts are the Federal Mediation and Conciliation Service and the Morgan Stanley Investment Bank.

The Art of Program Maintenance

Partners at the CPA firm of DeLoitte & Touche work mainly with COBOL systems and believe they will be doing so in the foreseeable future. The investment in existing software is just too high to make big changes.

Rather than using 4GLs, DeLoitte & Touche advocates using CASE tools that can generate COBOL code, increasing coder productivity by as much as 80 percent. A client undertaking the restructuring (or reengineering) of old code usually needs the assistance of professionals who are thoroughly familiar with software tools and restructuring. DeLoitte & Touche provides a package called 4-Front, which includes theory, procedure, policy, methodology, and six or seven software products, including the Endeavor reengineering package. Fewer than 50 percent of its clients "do it alone" but use consultants to work with the MIS shop during conversion. Andersen Consulting also offers reengineering services, using the three-module CASE tool Foundation, which runs on PCs as well as on mainframes.

When talking with the partners, I brought up the delicate subject of the quality of COBOL programmers, most of whom are trained in two-year colleges or proprietary schools, since many universities won't teach it. The partners had not learned COBOL in school, as is the case for many systems analysts. There seems to be a division of labor in the MIS world, with coders turning very explicit specifications into COBOL code but not being responsible for program design. Ken Belcher of Realia says that a COBOL programmer can make suggestions, which are usually well received by a systems engineer if they improve the end product. The programmer knows COBOL, and the engineer is responsible for system requirements.

A Brief History of COBOL

In April 1960, the short-range committee of the Conference on Data Systems Languages (CODASYL) published the first version of COBOL, knowing that added features were needed. Two of these features were a sort facility and a report writer. The language was organized around three major divisions:

- Environment, which specifies which computers a program will compile on and which computers (possibly different ones) it will run on. In theory, this is the only division that needs to be changed when moving from one implementation to another, although this is not always the case.
- Data, which describes files, individual records, and fields within these files and is moderately machine independent.
- Procedure, which lists the actual statements that are to be executed and should be entirely machine independent.

The Identification Division, which identifies a program and its attributes, was added in COBOL61. In COBOL85, this division contains information about whether the succeeding program is Common and can be called from any program that contains it or Initial and reset to its initial state on each invocation.

COBOL65 added table handling, including indexing and search operations. Hardware advances had provided for data storage on drums or disks rather than on tape, so provisions for random access were included.

By 1968, the COBOL standards committee (then called

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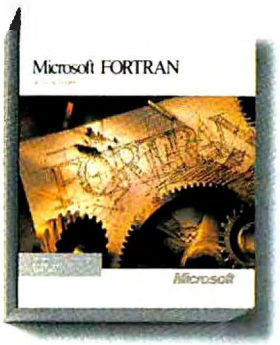

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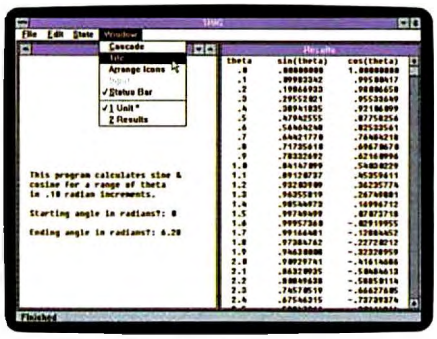
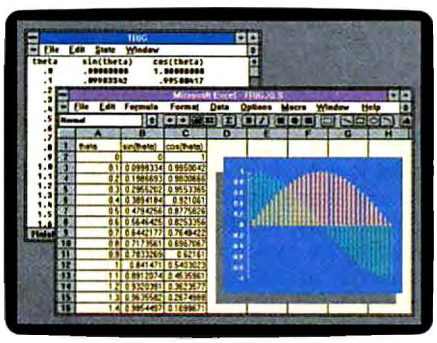


The Microsoft Windows graphical environment lets you have multiple windows in your FORTRAN applications. This means that you can resize and scroll input and output displays to view data...



...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.

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X3.4, now called X3J4) was established as the development and maintenance authority for COBOL. No changes can be made without going through this committee. In 1968, the major changes were that a COBOL "nucleus" was defined that all compilers must meet, and seven modules were standardized that might or might not be included in a marketed compiler. These modules are Table Handling, Sequential Access, Random Access, Sort, Report Writer, Segmentation, and Library. Thus, a COBOL compiler can be many different animals.

In 1974, the Random Access Module was split into Relative and Indexed I/O. Also, three new modules—Debug, Interprogram Communication, and Communication—were added. This last module allowed message passing between local and remote systems, but it was judged overly complex by the business community, which uses alternative, hardware-specific communications utilities. Interprogram communication provided a first attempt at structured programming with reusable modules.

COBOL85

The COBOL85 specification was published after a long controversy with users who were afraid that old programs would not meet the new standard. The issues were resolved by designating some COBOL74 features "obsolete." These may be deleted in a new standard (projected for around 1995), so programmers are warned not to use them in new code and to delete them from old programs. Fortunately, CASE tools are admirably suited for the task, but they take time and know-how.

Recognizing the larger sizes of modern computer memories, the 1985 standard provides for larger arrays and, in conformance with modern programming practice, new control structures such as `Performing With Test After (Before)`, paralleling Do Until and Do While loops in other languages. COBOL does not support recursion, nor is it likely to in the future.

Objects in COBOL

A major feature projected for COBOL is *objects*, currently being developed by an international CODASYL task force and expected to be presented to the ISO at its meeting in the Netherlands this month. An object is a module including data and procedures called *methods* and supporting encapsulation, abstraction, inheritance, and reusability. Ken Belcher described a typical object as encapsulating customer information. Programs would include references to customer numbers only through the object. If a company decided to change the numbers, it would change only the object. All client programs would automatically include the new object. Although object-oriented programming requires looking at programs in new ways, including pointers to small objects in existing structured programs or encapsulating entire old programs in objects should not require extensive programmer or user retraining.

COBOL has changed and will continue to change incrementally over the next several decades. Recent announcements of new versions of COBOL (from Micro Focus and Microsoft) that work with and under Windows and Presentation Manager are further evidence of its durability. Because of the large investment in existing programs and trained personnel, and because of its effective file- and database-handling facilities, COBOL should be in use for a long time to come. ■

Doris Appleby writes about mathematics, computer science, and pedagogy. She is also the chairperson of mathematics/computer science/information systems at Marymount College in Tarrytown, New York, and the author of Programming Languages—Paradigm and Practice *(McGraw-Hill, 1991). You can reach her on BIX c/o "editors."*

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NEW PRINTER TECHNOLOGIES

Back when I was young and personal computers were even more so, I was certain that the widespread use of such machines would render paper obsolete. Today, with every newspaper I peruse or book I read to my daughter, it becomes plain that paper is here to stay. Ironically, it is the advances in personal computer hardware and software in combination with the ever-increasing sophistication of printing technologies that have laid to rest the chimera of a world without paper.

The greatest change in printers over the past half decade has been the constantly growing intelligence they display. Today, it's likely that the printer you use is more powerful and has more memory than your computer. In "Smart Printing," Mike Riezenman explains why you need such powerful printers and how printer technology might evolve over time. In the text box "The Silence of the Pins," Ted Zajac discusses the steps taken by impact-printer manufacturers to remain competitive with laser technology in the office.

Color is the most exciting trend in printer technology today. The widespread use of graphical interfaces and applications has created an equally widespread demand for graphical hard copy. Desktop publishing, for better or for worse, has made the term *WYSIWYG* a part of our language. For many people running a Windows or Macintosh system, true WYSIWYG now includes true color.

Bringing color printing to the desktop is not an easy task. In "Color Printing," BYTE consulting editor Roger C. Alford discusses the challenges and problems inherent in color printing. Today, printers are capable of producing millions of colors on command, but the problem lies in matching those colors with what you see on your screen or with the output of other printers.

Alford also introduces the basic color-printing technologies: dot matrix, ink jet, thermal transfer, and laser. He explores the state of color dot-matrix printing in the text box "Ribbons and Color." Former State of the Art senior editor Jane Morrill Tazelaar brings you up to date on color laser technology in the text box "Color Laser Printing."

Dot-matrix and laser printing represent the two ends of the color-printing spectrum. Between them are ink-jet and thermal-transfer printing, which represent a compromise between the inferior output of dot matrix and the steep price of laser. In "Ink Jet Takes Off," A. J. Rogers looks at a technology renowned for its quiet operation and vibrant output, and he closes with a discussion of phase-change ink-jet printing, which makes the wonderful output you expect from an ink jet available on plain paper.

In "Hot Colors," Michael D. Nelson explores thermal-transfer color printing. Thermal transfer is the technology behind most high-end color PostScript printers. In a related text box titled "The Dye is Cast," Nelson describes dye-diffusion printing. Unlike color-printing technologies that dither colors on the page to produce more than seven colors, dye diffusion lets you directly print millions of different colors.

Color is great, but there remains great demand for printers that can reliably produce lots of output. One problem with laser printers is that they have a lot of moving parts. Something with fewer moving parts, of course, would probably be more reliable. Enter ion-deposition printers. In "Printing with Electrons," BYTE technical editor Ben Smith examines this potential competitor to desktop laser printing.

The trends in printing technologies mirror the trends in personal computing: more power, more color, and more reliability for less money. No wonder we don't want to give up paper.

—Bob Ryan
Technical Editor

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SMART PRINTING

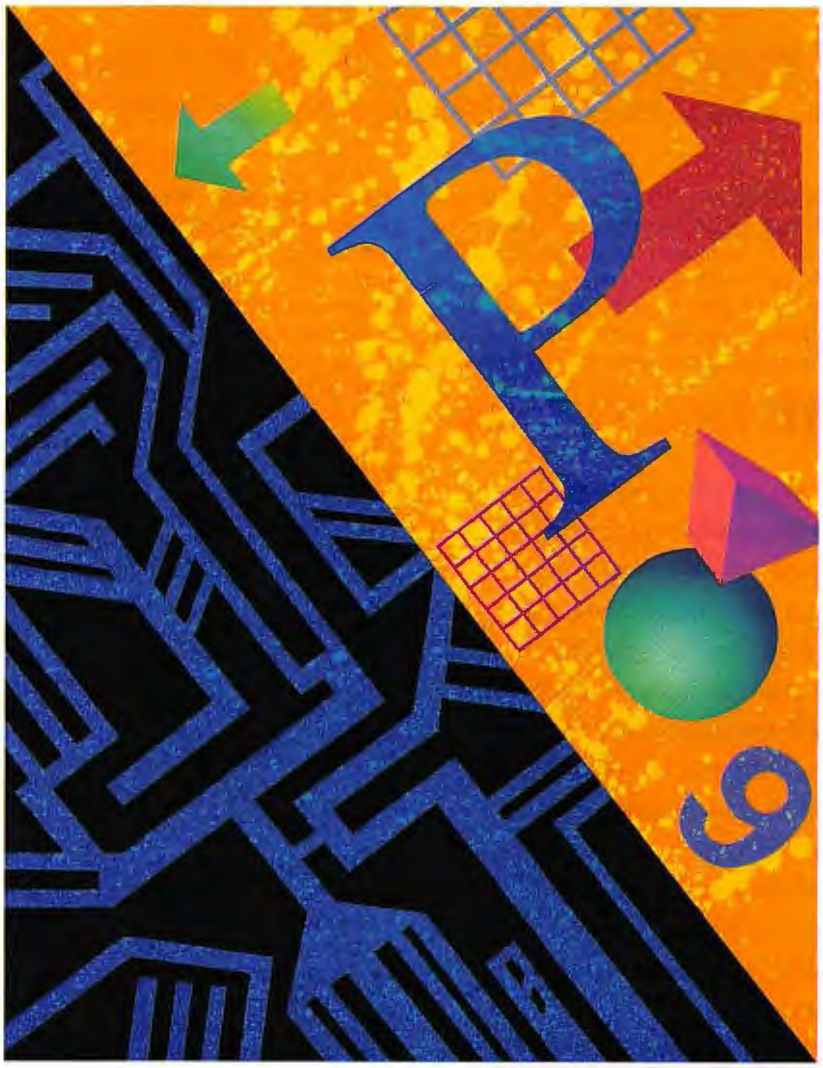
The days of the "dumb" printer are limited. As printing becomes more complex, so do the technologies that control it.

MIKE RIEZENMAN

Back in the days of print bands and daisy wheels, when almost all a printer controller had to do was accept a stream of characters from a computer and convert each character into a properly timed pulse to fire a hammer, you didn't worry too much about the controller's IQ. Even when dot-matrix printers came along, the basic picture did not change very much. The controller accepted a series of commands from its host and executed them as they were received. A simple one-to-one correspondence existed between the commands sent to the printer and the actions it was expected to perform. A printer's speed was limited only by its electromechanical components; the controller could easily deliver pulses to the marking mechanism as fast as the latter could accept them.

Today things are different. With the advent of page-description languages (PDLs) like PostScript, controllers are being asked to do a great deal more than just look up the precalculated bit patterns that make up a character. To print text, they must calculate the bit patterns for a particular style and size of type from a set of stored font outlines, and they are required to perform an intensive set of computational operations for every character on the page, scaling the appropriate outline to the desired size and then calculating the locations of all the dots required to fill it in.

For graphics, the demands made on the printer controller have increased significantly. Before the advent of PDLs, the computer put the printer into its graphics mode and then sent it a bit map detailing the location of every dot to be



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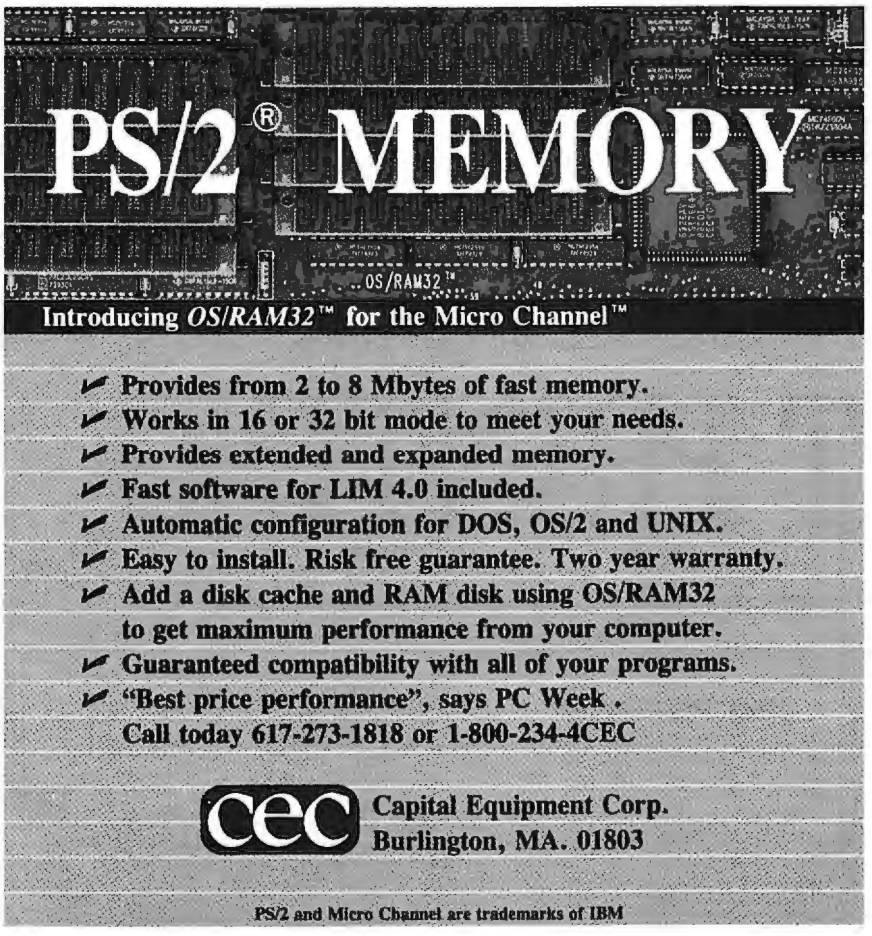

printed. With a PDL, the burden of calculating those locations is transferred from the computer to the printer. The computer sends the printer a description of what it wants printed. The printer controller converts the page description into a bit map—a process that can take several minutes per page. Whether generating characters or graphics, the process of creating the bit map is called rasterizing, formatting, or ripping (from RIP, which stands for raster-image processor).

But that's not all. Recent trends in the printer marketplace, especially those toward printer servers and multifunction printers, promise to give the controllers more things to do, less time in which to do them, or, quite possibly, both. Printers often seem barely able to do their jobs today. How can they be expected to take on additional chores tomorrow?

The answer lies in RISC and other special-purpose chips. RISC chips seem made to order for modern printers. They are fast, and they typically have on-board caches to help them get the most out of their speed. Some provide functions tailored to printing operations. To appreciate those features, it's necessary to review what's happening with the printers themselves.

BYTE ACTION SUMMARY

Today's printers need an incredible amount of horsepower to deal with modern page-description languages and graphical applications. To make printers more intelligent, manufacturers are tapping into the power of RISC and digital-signal-processor technology. For at least the next few years, the printers you buy will likely have to be more intelligent than your computers.

Adding Functions

Today the most exciting thing happening to electronic printers is the redefinition of their jobs. Printers used to be, well, you know, printers. Now all the talk is about printer servers for large companies and multifunction devices for one- or two-person shops. As the name implies, printer servers are intended to work on networks and provide printed output for several users. Even though speed is a major requirement in such an application, so is the ability to handle multiple inputs, to keep jobs segregated, and to easily handle multiple printer control languages.

At the other end of the market spectrum is a development that has barely begun: the multifunction printer. Multifunction printers are primarily aimed at small home businesses that need faxes, copying machines, scanners, modems, and printers but have trouble with the combined cost of all those devices, not to mention their combined size.

According to Rob Auster, group director for electronic printing at BIS Strategic Decisions (Norwell, MA) and a consultant specializing in printers, there are some 6.5 million businesses of that nature in this country, making the multifunction printer a very exciting prospect. A multifunction printer would typically combine a laser printer with a plain-paper fax and one or more of the other functions. Exactly which functions will be included will depend more on what the market wants than on any technological considerations.

Lest you get the wrong impression, controller speed is still very important for all laser printers, as it has been ever since they were introduced. Unlike its predecessors—which were asynchronous devices that were able to speed up, slow down, and even stop when necessary—the laser printer is a synchronous device. Once its marking engine starts running, it must keep running at a constant speed until it has finished processing a sheet of paper. The variables of the laser-printing process (e.g., toner characteristics, temperature, laser intensity, and charging voltage) are all optimized for a particular paper speed. If the paper slows down or stops in the middle of a cycle, the page is ruined. Thus, speed takes on additional importance for laser printers and other synchronous-printing technologies. Slow processing does not merely slow them down; it ruins their output.

To keep that disaster from happening, most laser printers today contain enough memory to store at least one full-page bit map—about a megabyte for an 8½- by 11-inch sheet of paper with a resolution of 300 dots per inch. With those printers, the marking of the paper does not begin until the whole bit map has been generated and stored in a frame buffer. After that, the page prints at the engine's rated speed, typically from 7.5 to 15 seconds per page, or 4 to 8 pages per minute, for a low-end laser printer. If the printer elec-

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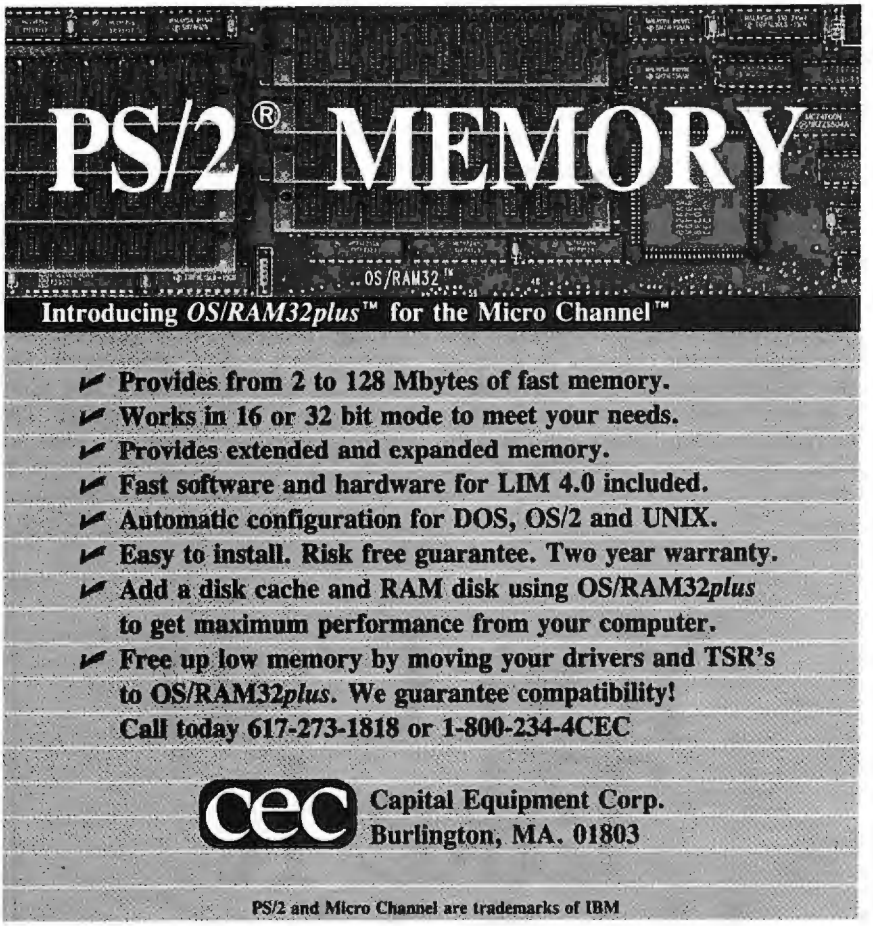

tronics are slow, you may have to wait several minutes between pages when you are dealing with a lot of high-density graphics no matter how fast the marking engine can run once it gets going.

So, one important trend in printers is to make them run faster by putting in faster marking engines and by designing controllers that allow those engines to operate at their rated speeds. And other trends are toward accommodating larger paper sizes, increasing resolution, and printing on both sides of the paper. All those developments involve putting more dots on each page; thus, each represents an increased processing burden.

These trends are not limited to laser printers. Impact printers are also having to deal with things like PDLs. In addition, many makers of impact printers are also coming to grips with the noise problem in order to compete more effectively with lasers (see the text box "The Silence of the Pins" on page 144).

Serving Up Print

Two recent products that epitomize the use of RISC chips in printer-server applications are QMS's PS-2000 and Hewlett-Packard's LaserJet IIISi (see "The LaserJet IIISi: Hewlett-Packard's Flagship Printer," page 52, April BYTE).

The PS-2000 is the first printer to be based on QMS's new Crown architecture, which is based on a 25-MHz Mips R3000 RISC chip. The PS-2000 boasts several features that were made possible only through the use of the R3000. One is its ability to handle several different ports and PDLs simultaneously and automatically. The PS-2000 is able to handle four ports: a parallel port, a serial port, an AppleTalk port, and an optional Ethernet port, which at present can be configured for TCP/IP or DECnet (with support for Novell's IPX/SPX to come in the future). All four ports are always active, not polled, and you need not turn them on and off.

When a job comes in through one of the ports, it is analyzed by the R3000 to determine which PDL was used to define the output. You don't have to specify whether the application puts out PostScript, CCITT Group IV, HP's Printer Control Language (PCL) or Graphics Language, or whatever format you're using. The PS-2000 uses Emulation Sensing Processing, which employs neural-network concepts to make the language determination and then to route the job to the appropriate parser module for conversion into a proprietary, low-level internal format. At that point, if the marking engine is free, the job is given to the rasterizer, and it then goes to the engine. According to David Gross, vice president of QMS, rasterizing proceeds quickly from the low-level internal format.

If the engine is busy, the job is stored in the internal format and printed when the engine is available. Because the internal format takes up less space than the rasterized version of a page, most jobs can be accommodated by the printer's 8 MB of RAM. But the Crown architecture is a virtual memory operating system, so if the RAM gets overloaded, the operating system automatically stores the job on disk.

The printer does not erase the copy of the document in the proprietary format until the entire job is finished. Hence, if there is a problem, such as a paper jam, the printer can recover by replaying the necessary page(s) to the rasterizer and the engine.

Keeping the entire document in an internal format also makes it very easy to print and collate multiple copies of documents. The machine just plays the document from beginning to end as many times as necessary, producing complete copies, one at a time.

A key benefit of the Crown architecture is that it never tells you to stop sending data. It may not be able to print a job immediately, but it will always accept it. According to BIS's Auster, that's very important to those who can wait a while for the hard copy but need to get print jobs off their screens as quickly as possible so they can go on to other work.

Where the PS-2000 printer uses the Mips R3000 RISC chip, the LaserJet IIISi uses an Advanced Micro Devices (AMD) 29000. From the printer maker's point of view, the differences between these chips are much less important than the difference between them and CISC chips—primarily, RISC chips are faster. Actually, it's not the clock rates of the chips that are impressive but the fact that they need only one clock cycle to execute an instruction (a typical CISC chip requires at least four clock ticks per instruction).

Because they waste no clock cycles, RISC chips would seem to require high-speed static RAM chips to deliver all the performance they are capable of. But SRAM is expensive, and printers are very price-sensitive, so RISC chips like the 29000 are specially designed to deliver blazing performance even when working with ordinary DRAM.

According to Jim Robillard, section marketing manager for printer applications at AMD, the key to getting SRAM performance from DRAM chips is caching. The 29000 has two types of cache: a branch-target cache and a stack cache. The BTC is a specialized store for instruction

memory that exploits the fact that most embedded processor applications, including printers, spend a lot of their time running loops.

The on-chip BTC stores the first four instructions of a subroutine. While the chip is executing them, the external bus mechanism on the chip can be fetching the fifth instruction. The first time a loop is traversed, the instructions have to be pulled in from DRAM, so the technique doesn't buy you anything on that cycle. But on subsequent cycles, when the chip can execute from the cache, the advantage is quite impressive.

Push and Pop

Much of a microprocessor's time is spent passing data parameters between software routines (e.g., C procedures). The most common way of doing that is by pushing and popping from the stack. The calling procedure dumps data onto the stack. The called procedure pulls it off the stack, works on it, puts the results back onto the stack, and returns to the calling procedure. Then the calling procedure goes to the stack and retrieves the results. Such routine operations take up a surprising amount of a processor's time. To cut that time, the 29000 includes a stack cache on the chip so that such operations can be performed without accessing off-chip memory.

Interestingly, one of the most noteworthy features of the LaserJet IIISi, its Resolution Enhancement Technology (RET), does not make use of the 29000 or any other general-purpose processor. Instead it is implemented in proprietary hardware that fits between the rasterizer and the marking engine.

The RET module takes the bit map coming out of the rasterizer and examines it to identify edges that were meant to be smooth but came out jagged because the rasterizer always places dots on 300-dpi centers. When it finds such edges, it smooths them by adjusting the time at which the laser beam is turned on and off in the vicinity of the edge in question.

Contrary to popular belief, not all laser printer images are made of dots. According to Gary Holland, R&D program manager at HP's Boise printer division, if a thick black vertical line is printed on a page, the beam turns on when it crosses the boundary onto the line and stays on until it moves off of it. Consecutive scans are located on 300-dpi centers, but within a scan, the resolution is limited by the system bandwidth (i.e., how fast the beam can be turned on and off) and the spot size. If the thick black line is almost—but not quite—vertical, then its edges can be cleaned up quite dramatically by adjusting the precise instant at which the beam is turned on and off, which is what the RET does.

Of course, sometimes you want discontinuity at a certain location, and the RET smooths it out. To prevent that, the LaserJet IIISi has a front-panel control for disabling the RET whenever necessary.

The RET is not the only method available for increasing the apparent resolution of your printed material. Destiny Technology (Milpitas, CA), a supplier of intelligent-printer-controller products, has created Edge Enhancement Technology to compete with HP's RET. The EET smooths out the "jaggies" that oftentimes occur at the edges of raster images. It supports any processor or print engine.

In addition to the EET, Destiny supplies a variety of chips and controllers to

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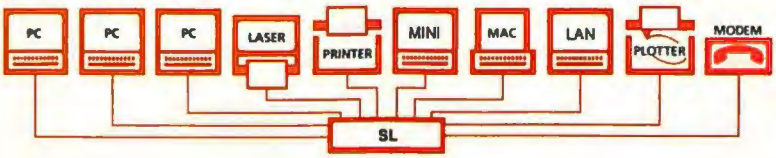

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HXS	4 Serial	Any Combination	256KB - 16MB	Pop-up or Buttons	$295 / 256KB $395 / 1MB
HWP	5 Parallel	3/2 4/1	256KB - 16MB	Pop-up or Buttons	$295 / 256KB $395 / 1MB
HXP	4 Parallel	2/2 3/1	256KB - 16MB	Pop-up or Buttons	$245 / 256KB $345 / 1MB
HCP	2 Parallel	1/1	256KB - 16MB	One Printer	$225 / 256KB $325 / 1MB
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The Silence of the Pins

Ted Zajac

You say you love how versatile and inexpensive your impact printer is, but you can't stand the noise? Good news! Quieter impact printers are on the horizon, and their noise levels are low enough to rival those of laser printers.

In recent years, the issue of noise levels in the office has come to the fore for several reasons. For one thing, the trend today is toward more distributed processing on LANs and on the desktop, and away from minicomputers and soundproof rooms, where noise levels are not a problem. This movement has raised the noise levels in the normal office environment substantially.

Another reason is that many companies today have adopted the open-office concept. In an open office, you can't confine printer noise to a small work area—it's everywhere. While you may be able to control whether or not you use *your* printer while you're on the telephone, you can't control the person in the next cube or the noise coming from an adjoining area.

Making an Impact

Why are impact printers so noisy? Basically, because they make impact. When one object strikes another, it creates noise energy. When one or both of the objects is soft, the noise is minimal. However, when both objects are hard, as they must be to print clean, clear characters, the noise level rises considerably.

In serial-head impact devices, the return action of the printing mechanism typically creates the noise: When the mechanism returns to its home position, it returns with as much force as it went forward, creating noise. In line-impact printers, the hit of the print head hammers on the paper creates the noise, which often reaches sound levels of 65 decibels or greater—quite disturbing to people nearby.

In the past, if you needed the capabilities of an impact printer, you had to take the good with the bad—you put up with the high noise level to gain a rugged printer that could tackle heavy-duty jobs. In addition, impact printers excel at tasks that other types of printers just can't handle, such as those requiring multipart forms.

But perhaps more important, impact printers are the most cost-effective if you have high-volume output. A typical page printed by impact technology costs less than a penny; those printed with nonimpact methods average about 3 cents per page. That's a dramatic difference for people running high-volume applications.

Quieting Down

At first, manufacturers took a stopgap approach to quieting down these printers. They made bigger cases, stuffed as much foam in them as they could, and hoped for the best. The added foam blocked out the higher sound frequencies but failed to absorb the lower acoustic frequencies, which are the most difficult to control. With this approach, a 55-adjusted decibel (dBa) noise level was about as low as you could get.

Finally, manufacturers came to the conclusion that quiet had to be built right into the printer from the ground up. One approach is the EuroLine family of 400- and 600-line-per-minute line printers, built by Output Technology (Spokane, WA). As the name indicates, this line of printers was designed to meet strict European sound standards. With each part engineered specifically to abate noise, the EuroLine printers achieve a sound level of 48 dBa while printing at full speed.

Controlling noise in a line printer is a difficult task because of the tremendous amount of energy generated within the printer. This energy generates heat, which must be eliminated by fans—a major source of noise. To solve this problem, the EuroLine printer incorporates a special reverse-scroll fan positioned midway in the airstream, the point where it will generate the least amount of noise.

Another problem is controlling low-frequency acoustic energy: Once noise hits the printer case, you can't minimize it any more. To solve this problem, every mechanism in the printer is suspended in and surrounded by a special noise-absorbing material. All the mechanisms float in suspension material that absorbs the low-frequency acoustic energy before it can get to the case.

printer OEMs. Destiny's products support 68000- and 80960-based controllers. The functions it provides include BitBlt, multibit shifting, interrupt control, and DMA. Destiny has recently introduced the RIDA (for Raster Image Device Accelerator) to decrease the time required to produce image bit maps.

The Swiss Army Printer

While the PS-2000 and the LaserJet IIISi fill an obvious need in the networked office, some industry observers see an obvious need for small home businesses; namely, a machine that combines the functions of a laser printer, a plain-paper fax, a copier, a scanner, and a modem.

Although a small home business needs all those functions, it rarely needs more than one of them at a time. Because there is a lot of duplication of parts among those office products (e.g., a copier is really a laser printer with a hard-copy input), a combination product could be produced for a lot less than the separate components. The combination product is expected to be especially attractive to small home businesses in part because of the space savings it offers. Anyone who works at home, as I do, needs only a moment's reflection to see how true that really is.

Although the multifunction printer will probably not be a powerhouse capable of churning out hundreds of pages a minute, it will need a fairly sophisticated and powerful RISC chip because of its many functions. Depending on how fast it is, it may use a chip like the National Semiconductor CG 160 or GX320—both of which are RISC chips with on-board digital signal processors (DSPs), bit/

More recently, Panasonic (Secaucus, NJ) has unveiled the 46.5-dBa Model KX-P2624, a new desktop 300-character-per-second printer. Because it is smaller than the EuroLine printers—it does not require fans—Panasonic approached the noise problem differently for this printer. Panasonic uses a diamond-shaped print head to dissipate the noise by spreading out the print-pin firings; all the pins rarely fire at once. This changes the acoustic noise to a higher frequency, which is more easily absorbed.

The introduction of these two new, quieter printers may well mark the beginning of a major trend in the impact-printer market. The U.S. Patent Office recently issued two new patents for quiet-impact technology: one to Citizen (Santa Monica, CA) and the other to Seiko Epson (Torrance, CA). Both of these patents use approaches similar to Panasonic's.

Citizen has developed a special material that reduces the sound of the return action of the print-head pins. Seiko Epson's design stops the pins from striking the back of the print head; the company has developed a print head that magnetically stops the return of the pins.

Output Technology, Panasonic, Citizen, and Seiko Epson have each solved the noise problem in a somewhat different way, and it's a sure bet that the other impact-printer manufacturers won't be far behind with their own approaches. Those who don't address the noise problem may well be out of sync with the industry.

The Boon of Competition

There really is no doubt that nonimpact printers have encroached on the impact-printer market in recent years, but there is ample proof that impact technology is here to stay. For one thing, you can print multipart paper forms only with impact printers. And sales of multipart paper forms have not declined over the last several years. In other words, there is still a strong demand for impact technology.

In addition, the low cost of impact-printer ownership is very attractive if you have high-volume printing needs. Nonimpact printing is just too expensive for the heavy-volume data processing and routine applications that impact printers were designed to handle.

In many ways, the competition from nonimpact technology has had a good effect on the impact-printer market. It's forced impact-printer manufacturers to make their products more reliable, more cost-effective, and quiet enough to run in an open-office environment.

Ted Zajac is director of strategic business for Output Technology Corp. (Spokane, WA). Previously, he was a senior industry analyst for Dataquest's Printer Group. He has also directed product strategy for Texas Instruments and Dataproducts. You can reach him on BIX c/o "editors."

block transfer circuitry, DMA controllers, and other features that are valued in printers. In particular, the processors include such special instructions as mask out a bit, shift right and add a bit, shift left and kill a bit, and so forth, which are valuable when manipulating graphical images.

The chips are members of National Semiconductor's core-based family of RISC chips, which it is using as the basis of a series of special-purpose chips. The company is taking its core processors and adding to them small amounts of special-purpose circuitry as needed for specific applications. But its ultimate achievement in that particular area is the Swordfish—a superscalar 100-million-instruction-per-second RISC chip that includes a powerful floating-point DSP, an instruction cache, a data cache, a two-channel DMA controller, a 16-bit timer, and a 15-level interrupt control unit. When it begins shipping later this year, the Swordfish will be used primarily in very high-end laser printers, color printers, typesetters, and high-performance, multifunction office peripherals.

What really distinguishes the Swordfish from other high-performance RISC chips is its inclusion of an on-board DSP. Although not terribly useful in straight printing applications, the DSP becomes extremely valuable the minute the printer is attached to a telephone line. It is exactly what's needed to speed the kinds of calculations involved in fax processing, voice manipulation, or digital copying, especially with compression and storage.

National Semiconductor is particularly proud of the Swordfish's DSP performance; it can calculate a 1024-point fast Fourier transform in 1.499 milliseconds (integer) and 1.050 ms (floating-point). That is faster than many dedicated DSP chips.

Like AMD's 29000 RISC chip, the Swordfish is designed to deliver its top performance when working with relatively slow DRAM chips. It makes use of caches, and it also has an on-board frequency doubler, so the chip runs at 50 MHz from a 25-MHz external system clock. That 25-MHz external-clock rate and some special-circuit techniques for stretching access times allow the Swordfish to work reliably with 62-nanosecond DRAM chips.

On-board, the 50-MHz superscalar architecture combines two integer units and an FPU so that the chip can almost always be executing two instructions at a time, for a peak processing rate of 100 MIPS.

Given the outstanding power of the Swordfish, you might well expect to find it in a high-powered machine like the Xerox DocuTech Production Publisher, a quarter-million-dollar machine capable of printing and binding up to 135 ppm. However, the DocuTech came out before the Swordfish was in production, so that combination just wasn't possible. In fact, the DocuTech uses a slew of proprietary parts to handle its enormous computational load.

At its introduction last year, the DocuTech accepted hard-copy input only. Later this year, however, Xerox will begin field testing of an electronic-input capability based on the use of two front-end AT servers—AT bus systems that use an Intel 960 RISC chip as a coprocessor for PostScript and HP PCL page decomposition. The 960 is installed on a Xerox-designed coprocessor board that runs the decomposition routines. Depending on the characteristics of the input job, the decomposition is differently partitioned between the front-end processor and the printer itself.

Like National Semiconductor's upcoming Swordfish, the Intel 960 is a

superscalar RISC chip for embedded applications. It's a 40-MHz part with a built-in memory management unit that supports a 64-bit virtual address space and a 64-entry fully associative translation look-aside buffer. Like the Swordfish, the 960 features a half-speed external bus to simplify interconnection with other components. The lower-speed bus also leads to lower levels of radiated interference, leading to easier compliance with FCC rules.

The Pendulum Swings

It seems pretty clear that printers will be getting smarter over the next few years. Some experts predict there will be more processing power in a typical printer than in the computer that's driving it.

The trend toward smart printers may not last forever. In the future, when the general-purpose processor in your personal computer (which may or may not be a RISC chip) is capable of a couple of hundred MIPS, much of the processing now done by printers may be performed on your desktop. This is how computers from Next handle their local laser printers, although the 68030 and 68040 chips used by Next don't have the throughput to produce bit maps for the printer without a visible performance hit on other processes active on the system.

In the next five to 10 years, your personal computer may have enough horsepower to produce bit maps for the printer without affecting other applications running on your system. Then, the scenario goes, the printer intelligence pendulum will swing back, and dumb printers will again be commonplace.

But even if print processing is moved back to the computer, you will still need to keep the traffic between the computer and printer at a reasonable level. This likely means that the bit maps sent to the printer will have to be compressed to some degree. Consequently, the printer will still require logic circuitry that implements a specific lossless decompression algorithm.

Of course, given that the resolution of laser printers keeps increasing—and with it the amount of processing required to produce a bit map—printers may always have to pack a significant processing punch. For the immediate future, printers will keep getting smarter, and they'll be doing it with RISC chips. At this point, you can't buy a printer that is too smart. ■

Mike Riezenman is a freelance writer specializing in electronics technology. He can be reached on BIX c/o "editors."

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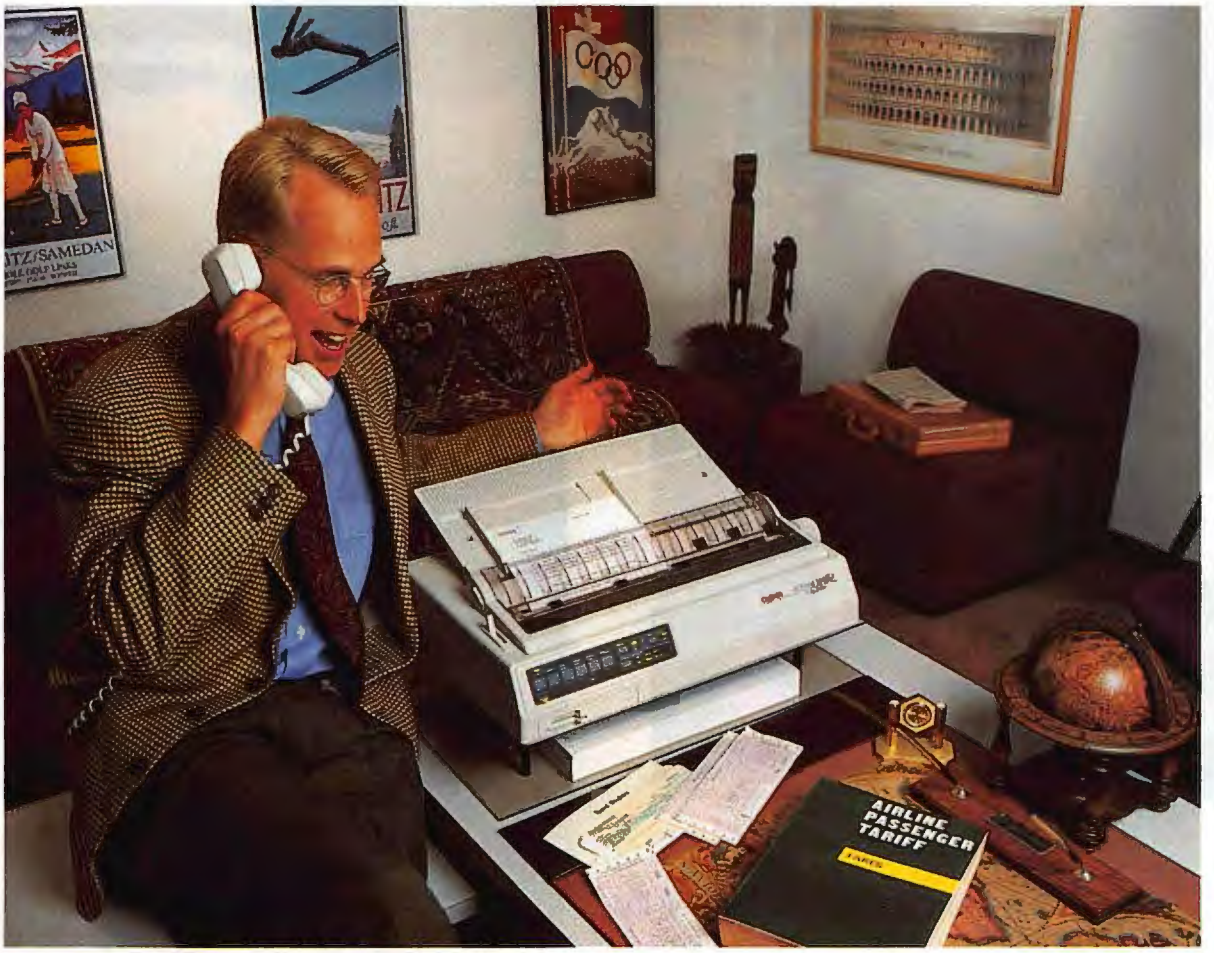

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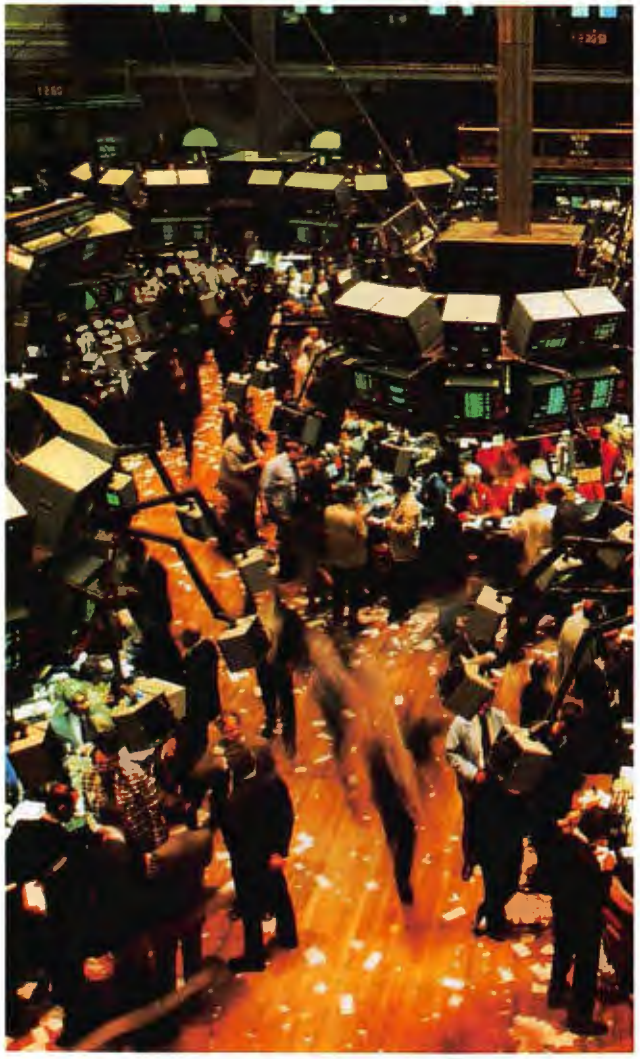

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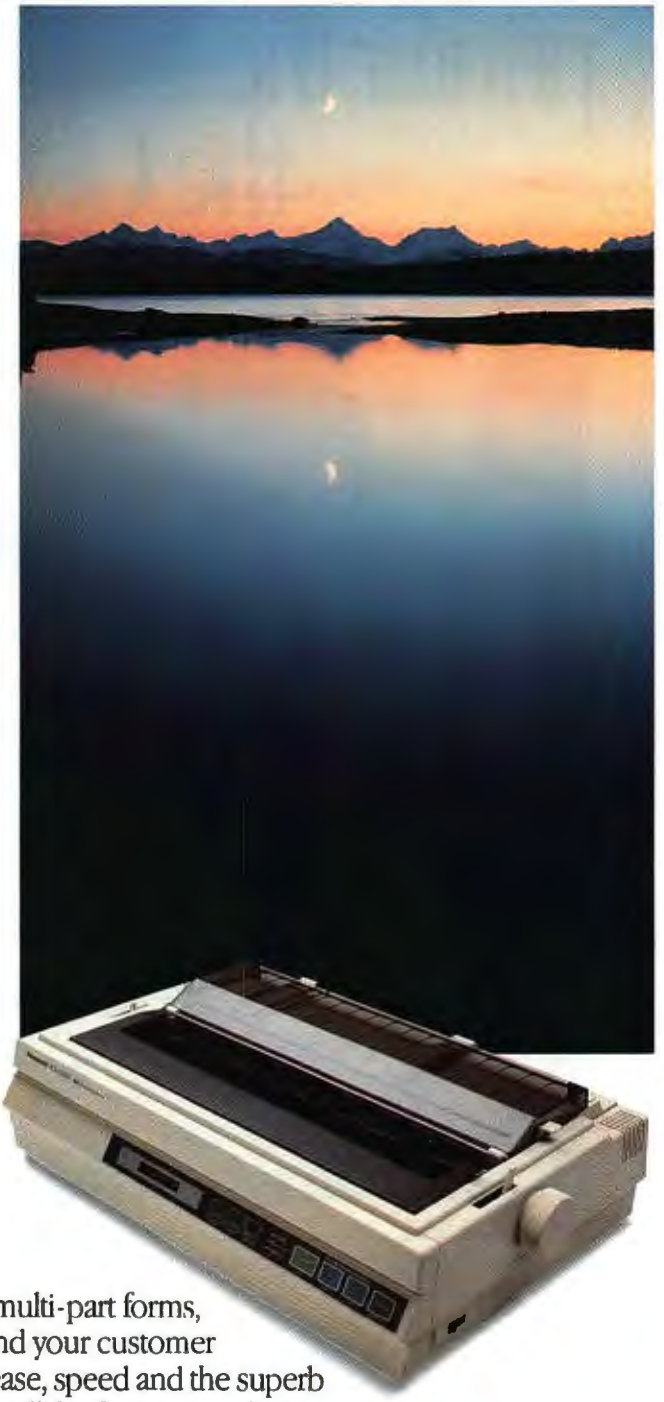

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COLOR PRINTING

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Any director of marketing or promotional manager will tell you how important color is in making effective presentations. Although conventional laser printers have forever changed the quality of documents produced in today's office, the high-resolution black-and-white output of these printers still lacks the critical dimension that's so highly coveted in presentation-oriented documents: color.

A sharp and well-designed black-and-white laser printout quickly pales in comparison to a similar document in full color. In addition to preparing presentations, color printouts are also valuable for creating proofs of color artwork for advertising or other literature before committing them to the expensive color-separation, stripping, and duplication processes at the local printer.

Color is naturally appealing to the human eye. Witness the proliferation of color monitors in the personal computer marketplace. Very few people buy monochrome monitors, even though many of them use only text-based applications in their work.

Color printers have been available for a few years, but high-quality, highly capable color printers under the milestone $10,000 price mark are a very recent phenomenon. Indeed, last year was an important transitional year in the color-printer marketplace because companies introduced many high-quality PostScript-compatible color printers priced as low as $7000. This year continues development of useful color printing with the introduction of Tektronix's Phaser III printer technology and Hewlett-Packard's 300-dot-per-inch ink-jet printer. In

ILLUSTRATION: KEN COFFELT © 1991

addition, a number of developing technologies provide strong indications that the next two years will see improved color-output quality and lower prices.

The combination of PostScript compatibility, Pantone-certified color simulations, sub-$10,000 price tags, and 300-dpi resolution has made quality color printers practical for many offices. Although their increased complexity will keep color printers from achieving price parity with their monochrome counterparts, lower prices will put color printers on an increasing number of desktops. Technological improvements will also bring high-resolution, near-photographic-quality output below the critical $10,000 price barrier in the not-too-distant future.

Most color printers on the market are available either in separate PC and Mac flavors or include multiple interfaces—serial, parallel, and AppleTalk—in one unit. Many also offer special drivers to take advantage of system-related features, such as color output for Microsoft Windows applications.

Mixing Colors

The use of color introduces a lot of complex issues that do not apply to black-and-white printers. Color printers cannot possibly hold enough inkwells or toner cartridges to make a separate one available for each of the hundreds, thousands, or even millions of colors that printers can produce. Instead, color printers use a few primary colors that are either mixed or dithered to create the desired output colors.

The concept of mixing colors to create a spectrum of shades is not new to the computer industry. Color monitors mix the *primary additive colors* (i.e., red, green, and blue) to form the other colors they display. Every pixel on an RGB monitor consists of a red dot, a green dot, and a blue dot. Combinations of these three colors at varying intensities form the set, or *gamut*, of colors the monitor can display.

For example, a standard VGA video controller uses a 6-bit D/A converter to control the intensity of each of the three primary colors, allowing one of 64 (2^6) intensities to be selected for each primary color. This gives the VGA controller the inherent ability to produce $64 \times 64 \times 64 = 262{,}144$ different colors. Equal intensities of red, green, and blue form the gray scale from black to white; black is the combination of completely unsaturated primaries, and white is the result of combining completely saturated red, green, and blue dots.

Monitors are light sources. Because printed material reflects light, the printing industry uses *primary subtractive colors*—CMY (cyan, magenta, yellow)—for color printing. You create subtractive primaries by subtracting a particular color from light reflected off a white page (i.e., cyan is the absence of red, magenta is the absence of green, and yellow is the absence of blue).

The subtractive primaries combine to form the other colors in the printer's color gamut, just as the additive primaries do. For example, a printer can combine the primary subtractive colors in equal amounts to generate the primary additive colors (i.e., magenta plus yellow gives you red, yellow plus cyan forms green, and cyan plus magenta produces blue). Equal amounts of the subtractive colors combine to form black. To generate a truer black, however, most color printers also include a separate black color (designated as *K* in the printing industry). When combined with the other primary colors, this forms the CMYK (cyan, magenta, yellow, black) color model, the standard four-color model in the printing industry.

All the popular sub-$10,000 color printers now print single-color dots of a fixed size. Thus, under the CMYK color model, these printers are capable of producing only seven colors (cyan, magenta, yellow, red, green, blue, and black), not counting the paper background color. To create other dot colors, a printer must be able to mix varying amounts of the primary colors to create each dot (this is likened to generating different intensities for each primary color on a color monitor). Because most designs do not allow this, most color printers use dithering to generate a wider spectrum of colors.

Dithering Around

At a distance, the human eye tends to combine the tiny printed dots in a given area into a composite image. Dithering takes advantage of this, and it tricks the eye into perceiving a single color from a pattern of colored dots.

Conventional black-and-white laser printers use dithering to generate halftones—images having a gray scale. Varying the ratio of black dots to the white-paper background results in shades of gray. The dithering process breaks a printout into pixels made up of a matrix of dots (at the printer's maximum resolution, typically 300 dpi). For example, a pixel may consist of 16 dots in a 4 by 4 matrix. By varying the number of black dots in the pixel (from 0 to 16), the printer can produce 17 different shades of gray (including pure white and pure black). At a distance of a few inches, the eye cannot distinguish the dots; it merely perceives a level of gray.

This concept applies to color printers as well. A color pixel consists of an array of color dots, ranging from a single dot to 64 (an 8 by 8 matrix) dots. The more dots there are, the greater the number of color combinations that the printer can create. There are a couple different ways to determine the number of color possibilities.

Because each dot can be any of eight colors (including the white background), the color gamut grows rapidly as you increase the number of dots per pixel. In a simple 2 by 2 matrix, each primary subtractive color can have from 0 to 4 dots turned on, for a total of five dot combinations. Because printers can overlay the matrix pattern of the primary colors on top of one another, the three primary subtractive colors combined can produce $125 (5 \times 5 \times 5)$ color shades. This quickly increases to 1000 shades for a 3 by 3 matrix, and it produces nearly 275,000 colors for an 8 by 8 matrix. Using an 8 by 8 dot matrix and figuring that each of the 64 dots can be any of four colors, many color-printer manufacturers claim to offer a gamut of 16.7 million colors.

The obvious drawback to dithering is that by using larger pixels you compromise the output resolution of the printer. For example, by using a 4 by 4 dot matrix for each pixel on a 300-dpi printer, you reduce the effective printout resolution to one-fourth, or 75 dpi. An 8 by 8 dot matrix effectively reduces the resolution to 37.5 dpi.

This resolution loss is especially apparent in colored diagonal lines. Some newer, high-end (and expensive) printers can vary the intensity of each primary color placed on each color dot, allowing

BYTE ACTION SUMMARY

Until recently, color printing was hampered by high costs and poor quality. The advent of ink-jet and thermal-transfer printers has changed that forever. In the future, true color laser printers and other, more exotic technologies will give you photographic-quality printing on your desktop.

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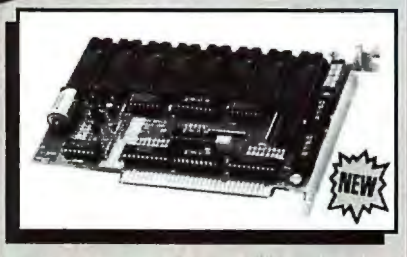

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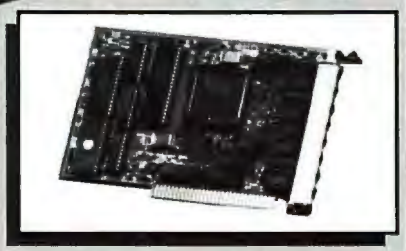

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Ribbons and Color

You are probably very familiar with the ubiquitous dot-matrix printer and its operation. The print head typically contains nine or 24 pins that strike a ribbon to create ink dots on the paper. The pattern of the dots defines characters or graphical images. Color dot-matrix printers work the same way, with the notable addition of a multicolor ribbon and the ability to move the ribbon up or down to select a particular color.

Color dot-matrix printers represent the low end in color printers (they generally cost under $1500), and they are often characterized by slow, noisy operation and often mediocre output quality. Some of the newer 24-pin models provide better output quality than earlier models, but their resolution and color saturation remain poor in comparison with those of other color-printer technologies. Still, there are a lot of color dot-matrix printers in use because they are often adequate for generating economical in-house color presentation materials. Color dot-matrix printers have the desirable inherent ability to print on plain paper, although they aren't geared for generating transparencies.

Resolution claims regarding color dot-matrix printers (e.g., 360 dots per inch) are often misleading because the actual printed dots are too large for true high-resolution output. Instead, the dots overlap in the high-resolution mode and create an output that lacks the expected crispness and detail.

Unlike other color printers, color dot-matrix printers use four-color ribbons, which incorporate red, blue, yellow, and black ink. As you may recall, red, blue, and yellow were the primary colors you painted with in elementary school, and they were the ones you combined to form secondary colors (e.g., red plus blue yielded purple, yellow plus blue produced green, and red plus yellow resulted in orange). This is basically the approach used in color dot-matrix printers, limiting their color gamut to a few basic colors.

It is difficult to be sure how many color-capable dot-matrix printers are currently being used for color output. Many people buy them only to put optional black-only ribbons on them to get four times the normal ribbon life (the ribbon is broken down into four horizontal sections that act like distinct ribbons). Some printer manufacturers, such as Star Micronics, make all their new printers color-capable, letting you select either a black ribbon for standard monochrome output or a four-color ribbon for color printing.

each dot to display the entire gamut of colors. Thus, although these printers may print at a dot resolution of only 150 dpi—lower than the 300 dpi common to other popular color printers—their effective output resolution is much higher than that of the 300-dpi units, because no dithering is required.

Of course, specifying the number of dots in a dithered pixel says nothing about the arrangement of the dots in the pixel. Reverting back for a moment to black-and-white dithering, note that the look of the pixel differs if all the black dots are placed on one side of the pixel and none on the other, or if the block dots are distributed in a checkerboard fashion throughout the pixel, or if the dots are distributed randomly throughout the pixel. The dot-distribution pattern in a pixel can have a substantial impact on the appearance of the printed page. Bad dot distribution can create negative effects, such as banding, blurring, or distracting patterns.

Color dither patterns vary from printer to printer, and most have several dither patterns from which to choose. Some color printers, like Hewlett-Packard's PaintJet and some Tektronix models, examine the image being printed and automatically select the best dither pattern to use. On the other hand, PostScript currently offers only one dither pattern, although PostScript level 2 supports *halftoning dictionaries* that let the software redefine the dither pattern. For example, Tektronix's new Phaser III PXi, which incorporates PostScript level 2, defaults to Tektronix's own dither pattern. However, you can explicitly request the standard PostScript pattern if you want.

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Color Laser Printing

Jane Morrill Tazelaar

At the high end of the color-printing spectrum is color laser printing. Also called color electrophotography for its primary function, color laser printing is a plain-paper technology. It doesn't need specially coated papers to prevent ink from bleeding into the paper or to keep images from having fuzzy edges. It uses a photographic process. The results of this process are then fused into the paper.

The printing process is conceptually similar to that of a black-and-white copier. Exposure to light creates an attraction on certain areas of a photosensitive surface, which then attract the toner. When the toner is transferred to paper and heated, the image is formed.

With monochrome laser printing, once the image meets the paper, the job is done. There is only one image to transfer. With color laser printing, however, the process is more complicated. The printer must lay down each of the subtractive colors separately, and it must carefully align them to create the clean, crisp images that laser printing is known for.

Two color laser printers have recently arisen from the color copier arena: the CLC 500 from Canon U.S.A. (Lake Success, NY) and the CP4007 from Colorocs (Norcross, GA). The technology is similar, because both are color laser printers née copiers, but the implementations are quite different.

The Canon CLC 500

Canon's color laser engine exists in one incarnation only: the Color Laser Copier 500. To use it as a printer, you must add an optional Intelligent Processing Unit (IPU). The copier itself remains the same, regardless of whether it is used as a copier or a printer. Thus, the copier and the printer have access to various creative copier functions (e.g., image repeating, texturing, mirror imaging, slanting, and contouring).

The IPU expands the copier's memory capacity by 12 MB to 24 MB, provides it with more complex image-editing capabilities, and allows interfacing with other electronic devices. You need either the IPU-48D, which is a general-purpose interface bus (IEEE-488) interface, or the PS-IPU, which includes a PostScript language interpreter from Adobe Systems (Mountain View, CA), to use the copier as a printer.

The CLC 500 uses a multipass indirect electrostatic process—one pass for each color—to print in four colors (CMYK, or cyan, magenta, yellow, and black) on plain paper. It uses a sharply focused microspot laser to dissipate specific charges and create a latent image on a charged photosensitive drum. Then a fine-grained dry toner, charged to the same voltage as the drum, is projected by electrical attraction to the latent image on the drum.

In a timed sequence, the toner is then transferred to the paper, one color at a time, as it makes a figure eight around the photosensitive drum and around a transfer drum for each color. When all four colors have been laid down, the paper passes through fixing rollers, where a combination of heat and pressure fixes the colors. Then the paper passes out of the copier.

The Colorocs CP4007

The Colorocs color laser engine has two different incarnations: one as a copier, the FC2207, and one as a printer, the CP4007. The printer already contains everything it needs to interface with your computer. It also has a PostScript-compatible color controller.

The CP4007 uses a single-pass process with dual flexible belts to put its output to paper. The print head doesn't contain a laser at all; it has LEDs instead. LEDs are asynchronous and can accurately (and quickly) control color placement. The photoconductor belt in the CP4007 works the same as the photosensitive drum in many copiers. The difference is that it transfers the toner image to a transfer belt instead of directly to paper. This transfer occurs by a combination of pressure and voltage.

When the image is complete (i.e., all four CMYK colors have been laid down), the transfer belt puts it to paper in one step. Then, fusing rollers combine heat and pressure to fuse the image to the paper. The use of an intermediate surface enables the paper to make a short, straight pass through the printer: from paper tray, past the transfer belt, through the fuser, and out.

The Same, Only Different

The method of laying down colors is similar between these two printers—dry toner from latent image to a surface where the colors are built up—but the means of putting the image to paper is very different. Colorocs's method probably better avoids frustrating paper jams than Canon's.

In addition, these companies use two different types of print heads: Canon uses lasers, and Colorocs, LEDs. This difference may well explain why the CLC 500 provides a higher resolution (400 dots per inch versus 300 dpi for the CP4007) while the CP4007 can really pump out the paper in single-color (black-and-white) mode (40 copies per minute versus 10 cpm for the CLC 500).

Laser printing has come to stand for print quality, speed, and low cost—at least on a per-copy basis. Color laser copiers/printers are still in their infancy, but they are already setting standards for other technologies to meet. However, fine-tuning color registration and toner application remains an ongoing task.

As more and more devices come to market, such technical challenges will diminish, and prices will come down. They'll have to. Color laser printers are expensive—big-time. Think between $30,000 and $65,000 for the device itself. At prices like those, I want perfection!

Jane Morrill Tazelaar is a BYTE consulting editor and a freelance editor and writer. She was formerly BYTE's senior editor in charge of the State of the Art section. You can reach her on BIX as "janetaz."

Color Matching

Controlling the colors produced by color printers is a growing concern. For some color printers, particularly low-end dot-matrix units, you simply get what you get: The colors follow no industry standard, and the printers simulate the desired colors as best they can. Other color printers attempt to follow color standards established in the printing industry, but they still let you vary the output. In certain cases, you might want a WYSIWYG printout that matches the color image on your computer monitor. In other cases, you might want to see true colors (conforming to industry color standards) on the printout, regardless of their appearance on a color monitor. High-end printers, especially thermal-wax-transfer types, have come far in accommodating these varying and often-conflicting desires.

Because colors vary from monitor to monitor—due to several reasons, including variations in the type, color, and thickness of the phosphor used—it is not a simple matter for a color printer to support a wide variety of monitors. The problem is compounded by other issues. The colors on a given monitor can vary depending on the age of the monitor, the brightness and contrast settings, and even the amount of time the monitor has been used. Unlike the PC, the Mac has at least some provision for calibrating its monitor colors: Color sensors can be placed on the screen, and the output can be used to direct compensating adjustments to the video controller.

A number of color-printer manufacturers, most notably Tektronix and HP, put a lot of emphasis on monitor/printer color matching, especially in the Mac environment. Through either a special driver or a command to the printer, you can specify the type of monitor you have, and the printer will adjust all subsequent color printouts according to the characteristics of the selected monitor. The fact that monitors use the RGB color model in contrast to the CMYK model used by color printers inherently gives these two device types different color gamuts. You need translation algorithms or lookup tables to achieve close color matches between them.

A great many graphic artists and other professionals use color printers to generate proofs of documents that will eventually be taken to a local print shop for quantity production. Their biggest concern is that the colors generated by the printer closely match those used by the print shop. They need access to a color standard. There are a number of such

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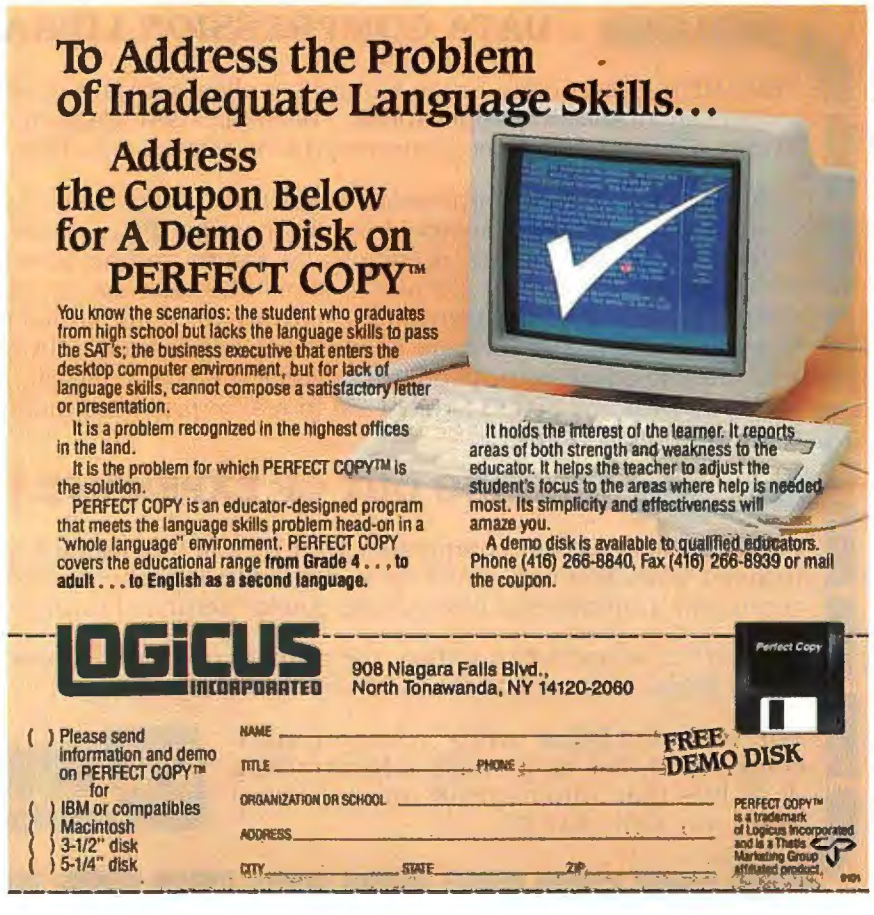

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standards, but one, the Pantone Matching System, stands out as the choice for color printers.

Pantone has been providing color references to the printing industry for over 25 years. The company's Pantone Color Formula Guide provides solid-ink samples of 747 Pantone colors on coated and uncoated stock, with a unique Pantone color number assigned to each.

Because color printers combine or dither primary colors (using the CMYK color model) to create their color gamut, instead of using pure *spot* colors, printers use color *simulations* to generate colors that match standard Pantone colors as closely as possible. Pantone defines the primary-color mixes required to simulate the Pantone colors in the Pantone Process Color Simulation Guide. This guide shows the solid-ink Pantone samples and the closest match produced using Pantone's recommended primary-color mixes, or *screens*, and approved inks. Only 736 color simulations are included in the guide, because the metallic and fluorescent colors can't be simulated on standard color printers.

A pantone-certified printer uses color-simulation formulas specific to that particular printer's ink and process characteristics, as determined by Pantone. A number of programs available for the PC and the Mac (e.g., Aldus PageMaker) support Pantone colors. Although Pantone is not a panacea for standardized color-printer output and does not support continuous-tone color, it has a strong foothold in the color-printer marketplace, and it is firmly embraced in the industry.

Even with color standards in place, you can still get great variations in the accuracy of color printers due to the numerous variables that remain, including paper color and quality, equipment condition, screen-tint values and angles, ink quality, ink flow, color registration, and the order in which the printer applies the primary colors to the page.

Color Printing Today

Companies have put a lot of R&D effort into color-printer technologies over the past several years, and the next few years will certainly see some of these come to fruition as products. Currently, three technologies dominate the color-printer marketplace: dot matrix, ink jet, and thermal-wax transfer (or simply thermal transfer). Dot matrix is the sales-volume leader and boasts the lowest price tag. Because it is an impact technology, color dot-matrix printing has the advantage of letting you use plain paper (see the text box "Ribbons and Color" on page 152).

Ink-jet printing has a definite quality advantage over dot matrix, but it can suffer from wicking problems when used with plain paper. Nevertheless, ink-jet printing is noted for good-quality output at a moderate price. HP and Tektronix have recently introduced notable enhancements to ink-jet printer technology, with HP moving to 300 dpi and Tektronix introducing its solid-ink phase-change technology (see "Ink Jet Takes Off" on page 163).

Thermal transfer is more expensive than dot-matrix or ink-jet printing, but it makes up for that in quality. It is the technology used in high-end PostScript desktop color printers from QMS, Seiko, and others. With prices ranging from $7000 to $13,000, and with a relatively high price per page, thermal transfer is expensive. But given its ability to produce good color saturation and superior

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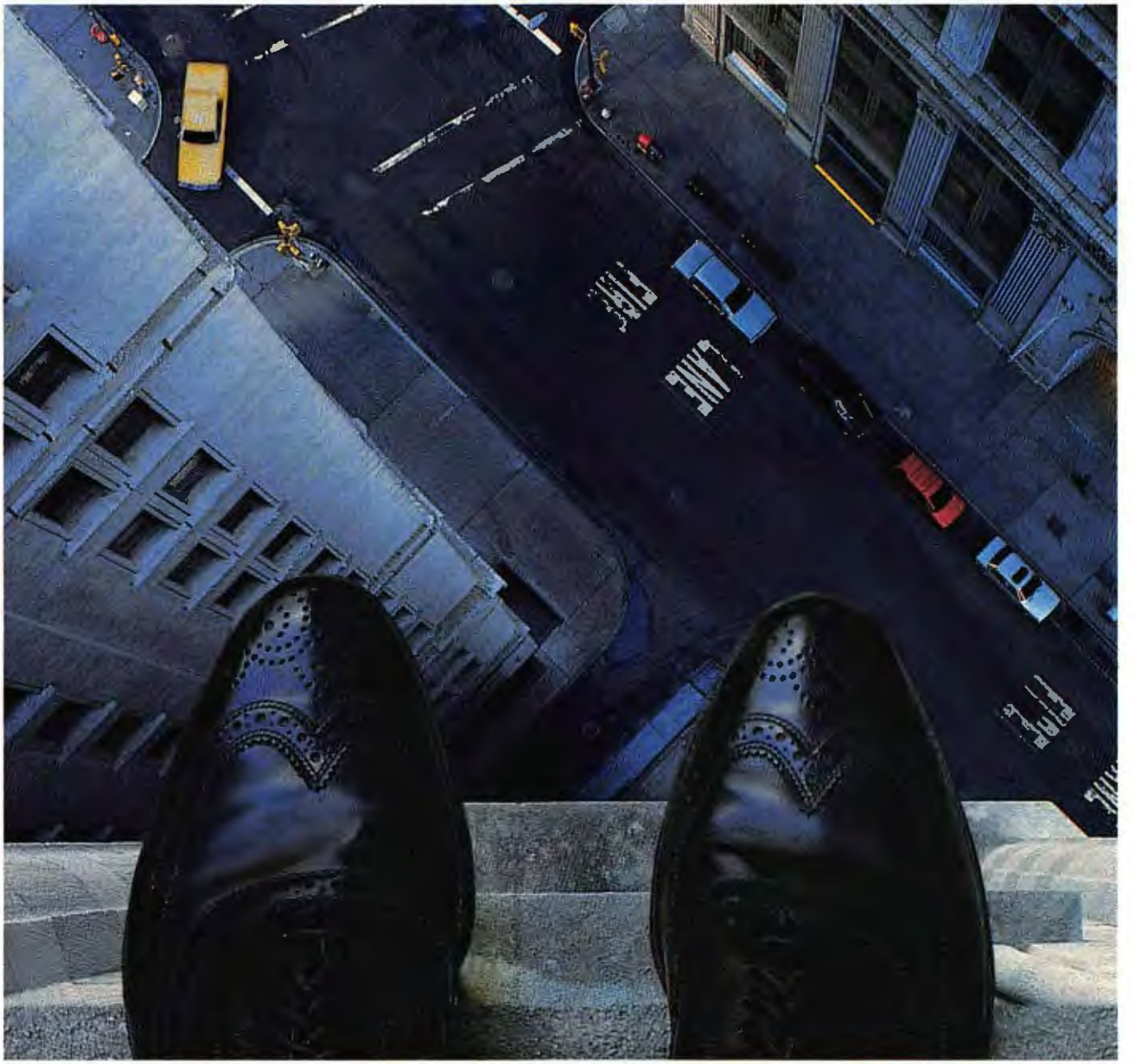

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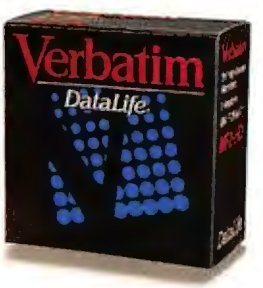

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color overhead transparencies at a reasonable cost per transparency, thermal transfer will continue to be the technology of choice for business-presentation graphics for some time. (For more on thermal-transfer technology, see "Hot Colors" on page 177.)

In regard to performance, color printers do not compete well with their black-and-white counterparts because of the extra work involved in creating color output. Whereas a standard black-and-white laser printer will typically print 4 to 10 pages per minute, a thermal-transfer printer typically prints about 1 ppm. Ink-jet and dot-matrix printers are even slower, with some requiring 4 minutes or more to generate a printout.

Over the Rainbow

Aside from the primary-color printer technologies noted above, there are a number of other technologies that show a lot of promise for meeting mainstream printing requirements.

Although they are expensive and complex, you can buy a color laser printer today. Two companies, Canon and Colorocs, are producing color laser engines for printing (the Canon printer is the CLC 500 Color Copier with a rasterizer attached). Color laser printers are faster than thermal-wax printers, but at typical costs of $30,000 and up, they are not yet economically practical for most users (see the text box "Color Laser Printing" on page 154).

Mead Imaging has developed cycolor, a technology that shows great potential for near-photographic-quality color output. Cycolor printers use a special film coated with millions of tiny dye capsules; each one is about one-tenth the diameter of a human hair. The dyes are light sensitive, and exposure to different colored lights hardens different dye capsules. After exposure, the printer compresses the film onto the paper, breaking the remaining (nonhardened) dye capsules and releasing the dyes onto the paper. The printer then heats the paper to enhance the color quality.

Another interesting technology is dry-silver printing, introduced last year by Honeywell. It uses special paper/transparencies with a silver-halide coating developed by 3M. The printer passes the coated paper over a CRT, exposes it to the RGB phosphors, and develops the paper at 275°C. The system then uses three densitometers to check the colors against an internal palette. The system automatically adjusts the CRT whenever it detects color deviations. Dry-silver printing offers continuous-tone output without dithering, with 300-dpi resolution and 32,768 possible colors per dot.

Color-printer technology has come a long way in the past few years, and continuing development efforts will ensure greater progress in the future. Last year, the big news was the introduction of a number of sub-$10,000 PostScript-compatible thermal-transfer printers. This year has witnessed the introduction of HP's 300-dpi DeskWriter C ink-jet printer and Tektronix's 300-dpi plain-paper Phaser III PXi printer. The next two years will see progress toward near-photographic-quality printed output, as well as continually decreasing prices. ■

Roger C. Alford is a consulting editor for BYTE. He is also president of Programmable Designs, a Michigan-based electronics-design firm, and author of the Programmable Logic Designer's Guide *(Howard W. Sams, 1989). You can reach him on BIX as "rogera."*

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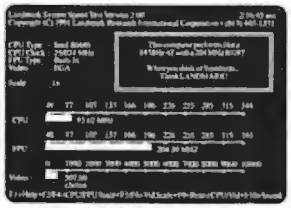

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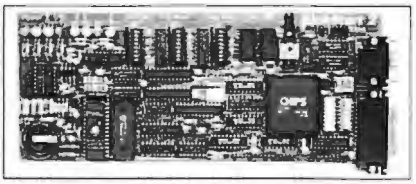

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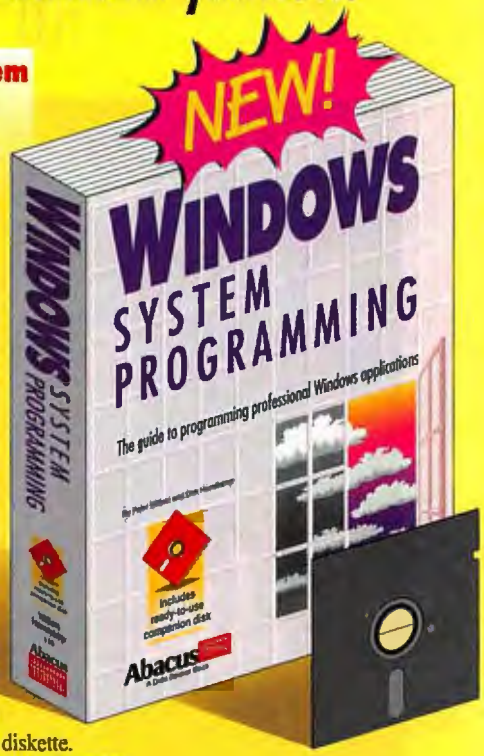

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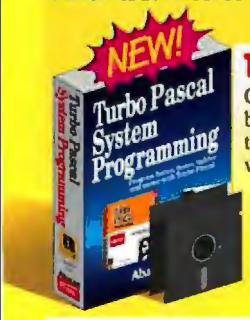

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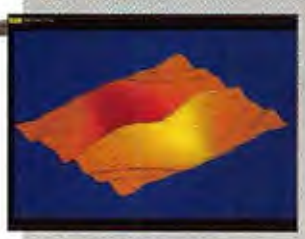

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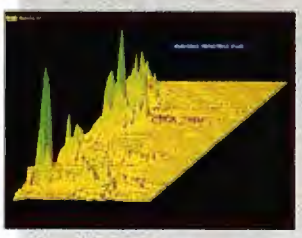

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INK JET TAKES OFF

High-quality color output at a reasonable price from an office printer? You bet!

A. J. ROGERS

Color is dramatic and rich in communication value, but in today's business world, people are very particular about its output quality. A report printed in color may be eye-catching, but if it's messy color or poorly aligned color, the impression it leaves may not be the one you want to create.

The prospect of obtaining high-quality color output at reasonable prices from office printers has improved considerably over the last few years. During this time, rapid advances have occurred in the quality of the output from monochrome laser printers, and their prices have declined dramatically. People are beginning to expect the same things from color printers.

However, although the gains in color printing have been dramatic (e.g., the price of a color PostScript printer has declined from $25,000 three years ago to less than $6000 today), high-quality, low-cost color output on the desktop still has remained somewhat elusive. Color printing is much more complex than monochrome printing, so the challenges are considerable.

The primary challenge of color printing is to create brilliant color in the same amount of time it takes to print monochrome, and at a similar cost. Other major issues involve what medium you can use (being able to print on any kind and weight of paper is important) and color fidelity—matching or calibrating the colors between a particular display screen and a specific printer.

Most of today's popular color-printing technologies still require a special, usually coated paper to achieve good quality. Two affordable technologies that can

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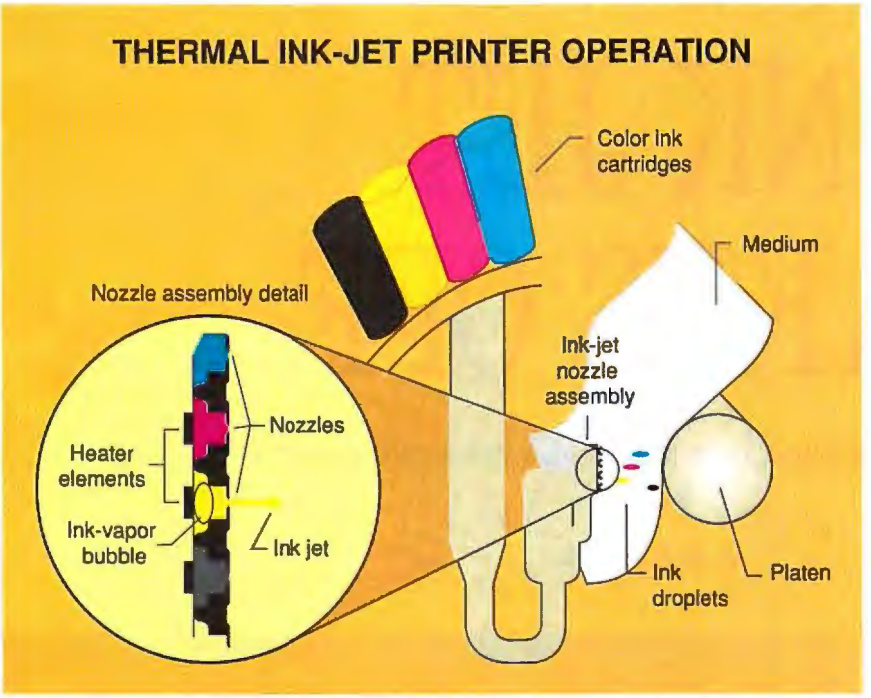

Figure 1: *Thermal ink-jet printers, the so-called bubble jets, work by heating a drop of ink until it forms a vapor bubble. The bubble forces the ink out of the nozzle and onto the paper.*

use plain paper of various weights are color dot-matrix printing and a new technology known as phase-change ink-jet printing.

Color dot-matrix printing is not considered a serious contender for meeting high-quality color-output requirements. As an impact technology, it has limited resolution, lacks brilliant color, and requires repeated passes to create colored output. And color dot-matrix printing generates less-than-presentation-quality output. One technology that strikes a balance between quality and cost is color ink jet.

BYTE ACTION SUMMARY

Printing high-quality color at a low cost on plain paper may seem like a pipe dream, but it's not. The prospect of obtaining high-quality color output at reasonable prices from office printers has improved considerably over the last few years. The options for color are many, and each has its drawbacks, but the reality is this: You can afford color.

Ink-Jet Engines

Ink-jet technology provides the middle ground for color output, with a low-to-moderate price tag, good color rendition, and medium-to-high-resolution output. Ink-jet printers use the CMYK (cyan, magenta, yellow, black) or the CMY color model to generate their output colors, with four liquid-ink cartridges to hold the colored inks. Units cost from under $1000 to about $2500.

Most ink-jet printers print at a resolution of 180 dots per inch (216 dpi in the case of Tektronix's ColorQuick unit), but companies are expected to move up the technology baseline with the introduction of 300-dpi ink-jet printers later this year.

Unlike thermal-transfer and laser technologies, ink jet is able to complete a color printout in one pass. This has the benefit of avoiding registration problems that can occur when using a multipass process.

Ink-jet printers can generally print on plain paper, but they get better results printing on specially coated paper or transparencies. Plain paper is inclined to cause *wicking* of the ink droplets, reducing the crispness of each dot and compromising the quality of the output. The coated paper provides a smooth, nonwicking surface, which preserves the integrity of the ink droplets and provides the best color quality possible.

Conventional ink-jet printers employ a technique known as *drop-on-demand* operation, whereby ink droplets are propelled from a nozzle when an electrical signal initiates the action. There are two different approaches now in use for propelling the ink droplets: thermal and piezoelectric. Thermal ink-jet printers, or *bubble jets*, as they are sometimes called, are the most common of the two approaches, and most of the patents for this technology are held by Hewlett-Packard and Canon.

Figure 1 illustrates the operation of a thermal ink-jet printer. A small amount of ink is present in each nozzle and is in contact with a resistive heating element near the outlet of the nozzle. When an electrical signal is applied to the heating element, a small amount of ink boils and begins to vaporize, creating an ink bubble. As the bubble expands, it pushes ink out of the nozzle, and the ink is propelled onto the paper. The resistive heating element heats up quickly, expelling the ink droplet within 1 millisecond. As the ink droplet exits the nozzle, new ink from the cartridge replaces it.

The operation of the piezoelectric ink jet is similar to that of the thermal ink jet. A small piezoelectric crystal is present in each nozzle outlet. An electrical signal applied to the crystal results in a small dimensional change that creates a pump-like action, pushing an ink droplet out of the nozzle and propelling it toward the paper. When the electrical signal is removed and the crystal relaxes, replacement ink enters in preparation for the next print-droplet operation. For faster operation, some ink-jet printers increase ink pressure with *air assist*.

Another ink-jet technology that shows promise was pioneered by Iris Graphics. With continuous ink-jet technology, the printer generates a continuous stream of each primary color, producing about 1 million microdots per second. Dots that are not intended for the paper are electrostatically charged and deflected into a gutter. The microdots are only about 15 micrometers in diameter, so multiple microdots are combined to form one dot of the printer's standard resolution (e.g., 300 dpi).

Because the printer is able to vary the amount (i.e., the number of microdots) of each primary color applied to a dot, it

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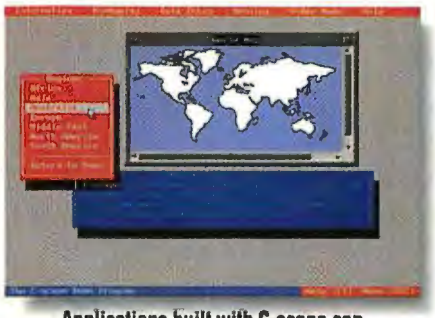

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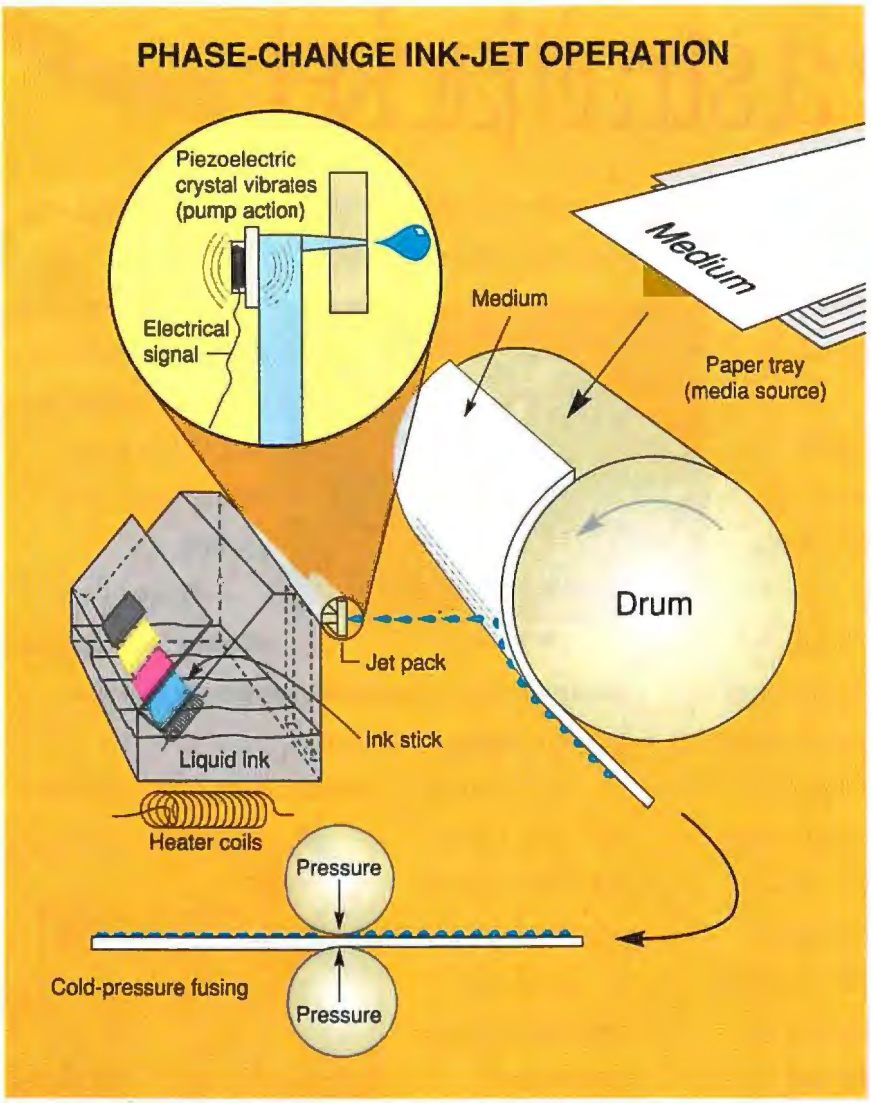

Figure 2: *Phase-change ink-jet printers propel ink onto the paper using the pumping action of a piezoelectric crystal. The ink solidifies as soon as it touches the paper, eliminating the wicking problem common to other ink jets.*

can generate its entire color gamut on each dot without dithering. At 300 dpi, the result is a near-photographic-quality printout. Unfortunately, this technology is still very expensive, and it is not yet approaching the critical $10,000 price barrier.

A New Phase

A relatively new color-printing technology promises many of the benefits of laser printing at a thermal wax-transfer price and with ink jet's simplicity and reliability. This technology, known as *phase-change ink jet*, is a form of solid-ink printing.

Phase-change ink-jet technology provides color print quality that rivals that of today's color laser printers, but at a much lower cost. Because of its relatively simple, single-pass approach, phase-change ink-jet printers require less ongoing service to maintain uniform print quality than do thermal-transfer printers. However, they are considerably slower than laser printers. A letter-size color page takes about 2 minutes to print using this technology.

Phase-change ink-jet printers offer plain-paper color at a reasonable cost per copy. They use inks that are solid at room temperature, and they do not require special paper because the inks resolidify so fast that most of the color remains on the surface of the paper.

The printer holds the inks in the chambers of a heated reservoir, where they remain liquid until a special ink-jet print head ejects them onto the paper. The ink droplets solidify almost immediately on contact with the paper due to the difference in temperature between the reservoir and the paper.

Unlike liquid inks, solid inks don't *wick* through the fibers of regular paper. They produce bright colors on a wide variety of paper weights and finishes. Solid ink was initially introduced by Howtek (Hudson, NH). A more advanced form of solid-ink technology called phase-change ink-jet printing is the basis for a new color printer introduced by Tektronix (Beaverton, OR): the Phaser III PXi. The significance of this print technology is that it does not require a special kind of paper.

The Phaser III ($9995) is a 300-dpi color printer that incorporates PostScript level 2, includes Pantone-certified color simulations, and supports printouts of up to 11 by 17 inches. It prints not only on plain copier paper but on virtually any medium from thin tissue to heavy cover stock. Because the technology does not require specially finished or coated paper, the Phaser III can print on various textures of paper as well.

Inside the Phaser III

The Phaser III printer combines characteristics of thermal wax-transfer and liquid ink-jet technologies (see figure 2). It uses a heated ink-jet print head made of laminated stainless-steel plates.

The print head operates at a constant 140 °C, keeping the inks liquid. The print head has 96 tiny holes, 48 for black ink and 16 each for cyan, magenta, and yellow inks. This bias for black ink allows you to print monochrome pages—and thus, most text—faster.

Behind the print head is a reservoir with storage chambers for each of the four colors of ink. The reservoir is also heated, so the inks remain liquid inside the printer.

The print head and reservoir shuttle back and forth inside the printer, much as they do in conventional ink-jet printers. Because all four colors are printed in one pass of the print head, color registration is very good.

The printer uses a drum and clamping mechanism to precisely control the paper during the printing process. The large-diameter drum can handle paper in a variety of sizes (from 4 by 6 inches to 12 by 18 inches) and weights (from onionskin to heavy card stock). The drum controls the vertical motion of the paper through the printer and maintains accuracy and constant spacing between the passes of the print head.

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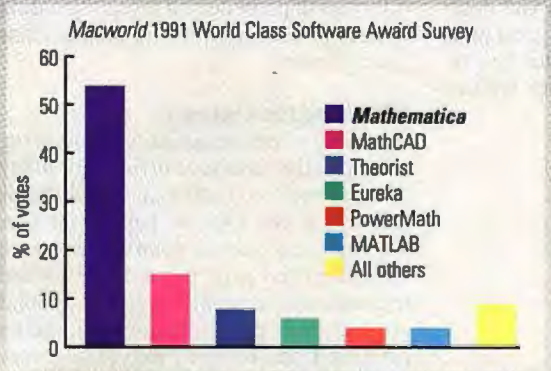

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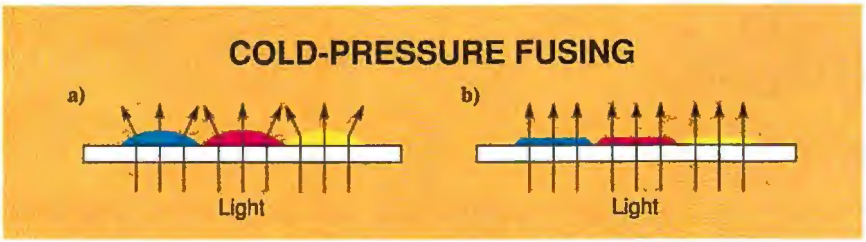

Figure 3: (a) *Without fusing, solid-ink droplets from phase-change ink-jet printers remain rounded on the surface. On an overhead transparency, this shape diffracts light away from the projector, resulting in a black-and-white projected image.* **(b)** *With fusing, the ink droplets are flattened, and the light proceeds normally to the projector, resulting in good-quality overhead transparencies.*

The inks for the Phaser III come in solid-color sticks. These sticks are pure wax-like bars of color, which the printer melts and then shoots in droplets onto the paper, where they solidify on contact, even on absorbent material. The sticks were developed to melt almost instantly at 140°C, and they solidify as quickly when the temperature falls below that point.

The color sticks are specially *shape keyed*—each color is a different shape. Thus, you can't load a color in the wrong place, which makes the process of adding ink to the printer virtually foolproof. The color sticks are also nonvolatile, so they won't evaporate or clog the print head nozzles.

After a page is printed, it proceeds through a cold-pressure fuser consisting of two specially designed rollers that flatten the ink droplets. This process ensures that the ink will adhere to the paper, and it eliminates the textured (sometimes referred to as braille-like) feel that would otherwise be present on the page. In addition, the fusing process makes it possible to produce projectable color overhead transparencies. Without fusing, the ink droplets remain on the surface of an overhead transparency in roughly a hemispherical shape (see figure 3a). This shape acts as a lens, diffracting light away from its path toward the lens of the overhead projector. The consequence is that the image appears to be black and white.

The fusing process flattens the ink droplets, greatly reducing the lens effect (see figure 3b). The result is reasonably high-quality overhead transparencies with somewhat less saturated colors than you could obtain with thermal wax-transfer printing.

The printing process is relatively slow. It takes about 45 seconds to print a monochrome page and 2 minutes for a color page in standard print-quality mode. The Phaser III also has an enhanced printing mode that further improves the print quality, but it is slower.

Paper Profits

The most apparent benefit to phase-change ink-jet printing is that you don't need special paper to achieve good print quality. You can introduce color into reports and business documents without losing print quality on text and without resorting to special paper. You can add color to a business proposal or a report using the same paper that you print the monochrome sections of the report on.

Phase-change printing doesn't require special paper to achieve good print quality.

A graphic designer can produce mock-ups of designs, brochures, and page layouts on the same paper that the final print job will use, providing a more accurate preview of the finished product. Engineering professionals can produce plots on drafting vellum and use the same printer to produce technical documentation, reports, and presentations.

Phase-change ink-jet printing makes it possible for you produce a variety of items in color that would be cost-prohibitive to produce in small quantities on a conventional printing press. This kind of short-run on-demand color printing is particularly useful in light of the small installed base of color copiers.

Phase-change printing costs approach those of laser printers for monochrome printing and offer substantial savings over thermal wax-transfer technology, provided the ink coverage on the page is less than 50 percent. On the Phaser III, a typical monochrome page with 5 percent coverage costs about 5 cents for the ink, and a typical color page with 30 percent coverage costs about 25 cents. For 100 percent coverage, a thermal wax-transfer printer costs less to operate than a Phaser III. To calculate real cost savings with any technology, you must consider what you are going to print and the average ink coverage on the page.

At less than two monochrome pages per minute, the Phaser III will not replace a monochrome laser printer. But if you need plain-paper color printing, it offers an unprecedented level of printing quality at a fraction of the cost of color laser printers.

Weighing the Options

A variety of options exist today to bring color printing into your office. For many of these options, output quality depends heavily on the type of paper you use. Thermal wax-transfer printing requires a special coated paper; dye-diffusion and dye-sublimation printing use a special photographic paper; and liquid ink-jet printing tends to bleed into plain paper and works better on a coated surface.

Plain-paper color printing is the venue of laser, dot-matrix, and phase-change ink-jet technologies. All three can handle the task, but with varying degrees of success. Color laser printers are extremely expensive, but they are relatively quick and produce good color. Dot-matrix color printers are slow and not very exciting in their color reproduction, but they are affordable. Phase-change ink-jet color printers are affordable and produce good color, but they are relatively slow.

Due to the nature of the technology and its cost-effectiveness, phase-change ink-jet printers hold great promise for the future. Over time, the speed and the price/performance ratio should improve. All things considered, this technology looks like a winner. ■

ACKNOWLEDGMENT

My thanks to Roger C. Alford for his contributions to this article.

A. J. Rogers is the strategic marketing manager for the graphics printing and imaging division of Tektronix, Inc. (Beaverton, OR). You can reach him on BIX c/o "editors."

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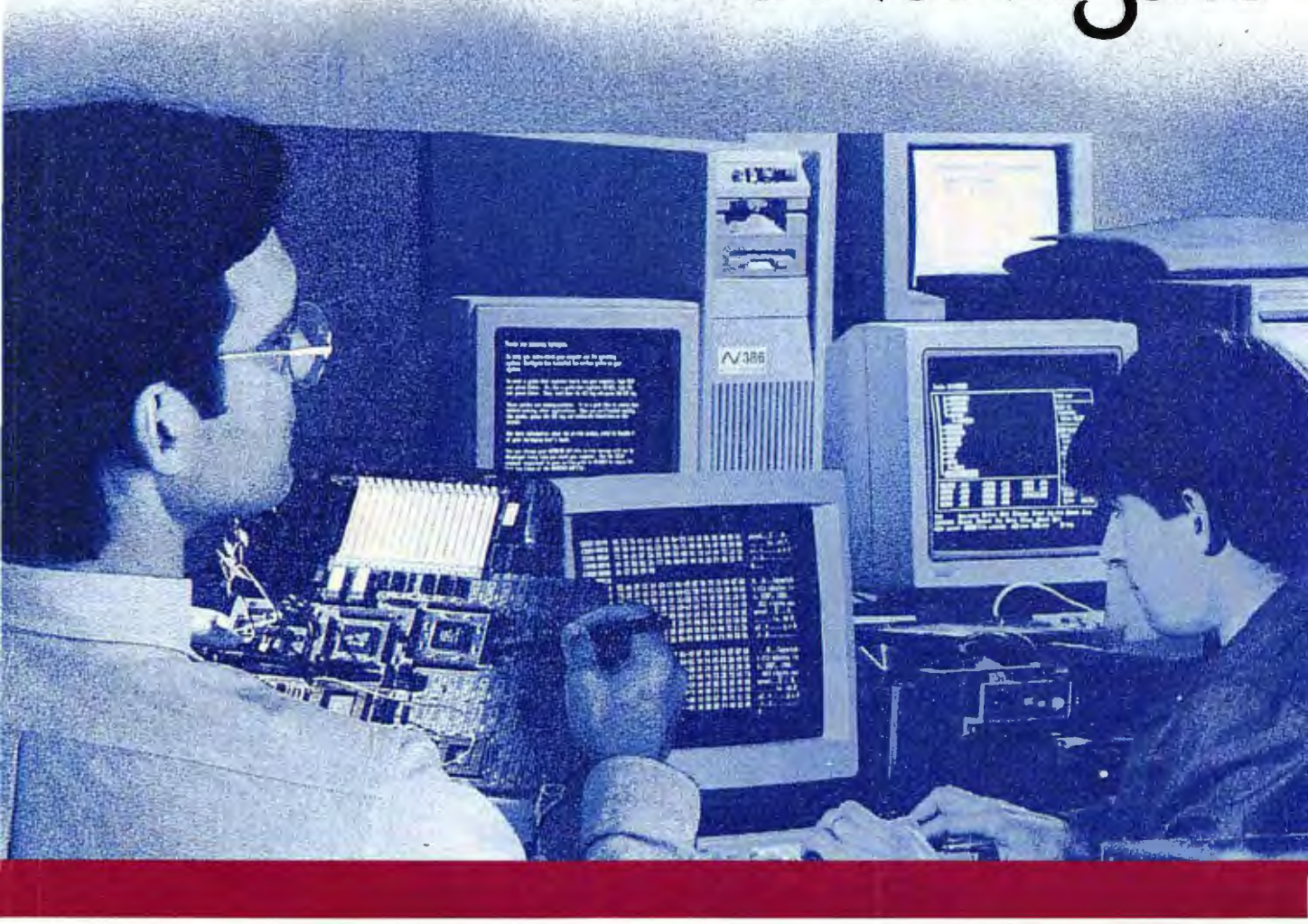

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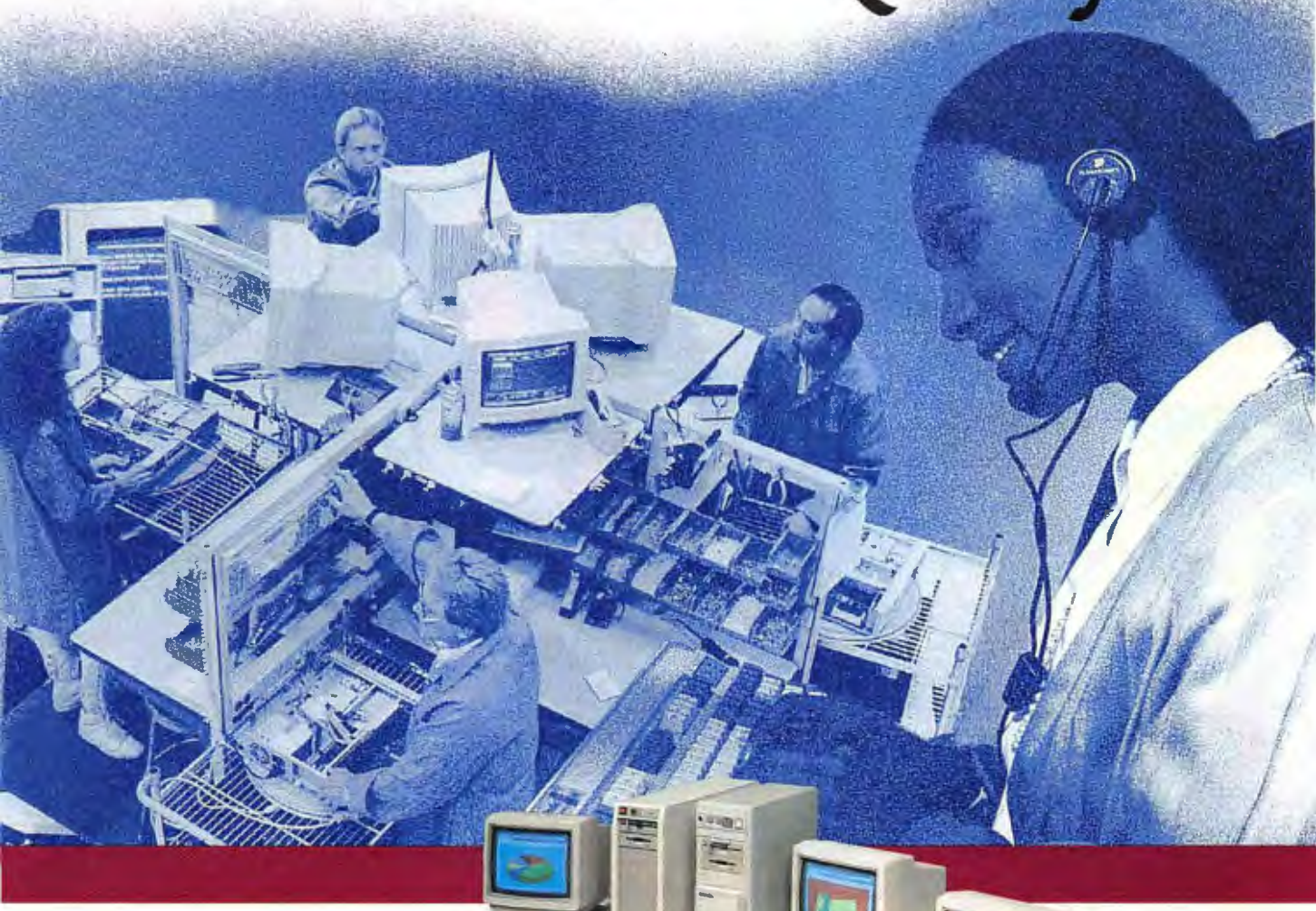

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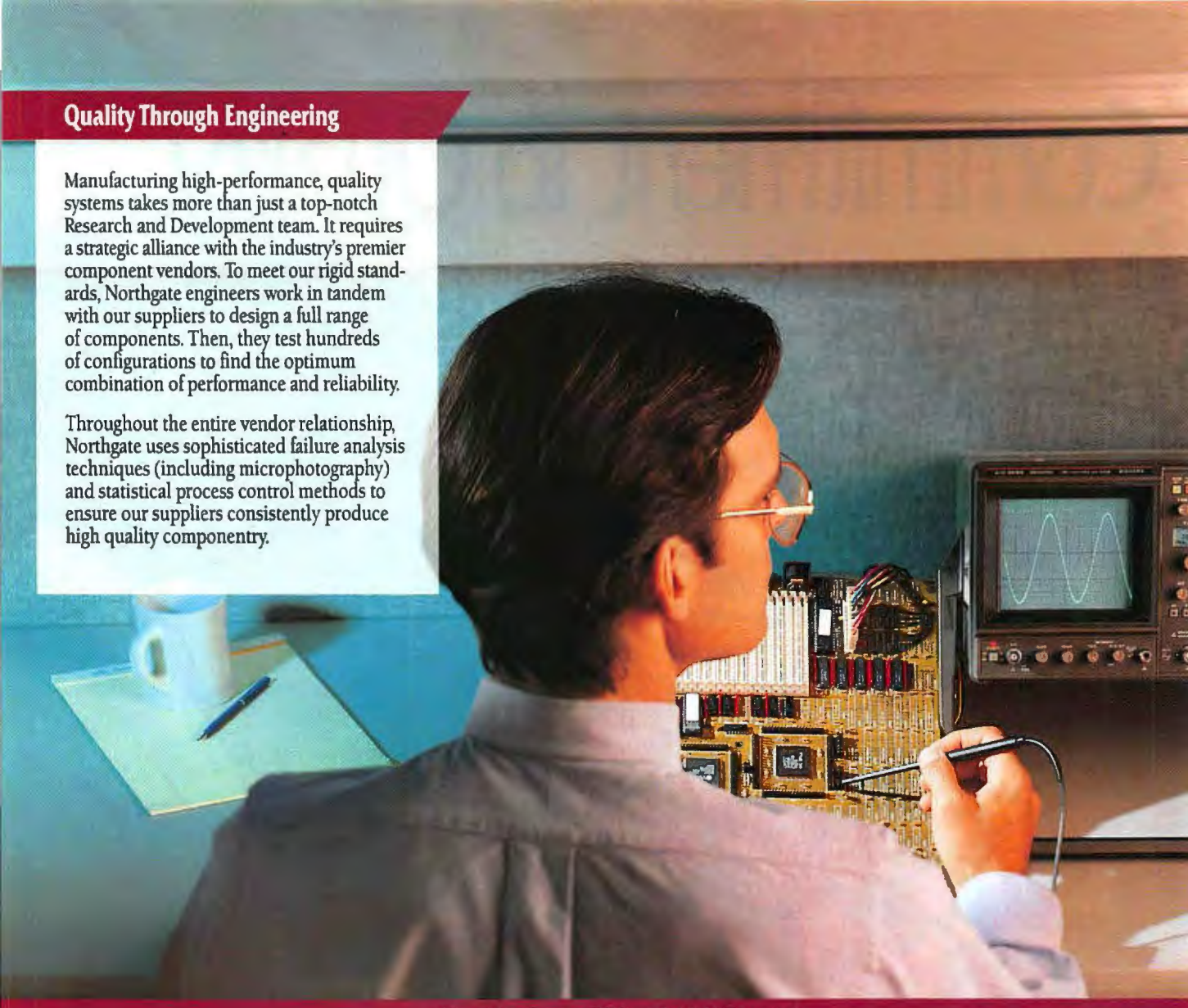

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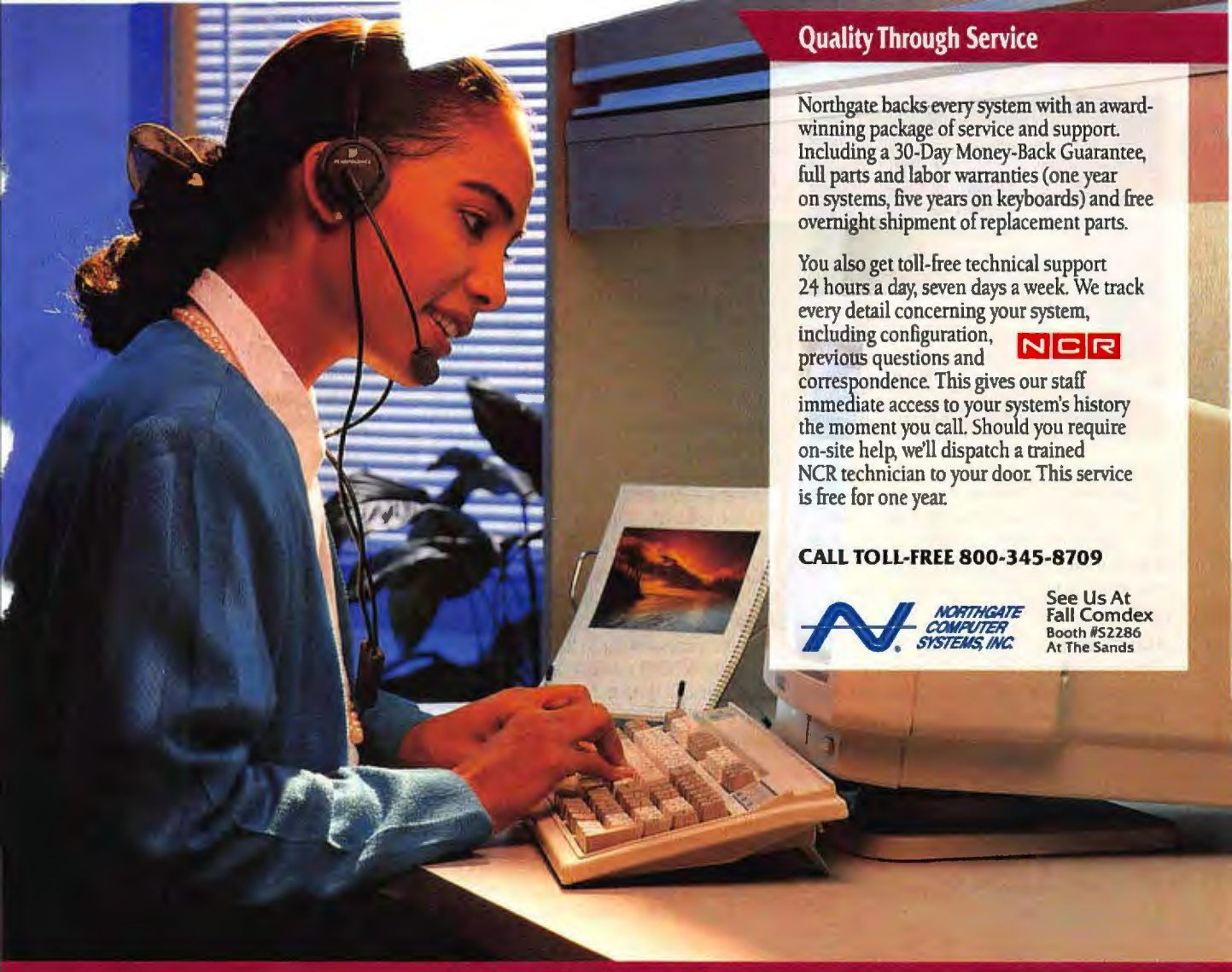

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HOT COLORS

Thermal-transfer technology heats up the desktop color-printing competition with a myriad of colors

MICHAEL D. NELSON

The desire to compute in color on the desktop is nearly as old as the personal computer industry itself. As early as 1977, the Apple II computer used some color on its display screen. But while color has long been at least a small part of the desktop's display environment, color printing—especially in full color—has only recently become economically feasible.

The primary obstacle to color printing has been finding a way to faithfully and economically emulate the process-color-printing method that commercial printers use to place full-color images on a page. Process printing puts tiny dots of cyan, magenta, and yellow—the primary subtractive colors—on paper in a pattern to create other colors.

"Full color" is something of a misnomer here, because the entire color spectrum is never available to you. The number of colors that you can represent with process printing depends on a wide range of factors, including the size of the dots, the distance between the dots, the density of the dot pattern, the number of dots you can put into the pattern, and the characteristics of the inks.

Today, you have a myriad of desktop technologies from which to choose to obtain full-color printing: liquid ink jet, thermal transfer, solid ink jet, dye diffusion (see the text box "The Dye Is Cast" on page 180), and laser. Each has its own advantages and disadvantages in terms of the number of colors available, the print quality attainable, price, and speed. One technology that strikes a balance of sorts among these factors is thermal-transfer color printing, well known for its presentation-quality output.

continued

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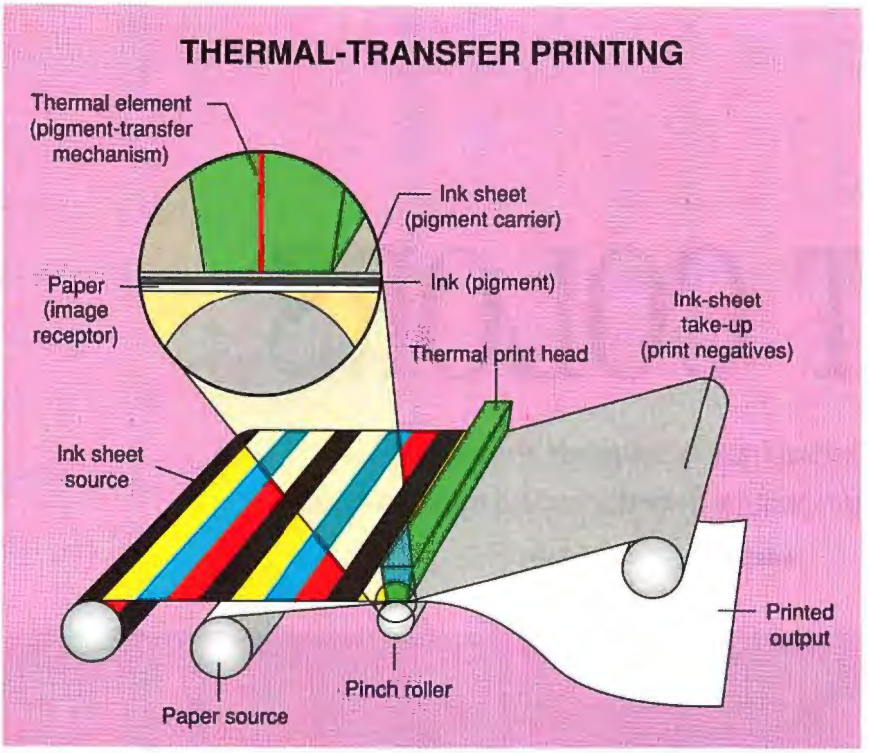

Figure 1: *To begin printing, the ink sheet and paper roll simultaneously toward a pinch roller, which pushes them against the thermal print head. Commands from the CPU or the printer turn on (and off) tiny semiconductor resistors in the print head to melt (and resolidify) the ink and leave dots of color only in the appropriate places on the paper. When each pass is complete, the ink sheet advances to the next color panel, and the paper retracts to its starting position until the full-color printing process is complete, when the paper advances as well.*

BYTE ACTION SUMMARY

Although the entire color spectrum is not available to you on the desktop, thermal-transfer color printing and its sibling, dye diffusion, give you choices numbering in the millions. Thermal transfer creates its colors with patterns of tiny colored dots, and dye diffusion actually merges the inks. Both provide presentation-quality output. You must decide if the purity of dye-diffusion color is worth its higher price.

Turning Up the Heat

Thermal-transfer color printing uses heat to transfer inks from a special ink sheet directly to paper or transparency film. These special ink sheets come in large rolls and have multiple panels—one for each of the three subtractive primary colors and sometimes for black—laid out in serial fashion. You need one of each of the colors to create a single full-color image.

Although it is possible to use standard-bond paper with thermal-transfer color printers, they perform best with high-quality, extremely smooth paper. With plain paper, the image suffers because of the coarser surface.

The ink sheet fits between the thermal print head and the paper. The thermal print head typically has 300 heating elements per inch (depending on the printer's resolution). As an electric current *fires* these elements, they heat the ink sheet and melt the ink onto the paper.

Because the ink-sheet panels are laid out serially, the paper must pass at least three times (and maybe four) beneath the heating elements—once for each ink panel—to create a full-color image. Figure 1 illustrates this procedure. Even though the concept is simple, the process is fraught with logical, mechanical, and thermodynamic engineering challenges.

First, because the print head makes three or four passes over the same sheet of paper, the alignment of the dot patterns on the paper, or the *registration*, must be precise. If the registration is off, the color pattern shifts, and the image becomes fuzzy. Logically, the printer controller directs the movement of the paper by controlling the mechanical devices that physically move it.

There are a number of mechanical design alternatives for this paper-handling mechanism, including roll and cut-sheet paper feeders with drum, platen, or capstan drive systems. Some systems use rollers to move the paper back and forth. Others use a drum and clamp system, similar to an offset printing press. Each alternative directly affects the system's ability to achieve good registration, and it also has a bearing on cost, size, and manufacturability requirements.

Second, controlling the heating elements requires the application of thermodynamic principles. The semiconductor resistors must be made of a material that heats and cools rapidly. If they heat too slowly, they may miss some of the dots in the pattern, or the printer may work too slowly. If they cool too slowly, retained heat could continue to melt ink and leave errant dots in the pattern. Likewise, the voltage must be tightly controlled to heat the resistors above 67 °C to melt the ink.

Two other factors also affect the quality of the color rendering: the ordered placement of dots in a pattern, called *halftoning*, and the resolution of the bitmap image that the print head creates.

Creating Many Colors

When you print a mix of color dots in a precise pattern, the unaided eye doesn't discern the individual dots if they are very small and tightly grouped together. Today, the leading thermal-transfer color printers print dots that are just 1/300 inch in diameter and are equally spaced from center to center (for a resolution of 300 dots per inch).

Each dot can have any one of eight colors: magenta, cyan, yellow, red, blue, green, black, or white. You can further combine these dots into *cells* to create the appearance of other colors. In a 2-dot by 2-dot cell, for example, the eight colors can combine to make 124 colors.

In choosing a cell size, however, you need to consider its effects on image quality. A small cell size may limit the

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The Dye Is Cast

A new type of color thermal-transfer printer applies a technology called *dye diffusion* to deliver millions of colors in continuous tones. The result is a near-photographic color quality. A 300-dot-per-inch dye-diffusion thermal-transfer printer gets the same visual results as the 2500-dpi halftone printing process used in many glossy magazines.

Although dye diffusion still applies heat to an ink sheet (or ribbon, in this case) to transfer colors, the process of creating different colors is radically different from that of traditional thermal transfer. Dye diffusion applies engineering advances in the electronics of the print head and in the chemistry of the ink.

Instead of using halftones, dye-diffusion printers physically vary the color intensity of each dot. The process is similar to that of a color monitor that varies the voltage to each screen pixel to achieve a certain color: the higher the voltage, the greater the intensity of the color.

In dye-diffusion printing, the dot is equivalent to a pixel. The printer controller applies variable voltages to each of the approximately 300 tiny resistors per inch in the print head (the actual number depends on the resolution of the printer). Each resistor, in turn, produces varying amounts of heat.

Dye-diffusion technology uses a type of ink different from the ink used in thermal transfer. This ink (or dye) converts directly from a solid to a gas when heated (a process called *dye sublimation*). The various intensities of heat regulate how much ink turns into gas and is applied to the paper, varying the density of the printed dot.

With dye sublimation, each dot can display a large portion of the color palette because the dyes are mixed in the proper proportions in the vapor state before being put on paper. Leading printers can step the voltage by 64 levels or more and create an equal number of individual densities per primary color. They are able to address a 24-bit palette of 16.7 million colors of continuous-tone output.

Dye-diffusion printers use a specially coated paper that takes an active part in the printing process. This paper is much like photographic paper. It is treated with a base chemical agent that reacts with the acidic colorant to actually *develop* the image as the colorant diffuses into the paper. An image created in this way has an enhanced durability as well, because it physically resides *in* the paper, not on it.

The mechanism and design of a dye-diffusion printer are similar to those of a thermal-transfer printer. But the cost of the dye-diffusion printing, the transfer medium, and the paper are considerably higher.

Due to the costs of the medium and the paper, letter-size prints from these machines will cost between $5 and $10 apiece. The printers themselves cost in the tens of thousands of dollars. Still, dye-diffusion technology excels in applications that require photographic quality for natural images. (See figure A to compare the output of dye-diffusion and thermal-transfer printers.)

A variety of dye-sublimation printers are now available, including (in order of price, from high to low) the 300-dpi 4Cast from Du Pont Imaging Systems (Wilmington, DE), the 200-dpi XL-7700 from Eastman Kodak (Rochester, NY), the 300-dpi CHC-S445 from Mitsubishi International (White Plains, NY), the 300-dpi CH6104 Professional ColorPrint from Seiko Instruments (San Jose, CA), and the 150-dpi S340-10 from Mitsubishi Electronics America (Torrance, CA).

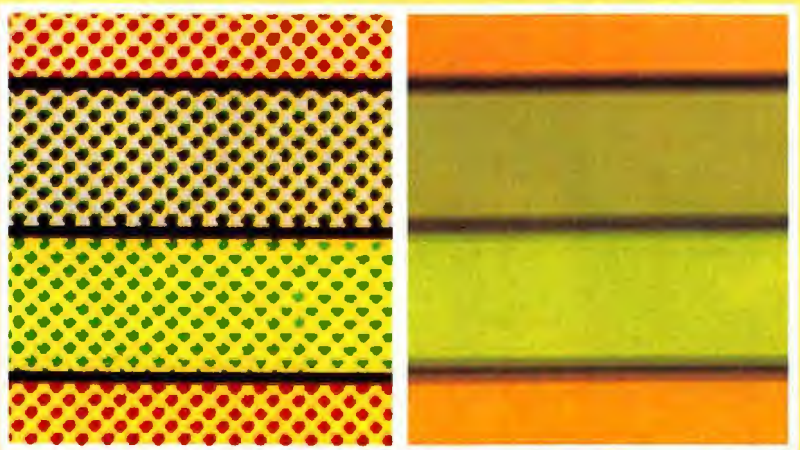

Figure A: *From a distance, the pattern of dots from the thermal-transfer color printer (left) can simulate different colors. Examined under ×5 magnification, however, the pattern of dots becomes very apparent. The color bars (right) are from Seiko's new dye-diffusion printer. Although both are 300-dpi printers, the dye-diffusion colors look nearly photographic, because this technology adjusts the density of each printed dot, eliminating the need for dot patterning or halftoning to create different colors.*

number of colors you can perceive, but it provides a better spatial resolution and a sharper image. Conversely, a large cell size expands your color choices, but it sacrifices image sharpness and spatial resolution. A cell size of 6 dots by 6 dots seems to be optimal for a 300-dpi thermal-transfer printer. It affords you a palette of more than 50,000 colors and crisp image quality.

Although the number of dots in a cell determines how many colors it can represent, the placement of those dots within the cell affects the quality of the color image. Different methods of half-toning

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One pattern, the spiral, is particularly effective in smoothing the visual transition from one color to another. However, it exhibits the grainiest appearance.

A dispersed pattern minimizes the appearance of cell array, but it sometimes introduces small geometric artifacts at the transition between the boundaries of certain colors. Although these geometric artifacts are analytically negligible, they can be quite prominent visually.

A random or pseudo-random dot pattern tends to exhibit good color blending and minimal graininess. But generating it is a computationally intensive process that can affect system performance.

In fact, the computational power required to implement *any* of these patterns is significant. The system must process each printable dot three or four times based on its intended color and cell location. But random patterning (typically implemented through an error-propagation algorithm) and PostScript (which supports the additional variable of angling cell arrays) incur even more computational overhead than other methods.

To address the overhead issue, many vendors are developing application-specific ICs and embedding powerful RISC microprocessors in printer controllers.

Return to the Source

Another important factor that affects the quality of a color image is the input signal. The three most common types of input to the printer are video signal, direct digital, and intelligent digital.

Video signal is the fastest of the three types of input, but it limits the resolution of the printed image to that of the screen, which is about 75 dpi for most commonly used color monitors. The video source sends the location of each video pixel directly to the printer. An A/D converter interprets the signal, and the printer captures, rasterizes, and prints the frame-buffer image.

Video-signal input is best suited to engineering-, scientific-, and medical-imaging applications (e.g., solids modeling, remote sensing, satellite imaging, and CAT scans).

Although slower than video-signal input, direct digital input and intelligent digital input define an image in software. The additional logic enables the system to process the image to make use of the maximum resolution of the printer. Further, neither of these two methods is restricted to printing the screen image—an important point when you need to print documents as well as images.

The primary difference between direct digital input and intelligent digital input lies in where the system converts the software information into a printable raster image.

Direct digital input uses the CPU as the raster-image processor. The system downloads the resulting raster image to the printer. Mac QuickDraw drivers, PC Windows drivers, Sun's Newsprint, and the Freedom of the Press PostScript Emulator are all examples of this approach.

Intelligent digital input assumes that the processing power resides on the printer—that it is an *intelligent* printer. This is the approach used with Hewlett-Packard Graphics Language and Color PostScript. The applications software and the printer driver—or both—define the image in a high-level format and send it to the printer. Then the processing power of the printer interprets this format and produces the printed image.

Because the intelligent-digital input approach requires a second powerful processor, it is more expensive than direct digital input; however, it also returns control of the computer to you more quickly and tends to be faster in processing the bit map. Conversely, although it is generally slower, the direct digital method is less expensive, because only one processor is involved.

Looking Ahead

Thermal-transfer technology balances high-quality output with a reasonable price tag. It is ideal for in-house production of presentation materials. And, like other technologies, thermal transfer is not standing still. The future will likely see greater quality and more capabilities at lower prices.

For example, Seiko recently introduced the ColorPoint PSX, a PostScript-compatible thermal-transfer printer that features a fast 25-MHz 960 processor; up to 34 MB of RAM-to-buffer input; and serial, parallel, and AppleTalk ports. The fast processor and large buffer let the printer download and store data from the host very quickly, releasing the host for other tasks.

The result of such advances is that desktop color printing is fast becoming a mainstream technology. You're the big winner. You have access to the power of color to enhance your communications, both on the screen and on paper. ■

Michael D. Nelson is manager of printer products marketing for Seiko Instruments U.S.A. (San Jose, CA), which manufacturers thermal-transfer color printers and dye-diffusion color printers. You can reach him on BIX c/o "editors."

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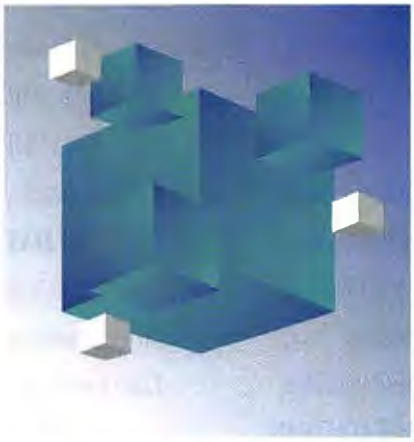

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PRINTING WITH ELECTRONS

Electronic-beam imaging is simpler than laser printing—and is becoming more practical

BEN SMITH

Laser printers have grabbed the market for high-quality personal printers. They have also dominated the high-performance print server market for years, but they may soon lose this segment of the market to electron-beam printing.

Electron-beam (also called ion deposition) printing uses beams of electrons (rather than light) to generate an image. The process is simpler than the electrophotographic method that laser and LED printers use. Electron-beam imaging is cost-effective primarily for high-speed printing applications, but it will soon be feasible for small offices as well. Due to the continuing R&D in electron-beam imaging by its developer, Delphax (Canton, MA), the usability and feasibility of these systems are becoming competitive with comparable laser printers.

What Goes On Inside

Although laser printers and electron-beam printers look very much alike, the principles behind how they work are quite different. Laser printing consists of six phases (see figure 1): charging the drum, removing the charge from nonprinting (white) areas using the laser, developing the image, transferring the image to paper, fusing the image, and cleaning the drum.

Electron-beam imaging is a four-phase process (see figure 2): generating the image on the drum with electron beams, developing the image, transferring and fusing the image, and cleaning the drum.

The most complex element of the electron-beam process is the electron cartridge, which generates the image on a dielectric drum. The paddle-shaped

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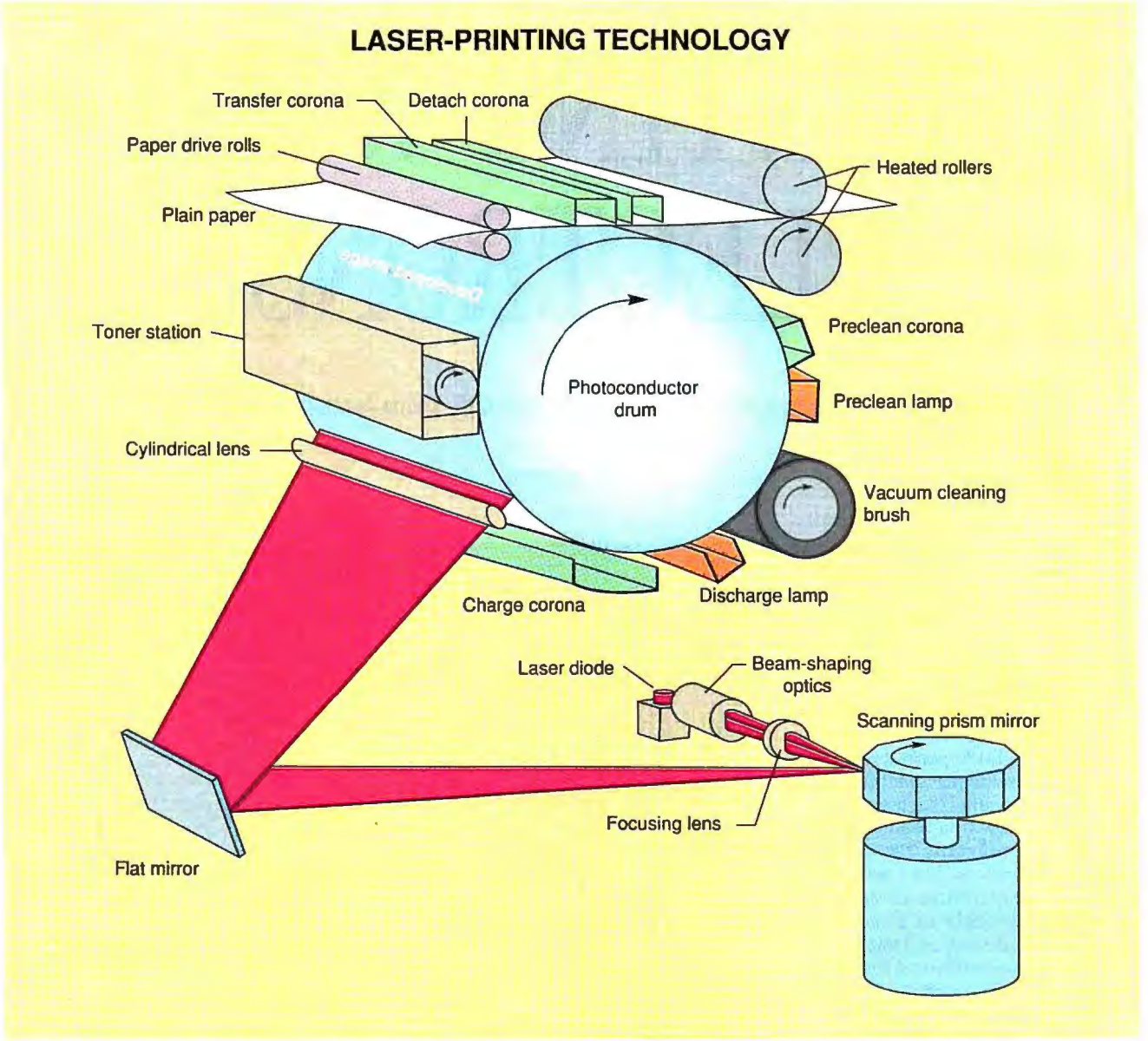

Figure 1: *In laser printing, the charge corona distributes a charge across the photoconductor drum. As the drum rotates, the scanning prism mirror rotates to focus laser pulses through a cylindrical lens and onto the drum. Where the light hits the drum, the charge is stripped away, creating a latent image on the drum. Toner is attracted to the charged areas only. The transfer and detach coronas apply an electrostatic charge to the paper, and, as a result, toner moves from the drum to the paper. Heated rollers fuse the toner to the paper. A neutralizing preclean corona and lamp loosen any residual toner, and a vacuum brush cleans it from the drum. Finally, a discharge lamp bathes the surface of the drum to ensure complete removal of any residual charge.*

electron cartridge contains a series of holes along the bottom side. Because this is a rasterized data device, when the electronics select one of the holes, the cartridge fires a stream of electrons toward the drum. When the electrons strike the drum's dielectric coating, this target (dot) becomes charged. The principle used in the electron-beam process is called corona discharge (the generation of free electrons and ions). This process uses 2600 volts at a high frequency (2 to 6 MHz) to generate free electrons.

Researchers have found that, in the electron-beam process, high frequencies produce a consistent level of corona discharge. There is a 350-V differential between the base of the electron generator and the nearby dielectric drum.

A series of pulsed electric fields (between the high-voltage electrodes and the dielectric drum) control and focus very small beams of free electrons onto the rotating dielectric drum. The control grid of the electron cartridge determines when an electron beam is on, and it can thereby generate a pattern of tiny electron *puddles* on the dielectric surface. As such, electron-beam printing is an additive process, and laser printing is a subtractive process.

It might seem easier to use a scanning electron beam (like the electron gun in the CRT of your TV) than a grid to write on the drum, but controlling such a beam is an enormous challenge. The electron-

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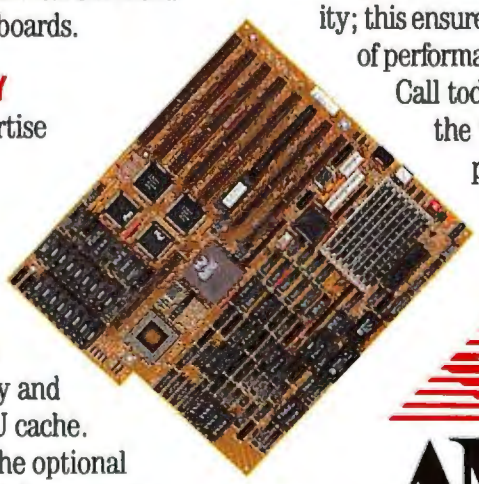

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beam cartridge developed by Delphax is a single, stationary, solid-state cartridge that generates the image.

The dielectric drum on which the electron cartridge writes consists of an aluminum-alloy tube coated by an anodizing process and sealed with a dielectric. The dielectric material holds the localized spots of electrons in the same way an electronic capacitor holds a charge.

To develop the image, the printer uses a magnetic-toner chain, a common way of distributing the toner particles to an intermediate *brush* (it is actually a roller) that uniformly wipes them onto the drum holding the latent image. In the case of electron-beam printing, the negative electrons on the drum overcome the toner's magnetic attachment to the brush. The toner is attracted only to the electron-laden areas of the dielectric drum. Electron-beam printers use a single-component toner, a method that obviates the need for carrier beads (a recycled intermediary that holds a charge and carries toner to the drum).

The printer transfers the developed image to paper by *cold-pressure fusing*, a much simpler process than the one used in copy machines and laser printers. This process uses a static charge to draw the particles onto the paper, and it then uses heat to fuse the toner onto the paper. Cold-pressure fusing uses a pressure roller that delivers 250 pounds per linear inch to transfer the image from the drum to the paper. The pressure alone creates the fusing.

Besides being a simple, one-phase process, cold-pressure fusing is more efficient (99.5 percent efficient, compared with 85 percent for electrostatic transfer and heat fusing). Because there is so little toner left on the drum, the printer requires only a simple scraper to remove residual particles from the drum.

But there is a drawback to cold fusing: The pressure polishes the paper and the image on it. The solution to this dilemma is to apply a flash of high-intensity light, which melts the toner and removes the gloss. Even then, cold fusing does not produce as tough a bond as does heat fusing; the printed page cannot stand as much abuse.

The final phase of the process involves the cleaning and the neutralizing of the drum in preparation for producing the next image. Unlike high-performance laser printers, which require elaborate mechanisms to remove the 15 percent remaining toner from the drum, the electron-beam cold-fusing printer requires only a simple scraper. After cleaning the drum, the next step is to neutralize the latent image with a positive-electron generator—the erase rod. The drum is then ready for another image.

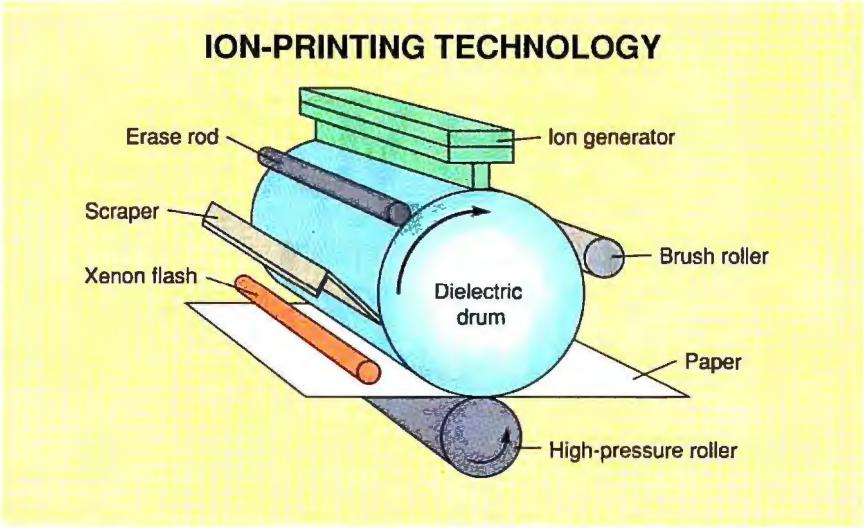

Figure 2: *The electron-beam cartridge uses high voltage and high frequency to generate free electrons (the corona effect) onto the rotating dielectric drum. The resulting puddles of electrons on the surface of the drum form a latent image and attract the toner away from the brush roller. The high-pressure roller presses and fuses the toner to the paper. A xenon flash removes the polish and increases the bond. Meanwhile, a simple scraper removes the very small amount of residual toner from the drum, and an erase rod removes all the remaining latent image.*

Front-End Processing

Inside an electron-beam printer, processing takes place in three areas. The first area consists of print-control protocols, which administer the transfer of data between the host computer and the printer. Available protocols range from the Printer Control Language (Hewlett-Packard) and Diablo emulations to proprietary IBM printer protocols. There are even PostScript interpreters. (Manufacturers originally marketed electron-beam printers as an alternative to minicomputer and mainframe band printers with their proprietary protocols, but recent efforts are focused more on open systems. The most common command language is PCL, and the most common interface is Centronics' SCSI and parallel connections.)

The second area is raster-to-image processing, which converts the image matrix into the control signals that are applied to the electron-generation cartridge and are used to produce the actual image.

Finally, hardware-control processing provides you with the interface that enables you to operate the printer—the buttons that let you put the printer on- and off-line, form feed, change fonts, and so on.

Several companies, among them Delphax and Image Systems of Irvine, CA, design and build the basic engines for electron-beam printers as well as provide the front-end processing. Image Systems controls the final development of low-end electron-beam printers (those that print fewer than 50 pages per minute). Its machines are marketed by other companies, such as C. Itoh of Japan. Image Systems' machines have 500- to 2000-page sheet feeders and weigh a hefty 180 pounds.

continued

BYTE ACTION SUMMARY

Because of the mechanical simplicity of electron-beam printers, they require less maintenance and expense for high-volume printing than do laser printers. This technology is now moving into the personal-printer market and is also pushing very high volume printing beyond its current limits.

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Compared to Lasers

Laser printers and LED printers fall under the family name of *electrophotography*, a process that evolved from plain-paper xerography. Because many laser printers are adapted from xerographic engines, the costs of their development are minimal.

But, as you can see from figure 1, the laser process is complex and requires precision mechanical devices for moving the laser beam, corona wires, and hot rollers for developing, transferring, and fusing the image. Hot fusing requires a great amount of electrical energy. Electron-beam printing is much simpler, requires fewer moving parts, and is more dependable. Cold fusing requires far less energy.

Because of the mechanical simplicity of electron-beam printers, a notable secondary savings over electrophotographic machines is achieved through lower maintenance costs. Compare the maintenance requirements of the two types of devices after 100,000 pages at 40 ppm.

For a laser printer, you need to call a manufacturer's service technician to add toner/developer, replace the cleaning blades, replace the development drum, mix and prime the developer, and run cleaning cycles. The typical downtime is 3 hours.

However, after the same number of pages on an equivalent electron-beam printer, an in-house person can vacuum the print engine, replace the electron cartridge, and increment the erase electron rod one turn. The typical downtime is 10 minutes. Short and infrequent downtime means more productive time.

Investments vs. Expenses

Despite the mechanical simplicity of electron-beam printing compared to laser printing, the initial investment is higher, primarily due to the expense of making the dielectric drum. Because of the abrasion of the cold-pressure fusing process, the surface of the drum must be as hard as a sapphire.

On the other hand, the photosensitive (selenium or organic photo conductor) surface of the drums used in laser printing deteriorate with use. Photosensitve drums need to be replaced after printing 20,000 to 100,000 pages. The new, extremely hard dielectric drums need replacement only after printing 3 million pages.

Electron-beam printing becomes economically advantageous when you have moderately high printing requirements—more than 20 ppm and 100,000 pages per month. Printers that are able to handle these volumes cost more than $20,000, whether they use laser or electron-beam technology.

Taking into account the maintenance and the consumables required to print 100,000 pages per month at a speed of 40 ppm, the expense of using laser printing runs from 3 to 5 cents per page, whereas the expense for electron-beam printing runs around 2 cents per page.

Wide Range

Electron-beam printers range from relatively inexpensive 30-ppm printers that cost about $10,000 to 300-foot-per-minute printers that cost around $400,000. The high-end market is still dominated by laser or LCD/LED electrophotography-based machines, such as the Xerox 9700 and the IBM 3900. But, according to Brandon Nordin of BIS Strategic Decisions (Norwell, MA), electron-beam machines will be penetrating the market for many of the high-end applications

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because of their low per-page costs. The move will be gradual, because replacing $400,000 equipment requires some long-term financial planning.

The obvious applications for electron-beam printing are financial statements and reports, inventory reports, stocking orders, and so forth. Direct-mail organizations are already profiting from this technology by using electron-beam printers for flyers and personalized letters. Because they output a denser black than laser printers, electron-beam printers are excellent for any kind of ad hoc labeling, especially if the labels require bar codes.

Looking Ahead

One of the drawbacks of electron-beam printing is its print quality. These are only 300-dot-per-inch machines at best. The low end for lasers is 300 dpi, and they go up from there. Additionally, the puddles of electron concentrations that form the image on the dielectric drum tend to pool, slightly rounding corners and filling intersections of the image. Delphax is working on pushing these limits while maintaining the high intensity of black. It also has been developing new fonts that take advantage of the rounding and filling properties.

With electrophotography, the type of toner, the method of toner transfer and fusing, and the method of image encoding all differ for each printer-speed range. But with electron-beam imaging, these factors are the same no matter what level machine you are dealing with. Electron-beam imaging has the potential to print at very high speeds, well above the current 300-fpm machines.

Delphax is focusing much of its research on pushing the technology to its upper limits. The firm is also working on gray-scale printing; its goal is to offer 150-screen gravure (magazine quality) with up to 32 levels of gray.

With high-speed electron-beam printing, don't expect to see high performance with graphics and PostScript. The limiting factor in graphics printing is not the printing, but the image data transfer rates and the time required to compute an image from a high-level graphics language. High-speed graphics needs high-speed processing; even at 30 ppm, you need a fast RISC microprocessor.

However, there is exciting news about low-end electron-beam printers. Within a year, we can expect to see electron-beam printers that yield 30 ppm, but cost only $3000 or $4000. ■

Ben Smith is a BYTE technical editor. You can reach him on BIX as "bensmith."

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PC MAGAZINE EDITORS' CHOICE
November 13, 1990
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Color Printers

The technologies that let you get color hard-copy output from your PC have advanced rapidly in the past decade. In place of washed-out graphics produced by impact printers with fabric ribbons, you now have a choice of technologies that produce vibrant colors on a page. These include ink-jet, thermal-transfer, and, at the high end, true laser color output. The companies below manufacture and market color printers.

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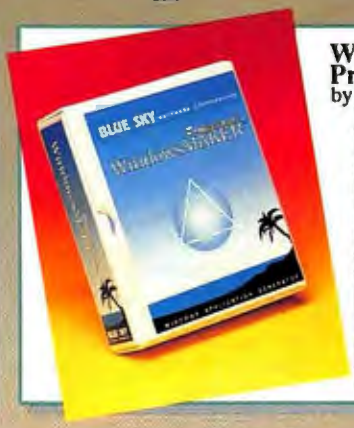

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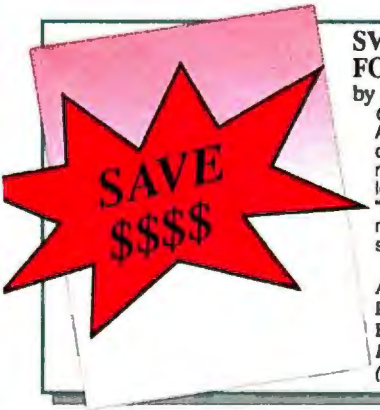

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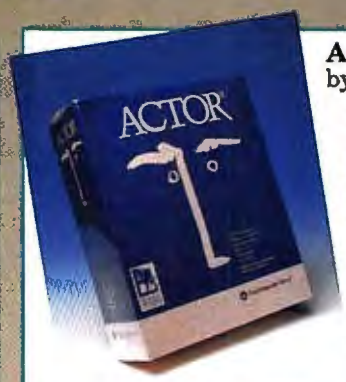

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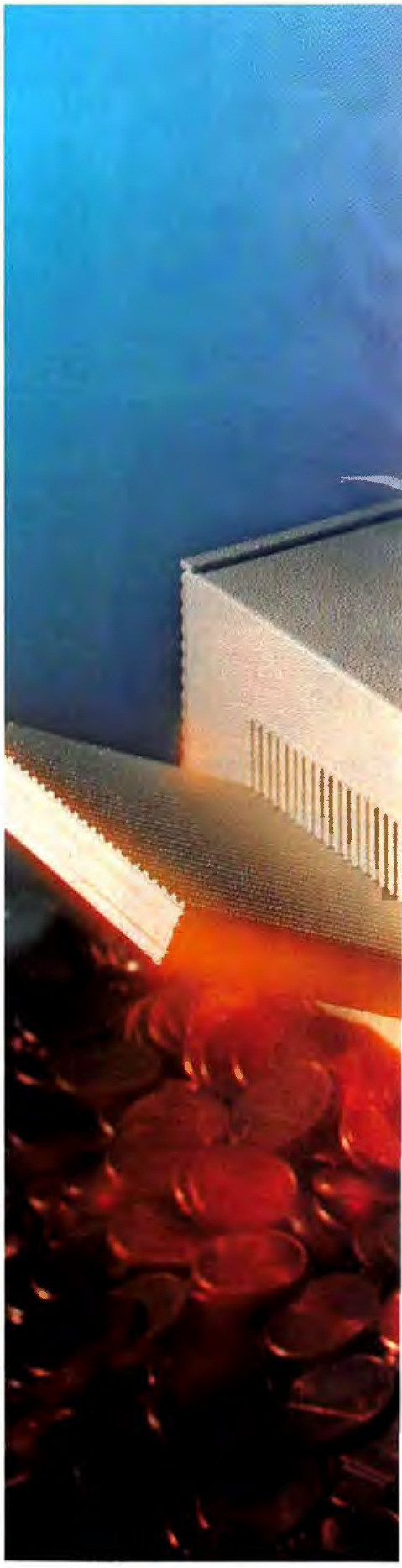
PENNY-WISE POSTSCRIPT



The BYTE Lab tests nine printers that make plunging into PostScript affordable

STANFORD DIEHL AND HOWARD EGLOWSTEIN

Two years ago, Hewlett-Packard's LaserJet IIP printer ushered in the era of the personal page printer. If you wanted inexpensive laser output for the desktop, a $1500 LaserJet IIP printer was the way to go. On the other hand, PostScript remained among the printer elite with its undeniable advantages for intensive graphics applications. But to get what PostScript had to offer, you had to abandon price as a critical criterion. If you had to ask how much a PostScript printer cost, you probably couldn't afford it.

Given time, a revolution can bring down the elite. And so it is with PostScript. The same forces that brought Printer Control Language to the desktop—less expensive engines and a very competitive market—have worked the same magic on PostScript. According to a recent BYTE printer survey, almost half of all respondents said they planned to buy laser printers in the next year. And for the first time, these potential buyers are equally divided between those considering a PCL-compatible printer and those considering PostScript.

This month, the BYTE Lab tested nine printers that offer PostScript capability for under $2500: Abaton's LaserScript LX, Apple's Personal LaserWriter NT, C-Tech's Ci-4 Laser Printer, GCC Technologies' BLP II, HP's LaserJet IIIP and PostScript cartridge, IBM's LaserPrinter E, NEC's Silentwriter2 Model 90, Star Micronics' LaserPrinter 4 StarScript, and Texas Instruments' microLaser PS35. Actually, the LaserWriter NT broke the $2500 price barrier slightly, but we still felt obligated to include it because it is an undeniable market leader. Apple users will probably consider it regardless of its price. On the other hand, we could not include a printer we regard highly, the QMS-PS 410, because at $2795 it exceeded the price criterion handily (for more information on the 410, see "No-Muss, No-Fuss, Low-Cost PostScript Printer," August 1990 BYTE).

A note about prices: Through mail order, some of these printers cost even less—some below $1500. If price alone has been keeping you out of the PostScript market, your wait may be over (see table 1). However, no matter what you pay for

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BYTE ACTION SUMMARY

- **WHAT POSTSCRIPT PRINTERS DO**
  These printers deliver the industry-standard PostScript language (or a compatible alternative) and a selection of scalable fonts at reasonable prices.
- **LIKES**
  All these printers produce acceptable laser output and PostScript compatibility at bargain prices.
- **DISLIKES**
  PostScript is still slow. It requires a screaming processor to keep you from getting fidgety between print jobs. Laser printers are not suitable for forms or listings. Consumables can get expensive.
- **RECOMMENDATIONS**
  The best deals come from among four of the printers: the GCC BLP II, the IBM LaserPrinter E, the NEC Silentwriter2 Model 90, and the Texas Instruments microLaser PS35. Prices being equal, we like the Silentwriter best.

a printer, it's not a bargain if the machine does not meet your office's needs. To help you match printing technologies to specific applications, see the text box "The Right Printer for the Job" on page 202 and the accompanying table A. Also, "New Life from an Old Printer" on page 204 discusses add-on products that can upgrade your present printer to PostScript and improve performance in other ways. "Choosing a PostScript Printer," page 208, offers buying advice based on what BYTE readers say are their most important criteria.

The Coming of the Clones

First introduced by Adobe in 1985, PostScript rapidly caught on, mainly because of its device independence. This made it a natural as a cross-platform standard. In June 1990, Adobe announced the first major upgrade to its printer language, PostScript level 2. Level 2 should clear up the confusion over the many different PostScript revisions by unifying them all under one release. Level 2 offers support for color images, non-Roman character sets, and optimized text and graphics operators currently used in Display PostScript systems. The upgraded language also addresses a major complaint about PostScript: its slow performance. Level 2 caches predefined forms and patterns,

The Right Printer for the Job

Your accounting department just switched its entire East Coast office off the mainframe and onto a Mac. It now needs to find a good, fast printer. What would you suggest? Marketing needs a color printer: Would it be better off with ink-jet or wax-transfer technology?

The first step when choosing from among competing printer technologies is to understand how they work. Know what each is best at and then look at the kind of printing you do most often.

Second, be realistic. In many offices, even a busy LAN can get by beautifully on an inexpensive printer. True, you can buy a snarling, paper-spewing beast for a few thousand dollars more, but do you need it? If you're not processing complex graphics and your page output is low, perhaps a cheaper printer can do the job. The money you save will make you look like a hero to the bean counters; using the right printer will also make your life a lot easier.

Below, we describe the major printer types and the applications for which they're best suited. Table A encapsulates our discussion to help you match, at a glance, printer technologies and applications.

A Thousand Points of Toner

The most attention these days goes to the laser printers, which come in many forms priced for almost any budget. These printers image a whole page at a time. A computer-controlled laser, an array of LEDs, or an LCD-shuttered incandescent light source exposes the image onto a light-sensitive drum. An electric charge on the drum attracts plastic toner particles that transfer to the paper and melt onto its surface. Because of the complexity of the heat-fusion process, you can expect a laser printer to have a lower page-per-month duty cycle than printers based on other technologies.

At the high end are printers designed for high-volume applications. First, there are lasers that pump out 17 or more pages per minute for mid- to large-size LANs. Hewlett-Packard's $6000 LaserJet IIISi (see "The LaserJet IIISi: Hewlett-Packard's Flagship Printer," page 52, April BYTE), the QMS-PS 2000, and the Siemens-Nixdorf 2030 are three high-speed, paper-breathing dragons. To enhance their performance on networks, these printers can handle direct connections to your LAN, as well as standard parallel and serial connections.

Related to laser printers are printers based on *cold-fusion* and *ion-deposition* technology. A cold-fusion printer can handle 200,000 or more copies each month at 30 to 50 ppm for less than three cents each—perhaps the best printing technology for an organization that has high-volume printing needs. However, the Xerox 4075 and other models like it cost about $65,000.

Like a laser printer, an ion-deposition printer uses plastic toner and electrostatic charges to form the image on paper. Unlike a laser, it has no fuser roller. A high-pressure roller simply squeezes the toner into the paper's surface. Here the emphasis is speed, lower per-page cost, and sturdy construction.

Continuous-form laser printers are a fairly new category. As nice as laser output can be, a long listing delivered as separate cut sheets can be unwieldy. Output Technology and Pentax continuous-form printers offer an impressive 16 ppm for reasonable prices: $6000 and $4000, respectively. If your office has been wrestling with slow laser printers with ever-empty paper trays, one of these printers might be just what you need. The programmers in your R&D group will thank you.

Personal Lasers

A good laser-printer choice for some workgroups and midsize networks is one of the many 8- or 10-ppm desktop laser printers on the market. Most models can support PostScript, and these range from $2000 for a small-footprint HP clone to $5000 for Apple's LaserWriter IINTX.

Most laser-printer development has been in the workgroup (10 to 17 ppm) and personal (4 to 6 ppm) categories. When you can get a LaserJet IIISi for $6000, putting a $2500 LaserJet III on your LAN isn't necessarily your best choice. Still, for small workgroups or LANs with low printing needs, 8 ppm is just about right.

Thrifty Dot Matrix

Dot-matrix printers can handle multipart forms and graphics output. Unfortunately, they're noisy and relatively slow. However, dot-matrix printers and their replacement ribbons are relatively inexpensive and are steadily dropping in price, making these printers the primary choice for the thrifty office. A wide-carriage dot-matrix printer may be the best answer for spreadsheets.

Dot-matrix print heads have a number of small pins (i.e., hammers) arranged in a vertical line. A matrix in the printer's ROM defines each character, which is built out of black dots created by the pins striking the paper. The printer scans the head across the paper, firing individual pins as needed to form a character. The first dot-matrix machines used a single row of nine pins; the newest ones use several staggered rows to create a higher-resolution character with 24 pins. In "When Laser Printers Can't Cut It" (December 1990 BYTE), the BYTE Lab looked at a number of wide-carriage 24-pin printers.

Kinder, Gentler Printers

Think of an ink-jet printer as a cross between a dot-matrix and a laser printer. It offers quality close to that of laser printers at a lower price for general business and portable applications.

Ink-jet printers use a special ink cartridge and a print head with a small row of ink tubes (arranged like dot-matrix pins) that passes over the paper. To print a dot, the printer heats up a resistor in a tube, causing the ink to boil and form a bubble. The bubble forces out a small drop of ink onto the paper. To achieve the best-quality printing, the paper must have a short, tight grain so the ink won't wick and look smeared. Since the introduction of its ThinkJet, HP and others have improved the inks so that they dry very quickly and are less prone to smearing on poor-quality paper.

GETTING THE JOB DONE

Table A: *While almost any technology can handle any job, there's always a best choice. When you're buying a new printer, pick the kind that's best for your application. You don't always want a laser printer.* (● = *yes*; ○ = *no.*)

	Office correspondence	Proposals	Spreadsheets	Programming	Presentations	CAD	Illustrations	DTP	Photo-imaging
Daisy wheel	●	Not flashy enough	○	○	○	○	○	○	○
Dot matrix	● (24 pin)	● (24 pin)	●	●	● (24 pin)	○	●	● (24 pin)	○
Wide-carriage dot matrix	○	○	Definitely	Definitely	○	●	○	○	○
4- and 8-ppm lasers	●	●	○	○	●	Too slow	●	●	○
High-resolution lasers	○	●	○	○	●	Landscape	●	●	●
High-speed lasers	Networked	Networked	Networked	Networked	Networked	Networked	Networked	Networked	○
Continuous-form lasers	○	○	●	Definitely	○	○	○	○	○
Ink jet	●	●	● (wide paper)	○	○	○	○	●	○
Color dot matrix	○	●	○	○	●	●	○	●	○
Color ink jet	○	●	○	○	●	●	●	●	●
Color laser	○	Definitely	○	○	Definitely	Definitely	●	●	●
Color sublimation	○	○	○	○	○	○	●	○	●

Ink-jet technology is popular for small, lightweight portable printers because it uses less energy than an equivalent dot-matrix printer. It's also better in the office because of its quiet operation and rich, dark output. Unfortunately, an ink-jet printer can't make multiple copies. Also, be careful if you take one with you on an airplane. The pressure changes in the cabin will often force the ink out of a portable ink jet's cartridge.

A Colorful Idea

If you're a graphics professional or the person responsible for producing your company's sales literature and presentations, you may require color. The least expensive way to get color on paper is with a dot-matrix printer that supports multicolored ink ribbons. By making multiple passes over a line, the printer combines basic colors to produce many more. Although inexpensive, this approach is slow, and when compared to other technologies (e.g., ink jet), dot-matrix color looks pale and washed out.

If you need high-quality color and PostScript compatibility, take a look at *wax-transfer* printers. They use a transfer roll coated with alternating sections of cyan, magenta, yellow, and black wax on a plastic sheet. The print engine creates the image in memory, lines up a piece of paper against the first colored section, and transfers the image line by line. After the entire page has been transferred, the paper moves back up to the top and the next color is applied. The resulting image is highly dithered with good color, but it requires specially coated paper stock.

The Spectra*Star 400 family of wax-transfer printers from General Parametrics starts at $5000 for a basic model and goes up to $7000 for the RISC-based, PostScript-compatible Model 430. QMS's ColorScript series includes the new Model 10p, which costs just $7000, as well as a massive 11- by 17-inch beast, the Model 30i, which costs $13,000. You can also find models with various capabilities from CalComp, Océ Graphics, Seiko, and others.

Tektronix has recently announced a new color printer that prints like a wax-transfer printer but does not require the special (and expensive) paper. The Phaser PXi (which starts at about $10,000) uses solid sticks of colored ink instead of the coated plastic sheet. As the paper passes by, the printer melts the ink and sprays it onto the paper (like an ink jet), where it cools and becomes solid again. The output is excellent, although the Phaser PXi's overall performance is somewhat slower than that of a wax-transfer printer. The printer handles 12- by 18-inch paper.

At even higher prices, several color-laser-copier companies offer PostScript printer conversions for their plain-paper copiers. Canon's color laser copier with a computer interface and PostScript interpreter costs about $50,000. Colorocs has a $30,000 PostScript printer that delivers 5 ppm in full color or 40 ppm in black and white.

Sudden Impact

Daisy-wheel printers, among the first printer choices for personal computers, continue to be good picks for some applications. They are the best-known example of a *fully formed* character printer. The type element is a flat (or cup-shaped thimble) plastic/metal affair with separate petals for each character. Each letter is molded in full relief at the end of a petal. Because the character is continuous, the resolution is essentially infinite. A top-quality daisy wheel will print in true letter quality. By definition, everything else short of a typesetter can print in only near letter quality.

Unfortunately, daisy wheels are slow and noisy, and you cannot change character styles and sizes without changing the print wheel. In the age of lasers, why think about daisy wheels? They're good at printing multipart forms, have the best-quality characters of any desktop technology, and are a cost-effective way of printing short memos.

The Right Printer

On the surface, picking the right printer is easy. First, you should consider your needs. What kinds of output do you need most often? Do you require large paper capabilities? Color output? Will you be producing overhead transparencies? Next, examine the technologies to see which seems best and then select a printer that matches your budget. With all the choices available today, there's a printer for every job and budget. All you have to do is find it.

POSTSCRIPT PRINTERS AT A GLANCE

Table 1: *Key features of inexpensive PostScript printers. Don't overlook the silicon: When it comes to PostScript jobs, performance depends more on processing power than on raw engine speed. Prices include all options necessary to run PostScript, including the language cartridge, memory upgrades, and fonts. "Standard memory" is the minimum memory sold in a PostScript configuration. (N/A = not available.)*

	Abaton	Apple	C-Tech Electronics	GCC Technologies	Hewlett-Packard
Printer	LaserScript LX	Personal LaserWriter NT	Ci-4 Laser Printer	BLP II	LaserJet IIIP
List price	$1995	$2599	$2155	$1999	$2495
Engine					
Manufacturer	TEC	Canon	TEC	Okielectric 400	Canon
Speed (pages per minute)	6	4	4	4	4
Resolution (dots per inch)	300	300	300	300	300
Life	300,000 prints	150,000 prints	150,000 prints	5 years or 180,000 prints	150,000 prints
Duty cycle (prints per month)	3000	Unlimited	2500	3000	2500
Memory					
Standard	2.5 MB	2 MB	2.5 MB	2 MB	2 MB
Maximum	4.5 MB	8 MB	2.5 MB	4 MB	5 MB
Processor	25-MHz National Semiconductor	12.5-MHz 68000	10-MHz 68000	16.67-MHz 68000	16-MHz 68000
Paper handling					
Standard paper tray capacity	150 sheets	250 sheets	100 sheets	200 sheets	70 sheets
Optional paper tray capacity	None	None	300 sheets	None	250 sheets
Paper sizes supported	Letter, legal, A4, B5, env., labels, transp.	Letter, legal, exec., A4, B5, env., labels, transp.	Letter, legal, exec., A4, B5, env., labels, transp.	Letter, legal, exec., A4, B5, env., labels, transp.	Legal, letter, exec., A4, B5, env., labels, transp.
PostScript					
Number of fonts	35	37	35	35	35
True Adobe?	No	Yes	No	Yes	Yes
Physical characteristics					
Dimensions in inches (D, W, H)	15.4 x 16.1 x 8.3	17 x 15 x 9.5	15.9 x 14.3 x 7.7	17.7 x 17.7 x 5.24	16 x 14 x 8.25
Weight (lbs.)	35.3	32	28.7	24.2	22
Emulations	PostScript, LaserJet II	PostScript, Diablo 630, HP LaserJet Plus	PostScript, LaserJet IIP	PostScript, Diablo 630	PostScript, LaserJet II, HPGL/2, Epson FX, IBM Proprinter
Interfaces (P=Centronics parallel)	P, 2 RS-232, AT	AT, RS-232	P, RS-232, RS-422A	AT, P, RS-232, RS-422A, SCSI	P, RS-232, AppleTalk
Warranty (years)	1 (90 days on-site)	1	1	1	1
Options	HP cartridge support	None	None	Interfaces, HP emulation	Type Director, RS-422 interface

New Life from an Old Printer

That printer you bought a couple of years ago was state-of-the-art. Now you need to have PostScript, or better performance, or blacker blacks. There may be hope for that old dinosaur.

A number of manufacturers sell PostScript and processor upgrades for Hewlett-Packard's LaserJet family and other printers. Some products, such as Adobe's and Pacific Data's PostScript interpreters, slip into the printer's font-cartridge slot. Others use a video interface in the printer's optional I/O port and a speedy board-based RISC processor in your computer. Pyramid Computer's Mustang accelerator for the HP Series II and III uses a 32-bit National Semiconductor processor and the PhoenixPage PostScript clone to add PostScript to your HP.

If you have a Canon LBP printer, Canon recently announced PostScript interpreter cartridges for some of its models. Metro Software's LaserTwin In A Cartridge can add HP's Printer Control Language to your Canon LBP-8 and LBP-4 printers, making them work like an HP Series II, IIP, III, or IIIP.

Maybe you have PostScript but your printer doesn't have an AppleTalk port. Extended Systems' BridgePort can take care of that. It has LocalTalk, RS-232, and parallel inputs for your computers, and RS-232 and parallel outputs for the printer. You connect your printer or typesetter to the output, and your computers to the inputs. You can feed data through one parallel port, one serial port, and any number of Macs at once. BridgePort takes care of switching among the ports and handles the LocalTalk printer protocol.

There are several other instances of add-on products that can give your old equipment new functionality, but we'll leave you with just one last one. Questar Technologies offers the Starburst Print Controller, a stand-alone PostScript interpreter that takes input from parallel, serial, and optional LocalTalk ports, images in black and white or color, and outputs the image to almost any printer you can name (including color laser copiers). Different models provide different levels of performance for under $3000.

POSTSCRIPT PRINTERS AT A GLANCE

IBM	NEC Technologies	Star Micronics	Texas Instruments
LaserPrinter E	Silentwriter2 Model 90	LaserPrinter 4 StarScript	microLaser PS17/PS35
$2443	$2495	$1995	$1399/$1749
IBM 5 300 N/A 12,000	Minolta 6 300 180,000 prints 6000	Canon 4 300 5 years or 150,000 prints 2500	Sharp 6 300 180,000 prints 10,000
1.5 MB 4 MB	2 MB 4 MB	2 MB 5 MB	1.5 MB 4.5 MB
N/A	16.67-MHz 68000	10-MHz 960 RISC	12.5-MHz 68000
200 sheets 500 sheets Legal, letter, exec., A4, B5, env., labels, transp.	250 sheets None Legal, letter, exec., env., labels, transp.	50 sheets 250 sheets Legal, letter, exec., A4, B5, env., labels, transp.	250 sheets 250 sheets Letter, legal, exec., A4, B5, env., labels, transp.
17 Yes	35 Yes	35 No	17/35 Yes
20.5 x 14.2 x 10.2 33.6	13.6 x 18 x 8.1 44	15.2 x 16.4 x 7.3 24.5	14.2 x 13.4 x 10.9 33.5
PostScript, LaserJet II, HPGL	PostScript, LaserJet II	PostScript, LaserJet II, Epson FX	PostScript, LaserJet II
P, RS-232	AT, P, RS-232	P, RS-232, AppleTalk	P
1	1	[redacted]	1
Automatic envelope feeder, font cards, upgrade to 10-ppm engine	Face-up tray	IBM Proprinter emulation	Appletalk, RS-232, RS-422, Diablo 630 emulation, Epson FX emulation, fonts on microcartridges

includes data compression, and handles memory and resources more efficiently.

Today, PostScript continues to be the predominant page-description language for graphics applications. Nearly every printer and image-setter vendor offers a PostScript-compatible device. However, this compatibility is no longer the exclusive province of Adobe. PostScript's success has spawned a predictable by-product: a healthy market for clones. The waters were further muddied when Microsoft announced its own PostScript clone, TrueImage. Although we tested no TrueImage products, one of the printers uses the popular Bauer clone. The Bauer clone was recently purchased by Microsoft, so it may end up being integrated with TrueImage. We'll see.

In any case, our group of printers includes three models with non-Adobe interpreters: the Abaton LaserScript LX with the Microsoft/Bauer clone, the C-Tech Ci-4 with the Pagestyler clone from Destiny Technologies, and the Star Micronics StarScript with its own proprietary interpreter.

Our modified Genoa Technology test suite checked out the clones for PostScript compatibility (see the text box "The Race Is On" on page 206). We did uncover some problems with the StarScript implementation, specifically a test page that would not print. But in general, the clones seemed to do the job. You may miss the true Adobe fonts (most of the clones use Bitstream fonts), although we could only detect differences in the smaller point sizes. Clearly, you can save a lot of money by going with a PostScript clone, but you'll sacrifice the security of going with the original.

Little Engines That Could

The main impetus behind the personal page-printer revolution was the 4-page-per-minute L6BP-LX Canon engine. It's a smaller, slower, and less-expensive engine than the one in the 8-ppm LaserJet Series II. Other engine manufacturers soon followed suit, offering slower versions of established models.

The Canon engine (housed within the LaserWriter NT, the LaserJet IIIP, and the StarScript) generates fine output. In fact, the output is noticeably crisper than that from the original 8-ppm Series II engine. The engine is also easy to maintain. The toner and the drum share a single cartridge that slides easily into the printer. When the toner runs out, you just replace the entire cartridge, drum and all. This may seem inefficient, but the availability of the cartridges keeps the price reasonable. The environmentally conscious can refill old cartridges or simply sell the cartridge to a remanufacturer. (For more on laser-printer toner, see the text box "Laser Printing to Dye For" on page 208.)

When printing long text jobs, you'll appreciate the faster speed of IBM's 5-ppm engine. You'll also like the output quality. The IBM engine also uses an integrated toner and drum; however, prices may run a little higher for the cartridges because they can be used only in an IBM printer. You will also have a harder time selling a used cartridge, since many remanufacturers deal exclusively with HP cartridges.

We were especially pleased with the quality of the Minolta engine's output. The Silentwriter2 Model 90 generated the best blacks of the bunch. As with the Canon and IBM engines, the Minolta model uses an integrated toner-and-drum cartridge.

Two of the vendors (Abaton and C-Tech) chose the Tokyo Electronics Corp. engine. Maintenance is not quite as convenient with this engine as it is with models that have an integrated toner/drum cartridge. The TEC's consumables are all stored in a basket that lifts out of the printer. You replace only the toner when it runs out. Regardless of how you feel about the refilling issue, separate toner is a more efficient way to go. You replace only the parts that need replacing. Makes sense. When it comes to ease of use, though, you can't beat the single-cartridge approach.

However, we were not particularly impressed by the quality of output from either of the printers with TEC engines. Coincidentally, both printers also employ PostScript clones, so we weren't sure if the engine was to blame. In any case, it's a tough one to call: All the tested printers generated acceptable laser output.

The Okielectric 400 engine in the GCC BLP II is the only one that does not use lasers to create its image. It uses LEDs instead and produces very nice output. The separate toner comes packaged in a metallic cylinder. To replace the toner, you pop the cylinder into the engine and rotate it a half turn to release the powder into the toner well. The cylinder remains in place.

The Texas Instruments microLaser is

The Race Is On

For PostScript printers, it's not enough to be fast—they have to be accurate, as well. The performance tests that we did on these printers were made of sample pages from the industry-standard Genoa Technology test suite. The standard test suite is over 700 pages from 60 popular Mac and PC applications and ensures a good level of PostScript compatibility. If a printer can successfully make its way through the tests, it will be compatible for many business applications.

Our first test, the first-page index, suggests how well a printer can print short memos or business letters. We used Lotus's Ami Pro to generate a single-page business letter. The measured time includes both processing the PostScript code and waiting for the printer to drop the paper into the output tray.

Next, we took 50 pages from the Genoa test suite and split them into three groups by product category. The times in these three categories suggest the level of performance you might expect if you use the printer for these types of applications.

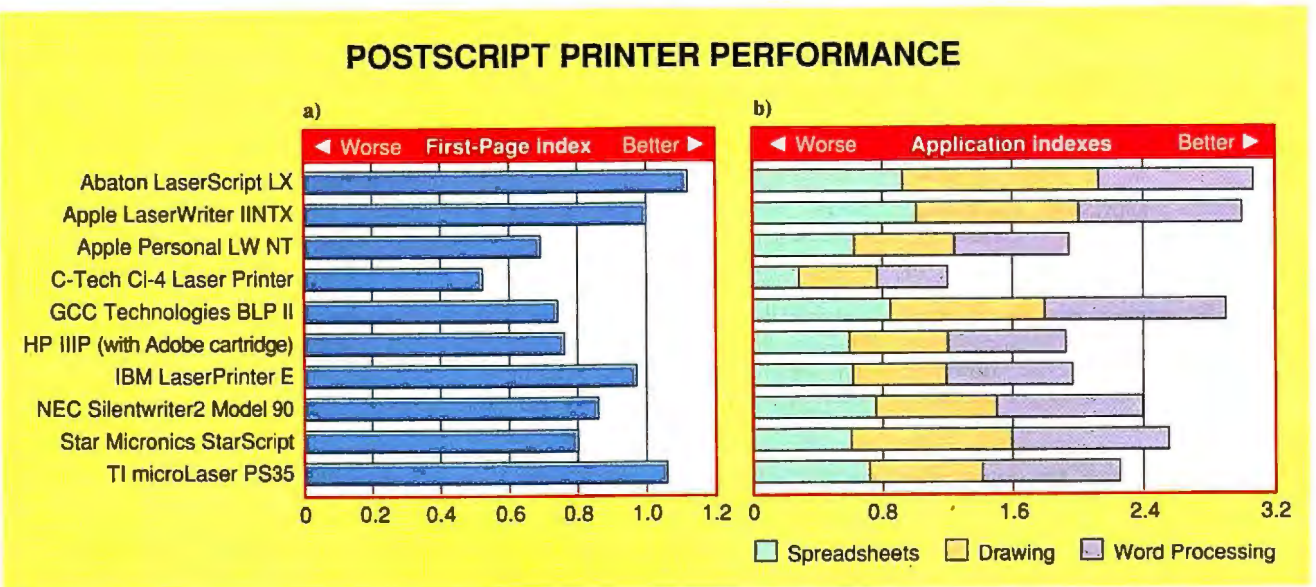
The spreadsheet group included pages from different versions of Lotus 1-2-3 and Microsoft Excel. The spreadsheet images have a lot of heavily formatted text and several three-dimensional graphs.

The drawing group included AutoCAD, PageMaker, Ventura Publisher, and several illustration packages. The CAD images contain thousands of tiny lines and shapes, while the desktop publishing and illustration pages focus on larger areas, intricate shapes, and complicated fill patterns.

The last group, word processing, focuses on pages of text with several font changes. Printers that have trouble rendering complicated curves will usually do better in this area of the test.

Finally, Genoa provided us with specific test pages to exercise the PostScript operators that weren't tested by the application pages. PostScript is a complex language, and most applications don't use very much of the language. Genoa's compatibility pages made sure that we didn't miss any of the less common operators. You won't find these pages in the performance graph, because the emphasis here is on complete PostScript compatibility, not performance.

The resulting graphs are indexed to the Apple LaserWriter IINTX. This $5000 high-end printer is an 8-page-per-minute screamer. We chose it as the baseline to show how far the market has come. The inexpensive printers we tested stand up very well against it.



From click to klunk: **(a)** *The first-page index tracks printer performance on a single text page. We started timing when the printer first received PostScript commands and stopped timing when the page fell into the output tray. Expect this type of performance for memos and simple business correspondence.*

(b) *The application index rates performance for a typical set of PostScript print jobs. Expect this type of performance on more complex PostScript applications. All results are indexed to the Apple LaserWriter IINTX. Longer bars indicate better performance.*

the lone printer with the 6-ppm Sharp engine. We like the TI's output, but setting up the toner and drum was a little tricky. Again, you give up convenience for efficiency. The Sharp engines seem a bit smaller than the others, resulting in the TI's compact footprint.

Pump Up the Processor

A fast engine is nice, but when you're up against complex graphical elements so typical of PostScript jobs, nothing beats a powerful processor. Our test results certainly bear that out (see the figure). The Abaton LaserScript LX, which is powered by a 25-MHz processor and a floating-point accelerator, outperformed every other printer we tested. Another performance winner, the GCC BLP II, sports a 68000 processor running at over 16 MHz. Other speedsters were the StarScript (boosted by an Intel 960 RISC

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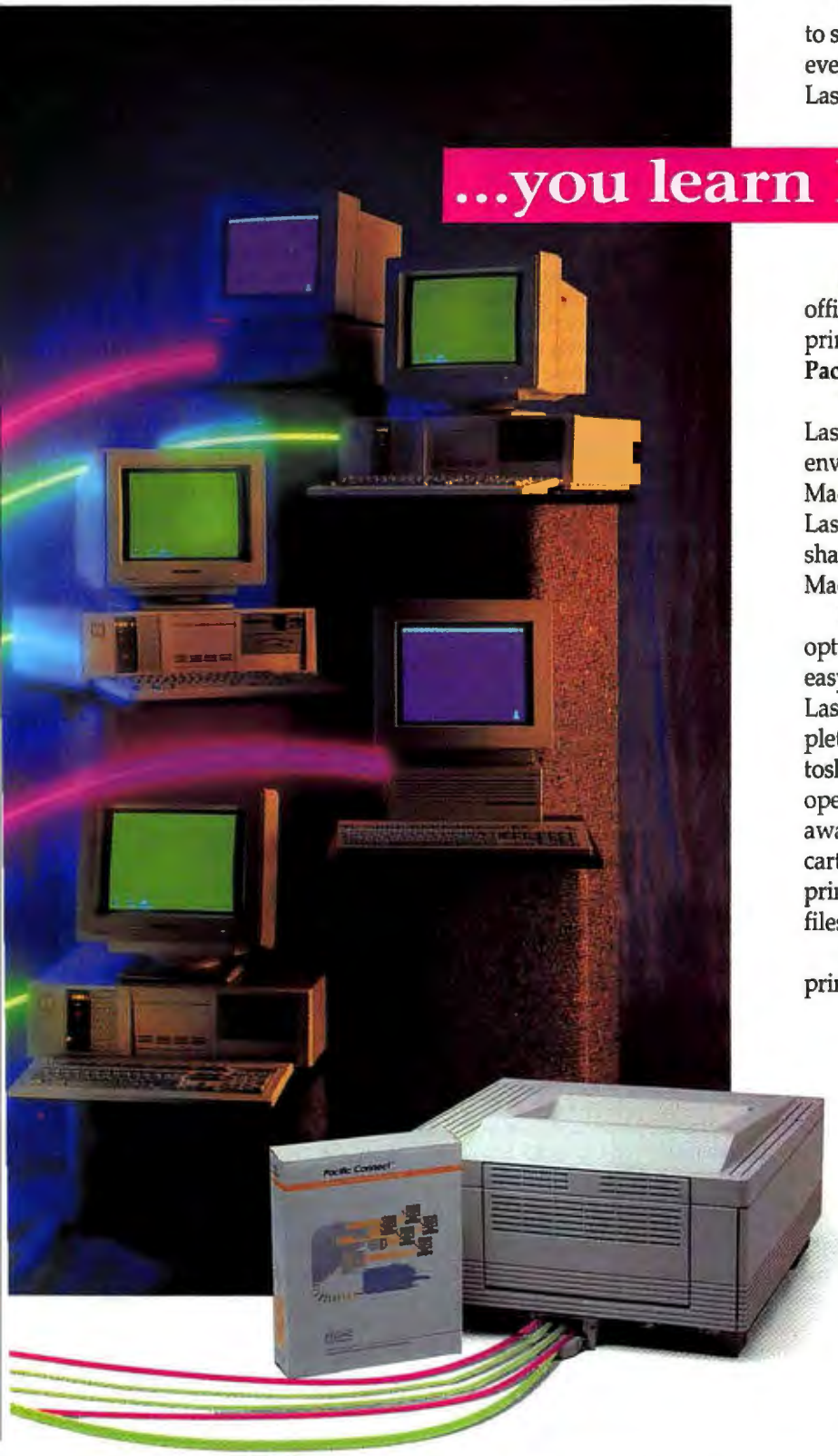

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PACIFIC DATA PRODUCTS

Choosing a PostScript Printer

According to BYTE's latest reader survey, you still choose purchase price as the top criterion for selecting a printer. That's understandable, but in the low-end PostScript category, this is a hard criterion to apply. All these printers are tightly grouped within a narrow price range. It's up to you to look around for the best prices. There are some excellent mail-order deals out there. Decide on a set of printers that meet several of your criteria—you should be able to find three or four—and you'll then have some flexibility as you search for the best buys.

Don't forget to figure operating costs into the equation. Our survey placed that criterion fourth in importance, but it should probably be considered along with the purchase price. Printers with Canon engines accept standard Hewlett-Packard toner cartridges. You can find them anywhere. If you choose a less popular engine, make sure the consumables are within your budget and readily available, preferably from multiple sources. Try not to get locked into products from a single vendor.

Our readers' second most popular criterion is resolution. All the printers tested in this review produce 300-dot-per-inch output. Even so, print quality varies. It can depend on the type of output you will be producing. Try to inspect a range of print samples: gray-scale images, varied fonts, solid blacks, different shaded gradients, and so forth. You shouldn't rely on a single sample.

Three-quarters of our respondents listed print speed as a major criterion. When it comes to performance, you needn't worry too much about the rated engine speed. PostScript code demands significant processing punch. The best performers in our group had the fastest processors. That's what you should concentrate on when you're evaluating performance. In the end, the engine speed will not make that much difference except for long text jobs. Look for at least a 12-MHz 68000, and don't underestimate the performance boost from a 16-MHz version. You will appreciate all the processing muscle you can get.

Always keep your future expansion needs in mind. This includes optional high-capacity paper trays or dual-bin feeders, maximum RAM limits, support for various emulations and platforms, and font upgrades.

Laser Printing to Dye For

Your laser printer is good for more than just printing black-and-white text on paper. Imagine printing your company's promotional materials for trade shows, coffee mugs, or trophies for the company picnic. Furniture designers can print their own custom fabrics. Black Lightning, a toner cartridge remanufacturer, has figured out how.

Laser toner consists basically of plastic and metal particles combined into little blobs that printers melt onto paper surfaces using the fuser roller. The overall toner composition is designed for particular print engines, and the choice of materials determines its color. The most popular printer engine in 4- to 8-page-per-minute desktop printers is the Canon engine, and the most popular toner color is black. Unfortunately, however, printing on paper is as far as standard toner can take you.

Black Lightning's primary business is remanufacturing toner cartridges. The process involves taking apart each cartridge, cleaning it, and reassembling it with fresh toner. The company makes its own toner and has become adept at making custom toners. One new trick is sublimation-transfer toner. When making the toner, Black Lightning adds a colored dye to the mix. When printed on paper, this toner looks black, but when you reheat it, the colored dye transfers to another surface. Black Lightning sells the toner in many stock and custom colors in remanufactured Canon EP and EP-S cartridges for the original LaserWriter, LaserJet, LaserWriter II, LaserJet Series II, and compatible printers.

To use it, you simply insert the cartridge and print on the laser printer as you usually do—except that you flip the image horizontally so it looks as though you were reading it in a mirror. For multiple color work, you change the cartridge and print the same sheet again. When you are ready to transfer the image, you place it, toner side down, on the material and heat-press it gently into the surface. The embedded dye particles transfer to the material, leaving the black toner behind.

We tested several transfer cartridges using an Apple LaserWriter IINT and a Mac. Without special equipment, the easiest material to transfer on is fabric. By using just the printed output and a household iron, we created a display banner suitable for a trade show booth. Naturally, we tried making BYTE Lab T-shirts and, using our environmental chamber for heating, tried our hand at transferring our design to metal. The metal transfer didn't work because we hadn't prepared the surface properly.

Color cartridges start at $80 per color. It's a fascinating process, and printing your own short-run promotional materials could save your company money. Besides, it's fun.

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Programmable sharing units for both serial/parallel printers, plotters and PCs. Designed for CAD/CAE, high-level graphics, Desktop publishing or general applications.

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- 8 concurrent serial inputs (C)
- 1 serial and 1 parallel output
- Expandable buffer memory from 256 KB to 2 MB
- Separate baud rate, flow control, parity and messages for each port
- Pop-up menu software for easy printer/plotter selection
- Easy menu-driven configuration and set-up
- Prompt and response messages for plotter applications
- Support all laser printers including PostScript® printers and all types of plotters.

8 inputs; 2 outputs; buffered from 256 KB to 2 MB ..... start at $595

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Printer Server; buffered from 256 KB to 4 MB ..... start at $295
Expansion Module with Printer Select Switch ..... $149 ea.

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- 6 RS-232 serial inputs - RJ-11 connectors
- 2 user-selectable laser/dot-matrix printer ports
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processor) and the NEC Silentwriter2 (also with a 68000). The RISC processor is a coming force in inexpensive PostScript printers. It brings the promise of faster printers at a lower cost.

The BYTE Lab's first-page test favors the faster engines. The LaserScript LX lapped the field, aided not only by its screaming processor but also by its 6-ppm TEC engine. You can attribute the poor performance of the Ci-4 and its TEC engine to a slow (10-MHz) 68000. The 5-ppm LaserPrinter E and the 6-ppm microLaser PS35 and Silentwriter followed close behind the LaserScript LX. A print job with numerous pages of text will further highlight the advantages of a fast engine, but if your main applications are textual, you should consider an inexpensive PCL printer. PostScript might be overkill.

Bells and Whistles

A few of the printers stand out from the pack with special features. Following the QMS innovation, the LaserScript LX automatically switches emulation modes and ports. You can hook up to all four of its ports (two serial, one parallel, and one AppleTalk) and send jobs to the printer simultaneously. Not only will it accept input from all four ports and keep track of the jobs, it will automatically change modes to accommodate PCL and PostScript documents. It almost makes the control panel unnecessary.

The LaserPrinter E also includes automatic emulation and port sensing, but its implementation is software-based. This approach isn't as slick, but it does the job. The Silentwriter can automatically switch between the parallel and serial ports, but you have to reconfigure it when mixing PCL and PostScript jobs.

If you anticipate a heavier workload for your printer sometime in the future, IBM has some nice options. You can purchase a 500-sheet paper tray that attaches to the bottom of the printer, or you can even upgrade to the IBM 10-ppm engine for $1099.

Pay attention to paper handling. The StarScript has a fold-down tray that will accept only 50 sheets at a time. You'll probably want to add a standard HP 250-sheet paper tray. The IIIP's standard tray holds 70 sheets, but you'll still find yourself wanting the extra 250-sheet tray that delivers dual-bin capability. The Ci-4 also has a fold-down tray, but it will hold up to 100 sheets. We prefer a dedicated paper cartridge. Cartridges that slide into the printer are easier to load and handle. Most cartridges also include a slot on top for manual paperfeed and envelopes. Paper trays that tuck away under the printer (such as the ones found on the microLaser and the LaserPrinter E) save some space, but they lack the manual-feed feature. IBM charges extra for an envelope feeder. With all the printers, you can choose to route output along a straight paper path. You'll need that capability for printing envelopes.

Most of the printers offer some kind of support for additional fonts. Predictably, the IIIP has a single font cartridge to accommodate all HP-compatible font cartridges. The StarScript also comes standard with a single HP-compatible font-cartridge slot, while the LaserScript requires an upgrade before it can accept standard HP font cartridges. IBM and GCC offer additional fonts on credit-card-size font cards. NEC sells a selection of soft fonts, and TI packages its font upgrades on small "microcartridges."

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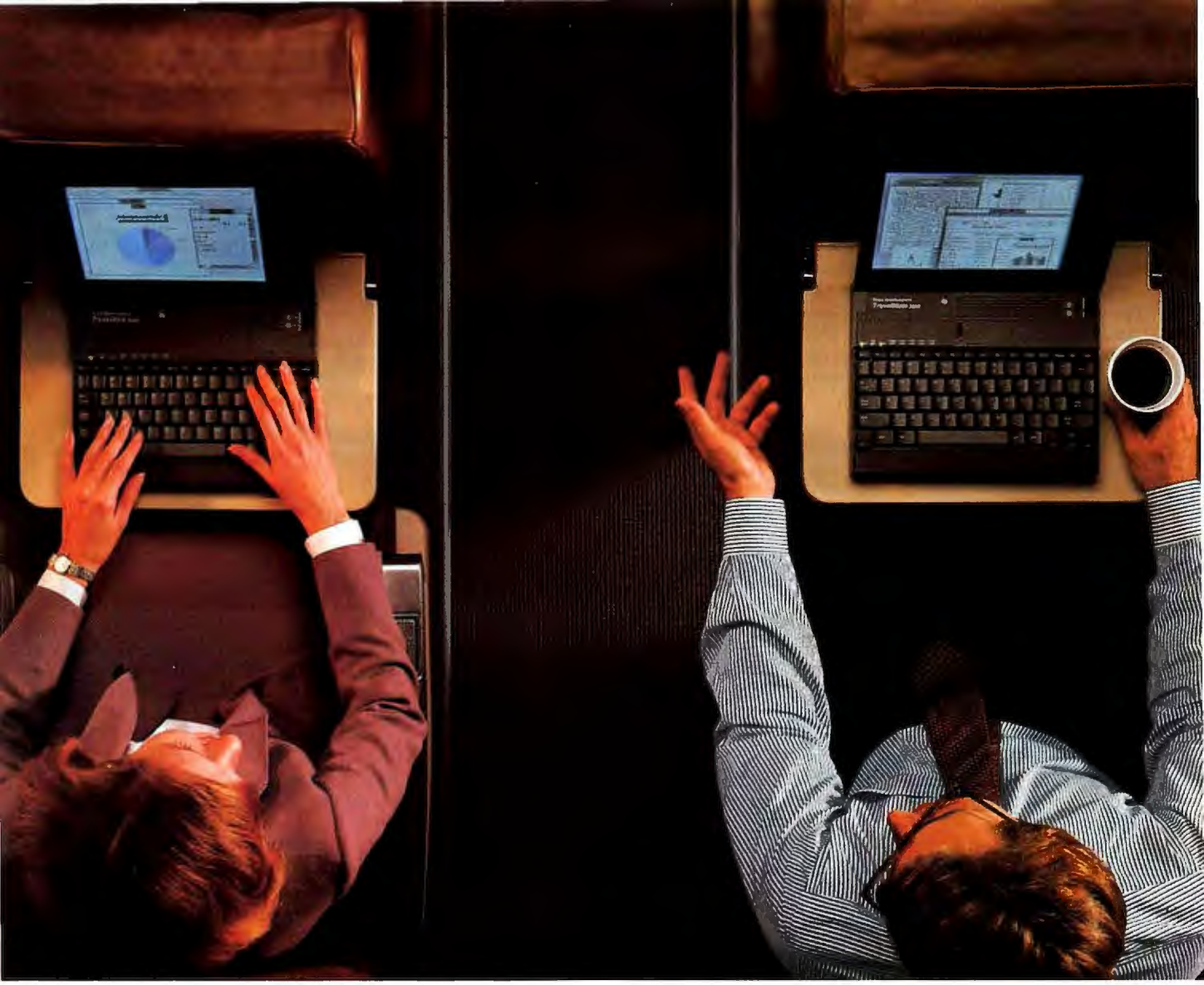

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The Good, the Bad, and the Adobe

Although we didn't encounter any serious compatibility problems with any of the printers, we hesitate to recommend the Adobe clones. One was slow, one produced questionable output, and one was a bit quirky. We felt more comfortable working with the true Adobe printers. You'll pay a little more for the security of owning the real thing, though.

Having said that, we still have to recognize the strong showing of the Abaton LaserScript LX. You won't find a faster printer in this price range, and it's full of impressive features, including automatic emulation and port switching. The 2.5-MB model sells for only $1995. However, we have to pass because of its low-quality gray scales. If you have no need for printing scanned images, the Abaton will get you home from work earlier.

There are some other very attractive printers in the bunch. We really loved the output of the NEC Silentwriter2 Model 90, for instance, although its price is just below our ceiling ($2495). With this model, you'll get convenience, fast processing, high-quality prints, and excellent paper handling.

The IBM LaserPrinter E offers good performance, fine output, and lots of upgrade options. The $2443 price listed in table 1 represents a bare minimum for PostScript. The printer has only 1.5 MB of RAM and 17 outline fonts. IBM bundles the PostScript option and the font card for $899, bringing the LaserPrinter E's price (with PostScript, 39 fonts, and 1.5 MB of RAM) to $2843. This is a nice printer, but you can probably find a better deal out there.

Four favorites. *Out of an impressive bunch of inexpensive PostScript printers, we like these four best: the IBM LaserPrinter E (left), the GCC Technologies BLP II (rear), the NEC Silentwriter2 Model 90 (front), and the Texas Instruments microLaser PS35 (right).*

Take the GCC BLP II, for instance. It delivers the full complement of 35 Adobe fonts, 2 MB of RAM, and a 16.67-MHz processor for $1999. The BLP II looks like a real bargain to us.

TI offers the best deal of all. The microLaser PS17 ships with 17 fonts and 1.5 MB of RAM, and it has a price tag of $1399, over $1000 less than a similarly configured LaserPrinter E. The microLaser PS35 (35 fonts, 1.5 MB) sells for only $1749. The company just announced these new price cuts at press time. Such aggressive pricing may force other vendors to cut prices as well.

Research mail-order sources or haggle with your dealer. We think four of these printers are can't-miss buys: the GCC BLP II, the IBM LaserPrinter E, the NEC Silentwriter2 Model 90, and the TI microLaser PS35 (see the photo). Look for the best deal among these four. Prices being equal (or close enough to shrug off), go with the Silentwriter2. The reason is simply black-on-white. ■

Stanford Diehl and Howard Eglowstein are testing editors for the BYTE Lab. They can be reached on BIX as "sdiehl" and "heglowstein," respectively.

COMPANY INFORMATION

Abaton
(LaserScript LX)
48431 Milmont Dr.
Fremont, CA 94538
(415) 683-2226
fax: (415) 683-2151
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Apple Computer, Inc.
(LaserWriter IINTX, Personal LaserWriter NT)
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Cupertino, CA 95014
(408) 996-1010
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Black Lightning
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C-Tech Electronics, Inc.
(Ci-4 Laser Printer)
2515 McCabe Way
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GCC Technologies, Inc.
(BLP II)
580 Winter St.
Waltham, MA 02154
(800) 422-7777
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Hewlett-Packard Co.
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IBM/Lexmark
(LaserPrinter E)
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(606) 232-7514
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NEC Technologies, Inc.
(Silentwriter2 Model 90)
1414 Massachusetts Ave.
Boxborough, MA 01719
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Star Micronics America, Inc.
(LaserPrinter 4 StarScript)
420 Lexington Ave.,
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HARDWARE

Modems That Squeeze the Most out of V.32

STEVE APIKI

Blasting 9600 bits of data per second over thousands of miles of wire demands about all a standard phone line can give. By employing sophisticated echo-canceling circuits to deliver full-duplex, 9600-bps transmission over dial-up lines, V.32 modems make the most of available bandwidth. Recently, these modems' prices have dipped below $1000—good news for speed-hungry customers who need high data throughput for sending and receiving images, for asynchronous network bridges, or for other high-volume applications.

Nevertheless, some people may find that 9600 bps is still not enough. So V.32 modem vendors include data compression to increase the effective throughput without requiring higher transmission speeds. V.42bis, which is CCITT's recommended data-compression method, boasts compression ratios of up to 4-to-1; that's 38,400 bps over a 9600-bps connection. Communication is also guaranteed to be error free, since data-compression technology must ride on top of error-correction protocols.

The world's fastest modem won't do you any good if the people you need to talk to don't have modems with similar capability. V.32 and V.42bis are both widely accepted international standards, and the number of modem manufacturers that support them is growing rapidly.

Each of the 12 modems I reviewed includes V.32/V.42bis capabilities and sells for less than $800. Although I tested compatibility and performance, I found the greatest difference between them is simply a matter of price.

High Standards

Without standards, modems from different vendors can't communicate with each other. CCITT, an international legislative body that governs modem communication, has made recommendations that cover modulation, error correction, and data compression. Each modem tested claims conformance to a broad spectrum of CCITT recommendations, as well as support for the de facto MNP standards. The table lists these compatibility claims and other features.

V.32 is a CCITT standard for 9600-bps transmission. Like modulation standards for 2400-bps modems, V.32 increases throughput by encoding several bits of information in each symbol, using a technique called Quadrature Amplitude Modulation. Each modem in this review also provides Trellis Coded Modulation, a modulation method more error resistant than QAM.

Besides the V.32 standard, Zoom Telephonics' Zoom/Modem V.32 Turbo also supports a 12,000-bps "turbo" mode for communicating with other Zoom modems. Zoom claims that turbo mode is compatible with the first fallback speed of V.32bis, which is the newest CCITT modulation standard. V.32bis covers 14,400-, 12,000-, and 7200-bps transmission rates. Several manufacturers (including some in this review) have begun offering V.32bis modems, but the number of V.32bis modems in the field is currently small.

All these modems will also negotiate communications with older, slower modems, using other CCITT standards and Bell standards. The CCITT and Bell standards listed in the table represent 300-, 1200-, and 2400-bps modem communication rates.

The CCITT V.42bis recommendation describes a scheme of data-compression that is based on the Lempel-Ziv algorithm. V.42bis compresses data by encoding frequently occurring strings with a single symbol. The algorithm automatically updates its lookup tables based on incoming data. Naturally, the amount of compression that you can get from this scheme varies with data type. Although most modem manufacturers claim 4-to-1 compression ratios using V.42bis, you can generally expect less if you transmit executable or other encoded binary files.

No modem-compression method will significantly decrease compression time for precompressed files (e.g., PKZip or Stuffit files). In fact, the V.42bis compressor switches compression completely off if it detects transmitted data that is not effectively compressible. To main-

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BYTE ACTION SUMMARY

- **9600-BPS V.42BIS MODEMS**
- **WHAT THEY DO**
  Provide high data throughput for sending and receiving images, asynchronous network bridges, and other high-volume communications applications.
- **LIKES**
  The reviewed modems couple 9600-bps operation with standard data-compression schemes to deliver effective throughput of up to 38,400 bps for under $800.
- **DISLIKES**
  Few on-line services and BBSes support V.42bis compression. Also, compression efficiency varies with data type, and V.42bis won't speed up transmission of precompressed files.
- **RECOMMENDATIONS**
  Given similar levels of performance and compatibility, make your decision primarily on price. The Zoom/Modem V.32 Turbo and the ATI 9600ETC-E are as effective as the other modems we reviewed and are considerably less expensive.

tain compatibility with installed modems that support the MNP protocols, each modem I reviewed supports MNP level 5 data compression—a statistical compression method that typically delivers a 2-to-1 compression ratio—so V.42bis is preferred wherever it's supported.

Although it's less flashy than data-compression hardware, the error-correction capability of these modems is arguably their best feature. Each modem supports both MNP and V.42 (LAP-M) error-correction protocols. Error-correction protocols detect transmission errors and request retransmission of errant data; the receiving computer or terminal never sees a single blip. MNP and V.42 error correction provide the reliable link required for MNP level 5 and V.42bis data compression.

Hands On

I tested each modem for compatibility and performance. The figure shows test results of throughput measurements under various conditions.

Data-compressing modems work best when the computer-to-modem speed is set higher than the actual modem-to-modem speed. In this arrangement, the computer fires out data several times faster than the line speed to make sure the modem buffers never empty. The modem compresses the data in its buffer and sends it down the line as quickly as possible. If its buffers are nearly full, it sends a flow-control signal to the computer to stop transmission until the modem has a chance to catch up.

For each measurement, I connected the modem being tested to a 386SX/16 system that was running Procomm Plus 2.0. I used Procomm Plus to establish a 38,400-bps link between the computer and the modem and configured both Procomm and the test modem to communicate using hardware flow control.

I used AEA Electronic's Autotest line simulator to simulate phone connections between two modems. The Autotest unit allowed me to simulate various impairment combinations, modeling the effect of phone lines of varying quality.

My first set of tests measured compatibility. I connected a test modem to one end of the simulator; to the other end, I attached a Hayes Ultra V-Series modem. I configured the line simulator to emulate a typical U.S. phone connection.

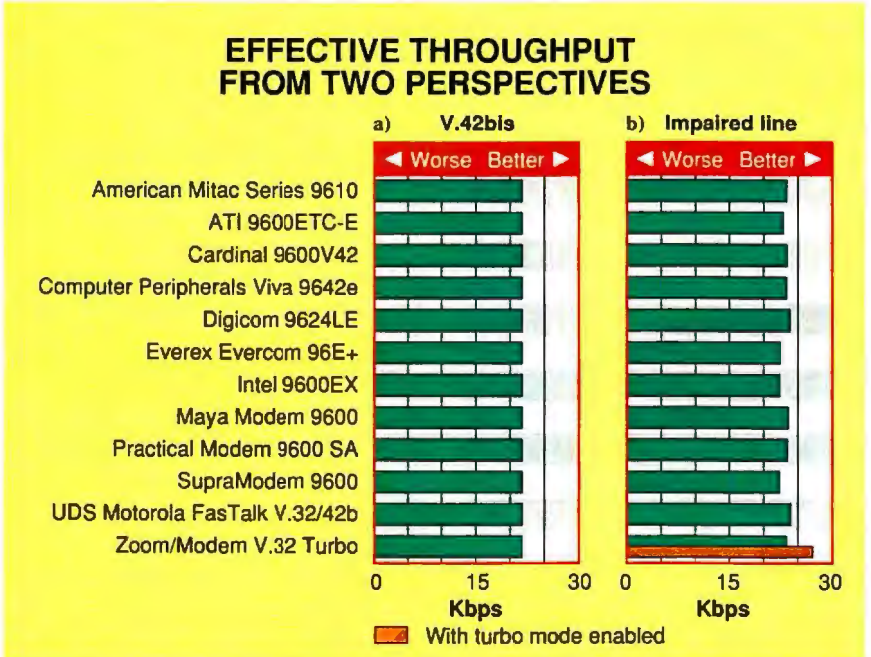
Part a of the figure shows the effective throughput between the test modem and the Hayes Ultra using V.42bis compression. The modems all showed similar results; each one averaged about 22,000-bps effective throughput in sending the BYTE Lab's ASCII text document using

MODEM MATCHUPS

Although each modem presents a different selection of perks—like callback security, communications software, and additional configuration storage, other categories reveal little differentiation (●=yes; ○=no).

Modem	Price	Bundled software	Serial cable	Synchronous operation	Leased-line support	Remote configuration	Callback security	Telephone number storage	Configuration storage*	Warranty (years)
American Mitac Series 9610	$695	○	○	●	2-/4-wire	●	○	1	1/1	1
ATI 9600ETC-E	$499	○	○	●	2-wire	○	○	3	3/2	2
Cardinal 9600V42	$699	○	○	●	2-wire	○	○	4	1/2	1
Computer Peripherals Viva 9642e	$649	Quick Link II	○	●	2-wire	○	○	4	1/2	5
Digicom 9624LE	$795	○	○	●	2-wire	○	●	10	1/1	2
Everex Evercom 96E+	$699	Procomm	○	●	2-wire	○	○	4	2/2	2
Intel 9600EX	$799	Communications by Crosstalk	○	●	2-wire	○	○	4	1/2	5
Maya Modem 9600	$699	○	Macintosh	●	2-wire	○	●	4	1/2	5
Practical Modem 9600 SA	$899	○	○	○	○	○	○	4	1/2	5
SupraModem 9600	$699.95	○	○	●	2-wire	○	○	4	1/2	5
UDS Motorola FasTalk V.32/42b	$795	○	○	●	2-wire	○	○	4	1/2	1
Zoom/Modem V.32 Turbo	$599	○	○	●	2-wire	○	○	4	1/2	2

* Factory configuration/user configuration.



Effective throughput is measured under various conditions. **(a)** *Each modem performed equally well when connected to a Hayes Ultra V-Series modem using V.42bis compression.* **(b)** *The UDS Motorola FasTalk V.32/42b proved to be slightly faster than the other entries using a V.32 connection over impaired lines. However, the Zoom/Modem V.32 Turbo's turbo (12,000-bps) connection gave it the highest overall throughput when two Zoom/Modems were connected.*

the ZMODEM protocol.

My second test measured throughput using an MNP level 5 connection to the Hayes Ultra modem. Again, each modem offered similar performance—about 18,800 bps on my test document. This is the speed you can expect with older modems that implement MNP level 5 but not V.42bis compression.

I also didn't see much variation when I connected these modems to a V.32 modem that offered neither error detection nor data compression. Initially, Digicom Systems' 9624LE exhibited some problems in completing this test using hardware flow control. Digicom explained that ZMODEM implementations automatically activate flow control to the modem for each received packet. This causes problems when there is no error-control protocol in use, because the receiving modem has no way of stopping control from the remote modem, and its buffers overflow. The other modems used modem pacing, which allowed them to regulate data flow without using error-correction protocols. Later, Digicom's modem successfully completed the test with a firmware update that implemented modem pacing.

My last test measured raw speed over several impaired lines. I connected two of each vendor's modems through my line simulator. Each modem connected over several different lines; the impairments for each line were based on recommendations presented in the Electronics Industry Association's EIA-496A standard for modem testing. Part b of the figure shows the average throughput over these channels. The test lines don't completely stress echo-canceling modems; the EIA committee responsible for these testing recommendations is finalizing a new set of impairment channels that will better test high-speed modems.

None of the modems had any real difficulty with these lines. Moreover, pairing these modems with their identical twins allowed them to attain peak performance, and they performed better than they did when connected to the Hayes control modem. Although UDS Motorola's FasTalk V.32/42b outdid the

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ATI 9600ETC-E

other V.32 modems by a slim margin, transmission speed was about the same for all 12 modems.

I tested the Zoom/Modem V.32 Turbo with and without turbo mode enabled. It performed well throughout the impairment channels and delivered about a 20 percent better performance boost in 12,000-bps turbo mode.

Beyond Speed and Compatibility

While high speed and good compatibility are the most critical factors to consider when choosing a modem, many of these products offer perks that you may find helpful in making a decision.

You can configure and communicate with each of them using the standard Hayes AT command set. Each also supports its own extended AT commands and configurable S-registers for fine-tuning error-correction and compression parameters. American Mitac's Series 9610 also provides V.25bis control.

Computer Peripherals, Everex Systems, and Intel PCED bundle communications software with their modems. Although these packages won't provide full-blown communications à la Crosstalk Mk.4 or Smartcom, they do provide basic functionality and get you up and running very quickly. Maya Computer's Maya Modem 9600 comes bundled with a Macintosh modem cable to help you get your Mac hooked up with few hassles.

If you intend to use one of these modems for a synchronous application (PC applications are asynchronous), any but Practical Peripherals' Practical Modem 9600 SA will fill the bill. Similarly, every modem except the Practical Modem supports operation on a leased line.

V.42bis for Less

With few exceptions, these modems demonstrate similar levels of compatibility, performance, and handling of poor phone lines. Each was uniformly easy to configure for typical PC operation, and except where noted, I had no difficulty getting them to communicate with each other.

Zoom/Modem V.32 Turbo

But at $499 and $599, respectively, ATI's 9600ETC-E and Zoom Telephonics' Zoom/Modem V.32 Turbo clearly provide better value than the others. Both are solidly built and provide documentation as good as or better than that of the other entrants. For an extra $100, the Zoom/Modem provides some V.32bis capability, and its status lights are easier to read and more informative than those of the ATI 9600ETC-E. ■

Steve Apiki is a BYTE technical editor. You can contact him on BIX as "apiki."

COMPANY INFORMATION

American Mitac Corp.
(Series 9610)
410 East Plumeria Dr.
San Jose, CA 95134
(800) 648-2287
(408) 432-1160
fax: (408) 432-0866
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ATI Technologies, Inc.
(9600ETC-E)
3761 Victoria Park Ave.
Scarborough, Ontario, Canada
M1W 3S2
(416) 756-0718
fax: (416) 756-0720
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Cardinal Technologies, Inc.
(9600V42)
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Lancaster, PA 17601
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(717) 293-3000
fax: (717) 293-3055
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Computer Peripherals, Inc.
(Viva 9642e)
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Newbury Park, CA 91320
(800) 854-7600
(805) 499-5751
fax: (805) 498-8306
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Digicom Systems, Inc.
(9624LE)
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Milpitas, CA 95035
(408) 262-1277
fax: (408) 262-1390
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Everex Systems, Inc.
(Abaton subsidiary)
(Evercom 96E+)
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Fremont, CA 94538
(800) 821-0806
(415) 683-2100
fax: (415) 651-0728
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Intel Corp.
(Personal Computer Enhancement Division)
(9600EX)
M/S C03-07
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Hillsboro, OR 97124
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(503) 629-7000
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Maya Computer Co.
(Maya Modem 9600)
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Waitsfield, VT 05673
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(802) 496-6982
fax: (802) 496-8110
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(Practical Modem 9600 SA)
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UDS Motorola
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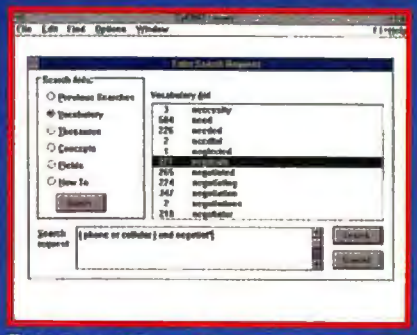

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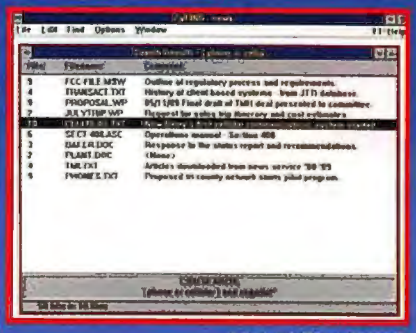

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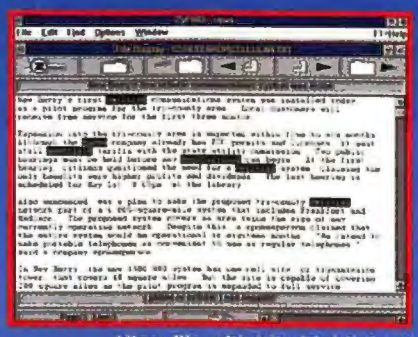

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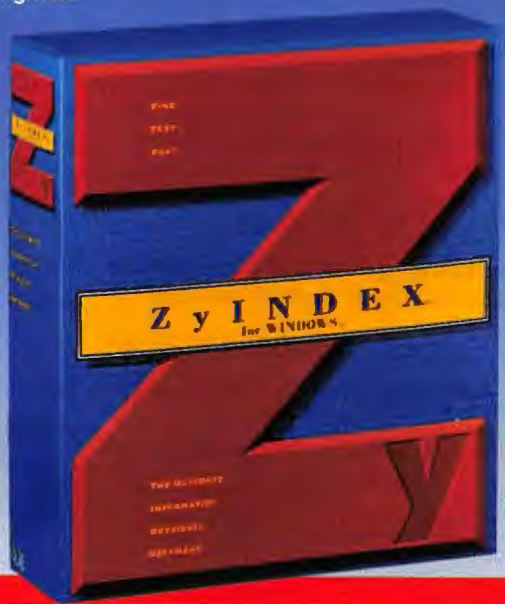

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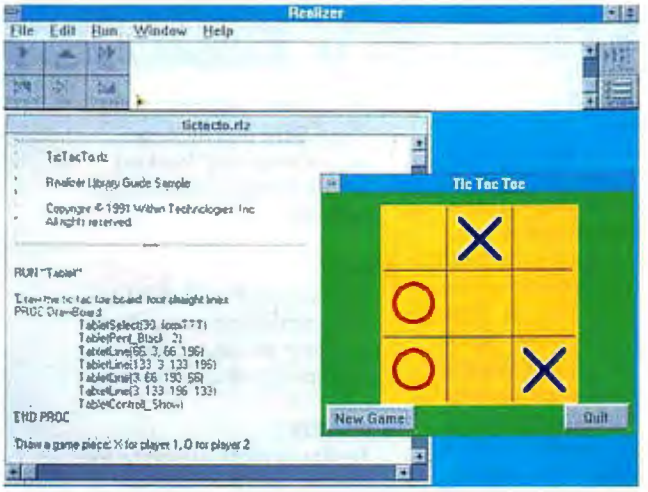
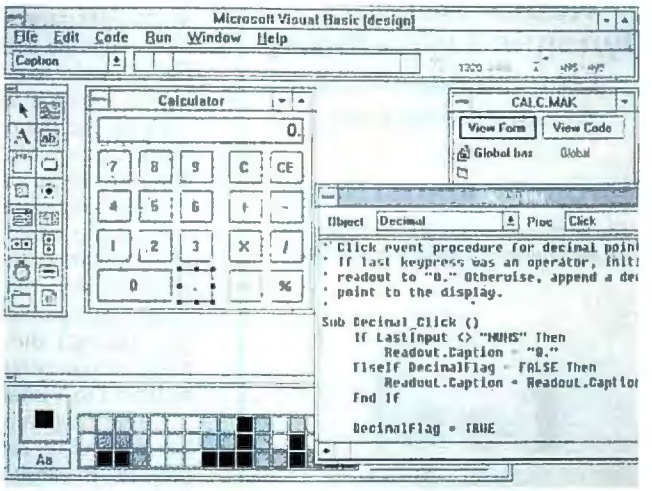


▲ **Screen 1:** *Designing a Visual Basic program (like the calculator shown here) involves creating interface objects and then linking event-driven subprograms to them.*



◀ **Screen 2:** *While Realizer uses a more traditional programming model, it has a richer set of standard functions than Visual Basic.*

Although C is the established standard language for DOS applications development, it isn't always the best choice. It can tie a developer up in endless iterations of edit-compile-test, even for fairly small programs. Dealing with the vagaries of Microsoft Windows on top of that can sometimes be more than a developer can handle in the time he or she has. Thankfully, Windows developers now have two BASIC alternatives to C.

Microsoft's Visual Basic and Within Technologies' Realizer promise truly easy Windows application development. Both companies bill their products as intended for use in creating *real* Windows applications, serious tools for professional programmers rather than experimenting amateurs. Both products also include features not found in traditional languages.

Visual Basic

When you look at the name *Visual Basic*, put the stress on the first word and not the second. The paradigm that Visual Basic applies to programming is one in which all the visible elements of a program are designed first, using graphical tools in a WYSIWYG manner (see screen 1). Code is later attached to these visual items, and sometimes very little code is required to make a working application.

What Visual Basic *isn't* is BASIC, in both senses of the word. First, although the code resembles QuickBasic code, it differs widely in input and output and relies heavily on objects and constructs that are built graphically. Visual Basic is also very complex—not difficult to use, but a complex program that requires you to learn new concepts and build up a fund of knowledge to make the most of Visual Basic's facilities.

When you open a program file, a project window appears showing the code sections and forms (collections of interface objects) that are part of that program (which Visual Basic calls a *project*). Code sections are essentially subroutines attached to events (like key and mouse-button presses) associated with a project's interface objects. A subroutine is called whenever the event associated with it takes place. You might, for example, create a button object labeled "Quit" in your project and attach a code section to it that exits the program when the mouse is clicked over that graphical button. An object can (and usually does) have several code sections associated with it, each responding to a different type of event or group of events.

You build forms visually by selecting interface objects (e.g., buttons, text boxes, list boxes, and other controls) from an iconic toolbox and using the mouse to position and size them within the form window. Other attributes, such as color, can be altered using Visual Basic's color palette or properties bar.

The properties bar lets the programmer access all the properties of an object, both visible and invisible. Some properties deal with how an object looks, others with how it acts when pointed at by the mouse, and others with how it fits in with other controls on the form. You can accept the default properties or select new values by picking from a list of choices.

Programs you create in Visual Basic can run within Visual Basic, where they can be debugged, or they can be turned into Windows .EXE files. These .EXE files are typically small but require a 270-KB run-time dynamic link library to operate on their own. Only the one run-time DLL is required for multiple Visual Basic programs, and the DLL can be freely distributed.

New Windows programmers often find it hard to create the interface for a new program. Visual Basic makes this amazingly easy. I was able to write a simple adding-machine application in slightly over 5 minutes after simply going through the tutorial. As long as your

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application can be contained in one window, interface design is easy. Also, the process of coding is made much simpler by the tight integration between the interface and code sections of the program. For example, to enter the code for clicking on a button in a form, you double-click on the button when designing the form. Up pops the appropriate code window, which you can then modify.

There are several capabilities, particularly at the lower system levels and involving more esoteric ways of interfacing to Windows, that are beyond Visual Basic. This problem will be alleviated in part through the availability of third-party custom controls and DLLs that can be linked to Visual Basic.

Debugging under Visual Basic is easy but gets more complicated with larger projects. Because Visual Basic programs use an event-driven model, it can be a little difficult to trace through a program. Visual Basic gives you the opportunity to single-step through programs or step through one subroutine at a time. However, stepping through a complicated program can involve opening and closing many code windows. And when you step through a program that requires mouse input, you must manually close subroutine code windows when the program is waiting for mouse input—a minor irritation.

One of the best features of Visual Basic is its phenomenal on-line help. It is extensive and includes real-world examples of code for every function and object in Visual Basic. These examples can be cut and pasted into programs to let you experiment with the functions to work out what you want to do. The manuals are also excellent, so you'll have no trouble getting to know Visual Basic.

Overall, Visual Basic does an excellent job of making programming for Windows easier. Its approach is so novel that it will take programmers who are used to a normal procedural style some time to get used to it.

Realizer

Realizer is, superficially, similar to Visual Basic. It, too, is a BASIC for Windows that includes a method for visual programming. But Realizer is, foremost, a version of BASIC that works in the Windows environment and that can create Windows programs. Realizer also comes with an extensive array of standard features. Unlike with Visual Basic, you can write programs simply by typing in code and then running that code. Realizer also includes a graphical program development tool called FormDev.

Realizer has a much more complete set of commands and functions than Visual Basic (see screen 2). It has an impressive set of libraries that cover statistics, communications, matrices and arrays, complex string functions, and others. One of its most impressive features is that one-dimensional arrays of numbers can be operated on en masse, as if they were simple integers. Realizer also uses dynamic allocation so that arrays can be extended in size while in use.

continued

BYTE ACTION SUMMARY

- **WHAT THESE PACKAGES ARE**
  Visual Basic and Realizer are medium-level Windows programming solutions based on BASIC.
- **LIKES**
  The novel approach of Visual Basic and its tight integration; the depth of features and commands built into Realizer.
- **DISLIKES**
  Realizer's slight instability; the need to go to third parties for more power in Visual Basic.
- **RECOMMENDATIONS**
  Both products are recommended: Visual Basic for those starting from scratch or wanting to follow the Windows paradigm, and Realizer for those moving up from other BASICs or who need the built-in power of some of Realizer's functions.
- **PRICE**
  Realizer, $395
  Visual Basic, $199
- **FOR MORE INFORMATION**

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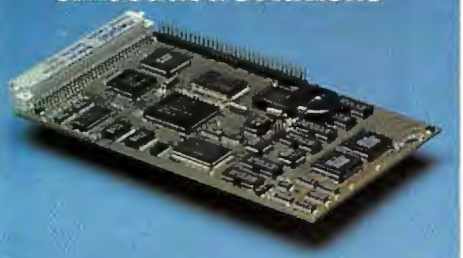

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Realizer also has a larger set of basic interface objects (which it calls Programmable Application Tools) than does Visual Basic. Besides the standard Windows interface objects, Realizer has table and spreadsheet objects. These include the ability to create multiple views of a single set of data. Realizer also can directly read spreadsheet data-file formats, including Excel and Lotus 1-2-3. Another powerful interface object is the chart. This graphing object displays graphs that can be automatically scaled.

Developing an application using Realizer involves using either traditional programming methods or the FormDev visual programming tool as a starting point. Although FormDev can be used to create complete simple applications, it really isn't a sufficiently integrated part of Realizer to use it alone for even mildly complex programs. It does serve very well as a way of designing the interface and making a first stab at coding a program, but you would probably then want to work directly with the code itself to debug and make the program run properly.

Realizer is a very good way to move existing BASIC programs, QuickBasic or otherwise, to the Windows environment. Strangely, it is in many ways more compatible with ordinary BASIC than Visual Basic is. For example, the INPUT statement in Visual Basic is used only to get data from a file. In Realizer, INPUT automatically brings up a data-entry dialog box.

Realizer comes with an excellent set of manuals, except for the FormDev manual, where Within Technologies could have gone into more depth in terms of examples. The on-line help in Realizer is pretty good but does not include examples of the use of each command and function. Where Realizer shines is in the examples that come with the program. These include the code for the FormDev application (which, being a Realizer program, is a testament to this program's power) as well as a wide range of other examples.

Some of the other features of the language include full date and time functions and a scheduler to run programs at specified times. It also has a powerful debugger with single-step and trace functions as well as the ability to display a call tree and to examine and change variables while the program is paused. Realizer supports DLLs and Dynamic Data Exchange, and it can also make direct Windows calls.

In my tests, Realizer was not always reliable. When, for example, I neglected to put in code explicitly to exit an application, I was not only unable to exit the application, I also couldn't exit Realizer or even Windows itself.

Overall, Realizer is a very good implementation of BASIC running in the Windows environment. It has some powerful features not found in any other language in such a simple form. However, it doesn't really lend itself to visual or event-driven programming models and is instead based on the more familiar procedural model. This is a point in its favor for those wanting to move to Windows without altering the kind of programming they do now, but it does not reflect the event-driven realities of the Windows environment.

Better Than C?

Comparing the two products was a more difficult task than it seemed at first. Although they are both based on BASIC, Visual Basic diverges considerably from the BASICs of the past. Each program has distinct advantages and disadvantages.

Realizer has plenty of functions and power, is very easy to use for programmers familiar with procedural programming, and is sufficiently in conformance with BASIC that it would be easy to move BASIC programs to Windows. It is not truly a visual programming tool, since FormDev does not go far enough and is not integrated with the rest of Realizer. Realizer, too, requires more straight coding and more programming knowledge.

Visual Basic is novel in its method of visually constructing an application, is extremely easy to use, and promises to have a good range of powerful third-party add-ons. Visual Basic, which is difficult to use for porting BASIC applications to Windows, doesn't have as many built-in functions as it might and relies extensively on third parties for extensibility. It is also hard to use when dealing with complex, multiform applications.

But with all these considerations, Visual Basic and Realizer are still excellent alternatives to C and C++ for Windows application programming. The resulting applications, in my tests at least, were somewhat slower than Windows programs produced in more traditional languages, but the time saved in design and coding makes them a big win for rush projects. ■

Owen Linderholm is a BYTE senior news editor in San Francisco. He can be contacted on BIX as "owenl."

HARDWARE

Super-Priced Super VGA Boards

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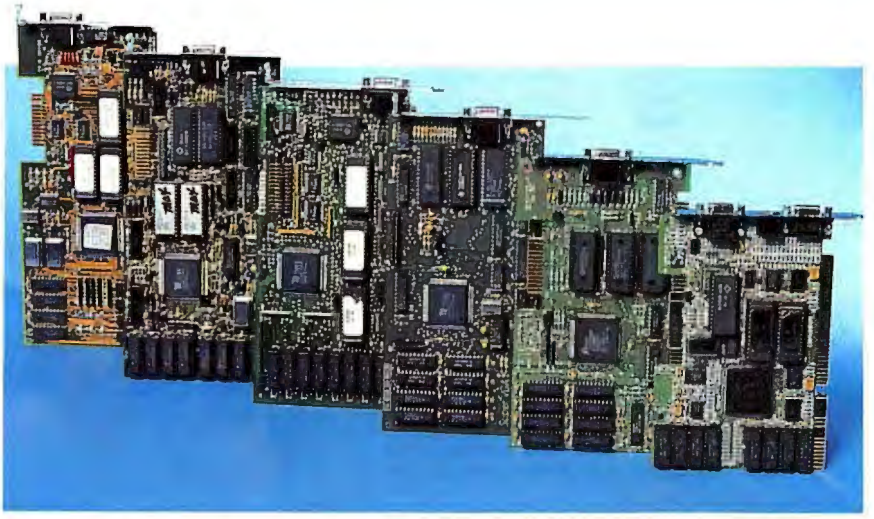


Super VGA for under $400: The BYTE Lab tested boards from (left to right) Everex, Focus, Cardinal, Boca, Trident, and ATI.

BYTE ACTION SUMMARY

- **LOW-COST SUPER VGA BOARDS**
- **WHAT THEY DO**
  Provide compatibility with IBM VGA and the modes that it supports. All the reviewed boards support at least 1024- by 768-pixel resolution with 256 colors.
- **LIKES**
  The extended resolutions for Windows and for many other applications, plus the extensive driver support and support for VESA BIOS extensions. Also, high vertical refresh rates reduce eyestrain.
- **DISLIKES**
  Performance, though generally excellent, is heavily dependent on the quality of the application driver. If you plan to run unusual applications, check out the performance of specific board-driver combinations before making a decision.
- **RECOMMENDATIONS**
  For Windows, ATI's VGAWonder XL is an excellent choice. If low cost is your first criterion, choose either Focus's 2theMax VGA 4000 or the SuperVGA by Boca.

Super VGA is a technology whose time has come. The popularity of Windows 3.0 and other GUIs has created an unprecedented demand for low-cost, high-resolution graphics systems. While Super VGA graphics boards still lack standardization, their ability to deliver up to 1280- by 1024-pixel resolution, 15-bit color, and eyestrain-relieving refresh rates for under $400 makes them the ideal Windows platform.

The six Super VGA cards reviewed here each come with 1 MB of memory installed. Prices vary widely (see the table for price and configuration information), but so do performance, supported resolutions, and extra perks.

Extended Modes

All the boards provide compatibility with IBM VGA and the modes that it supports. Through application drivers, Video Electronics Standards Association (VESA) BIOS extensions, and 8514/AI drivers, they also support extended modes with greater resolution and more color depth. You will need at least a dual-frequency 8514/A-type monitor to run these extended modes, and only a true multifrequency monitor will run a non-interlaced 1024- by 768-pixel resolution and some of the high-frequency modes.

The highest resolution the boards support is 1024 by 768 pixels with 256 colors. Everex Systems' Viewpoint Premium and Focus Information Systems' 2theMax VGA 4000 handle resolutions of up to 1280 by 1024 pixels with 16 colors (interlaced). Trident Microsystems' Impact III supports a 768- by 1024-pixel portrait mode with the proper monitor.

Four of the boards I reviewed—ATI Technologies' VGAWonder XL, Cardinal Technologies' VGA732, the Viewpoint Premium, and the 2theMax VGA 4000—are among the first Super VGA boards to support 15-bit color. Made possible by relatively new 15-bit video D/A converters, 15-bit color means that in some applications, you can have up to 32,768 on-screen colors. These applications include Windows programs, like CorelDraw, that provide support for 16-bit bit maps.

For most of the history of Super VGA, there has been no standard way for applications to access and use these extended modes unless you resorted to a software driver. All these boards come with Windows drivers for the graphics modes they support, plus drivers for most other popular applications. Since software updates usually happen quickly, it's a good idea to buy a board from a vendor that provides driver updates through a BBS.

But the unsettled frontier of Super VGA is becoming more civilized. VESA has come up with a standard software interface for the most popular Super VGA modes. (See "VGA to the Max," December 1990 BYTE.) These VESA BIOS extensions allow software to determine a Super VGA board's capabilities regardless of its chip set. They also define a standard set of graphics and text modes.

Although support is limited for the VESA modes, the standard is likely to gain momentum as more boards with extensive VESA support (like those reviewed here) hit the market. All but the Viewpoint Premium also provide a driver that will work with applications written to IBM's 8514/A interface.

Faster Than a Speeding Bullet

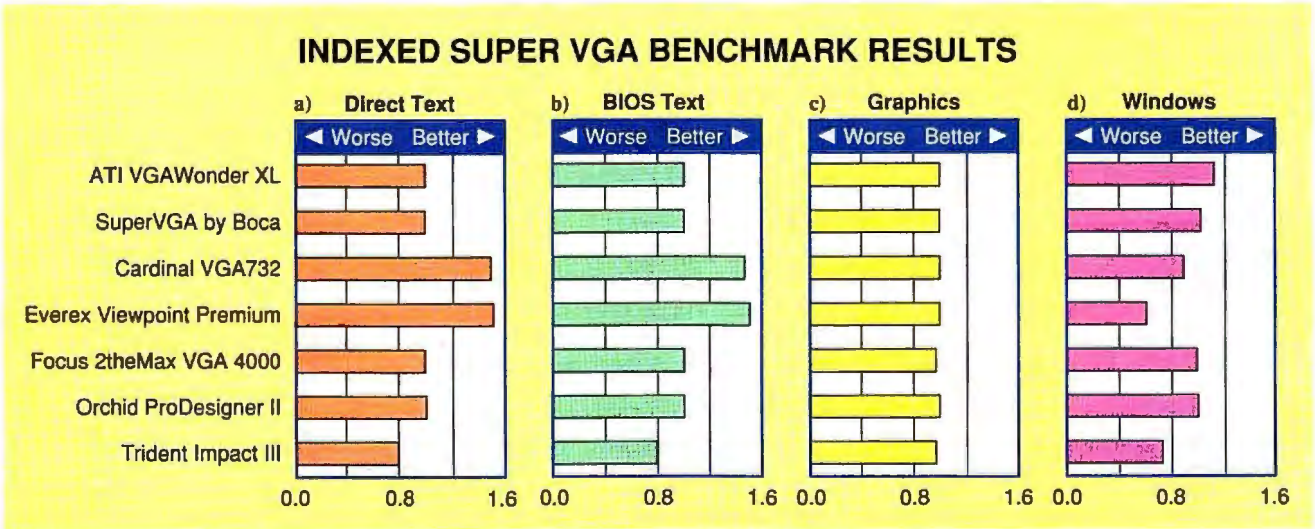
If you're upgrading from an older, 8-bit VGA adapter, any one of these boards

COMPARING SUPER VGA CARDS

Table 1: *Six low-cost VGA cards that support a wide variety of applications and offer 1-MB configurations for under $400.*

Manufacturer	Model	Price[1]	VGA chip set	Memory range[2]	Feature connector	Included application drivers	Other software	Support
ATI Technologies	VGAWonder XL	$399[3]	ATI 28800-5	256K-1MB	Card edge	AutoCAD, AutoShade, Gem, Lotus 1-2-3, OS/2 PM, Symphony, Ventura Publisher, Windows, VCAD, 3-D Studio	RAM-based BIOS, ANSI driver, mode utility, test utility, other utilities	2-year warranty; telephone; BBS
Boca Research	SuperVGA by Boca	$245	Tseng ET4000AX	256K-1MB	Pin header	AutoCAD, Gem, Lotus 1-2-3, Symphony, Ventura Publisher, Windows, WordPerfect	RAM-based BIOS, ANSI driver, mode utility	5-year warranty; telephone; BBS
Cardinal Technologies	VGA732	$239	Tseng ET4000AX	1MB	Pin header	AutoCAD, Gem, Lotus 1-2-3, OS/2 PM, Symphony, Ventura Publisher, Windows, WordPerfect	RAM-based BIOS, ANSI driver, mode utility, test utility, other utilities	1-year warranty; telephone; BBS
Everex Systems	Viewpoint Premium	$339	Tseng ET4000AX	512K-1MB	Card edge	AutoCAD, AutoShade, Gem, Lotus 1-2-3, OS/2 PM, Symphony, Ventura Publisher, Windows, WordPerfect	RAM-based BIOS, mode utility, setup utility	2-year warranty; telephone; BBS
Focus Information Systems	2theMax VGA 4000	$220	Tseng ET 4000AX	256K-1MB	Card edge	AutoCAD, Gem, Lotus 1-2-3, Symphony, Ventura Publisher, Windows, WordPerfect	RAM-based BIOS, ANSI driver, mode utility, test utility, other utilities	18-month warranty; telephone
Trident Microsystems	Impact III	$295	Trident TVGA-8900C	256K-1MB	Card edge	AutoCAD, AutoShade, CADkey, Framework, Gem, Lotus 1-2-3, OS/2 PM, P-CAD, Quattro, Symphony, Ventura Publisher, VersaCAD, Word, Windows	RAM-based BIOS, ANSI driver, mode utility, test utility, other utilities	2-year warranty; telephone; BBS

[1] Price is for board in 1-MB memory configuration. [2] Each board was tested with 1 MB of memory. [3] Price includes mouse port and mouse.



All results are indexed. Orchid's ProDesigner II, a Super VGA card priced over my test-criterion limit, provided the baseline measurement; for each index, the ProDesigner = 1. **(a)** *Results of the Direct Text benchmark, which measures raw hardware performance. The Everex Viewpoint Premium and the Cardinal VGA732 were the fastest.* **(b)** *BIOS Text results closely tracked Direct Text results.* **(c)** *BYTE's Graphics benchmark, which yielded little variation, shows that these cards are fast enough to make CPU time the bottleneck in complex graphics applications.* **(d)** *The ATI VGAWonder XL excelled in the timed Windows test. A slow driver hampered the otherwise speedy Everex Viewpoint Premium.*

will provide improved performance. Each provides full 16-bit access to video RAM and video BIOS ROM, and each is built around a quick VGA chip set.

I ran a few benchmarks to quantify board performance. The figure shows indexed performance graphs for each test. Part a illustrates the results of the BYTE Lab's Direct Text benchmark. This is simply a timing of a series of 16-bit writes to video memory in text mode. It measures the raw speed of the card and reflects the performance you could expect in most text-mode applications.

The Viewpoint Premium and the Cardinal VGA732, both based on Tseng's ET4000AX, easily bested the rest of the pack. Both support zero-wait-state memory access; the other ET4000AX-based boards—the 2theMax VGA 4000 and the SuperVGA by Boca—require wait states

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and finished in the middle, about even with the VGAWonder XL. (At press time, Focus announced that the 2theMax VGA 4000 had begun to support zero-wait-state operation.) The Impact III, based on Trident's own TVGA-8900C, lagged a few steps behind the other boards.

Part b of the figure, BYTE's BIOS Text test, graphs the performance you're likely to see at the DOS prompt or running applications that use the BIOS. This is a timed scroll using the BIOS scroll routine. I tested each board using the RAM-based BIOS that each manufacturer supplied; not surprisingly, these results closely tracked the results of the Direct Text test.

BYTE's Graphics test times a seed-fill routine running in all the standard VGA graphics modes. In this case, every board was fast enough to make CPU speed the significant bottleneck, so the boards don't show much variation.

Of course, the performance numbers that matter most are those that reflect the performance you are likely to see inside a graphics application. Although raw speed is important, the quality of the application driver plays a major role in determining performance. Since running Windows is the task most of these boards will draw, I also timed a common operation in Windows, running in 1024- by 768-pixel by 256-color mode.

The VGAWonder XL proved to be an outstanding Windows performer, outrunning the second-place SuperVGA by Boca by almost 10 percent (see part d of the figure). The Viewpoint Premium proved disappointing, especially given its outstanding performance on other tests. Everex explained that the relatively new Viewpoint Premium was using a generic Windows driver designed to be easily ported from board to board and not optimized for performance. Everex is currently working on optimized drivers for the Viewpoint Premium.

Easy on the Eyes

I didn't have any trouble getting these boards installed or getting them properly configured for Windows. Most come with an installation utility designed to make setup completely bulletproof.

From a qualitative perspective, I liked the Windows display generated by the VGAWonder XL board best. But each board provided good, readable screens without flickering at 1024 by 768 pixels on NEC MultiSync 5D and Seiko CM-1450 multifrequency monitors.

Looking at a CRT all day can make you bleary-eyed by the time the five o'clock whistle sounds. Increasing a display's vertical refresh rate can reduce perceived flicker and drastically reduce eyestrain. Each of the boards offers high refresh rates to help alleviate fatigue. For example, at 800- by 600-pixel resolution, all the boards run at 72 Hz in 16 and 256 colors. (In 32,768 colors, the VGA732 supports 60 Hz, while the Viewpoint Premium and the 2theMax VGA 4000 support 72 Hz.) At 1024- by 768-pixel resolution and 16 colors, the VGAWonder XL leads at 72 Hz, while the other boards support either 70 Hz or 60 Hz. Finally, at 1024- by 768-pixel resolution and 256 colors, the VGA732, Viewpoint Premium, and Impact III run at 70 Hz, and the remaining boards run at 60 Hz.

Generally, higher refresh rates are easier on your eyes. However, the rate you can use depends on both the video card and the scan rates your monitor can handle. Older NEC MultiSync monitors

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like the 2A support only 56 Hz at 800 by 600 pixels, while more expensive tubes like Seiko's CM-1450 will handle 72 Hz at 800 by 600 pixels. VESA recommends 72-Hz refresh rates at resolutions of 640 by 480 pixels and 800 by 600 pixels, and 70 Hz at 1024 by 768 pixels.

Superior Super VGA

If low cost is your number-one criterion, you can't go wrong with either the 2theMax VGA 4000 or the SuperVGA by Boca. The boards are almost equivalent, but you may find the superior support offered by Boca worth the extra $25 that you'll spend on its SuperVGA board.

Everex and Cardinal provide faster boards for a bit more money. Of the two, Everex's is more configurable and thus likely to work reliably in more systems.

My overall favorite is the VGAWonder XL. It looked good, worked flawlessly, and provided excellent performance under Windows. Although its $399 price may seem a bit steep, the package includes a mouse port and mouse. ■

Steve Apiki is a BYTE technical editor. You can reach him on BIX as "apiki."

COMPANY INFORMATION

ATI Technologies, Inc.
(VGAWonder XL)
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Scarborough, Ontario, Canada
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fax: (416) 756-0720
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fax: (415) 651-0728
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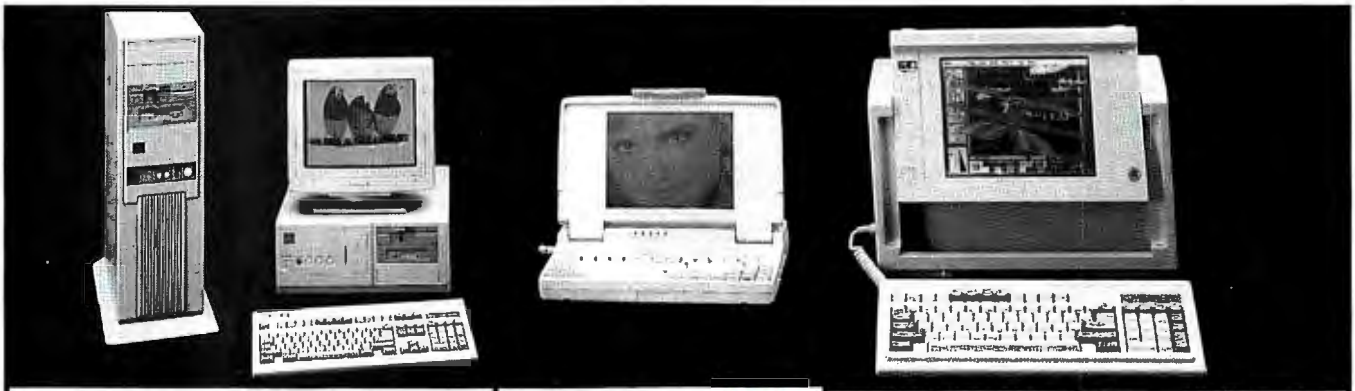

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amiga.hw	Amiga hardware design, use, and hookup
amiga.arts	Artistry using the Amiga
amiga.int	Developing for the international Amiga
amiga.special	Special guests and events
amiga.dev	Commodore's conference for developers

■ IBM Exchange

Barry Nance, Exchange Editor

ibm.pc	The venerable PC
ibm.at	The AT series and workalikes
ibm.ps	The PS/2 series
ibm.os2	OS/2 operating system
ibm.dos	PC/DOS & MS/DOS operating systems
ibm.os.386	Alternative 386 operating systems
ibm.utils	Utility software for IBM computers
ibm. repairshop	Garage and Tune-up Shop

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ibm.new. prods	New products for IBM computers
ibm.exchange	IBM Exchange clearinghouse
ibm.listings	Index to program files in the Exchange
ibm.other	Apps, printers, modems, etc.
microsoft	Products from Microsoft

■ Programmers' Exchange

Bill Nicholls, Exchange Editor

ada	The Ada language conference
ai.theory	Artificial intelligence and expert system theory
assembler	Assembly language
basic	Your BASIC conference
c.language	C programming language
c.plus.plus	Discuss the C++ programming language
cad	Computer-aided design
cpm	CP/M conference
editors	The Programming Editors Conference
forth	FORTH programming
fortran	FORTRAN language conference
games	Game programming and design
graphic.pgms	Programming and graphics
hypertext	Hypertext publishing
lisp	LISP language conference
modula.2	Modula-2 language conference
neural.nets	Neural Networks
ood	Object-oriented development conference
os.9	OS-9 conference
pascal	Pascal language conference
pick	The PICK operating system
postscript	Postscript
smalltalk	Smalltalk language conference
soft.eng	Efficient and reliable software design
telecomm. pgms	Telecommunications programs
unix	The UNIX conference

■ Macintosh Exchange

Dr. Larry Loeb, Exchange Editor

mac.apple	The word from Cupertino
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mac.desktop	Publishing with a Mac
mac.external	Information from all over
mac.hack	Technical information about the Mac
mac.hypercard	Using the HyperCard programming environment
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mac.products	Listings of new hardware and software
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Image Editor Promises New Respect for PCs

GREG LOVERIA

PCs are no longer too expensive or too inferior to Macintoshes to attract graphics professionals who work with photographic-quality images. A variety of Windows- and Texas Instruments Graphics Architecture–based hardware and software are coming onto the market to offer 24-bit (16.8-million-color) imaging at 8-bit (256-color) display prices.

Image-In-Color is one such software application. It offers Windows 3.0 image editing and retouching reminiscent of Adobe's Photoshop for the Mac. Significantly for a Windows product, it is one of the first to provide color RGB and hue-saturation-luminance (HSL) image editing for color separations.

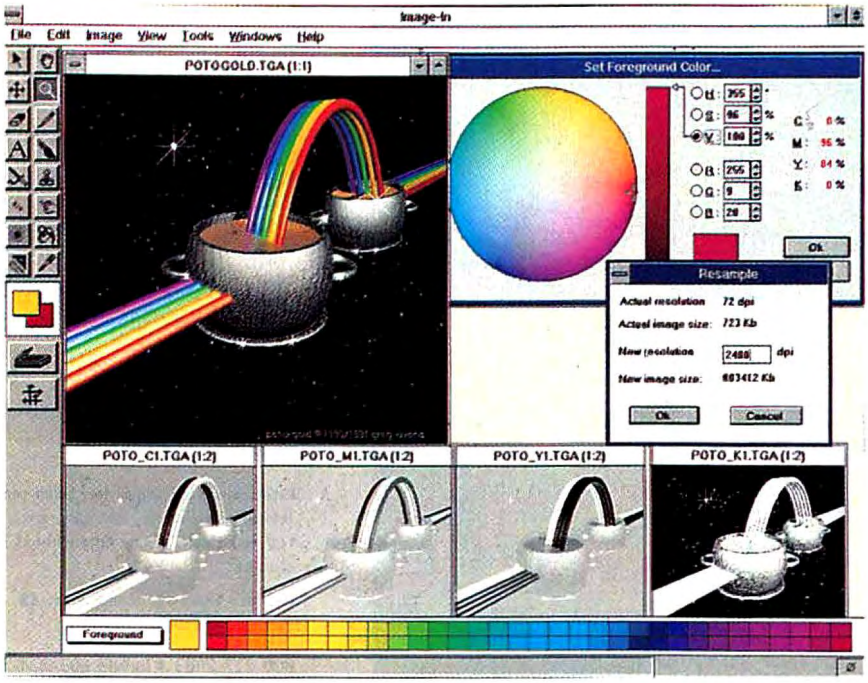
This capability not only boosts PC productivity and creativity, it also blurs the established job descriptions of artists, printers, and photographers. (Last spring, Aldus purchased U-Lead System's PhotoStyler, a similar Windows-based image editor that briefly had been shipping. At press time, Aldus was not commercially shipping the product but said it planned to reintroduce PhotoStyler by the beginning of next year.)

In-House Color Separations

Agfa Compugraphic calibrated Image-In-Color's color separation and compensation algorithms. Image-In-Color performs CMYK (cyan, magenta, yellow, black) color separations directly from 24-bit images. Traditional separations done by service bureaus represent much of the sizable costs of printing color images. The traditional process entails rephotographing pictures through colored filters to produce four separate pieces of film, which are then etched onto color printing plates.

Image-In-Color accomplishes the same feat using four CMYK gray-scale windows. The gray-scale-image windows represent the continuous tonal amount of each CMYK color separated from the 24-bit image. Typically, you save each CMYK gray-scale window as an EPS, TIFF, or TARGA file.

A number of Linotronic and PostScript imagesetters can read these DOS files directly and output them to film at resolutions of from 150 to 2400 dots per inch. Printers then use these electronically generated film separations to etch four CMYK color printing plates.



Screen 1: *Image-In-Color is among the first PC-based applications designed to edit four-color separations. The bottom four windows show the color TARGA image digitally separated into CMYK gray-scale percentage values. The program's pop-up HSV/RGB color selection box displays CMYK percentage values for the selected color. (Artwork by the author; image-to-slide conversions courtesy of Image Center.)*

Subtle Differences

The program offers CMYK gray-scale tonal adjustments for color balance, press gain, and under-color removal (UCR). Press-gain adjustments let you decrease color densities by separation to compensate for various ink, paper, and press combinations that can oversaturate color photos when printed. UCR eliminates extra cyan, magenta, and yellow in areas where they overlap in the image. This saves image details that normally would be lost due to over-inking black areas.

Image-In-Color, which requires 2.3 MB of hard disk space, supports TARGA or TIFF images (the formats of choice for most graphics professionals doing PC-based, 24-bit color retouching). It also reads and writes many other image file formats, including PCX, EPS, BMP, and GIF. This makes the program useful as a file conversion utility.

I found that I could easily rescale images to different pixel aspect ratios or physical image sizes. The digital resampling functions let me produce image screen and print conversions to resolutions of up to 2400 dpi. I could perform all 24-bit retouching and editing functions using standard 8-bit Super VGA display systems working at 640- by 480-pixel to 1024- by 768-pixel resolutions.

For 8-bit Super VGA tests, I used a Diamond SpeedStar Plus adapter and a Relisys RE-1520 monitor. For 24-bit display comparisons, I installed Matrox Electronic Systems' Impression adapter and worked at an 1152- by 882-pixel resolution using a 20-inch Nanao FlexScan 9500 multisync monitor. (Matrox's software drivers communicate with the board's 34020 graphics coprocessor. I coupled the adapter's 8-bit VGA pass-through with the SpeedStar Super VGA adapter's feature bus. This allowed me

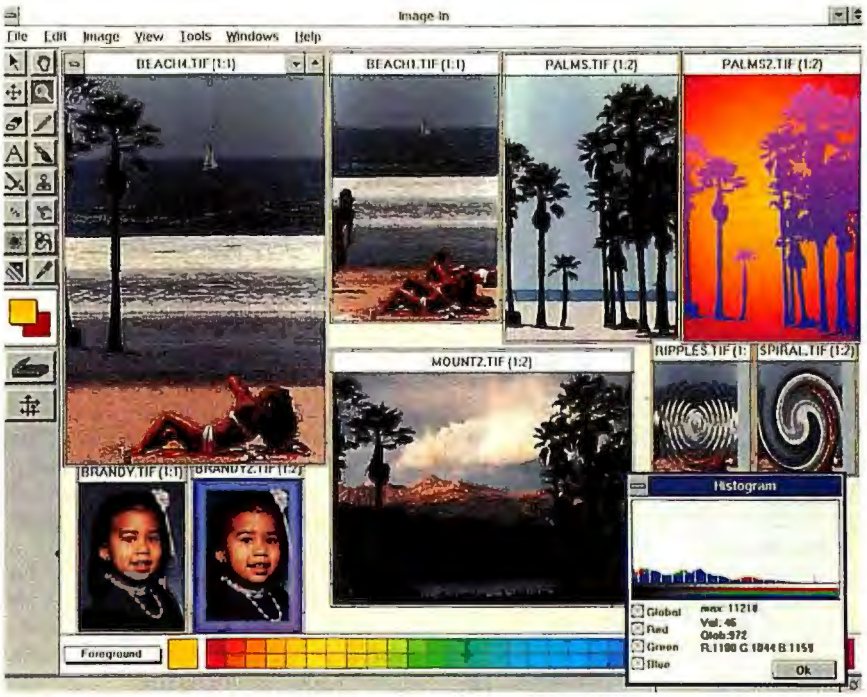
to do 24-bit Windows 3.0 image editing on the single Nanao display.) My test system was an EISA Zeos 486/25 with 8 MB of extended memory and a 344-MB SCSI hard drive.

My pointing devices included a mouse and Wacom's SD-420L pressure-sensitive digitizer. Image-In-Color supported the pressure-sensitive stylus. I used the Microtek Lab MSF-300Z 24-bit color scanner to import images and test compatibility.

Image-In-Color's tool-icon panels open when you load images, but you can't edit 8-bit images directly. If you load an 8-bit GIF image first, for example, the program provides only a limited number of tools, such as Magnify or Move. To access editing tools and pull-down functions, you must convert your image to RGB 24-bit color, gray-scale, or line art.

You convert images by simply selecting a menu item. If you use an 8-bit display, 24-bit images will be a bit dithered, but they're highly workable, especially at 1024- by 768-pixel resolutions.

You can also perform monitor gamma corrections for each image. This assures that image midtones, color balance, and gray-scale values reproduce accurately on any monitor in any lighting environment.



Screen 2: *All the images were scanned at 93 dpi. A purple gradient fill was framed and feathered into the child's portrait. The palm trees were auto-selected, copied, and pasted into the mountain scene using selection tools. Two ripple and spiral special-effects filters were applied to the BEACH1.TIF image. The original beach image was retouched using the floating stamp tool to remove foreground figures. The palms were pasted and resized into the final retouched image, BEACH4.TIF. The airbrush retouched palm shadows in the water. (All photos by the author.)*

Formidable Filters

From a photographic and artistic viewpoint, special image filters are the most exciting aspects of the product. The filters range from global image blurring, sharpening, image reversal (negatives), and pixel magnification to special effects such as spirals, ripples, and motion blurring. You can incrementally set spiral or ripple values to warp images into swirling patterns or fun-house mirror effects. The edges-only filter produces an effect that's reminiscent of photographic line-art darkroom techniques. User-definable filters let you set incremental image "warpage" by pixel measurement.

In addition, Image-In-Color can display guide rulers in pixel, millimeter, centimeter, inch, pica, or point increments. The package also includes the standard paint program drawing functions, as well as traditional cut, paste, erase, fill, and move routines. However, there are some twists. You can click on the mouse or pen stylus from any screen position to access pop-up boxes and submenus for the current tool selected. This is intuitive and saves time.

You select colors from Image-In-Color's bottom color palette display. You can directly select colors from the image using a "magic wand" tool, which doubles as a light meter or densitometer by displaying pixel RGB, HSL, or CMYK color percentage values. Color shading and opacity, which translucently "washes" in color, can also be set. You perform precise color mixing for detail work, such as airbrushing, from pop-up RGB/HSL color display tables. And thanks to Image-In-Color's support of the Wacom pressure-sensitive tablet, functions such

BYTE ACTION SUMMARY

- **WHAT IMAGE-IN-COLOR DOES**
  It provides Windows-based color RGB and HSL image editing for retouching and color separations.
- **LIKES**
  You can use your PC to retouch photographs and manipulate 24-bit image files on both 8- and 24-bit display adapters.
- **DISLIKES**
  Editing functions become inoperable when working with large 24-bit image files.
- **RECOMMENDATIONS**
  Image-In-Color performs admirably as a sophisticated, Windows-based image editor.
- **PRICE**
  $795
- **FOR MORE INFORMATION**
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as airbrushing are fluid and realistic.

Fonts in the program are extensive. They include good-looking Helvetica and Times Roman faces from 8 to 42 points, which can have any color attribute.

Imaging Tools

My favorite imaging icon tools were Stamp, Select, and Gradient Fill. The Stamp tool duplicates images. With Image-In-Color, you can select an anchored or free-floating Stamp origin point. This free-floating feature lets you duplicate multiple image areas quickly.

Select icons allow you to pick image areas for cropping, cutting, or pasting. Once you select image areas, you can resize, distort, warp, or stretch them. The Select procedures are unique compared to other imaging packages I've worked with. You can specify border threshold limits around the image clipping for a razor-sharp cut, or a smooth fade-out around the clip image for vignette effects. Image-In-Color's 32-pixel, 256-color pixel/threshold control can make vignettes look photographic.

Gradient Fill generates fades between any two RGB or HSL color values using linear, radial, square, or elliptical patterns. You place foreground color center-fill positions and drag rubber-banding lines outward, setting gradient blend and diffuse rates. Gradient-fill controls are in pop-up preview boxes, which saves you time by showing results before application. Pasting vignetted clips over gradient fills can be striking (see screens 1 and 2).

Scanner Support

The package supports a wide variety of popular scanners, including models from Microtek, Sharp, Howtek, Canon, and Hewlett-Packard. Generally, a 4- by 4-inch image scanned at 300 dpi records 10,000 dots per square inch; 24-bit scans this size would produce a 4.32-MB file. The software allows image resampling (i.e., dpi conversion) and image resizing by pixels or inches. After resampling to 2400 dpi, the 4.32-MB image could become a 34.5-MB file. Fortunately, you can save image files using Lempel-Ziv-Walsh 2-to-1 file compression.

However, when I worked with 24-bit image files above 4 or 5 MB, the editing tools were extremely sluggish and sometimes unusable. To edit scanned, 24-bit, 300-dpi files in either program, I had to rescale them to smaller file sizes (around 1 or 2 MB) so that the tools functioned properly. Once I edited the images, I resized them to their original file sizes.

Image-In-Color works with any printer that uses Windows 3.0 device drivers. I tested PostScript and Printer Control Language laser output on an HP LaserJet IIP with and without Pacific Data Products' PE PostScript cartridge. I produced color prints and CMYK separations with QMS's ColorScript 100 Model 30i and Mitsubishi/Shinko's CHC-445 thermal-transfer color printers. Color and monochrome halftone output from Image-In-Color at 300 dpi in various line-per-inch and screen-angle settings was superb.

The manual details color electronic imaging extensively, and it should be viewed as reference rather than simply software documentation. It exhibits a high degree of cognizance in the still-fuzzy areas of desktop color separation and color press procedures.

A Vote for "Feelings"

Most of my editing work revolves around smaller 1- to 2-MB 24-bit image files that I create using three-dimensional animation software. However, I was a bit dismayed to discover the problems editing larger, 24-bit scanned files. I worked around the problem by rescaling and resizing to bring scanned files down to operable sizes. Depending on your needs, this may or may not be an issue. For me, it isn't as yet. But this could change as my image file sizes increase.

I give Image-In-Color high marks for not making me move back and forth across the desktop to invoke pop-up boxes and tool submenus. Also, its right-button menu-access feature is a genuine time-saver, and the incremental controls for cut-and-paste in its Select feature make for superb vignetting and feathering. Lastly, its painting and drawing tools "felt" realistic in both 8- and 24-bit display modes thanks to its support for Wacom's pressure-sensitive tablet.

This package advances PC image editing and print functions to a new plateau. If you're a professional artist, photographer, or printer, Image-In-Color deserves a look. It's the most complete Windows-based PC image-editing package I've worked with to date. ■

ACKNOWLEDGMENT

Colin Relph, who has 35 years of professional color separation and printing expertise, contributed technical information for this article.

Greg Loveria is a computer graphics and desktop publishing consultant, animator, and technical writer in Binghamton, New York. He can be contacted on BIX as "loveria."

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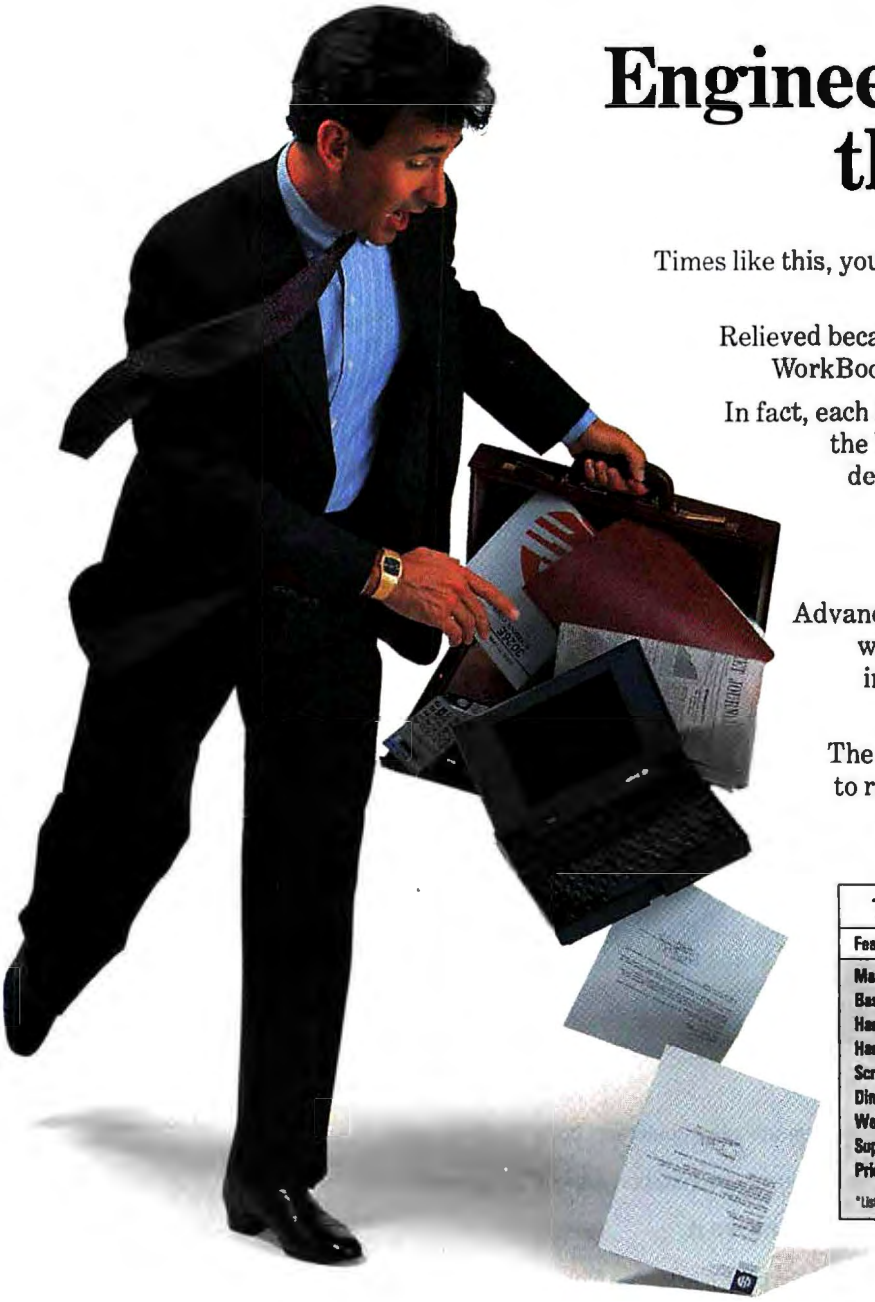

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HARDWARE

Hewlett-Packard's 425e Shows Off the Power of the 68040

TOM YAGER

The HP Apollo 9000 Model 425e, shown here with an internal floppy drive and color monitor, is HP's designated successor to the Apollo line. ▷

When Hewlett-Packard introduced a series of workstations that it co-developed with its subsidiary, Apollo Computer, I looked forward to the new merged platform. I hoped to see some of the innovation that made Apollo, the company that invented the workstation, a company to watch. After testing the entry point in HP's new 9000 series, I came away more convinced of the value of the 68040 and of HP's top-notch software but slightly disappointed in the hardware.

The HP Apollo 9000 Model 425e is a 25-MHz 68040-based desktop workstation in a pizza box case. It runs as either an HP or an Apollo system, accommodating both the HP/UX and Domain/OS operating systems. It even has two keyboard connectors for HP- and Apollo-style keyboards. HP sells a diskless Model 425e with 8 MB of RAM and a 19-inch gray-scale monitor for $5490; a 16-inch color monitor brings the price to $7490. For our color system with a 200-MB hard drive, you'll pay $9490—still a reasonable price.

The Benefits of Turning 040

The Model 425e's value lies not in its hardware, which is unspectacular (save for the 68040), but in its software. Few workstation vendors can claim as much software added value as HP. The HP/UX operating system (discussed in more detail in "A New Workstation Standard," June BYTE) includes the X Window System, the HP VUE graphical environment, System V and Berkeley Standard Distribution compatibility, and a host of networking facilities.

The Model 425e's ability to run Domain/OS is a bid to keep users of pre-takeover Apollo workstations in the fold, but the sales literature makes it clear that HP thinks HP/UX is where it's at. All other things being equal, HP/UX is a better operating system and GUI than

BYTE ACTION SUMMARY

- **WHAT THE HP APOLLO 9000 MODEL 425E IS**
  A Unix workstation with a 25-MHz 68040 and dual HP/Apollo software compatibility.
- **LIKES**
  Good hardware performance for the money; very fast file I/O; the HP/UX operating system bundle is more valuable than most.
- **DISLIKES**
  The case sags under the weight of a 16-inch monitor.
- **RECOMMENDATIONS**
  The Model 425e should be considered for any low-end workstation shopping list.
- **PRICE**
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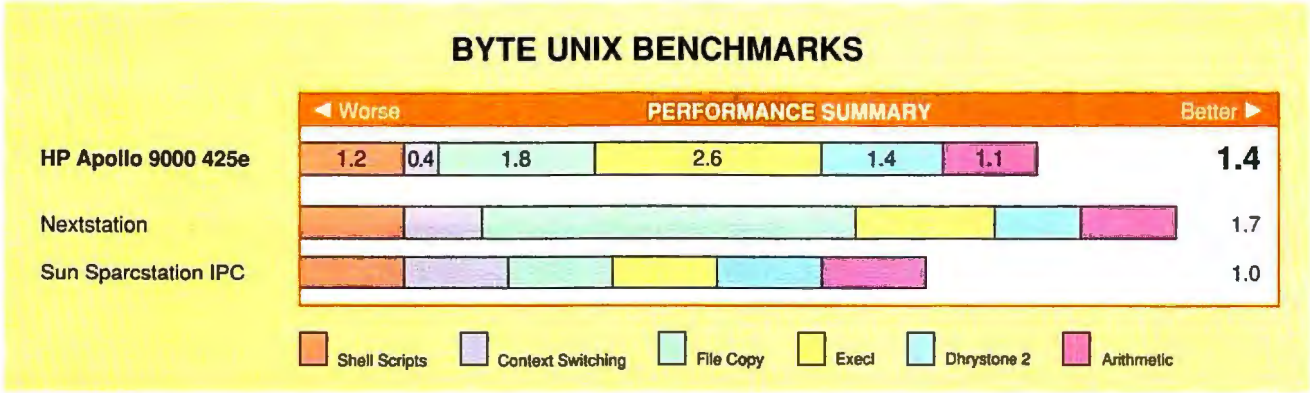

The graph above summarizes the results of BYTE's Unix benchmarks (version 3). We index the results to show relative performance; for all tests, a Sun Sparcstation IPC = 1. The cumulative index is formed by summing the indexed performance results for the individual tests. The tests show relative performance for running a shell script with eight concurrent scripts running, pipe-based context switching, file copy throughput (in 5 seconds), spawning a process (execl()), the Dhrystone 2 benchmark, and double-precision arithmetic.

BYTE's Unix benchmarks are available on the Usenet, from Demolink, and in the "listings" area on BIX, or on disk. See page 5 for details. Comprehensive results are available by contacting BYTE.

Domain/OS. But all things aren't equal: Given HP's migration away from Domain/OS, Apollo users will almost certainly have to give up their familiar Apollo gear and software at some point.

HP has striven to make the Model 425e and other members of the HP/Apollo 9000 line attractive to both existing and new customers. The best thing for Apollo customers is the 68040, a logical step up from the 68030 processors in previous Apollo models. The Model 425e lacks expansion slots, but you can still beef it up a little. It has room inside for 48 MB of memory and up to 840 MB of disk storage when configured with two 420-MB 3½-inch hard drives.

Like the Solbourne S4000, this is another desktop machine whose disk I/O performance numbers are so impressive (see the benchmark table) that it can be considered as an inexpensive file server. The Model 425e comes equipped with audio I/O; the owner's guide describes the port commands and how to attach devices. Higher up the HP 9000 line, systems take on everything from expanded

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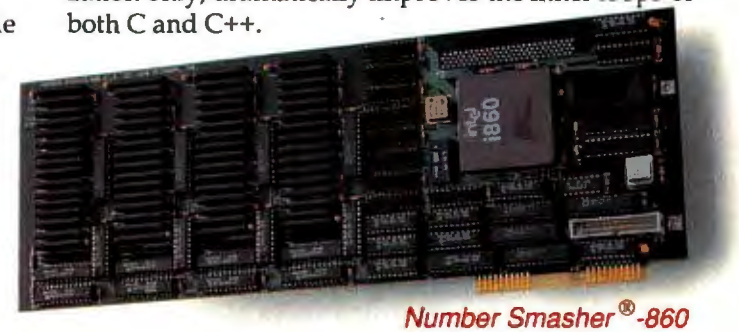

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NDP Fortran is a full ANSI 77 that is 99% compatible with VMS Fortran and has extensions from BSD, DOD and Microsoft. The DOS version includes the GREX™ library of 88 graphics primitives and I/O functions that give it a BASIC-like flavor.

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memory capacity to accelerated graphics and RISC CPUs.

The benchmark table shows that the 25-MHz 68040 is a respectable performer. The Model 425e holds its own when pitted against the 68040-based Nextstation and the Sparcstation IPC (with 25-MHz SPARC). It lags behind its meanest competition in the area of price, but only a little: A comparable color Next system (8 MB of RAM, 17-inch color monitor, and hard and floppy drives) sells for $7995—probably the least expensive configured workstation on the market. The Model 425e sells for $9490, but it includes a 200-MB hard drive and no floppy drive. The Model 425e's price puts it squarely in Sun's low-end neighborhood.

Other hardware features include a trio of serial ports, a parallel port (a genuine rarity on workstations for some reason), an external SCSI connector, and both thick and thin Ethernet connectors. The Model 425e's front bezel is normally smooth, but the right side pops out to accommodate either a high-capacity 3½-inch floppy drive or a cartridge tape drive. With either of these, the Model 425e makes a fine workstation at a competitive price.

Fetch My Earmuffs

I experienced a couple of annoying traits with my Model 425e. The case fit together poorly and bowed slightly under the weight of the 16-inch monitor. More annoying by far was the racket created by a defective cooling fan. An HP spokesperson stated that the fan should be nearly silent. This was the case with the more powerful HP RISC system reviewed in June. These problems could have resulted from shipping or from a quality-control slipup. If you're shopping for workstations, just make sure you get a chance to see, and hear, the 425e in action before you buy it.

The Model 425e has two main advantages over its competition: HP/UX, a mature, feature-laden combination of Unix, X, OSF/Motif, and a number of sweet extras; and the ability to run Domain/OS. For those who have Apollo equipment and wish to move up while maintaining compatibility for as long as possible, there's currently no other choice. As for the rest, anyone shopping for workstations would do well to disregard reports of the death of Motorola in the market and give the Model 425e, or HP's other 9000 series models, a serious look. ■

Tom Yager is a BYTE technical editor. He oversees BYTE's Multimedia Lab. He can be reached on BIX as "tyager."

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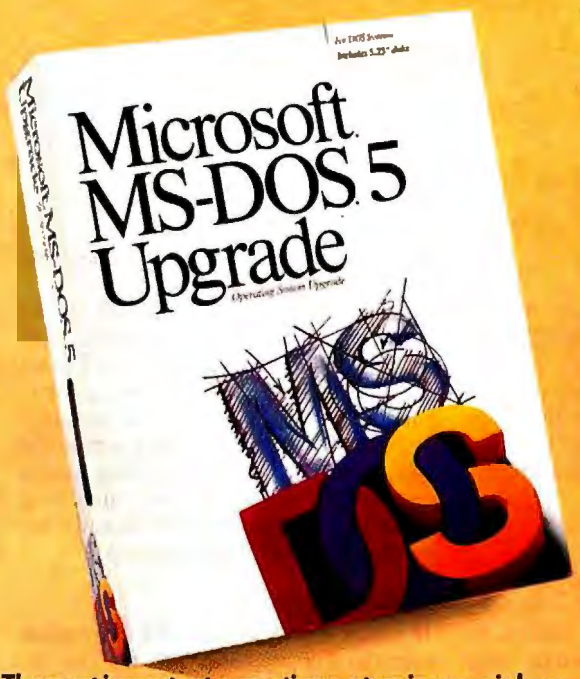

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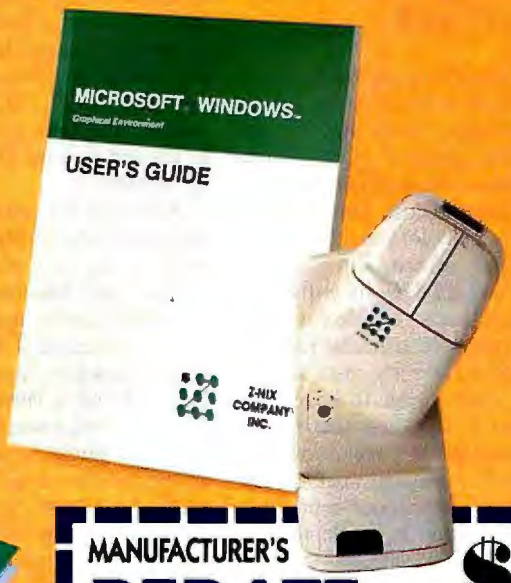

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REVIEWER'S NOTEBOOK

Color Takes a Twist with the Pivot

If you don't quite have the bucks for a big Mac monitor and you'd like a dash of color as well, there may be an answer. At $1995, Radius's Color Pivot monitor provides an interesting compromise between size and cost. Standing upright, it provides 16 colors on a full-page 640- by 870-pixel screen. Tip it on its side, and you have an 870- by 640-pixel landscape screen that's suitable for wide artwork or mondo spreadsheets. (A Nubus interface board, which costs an additional $795, allows you to have 256 colors on-screen.) So when you finish laying out those tall ad pages, you can flip the monitor sideways to work on the wide budget reports without rebooting the Mac: The Desktop is reoriented on the fly.

If you own a Mac IIci or IIsi, special software allows you to hook the Color Pivot into the computer's built-in video port. An INIT senses the monitor's orientation and has QuickDraw paint the screen sideways when you place the monitor in the landscape position. Not all Macintosh applications take kindly to having their graphics world switched behind their backs, but software producers are tuning their applications to work with the Color Pivot; for example, Excel 3.0 actually readjusts its windows and graphs when you tilt the Color Pivot.

If you need both portrait and landscape orientation for your Macintosh applications, the Radius Color Pivot may be the answer for you.

486SX Redux

Acer America's AcerPower 486SX and Everex's Step 486SX/20 arrived at the BYTE Lab too late for inclusion in our 486SX roundup (see "A Trio of 486SX Machines: Better Than 386 Systems?," September BYTE), but we did have time to benchmark both machines in the BYTE Lab.

AcerPower 486SX

The AcerPower is a small-footprint machine with an upgrade socket that accepts a 487SX/20, 486DX/33, or 486DX/50 CPU. Special logic senses which chip you've inserted and automatically adjusts the 66-MHz oscillator to run at the appropriate clock speed. The motherboard also accepts a Weitek math coprocessor and up to 26 MB of system RAM. Our test system ($4809) included 4 MB of RAM, a high-density floppy drive, a 200-MB Maxtor Intelligent Drive Electronics (IDE) hard drive, extended VGA, a 14-inch AcerView multifrequency monitor, DOS, Windows, and a bus mouse. The base system, with 2 MB of RAM and no hard drive or monitor, sells for $2495.

Acer puts the status lights, power and reset switches, and keyboard and mouse ports on the front of the machine, where they belong. The system's hardware and software security features restrict access to your system and storage devices. Our system had four available 16-bit expansion slots on a vertical riser card, and space for either one 5¼-inch or two 3½-inch half-height drive bays. Construction quality was good, although the case itself was a bit flimsy. Our test unit arrived with a defective keyboard, which Acer replaced. We had problems when running QEMM 5.0; however, QEMM 5.1 runs fine, and Acer includes its own memory manager with the machine.

The AcerView 35 monitor delivers an outstanding image. The integrated VGA subsystem supports 1024- by 768-pixel graphics in 16 colors, but you can't expand video memory beyond the standard 512 KB. The AcerPower also performed well on BYTE's video tests, but it turned in relatively slow CPU times, matching those of the Mitac 4270E that we reviewed last month (see the table).

Step 486SX/20

The Step 486SX/20 sells for a premium over the Tempo 486SX/20 that we reviewed last month. The extra money buys more expansion capability and a black tower case with a status LCD—and identical performance. Both units share the same motherboard design, which has a 128-KB external processor cache, and both are fast. The system includes a Weitek external processor cache and integrates two serial ports, a parallel port, and an IDE interface. A 32-bit memory board accepts up to 64 MB of RAM.

With the ViewPoint video RAM VGA adapter installed, the BYTE Lab's Step system had five 16-bit expansion slots and one 8-bit slot available. A Teac 1.2-MB floppy drive occupied one of the five half-height drive bays. Our test system, which had 4 MB of RAM, a 200-MB Maxtor IDE hard drive, 1 MB of video RAM and an Eversion analog multifrequency monitor, lists for $6086.

A faster video board and hard drive gave the Step system an edge over the low-end Tempo system in the low-level and application-level tests, but both machines posted the same CPU times. A comparably equipped Tempo should offer similar performance for less money.

We recommend the Tempo over the

BYTE DOS BENCHMARK SUMMARY

Everex's Tempo and Step machines are the fastest 20-MHz 486SX machines BYTE has tested. We tested the machines without math coprocessors, which precluded running the CAD and Scientific/Engineering benchmark suites. We calculated the application indexes accordingly. All the results are indexed; for each index, an 8-MHz IBM AT = 1.

Computer	CPU	Disk I/O	Video	Cumulative application index
AcerPower 486SX	3.8	2.8	13.9	18.0
Everex Step 486SX/20	5.1	2.6	12.0	20.4
Everex Tempo 486SX/20	5.1	2.8	3.8	19.8
IBM PS/2 Model 90 XP 486	4.4	2.0	11.4	17.0
Mitac 4270E	3.8	2.0	10.0	19.8

slower Acer and more expensive Step machines. The Step offers more expansion capability, however, and the AcerPower 486SX isn't a bad choice if you're set on a processor-expandable machine. An added bonus is that you can upgrade the AcerPower system to a 486DX/33 by just adding a CPU.

Acer could have gone a step further by allowing removal of the 486SX CPU, which serves no function after an upgrade and could be reused or traded in. The fact that Acer and other PC clone vendors have chosen not to do so attests to Intel's clout in determining how PCs are designed and marketed.

SX Upgrade Trade-Offs

The BYTE Lab tested a couple of new 386SX upgrade options this month: the Aox Stax SX and the Kingston Technology SX/Now. We ran into some of the same problems that we discovered several months ago (see "SX Upgrade Boards: Not for the Fainthearted," April BYTE). You should first make sure the upgrade works in the specific system you own. We couldn't get the Aox chip to work properly in our true-Blue lab AT, even after we received a new set of ROM chips and other technical help. The chip did work in one of the Lab's clones, however. Kingston solves that problem easily enough: The SX/Now board works only in the IBM PS/2 Model 50 or Model 60.

Both upgrade chips more than doubled the CPU performance of the systems that we upgraded. The BYTE CPU benchmarks confirmed a hearty performance enhancement. Remember, though, we're only talking about CPU performance here. That's the problem. The rest of your system will run the same as always, and the resulting bottlenecks will negate some of the CPU's newfound prowess.

You can't expect Windows and other disk-intensive software to run a whole lot faster. Of course, you will be able to run 386-specific software. That's perhaps the best justification for making the upgrade investment. Both chips enabled us to run a full suite of 386-specific programs, including QEMM for the 386.

If you really need 386 performance for applications like Windows, we suggest that you start from the bottom up. Buy a 386DX motherboard (typically $500 or so) and build from a full-fledged foundation. You won't spend much more than what you'll pay for the Aox Stax SX ($329 for the 20-MHz version; $279 for the 16-MHz version), and you'll have a much stronger foundation with a 32-bit bus for future expansion.

Unfortunately, PS/2 motherboard upgrades are harder to find. That makes the SX/Now board a bit more inviting. Still, the price is high ($495 for the 20-MHz version; $450 for the 16-MHz version), and you have to consider the same performance limitations. The bottom line? If you need to run 386-specific software, the investment will pay off, but if you're expecting full 386DX performance, you will be disappointed.

A Lower Price for Wireless Ethernet

Nothing stands still for long in this business. Since we reviewed Motorola's Altair wireless Ethernet (see "Full Ethernet Networking Without a Wire in Sight," July BYTE), Motorola lowered the price of each User Module from almost $3500 to just $995. At the time, Howard Eglowstein suggested that the price might be a bit high. Now, if you connect six workstations to each UM, the price is just $166 per workstation—very reasonable indeed. Also, the figure incorrectly said that the maximum number of workstations per UM is four. It's six, as stated in the text. ■

—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

AcerPower 486SX..... $2495
Acer America Corp.
401 Charcot Ave.
San Jose, CA 95131
(800) 733-2237
(408) 922-0333
fax: (408) 922-0176
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Altair User Module $995
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Altair Product Operations
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Color Pivot $1995
Radius, Inc.
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San Jose, CA 95131
(800) 227-2795
(408) 434-1010
fax: (408) 434-0127
Circle 1371 on Inquiry Card.

Stax SX
16-MHz version $279
20-MHz version $329
Aox, Inc.
486 Totten Pond Rd.
Waltham, MA 02154
(800) 726-0269
(617) 890-4402
fax: (617) 890-8445
Circle 1370 on Inquiry Card.

Step 486SX/20 ..... $3539
Everex Systems, Inc.
48431 Milmont Dr.
Fremont, CA 94538
(800) 821-0806
fax: (415) 438-5715
Circle 1372 on Inquiry Card.

SX/Now
16-MHz version $450
20-MHz version $495
Kingston Technology Corp.
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Fountain Valley, CA 92708
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Mport 333
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We could have stopped here...but we didn't. The Micronics M*port* 333 beats Toshiba on price, too. Theirs lists for $5,748 and ours lists for $5,495. We both give you 4 MB of RAM, but Micronics gives you 20 extra MB of disk for a total capacity of 120 MB!

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RICK GREHAN

APPLE SHARING

Here's what you need to know to work with the AppleTalk Filing Protocol

Some time ago in this column, I discussed the Macintosh's network operating system, AppleTalk (see "Two Tin Cans and Some String," October and November 1989). At that time, I didn't present the whole picture; I focused on AppleTalk's transport-layer protocols—the AppleTalk Transaction Protocol (ATP) and the Name Binding Protocol (NBP). I promised a follow-up article on AppleTalk's session-layer protocol. Well, here it is. (Note that this article covers material up to *Inside Macintosh* Volume V. Any AppleTalk features added in System 7.0 are not covered here.)

Actually, several AppleTalk protocols fall into the session layer: the AppleTalk Session Protocol (ASP), the AppleTalk Data Stream Protocol (ADSP), the Zone Information Protocol (ZIP), and the Printer Access Protocol (PAP). I will cover only ASP here (the others would be sufficient for yet another networking article). However, the discussion of ASP will appear to be peripheral, since my real goal is one layer up the Open Systems Interconnection (OSI) strata: the AppleTalk Filing Protocol (AFP). (See table 1.)

Starting at the Top

This month's application is a program that lets you locate AFP servers on your network and query them for various kinds of information. In most cases, an AFP server will be a Mac running as an AppleShare server. Novell also provides hardware and software that allow a NetWare server to look like an AppleShare server on the network.

Ordinarily, an application running on a workstation that supports AFP is not even aware of the presence of AFP. Calls that the application makes to the file system pass through the native filing interface—software that determines whether a call should be directed to the workstation's local file system or to a remote file system. If the destination is the remote system, then another piece of software—the AFP translator—kneads the local call into an AFP call and passes the appropriate data across the network.

At the other end of the network lies an AFP server. From your program's point of view, the AFP server is simply another Macintosh volume. If you glance through table 2, you'll see that AFP is "aware" of high-level entities such as files, directories, and volumes. A single AFP command can, for example, create a directory on a Macintosh volume.

AFP rides on the back of ASP. You send an AFP command to the server by attaching an AFP command block onto a parameter block that you pass to ASP. (For more information on the parameter block, see the text box "The Parameter Block and Friends" on page 250.) In most cases, the ASP routine is oblivious of the presence of the AFP data attached to the parameter block, and it passes everything to the AFP server unchanged.

This transparency is accomplished through a data structure known as a *command buffer*. Most of the ASP commands that AFP uses expect to find a command-block pointer in the ASP parameter block at offset 34. This command block is more or less another parameter block. However, ASP ignores the command block, simply passing its contents down the network to the AFP server machine. Code on the AFP server interprets the command block and acts accordingly.

For PC users: This scheme looks a lot like a technique for establishing a higher-level protocol on the back of NetBIOS. NetBIOS is a session-level protocol, at the same level as ASP in the eyes of the OSI definitions. If you're familiar with NetBIOS, you'll recall that the primary communication structure between an application and the NetBIOS driver is the NetBIOS Control Block. The NCB is analogous to the parameter block passed to ASP. NetBIOS programmers will also recall the buffer-pointer field located 4 bytes into the NCB. This is roughly analogous to the command buffer pointer in an ASP parameter block.

In true multilayered fashion, ASP is, in turn, built on the foundation of ATP. A careful investigation of ASP reveals that its raison d'être is to provide a logical connection between a client and a server. Once the connection is established, the general procedure is for the client to send commands to the server. The server executes those commands and returns appropriate responses. Consequently, it should be no surprise that ASP and AFP are built on the client/server paradigm. You should be aware that all the routines I'll speak of are client routines—routines your application program would use to transact business with an AFP server.

Although the higher-level protocols—AFP and ASP in this case—are designed to be as unaware of the lower-level protocols as possible, your program must still resort to requesting help from ATP and NBP. I'll take the apparently simple process of logging

ACRONYMS

Table 1: *A guide to the acronyms in this discussion.*

ADSP	AppleTalk Data Stream Protocol
AFP	AppleTalk Filing Protocol
ASP	AppleTalk Session Protocol
ATP	AppleTalk Transaction Protocol
NBP	Name Binding Protocol
NCB	NetBIOS Control Block
PAP	Printer Access Protocol
ZIP	Zone Information Protocol

AFP COMMANDS

Table 2: *The action resulting from a command is not always implicit in the command name.*

Command	Action
FPAddAPPL	Adds an APPL mapping to an application file on the server. This specifies the four-character tag that an application associates with any file created by that application.
FPAddComment	Adds a comment string to a file or directory.
FPAddIcon	Adds an icon to the volume's Desktop database.
FPByteRangeLock	Locks or unlocks a range of bytes in an open fork.
FPChangePassword	Lets you change your log-in password (AFP 2.0 or higher).
FPCloseDir	Closes a directory.
FPCloseDT	Closes a Desktop database.
FPCloseFork	Closes a file's fork.
FPCloseVol	Closes a volume.
FPCopyFile	Copies a file from one place to another on the same AFP server.
FPCreateDir	Creates a new directory.
FPCreateFile	Creates a new file.
FPDelete	Deletes a file or directory.
FPEnumerate	Lists contents of a directory.
FPFlush	Writes modified volume data back to disk.
FPFlushFork	Writes buffered data associated with a file fork to disk.
FPGetAPPL	Retrieves an APPL mapping from the Desktop database.
FPGetComment	Retrieves a comment associated with a file or directory.
FPGetFileDirParms	Retrieves file or directory parameters.
FPGetForkParms	Retrieves parameters for a particular file's data or resource fork.
FPGetIcon	Retrieves an icon bit map from the Desktop database.
FPGetIconInfo	Retrieves information about an icon on the Desktop database.
FPGetSrvrInfo	Retrieves descriptive information about an AFP server. (This command is actually directly mapped to the ASP command ASPGetStatus.)
FPGetSrvrParms	Retrieves information about volumes on a particular AFP server.
FPGetUserInfo	Retrieves information about a user registered with an AFP server.
FPGetVolParms	Retrieves information about a specific volume.
FPLogin	Establishes a session with an AFP server.
FPLoginCont	Some log-ins are a two-step process. This is part two of the process (see the main text for more details).
FPLogout	Ends a session with an AFP server.
FPMapID	Maps a user ID to a user name, or a group ID to a group name.
FPMapName	Maps a user name to a user ID, or a group name to a group ID (the inverse of FPMapID).
FPMoveAndRename	Moves a directory or file to another location on the same volume; the item moved can be renamed in the process.
FPOpenDir	Opens a directory.
FPOpenDT	Opens the Desktop database on a particular volume.
FPOpenFork	Opens a fork on a specified file.
FPOpenVol	Opens a volume on an AFP server.
FPRead	Reads a block of data from an opened fork.
FPRemoveAPPL	Removes an APPL mapping from a Desktop database.
FPRemoveComment	Removes a comment from a Desktop database.
FPRename	Renames a directory or file.
FPSetDirParms	Sets parameters for a specified directory.
FPSetFileDirParms	Sets parameters for a file or directory. (This call sets those parameters that are common to both files and directories.)
FPSetFileParms	Sets parameters for a specified file.
FPSetForkParms	Sets the fork length for a specified open fork.
FPSetVolParms	Sets the backup date for a volume.
FPWrite	Writes a block of data to an opened fork.

onto an AFP server as the launchpad for the rest of the article. Although you might expect that it's merely a matter of issuing an FPLogin command (AFP's symbolic name for the log-in command), it's actually more involved. First, you have to find the server's address. For that, you need NBP.

Make a Name for Yourself

I've talked about AppleTalk's NBP before. Its functions provide a kind of networkwide phone directory, a way of associating symbolic names with impersonal numbers.

For an application on your Mac to communicate across the network with an application on another Mac, you need the other application's internet socket address. This address is composed of three numbers:

- A network number that tells which network the Mac is on,
- a node ID that uniquely identifies the machine on the network, and
- a socket number that uniquely identifies the application on the machine.

If you're not a network heavyweight, you may wonder why an internet socket address needs a network number. The answer lies in the meaning of the word *internet*. An internet is a collection of networks, linked by routers. For example, an organization may have one network in sales and another in customer support. If the two networks are ever connected by a router, both networks stay in some sense separate, even though traffic can pass between them. The network number gives the router the information it needs to determine whether a packet should go to the sales network or to the customer-support network. Of course, your installation may consist of a single network, in which case the network number is superfluous.

In the above definition of an internet address, I've suggested that the socket number identifies one application running on the workstation. Actually, a single application can have multiple sockets active on a given machine. But for this example, I'll keep it down to a socket per application.

The internet address is inadequate as a permanent means of identification. A workstation actually chooses its node ID as it attaches itself to the network. The workstation transmits its chosen node ID across the network and, if no other workstation objects, keeps that ID. It is therefore likely that (unless you keep your

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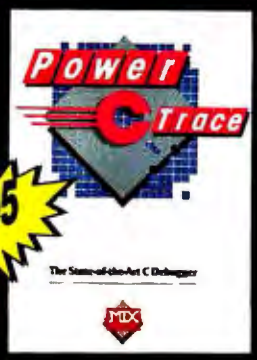

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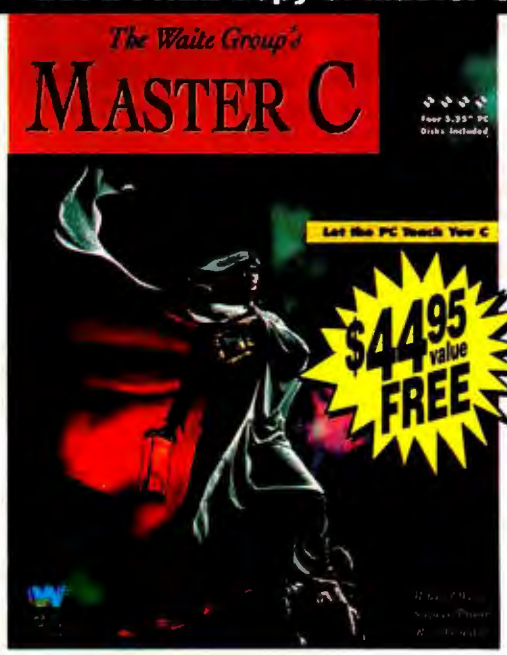

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The Parameter Block and Friends

If you've ever written an AppleTalk application (indeed, if you've even done moderately serious program development on the Macintosh), you are probably familiar with the data structure known as the *parameter block*. This is the means by which you transfer data to a Macintosh device driver when you want that driver to execute a particular command. The drivers associated with AppleTalk are as follows:

- .ATP, which handles the AppleTalk Transaction Protocol
- .MPP, which handles—among other things—the Name Binding Protocol (NBP)
- .XPP, which handles the AppleTalk Session Protocol and part of the AppleTalk Filing Protocol

If the term *parameter block* doesn't ring any bells for you, think of it as a well-defined chunk of memory that carries arguments into and out of a function. Macintosh functions that use a parameter block expect its address to be on top of the stack. The calling application must place function arguments at defined offsets within the parameter block. Likewise, any arguments that the called function returns to the application are placed at defined offsets within the same parameter block.

For example, if I want to execute a `LookUpName` function (one of NBP's commands), I have to reserve a 44-byte chunk of memory as the parameter block. Among other things, I must place 251 as a 16-bit value at an offset of 26 bytes within the parameter block that I pass to NBP. NBP reads location 26 to determine which command I want executed; it sees a 251 and recognizes that as the code for the `LookUpName` command. As NBP finds names that match my request, it increments location 42 in the parameter block. When NBP has completed, my application can examine location 42 and know how many matching names NBP found.

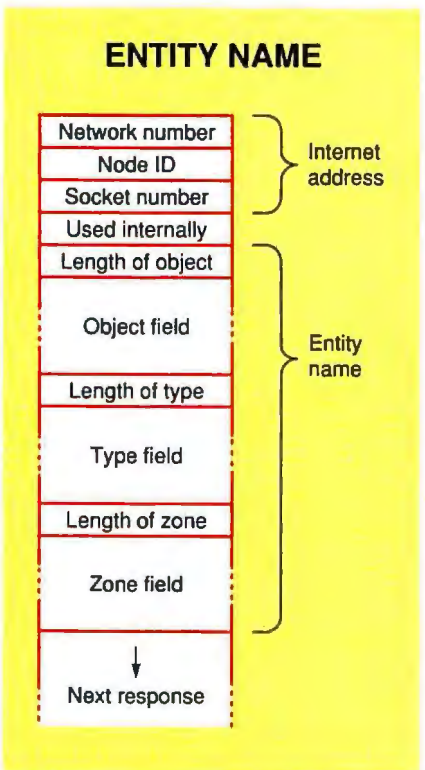

Figure 1: *The format of a single-response entry from the NBP* `LookUpName` *command. Each item in the internet address portion is a byte, except for the network number, which is a 16-bit value. Note that the elements of the entity name are counted strings.*

machine running and connected to the network continuously) the same machine will end up with a different node ID each time it attaches to the network.

With NBP, you can assign a symbolic name to your machine. In fact, you can assign different names to different applications running simultaneously on one machine. So, even if your internet address changes from Monday to Tuesday, your machine's symbolic name won't. Others on the network, by calling NBP's `LookUpName` routine, can find your machine's name and its associated internet address.

Thus, NBP provides the means by which you can locate the AFP servers on the network. The symbolic name (known as an *entity name*) that you associate with applications on your machine is composed of three fields: object, type, and zone. Each field is a counted string. The zone field allows network applications to divide themselves logically by some higher-level category—by department, for example. The type field specifies what the application is all about. Finally, the object field uniquely identifies the specific instance of the application.

Furthermore, NBP's `LookUpName` lets you specify wild cards in the different fields. The effect is much like wild carding in the directory commands of MS-DOS or other operating systems. You can ask NBP to find all names on the network for all zones that are of type "AFPServer." That, in fact, is how you locate all AFP servers on your network.

You might have more than one AFP server on your network. Here at BYTE, for example, the number fluctuates between three and four. Fortunately, one of `LookUpName`'s input parameters is how many responses the calling application is prepared to handle. Each response consists of an internet address, followed by an entity name (see figure 1). The calling application also has to set aside a *response buffer*, a region of memory large enough to handle all the responses. `LookUpName` continues to place internet addresses and entity names into the response buffer until it either locates as many as you've asked for, has found all that match, or times out.

These responses are packed nose-to-tail in the response buffer. Fortunately, `LookUpName` returns a count of the number of elements in the response buffer. Your application's job, then, becomes one of peeling the elements out of the response buffer and putting them into some useful data structure that maintains the relationship between internet address and entity name.

For example, the program provided with this month's column (the source code is available in a variety of formats; see page 5 for details) searches for all the AFPServer entities on the network. When the `LookUpName` routine returns, the application passes through the response buffer, pulling names out and placing them in list cells that will ultimately be

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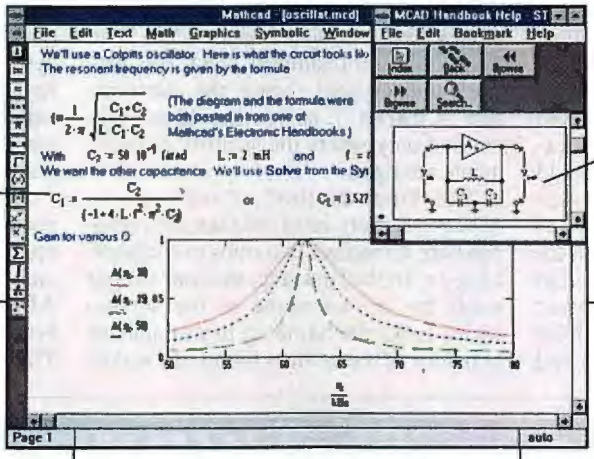

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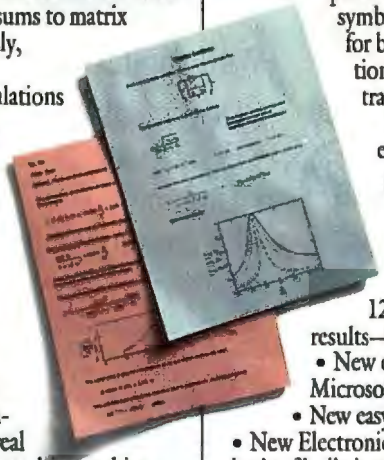

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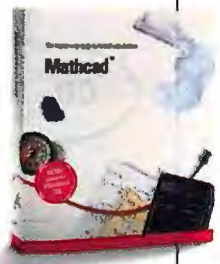

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handed to the list manager. Simultaneously, the program places internet addresses in an array such that the entity's list-cell index corresponds to the index in the internet address array.

Who Goes There?

Now that you know how to find the AFP servers on your network, you're ready to log on, right? Not quite. There is a security system to deal with. AFP implements *user authentication*, a means of determining whose grubby little fingers are allowed in which pie.

As of AFP 2.0, three versions of user authentication are supported by AFP servers; a given AFP server may allow one or more of the methods. User authentication goes into effect whenever you try to log into an AFP server. You can tell which versions the server supports by examining the user authentication method strings returned by AFP's `FPGetSrvrInfo` command. The UAM strings are simply counted strings packed back-to-back. The permitted values for the UAM strings are `NoUserAuthent`, `Cleartxt passwrd`, and `Randnum exchange`. (Note that, although I've mixed uppercase and lowercase letters, Apple's documentation on AFP states that testing the UAM strings should be done in a case-insensitive fashion.)

The first method, `NoUserAuthent`, simply means that no user authentication is required. Anyone can log onto the AFP server and do whatever he or she pleases as far as file and directory access restrictions permit.

The second method, `Cleartxt passwrd`, requires the server to verify each user's password during log-in. During the log-in process, the user transmits a password to the server, which checks it against its internal database of user names and associated passwords. The password is transmitted down the network unencrypted (hence the abbreviation "Cleartxt"), so you should use this method only where the security requirements are light.

The final method, `Randnum exchange`, is more involved than the previous two; it requires two steps to complete a log-in. In the first step, the user simply sends his or her name to the server, which looks the name up in its database as before. If the name is found, the server generates a random number and sends that number back to the user. Both server and user encrypt the number using the user's password as the encryption key. Now comes the second step: The user transmits the encrypted random number back to the server, which compares its own version of the encrypted number with the user's version.

If the user's copy of the password matches the server's copy, then both encrypted versions of the random number match, and the server gives the user clearance to complete the log-in process. Otherwise, of course, the log-in fails.

The encryption uses the Data Encryption Standard algorithm. The user's 8-byte password is used as the encryption key. Of course, implementing this user authentication method means your application program must have a DES encryption routine on hand.

AFP's user authentication is only a portion of the security system. You can apply further security controls to files and directories on an AFP server volume. AFP recognizes three types of directory access rights: search, read, and write. The names are fairly self-explanatory; I

continued on page 328

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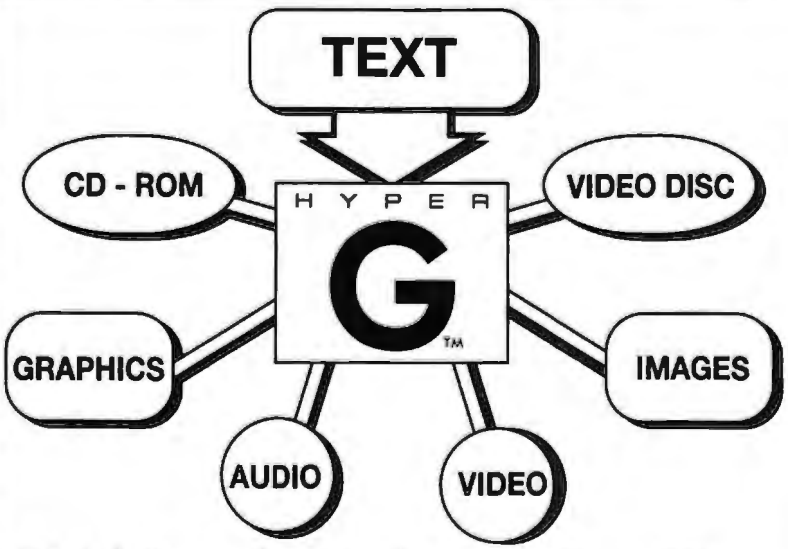

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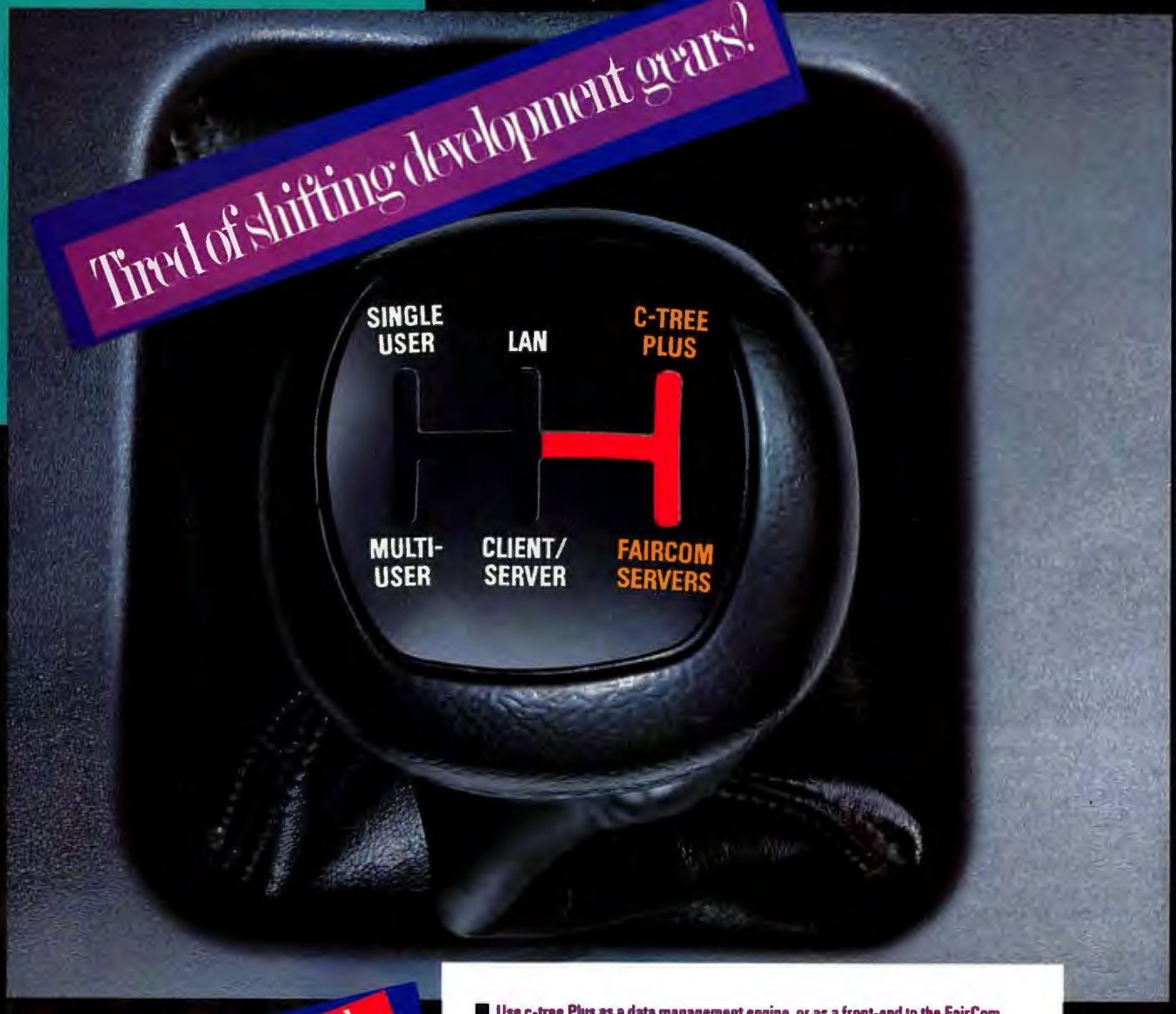

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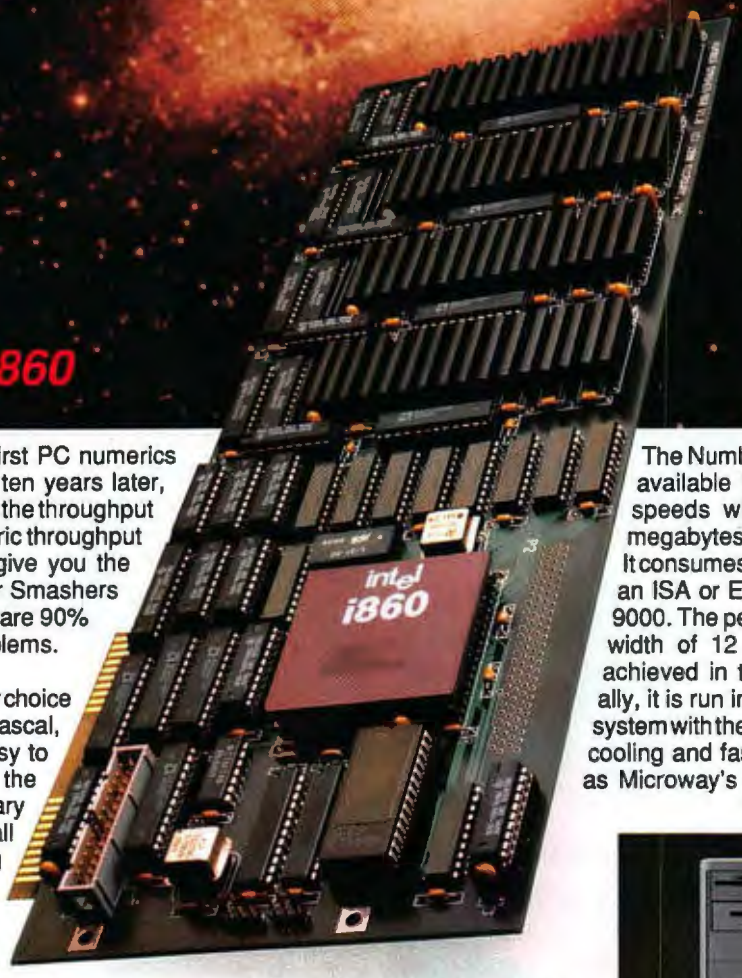

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JAMES MCGRATH

THE INCREDIBLE SHRINKING DISK

A look at the technologies that are making hard drives smaller, smarter, and faster than ever

In the excitement over new CPUs, more powerful systems, and innovative architectures, the hard-working hard drive may appear to be a mere commodity. In fact, however, contemporary hard disk technology represents some of the most advanced technology in fields as disparate as mechanical engineering and analog electronics.

In 1980, hard drives were not used in systems costing under $10,000 because of their high prices. Today, although the hard drive is still the most expensive subsystem in most desktop systems, the price has decreased dramatically—from over $100 per megabyte in 1980 to less than $10 per megabyte today. With the recent high penetration of hard disk technology into desktop systems, software developers are assuming that users will have large amounts of data storage, a situation that vastly simplifies developers' efforts and improves their products.

The popularity of notebook computers took off when the size and price of hard drives decreased sufficiently to suit that format. Now, advanced hard disk technology is starting to have a major effect on even smaller computing platforms. In the future, advanced hard disk technology will enable the development of palmtops that are practical personal computers, notebooks that are as inexpensive as desktops, laptops that serve as desktops, "diskless" workstations that can be locally booted, file servers with "disk farms" for massive data storage, and desktop applications that are even more graphical. Hard disk technology is already beginning to be important in noncomputing environments such as copiers, scanners, printers, and fax machines.

At the same time, the hard drive will remain a key limiting factor in overall system performance, because it carries the heaviest burden for handling I/O. So how can hard drives hold more and more data while manufacturers make them smaller and smarter?

Bits for the Buck

Currently, most personal computers are made with hard drives having at least a 40-MB capacity. For smaller-form-factor drives (e.g., 2½-inch and 1⅘-inch) to become viable in the mass market, they will have to hold at least that amount of data. To reduce the cost per megabyte for any given form factor, drives must have increased capacities (e.g., at least 1 gigabyte for 3½-inch drives).

But achieving higher capacities depends on producing denser mass storage (measured in megabytes per cubic inch). Reaching this goal means boosting any or all of the four primary drive parameters: raw track capacity, track density, format efficiency, and the number of disks and heads in a drive.

continued

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HEAD TECHNOLOGY

In cost, performance, and maturity, each head technology has the same relative ranking. Usually the designer chooses an appropriate head technology that yields a performance that satisfies the capacity requirements of the drive and is the least expensive and most mature.

	Cost*	Performance*	Maturity*
Composite	4	4	4
Metal-in-gap	3	3	3
Thin-film	2	2	2
Magnetoresistive	1	1	1

* 1 = highest cost and performance and least maturity

The priority in which drive makers will pursue these improvements is typically a function of "bang for the buck" (BFB). Vendors likely will work on track capacity first, because it has a direct bearing on the data-throughput performance—the more data you can pack on a track, the more data you can read in a single revolution of a disk. The difficult process of increasing track capacity focuses almost entirely on improving the media, head, and read/write technologies rather than those of the other parts of drive design.

In terms of BFB, improving format efficiency—how the bits are actually organized on a disk—runs a close second to track capacity. Clever formatting tricks, like multiple-zone recording, are usually inexpensive to implement. But increasing track density via improving servo technologies is no easy matter. It is a preferable method, however, to that of adding more disks and heads—an expensive process that does not improve performance.

More Bits by Flying Low

Track capacity depends on the amount of data that can be stored on a track. It is a direct function of data density and is measured in bits per inch.

The bpi is a function of both magnetic flux change per inch and the encoding technique that is used (e.g., RLL encoding). The fci is a function of how closely packed the magnetic field reversals (flux) are on a disk of a certain coercivity. Coercivity is a measure of how the medium resists reversals of the magnetic field; it does not limit the bpi.

Track density, on the other hand, determines the number of tracks that can be placed on a disk surface and is measured in tracks per inch. Bpi and tpi are the two dominant measures of hard disk capacity. Multiplied together, they yield a drive's *areal* density, or the amount of information stored per unit area (e.g., 100,000 Kb per square inch).

As bits are packed more densely and the size of the recorded bits shrinks, so too does the signal produced by the head. Thus, the fundamental challenge in packing bits closer together (i.e., increasing bpi) is flying heads closer to the medium to increase a signal's amplitude.

Smoothing out the medium to remove physical obstacles from a head's flight pattern is a good first step and is the key to decreasing the flying height of heads over the medium. In 1985, the flying height in state-of-the-art production drives was 9 microinches.

The flying height in most state-of-the-art drives today is approximately 6 microinches. Drives will achieve 3- to 4-microinch flying heights in the near future. Beyond that will be 2-microinch flying heights (in the realm of contact recording). At that point, designers will have a new set of problems to resolve, caused by wear between a head and the medium. These include excessive deterioration of the head and medium and the generation of contaminating particles, both of which preclude reliable reading and writing.

To allow for such low flying heights, media manufacturers must polish disks to a fine degree of smoothness. Economics demands that today's substrate of choice be an aluminum alloy. Because this material contains impurities that machine at a different rate than that of the host alloy, the medium contains some microscopic bumps and pits. Media makers, however, are developing highly sophisticated machining methods to try to increase the smoothness of aluminum alloy substrates.

Glass is the next favorite choice for achieving smoothness. This material is sufficiently rugged that it won't shatter at high revolutions or when shocked. But at two to four times the cost of aluminum, glass disks are simply too expensive for most applications. With the advent of higher volumes and improved production methods over the next few years, though, the cost should drop significantly.

More Bits by Getting a Head

The ability to increase the number of bpi is also highly dependent on the heads that have to write and read those bits—in particular, the magnetic properties of the heads and the mechanical suspension that supports them. The total cost of the heads is the most expensive part of a drive, currently running about $10 to $15 each.

But a drive's basic structure and objective are relatively simple. Essentially, a head is a piece of metal with a gap. It generates electrical signals as a head flys over a disk. A head is really a simple amplifier that translates magnetic pulses to electrical pulses.

Current and upcoming drives include models that are made from composite, metal-in-gap, thin-film, and magnetoresistive (MR) heads—from lowest to highest cost and data density (see the table). Composite and MIG heads are inexpensive but cannot attain the areal densities required for future applications.

Thin-film metal heads, currently used in leading-edge drives, will remain in vogue for some time. Thin-film heads come in many classes, but they are primarily characterized by the number of wire "turns" around a head (i.e., the more times the wire is wrapped around the head, the better it's able to pick up a signal).

Thirty-turn, thin-film heads are in wide use today and achieve optimal performance for a reasonable cost. Forty-two-turn, thin-film heads are closer to the state of the art, and vendors are just beginning to produce them in high volumes. Fifty-turn heads are just in the discussion stages.

IBM was first to develop MR heads. So far, however, heads made in this way have not been proven rugged enough to be produced in volume and used as commercial drives. MR heads are quite different from inductive-type heads. They rely on changes in resistance to sense the magnetic data on a disk. These types of head transducers are used for reading only. For the head to be used for writing, you need an additional inductive transducer. MR head transducers rely on changes in resistance to sense the magnetic data on a disk. They do not depend on the linear velocity of a disk to pick up a signal, so the rotational velocity of a

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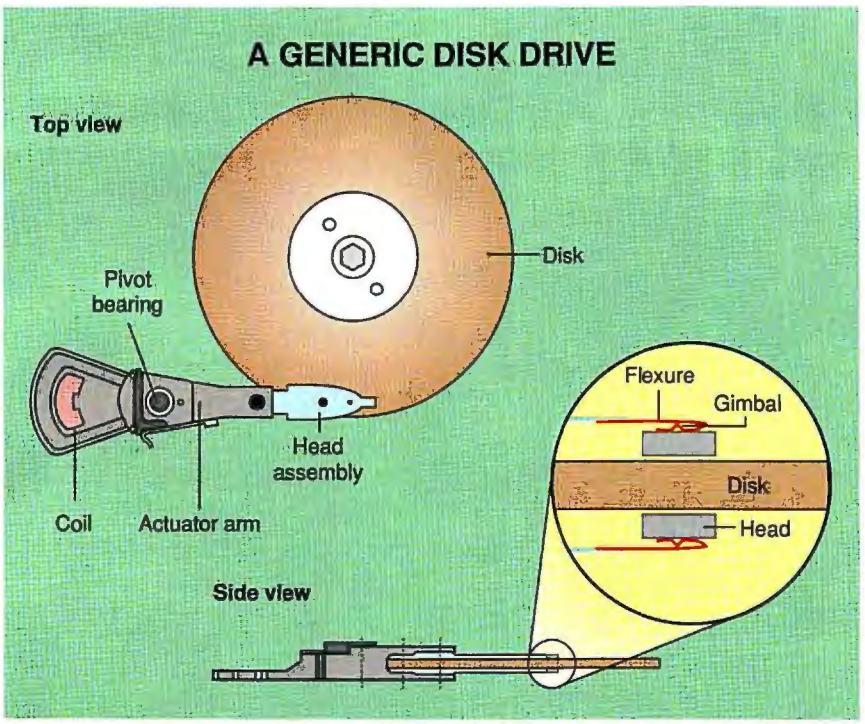

Figure 1: *The flexure is a thin piece of metal that connects the head to the load beam and allows the head to pivot around the gimbal point (or protrusion). The load beam provides the load for the head (i.e., the spring force that pushes the head toward the disk). The slider generates the lift to allow the head to fly slightly above the disk surface. The actuator arm positions the head across the disk. The way these components are designed is what creates variations in the head's flying height.*

drive can be changed from generation to generation of drives without immediate impact on the read electronics.

This rpm-independent read electronics will become more important in designing smaller-format drives. A 1⅘-inch drive has half the circumference of a 3½-inch drive. When rotated at 7200 rpm, the 1⅘-inch drive has the same linear velocity as the 3½-inch drive has at 3600 rpm. Therefore, it can use the same read/write electronics.

This high rpm rate conflicts with the low power requirements of portable computers. Until MR heads become viable, vendors will have to redesign their read/write electronics to achieve smaller form factors. The redesigns would slow the introduction of higher-capacity drives.

Next-generation drives will also require improved head suspension to allow for lower flying heights. The combination of the gimbal (the thin, flat piece of metal around which a head pivots), the slider (the mechanism that generates the lift to allow a head to fly mere microinches above a disk surface), and the pivoting of the rotary arm, or actuator (which positions the heads across the disk), creates variations in a head's flying height (see figure 1). Compensating for these variations would allow for better optimization of the read/write heads and permit higher capacities.

More Bits by Better Reading and Writing

Another way to achieve higher bit rates is improvement of hard disk read/write electronics. The primary aim of the read/write electronics is to detect when magnetic-flux changes occur and to translate that information into digital data for the control electronics.

Read/write engineers are a rare breed. They measure time in very short increments: picoseconds, or trillionths of a second. On tomorrow's 40-Mbps drives, the entire "window," or time frame, in which the read/write electronics must detect signal transitions will be only about 10 nanoseconds. To detect and convert flux changes that fast is beyond the ability of current digital technology, so this process remains a state-of-the-art, analog problem.

Higher data rates require more complex analog electronics, and eventually designers will move to emerging digital technologies that can process a signal better. There are other benefits to getting away from analog electronics: It is difficult to integrate it with digital technologies in silicon, it consumes more power, and it is much harder to test in manufacturing. A digital implementation of the read-channel electronics allows for the use of Partial Response–Maximum Likelihood (PRML), a decoding technique originally developed by IBM.

Traditionally, magnetic-flux changes recorded on media are detected when the signal exceeds a fixed threshold (or peak detection). As the flux-change density increases, the speed at which each signal peak must be detected increases. Since real signals are not perfect peaks, greater density leads to interference between the peaks, or intersymbol interference—a condition that often prevents correct detection of the flux changes.

PRML is due to replace peak detection in hard drives of the future. Rather than detecting flux changes when the signal exceeds a fixed threshold, PRML examines small incremental changes in the signal. This data is used to statistically determine the location of flux changes in the data stream. Theoretically, PRML will double the read-channel rate that is achieved using current peak-detection techniques.

More Tracks in the Works

Increasing tpi is primarily dependent on servo technology and the head/media combination. Track density is first limited by the size of a track's electromagnetic "footprint." The farther apart the tracks, the larger the footprint. Footprints that overlap will result in overwriting of data on adjacent tracks. The size of a footprint is determined by the worst-case flying height and the strength of the electromagnetic field.

Tpi is also a function of the type of servo system used to control the drive mechanics (i.e., the motor, in particular, as well as the actuator) and, therefore, the position of a head. If a head cannot accurately follow (or "register") a track, then "misregistration" results. The degree to which a head can veer off track is known as the track misregistration budget—the amount of misregistration a system can tolerate and still reliably read and write data. The smaller the TMR budget, the closer designers can pack the tracks together.

One major cause of misregistration is thermal expansion and contraction of a disk's aluminum substrate. Other causes are motor jitter and external forces impacting a drive. Hitting a system with your hand sets up forces that are millions

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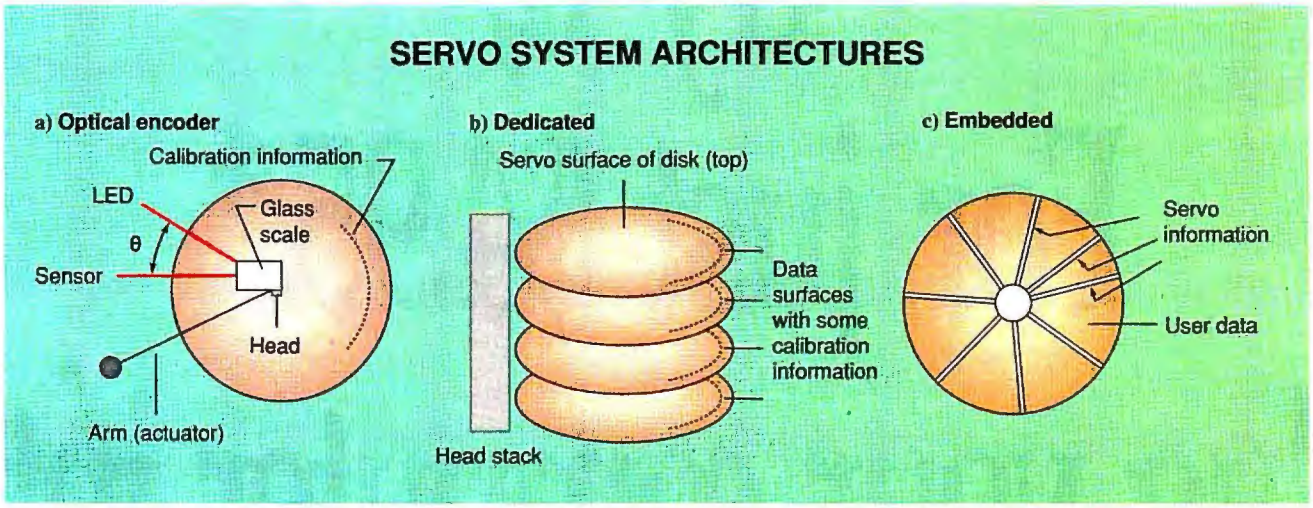

Figure 2: *In an optical system* **(a)**, *the LED generates light that illuminates the glass scale. By detecting the position of the light on the scale, the sensor measures the distance from itself to the scale. When the positions of these parts are known, the track is known. In a dedicated system* **(b)**, *the servo surface contains precise positioning information that the servo head reads. The servo system positions the servo head over the correct track based on the information from the servo surface. No user data is on the servo surface. Since the data heads are physically slaved to the servo head, they also should be over the desired track. Calibration information is used to compensate for varying thermal expansion/contraction. In an embedded system* **(c)**, *servo information is on every surface, located among the user data. The servo reads the information on the surface that it is accessing to determine its position. Since the positioning information resides on the surface containing the data to be read or written, no additional adjustments for thermal expansion/contraction have to be performed.*

of times greater than the forces drives could tolerate without a servo system.

Track density for one of today's leading-edge drives is 2000 tpi with 500 microinches from track center to track center. The TMR budget is typically kept to $\frac{1}{10}$ the width of a track, so the track must be accurate to approximately 30 to 50 microinches. In the next couple years, tpi will be on the order of 2500 to 3500. This track density will require a servo to position a head consistently within 30 to 40 microinches as it reads data across an entire disk.

The interaction between hard disk subsystems—in this case, the head/media combination and servo technology—is a beneficial feature of MR heads. These heads write a wide track but read only a narrow portion of the track. As a result, a servo system achieves a wider tolerance in positioning a head for reading. Because of this wider tolerance, a designer can increase the tpi.

Today's drives use three primary servo techniques: optical encoder, dedicated, and embedded (see figure 2). Optical encoder servos measure the position of the actuator arm relative to a drive's housing (i.e., its head/disk assembly, or HDA). Refined over several product generations of high-volume, lower-cost drives, optical encoders now permit higher tpi. Dedicated servos measure the position of the actuator arm with respect to one disk surface (i.e., the servo surface). Embedded servos measure the position of the actuator arm in relation to every disk surface.

More Tracks: Greater Dedication

Dedicated servos rely on positioning information residing on a single dedicated disk surface. The heads that read user data from the other disk surfaces are mechanically slaved to the head reading the servo information from this dedicated surface. There is a stronger coupling between the surface of one disk and another than there is between the HDA casing and the disk, so dedicated servos have some advantages over optical encoders.

But dedicated servos cannot take into account some components of positioning error that are head/disk specific (e.g., thermal expansion and contraction of disks and thermally induced offsets between the heads themselves). A dedicated servo mechanism compensates periodically for this situation by reading a small amount of servo data, located on each of the data surfaces, that is used to model the differences between the data and servo surfaces.

However, for smaller form factors, dedicating an entire side of a disk wastes as much as 50 percent of the potential recording surface. With higher-capacity drives, you can amortize the cost over more disks.

Embedded servo systems are destined to become the primary technique for the next several drive generations. They overcome the limitations of both optical and dedicated servos by reading the "bursts" of servo information on every track. Embedded servo systems position a head with respect to an actual disk containing user data. This process enables the servo to compensate for elements of positioning error caused by variations between different heads and disks. In addition, unlike dedicated servos, embedded servo systems can be used cost effectively in single-disk drives.

The downside of embedded technology is that the servo data requires the dedicated use of approximately 10 percent of all data surfaces, leaving the remainder for header and user data. A 2000-tpi embedded servo drive provides the same capacity as an 1800-tpi optical encoder drive. The servo data for embedded servo drives still requires less recording area than dedicated servo data until there are five disks in a drive. At that point, the dedicated servo information, as a proportion of the entire disk surface, equals 10 percent—the same as with embedded servo systems.

Embedded servos still provide lower performance than dedicated servos because of their track-seeking method. To locate a desired track, dedicated servos only need to count the number of tracks the heads have crossed. Embedded servo

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information, on the other hand, is available only on the portion of the tracks over which a head is flying at any point in time. Thus, embedded servo bursts must encode the actual track number that is read whenever the head's flight path happens to intersect the servo data—perhaps only every 20 tracks.

An embedded servo's decreased sampling rate also reduces its track-following capability, potentially limiting the tpi. Other limitations in head-width and drive mechanics provide the current constraints on the tpi. In the future, servo systems will use microprocessors and digital signal processing techniques to crunch servo data even faster once it has been retrieved. The servo system will use the data to create more sophisticated models of the mechanics that will allow for better compensation of mechanical limitations. These new and improved models will reduce the effects of mechanical "jitter," an improvement that will permit higher tpi and faster seek times. The one major challenge to implementing embedded servos is the extreme complexity in merging this technology with another leading-edge formatting technique: multiple-zone recording.

Format Efficiency: Zoned Out

Multiple-zone recording takes advantage of the fact that tracks toward the outer diameter of a disk can accommodate more sectors per track than those on the inner diameter. In traditional architectures, the number of sectors per track is limited by the number of bytes or sectors that fit in the innermost track. Multiple-zone recording techniques locate more sectors (and thus more data bytes) on the outer portion of a disk, providing a more efficient use of the disk surface.

This technique increases the effective storage capacity by as much as 25 percent. It also boosts the overall disk-to-buffer transfer rate, since with more bytes per track, tracks in the outer zones are read at a faster rate. This difference is significant, since the disk-to-buffer transfer rate is one of the limiting factors in the sustained transfer rate from a drive to a host system.

The varying numbers of sectors per track associated with multiple zones substantially complicate the implementation of embedded servo technology. Traditionally, there is one servo burst per sector—a setup that works fine with a constant number of sectors per track, because it results in a constant number of servo bursts. However, if you maintain one servo burst per sector but have a variable number of sectors per track, you get a variable number of bursts per track.

Servo systems are based on a time function, so a variable number of servo bursts per disk revolution gives a variable sample rate. Thus, for multiple-zone recording, servo designers would have to make a different servo to respond to the changing servo burst rate for each of the eight to 32 zones on a drive. This change would further complicate an already difficult task by an order of magnitude.

The solution is to keep the number of servo bursts constant per zone but not to have one burst on every sector. On the outer diameter of a disk, for example, you might have 2½ servo bursts per sector, and on the inner diameter of the disk, just 1½ bursts per sector. Obviously, this variation necessitates placing servo information in the middle of sectors (i.e., user data fields must be split up with servo information). As a result, designers must develop controller electronics that can handle split data fields.

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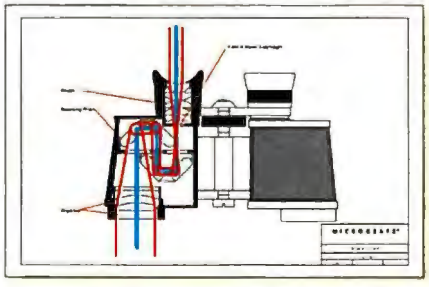

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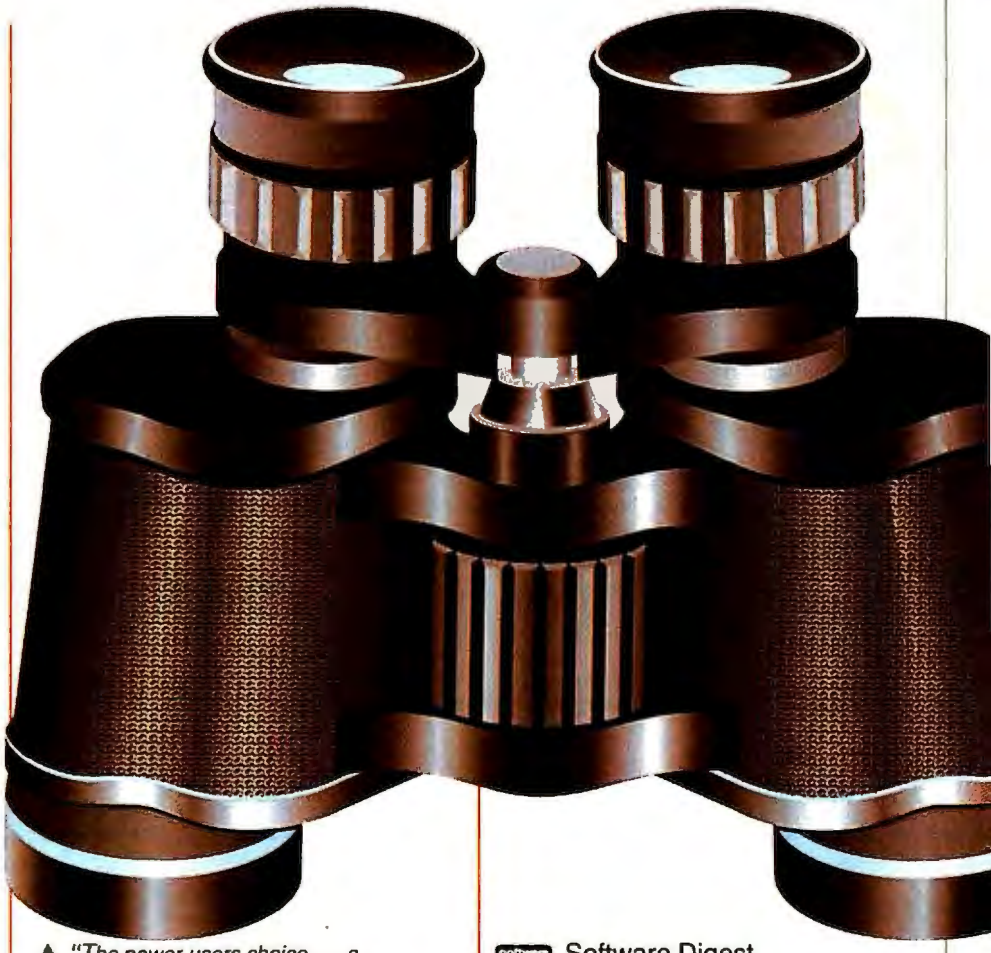

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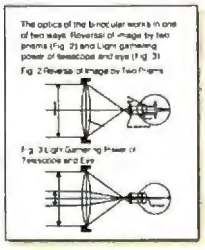

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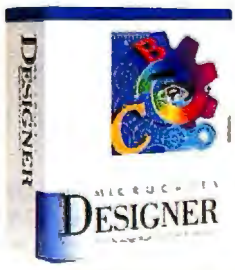

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Load 'Em Up: Adding Disks

The most obvious way to increase drive capacity is to add more disks. However, that adds expense and complicates manufacturing, since it involves trying to pack more hardware into less space.

In 1986, it was considered impressive when vendors could put six disks in a 3-inch-high package. Today, they are shipping up to eight disks in 1⅗-inch-high drives; tomorrow it will be a dozen or more. Packing in more disks will require vendors to develop thinner disks and smaller heads for closer disk spacing.

But the greatest challenge today in achieving smaller form factors is the classic problem of integrating chip functions so as to reduce the height and real estate requirements of the drive electronics. The problem is that, with each step down in form factor, you have to fit the same printed circuit board functionality in half the area. For example, the area for 2½-inch drives is less than 6 square inches, while a processor alone can take up to 2 square inches. Worse, the minimum height of PCBs using current technology is about 5 millimeters—fully one-third the height of today's 15-mm-high packages for 2½-inch drives. For next-generation 1⅗-inch drives, people are talking about 10-mm-high packages—so fully half of the entire height would be devoted to 5-mm-high PCBs.

Driving Multiple Disks

Drive makers have several methods at their disposal to improve the overall performance of disk-based mass storage for high-end workstations and file servers. One is placing many inexpensive drives into a single disk array. This technique is analogous to multiprocessing at the CPU level. You can either read sequential data from multiple drives simultaneously (i.e., achieve 20,000-KBps transfer rates from 10 2000-KBps drives) or spread data with random access across all the drives. In theory, the transfer rate will scale in direct proportion to the number of drives used. (For more on multiple disk arrays, see "Strength (and Safety) in Numbers," December 1990 BYTE.)

Getting Small

Capacity is one dimension of hard disks, performance is another, and size is the third. Historically, the width of the previous form factor has become the length of the next (a 7-to-5 ratio). We've gone from 5¼ inches to 3½ inches to 2½ inches. The next step is 1⅗ inches, and then perhaps 1⅜ inches, 1 inch, and maybe even ⅘ inch (the size of a matchbook). Each new generation has occupied half the recording area of the previous drive.

As form factors shrink, the mechanics get better. Actuators with less mass move faster. Smaller disks with less inertia spin faster. Motor magnets get proportionally stronger. The overall mechanics use less power, make less noise, and react less to shock and vibration. With contemporary micromotors the size of pencil erasers, there's no telling what the ultimate destiny of hard disks will be. ■

James McGrath is a systems engineer at Quantum Corp. and developer of the industry's first implementations of read and write caching in embedded-controller disk drives. For the past four years, he has represented Quantum in various standard-setting bodies, including ANSI's X3T9.2 (the SCSI and AT interface committee). He can be reached on BIX c/o "editors."

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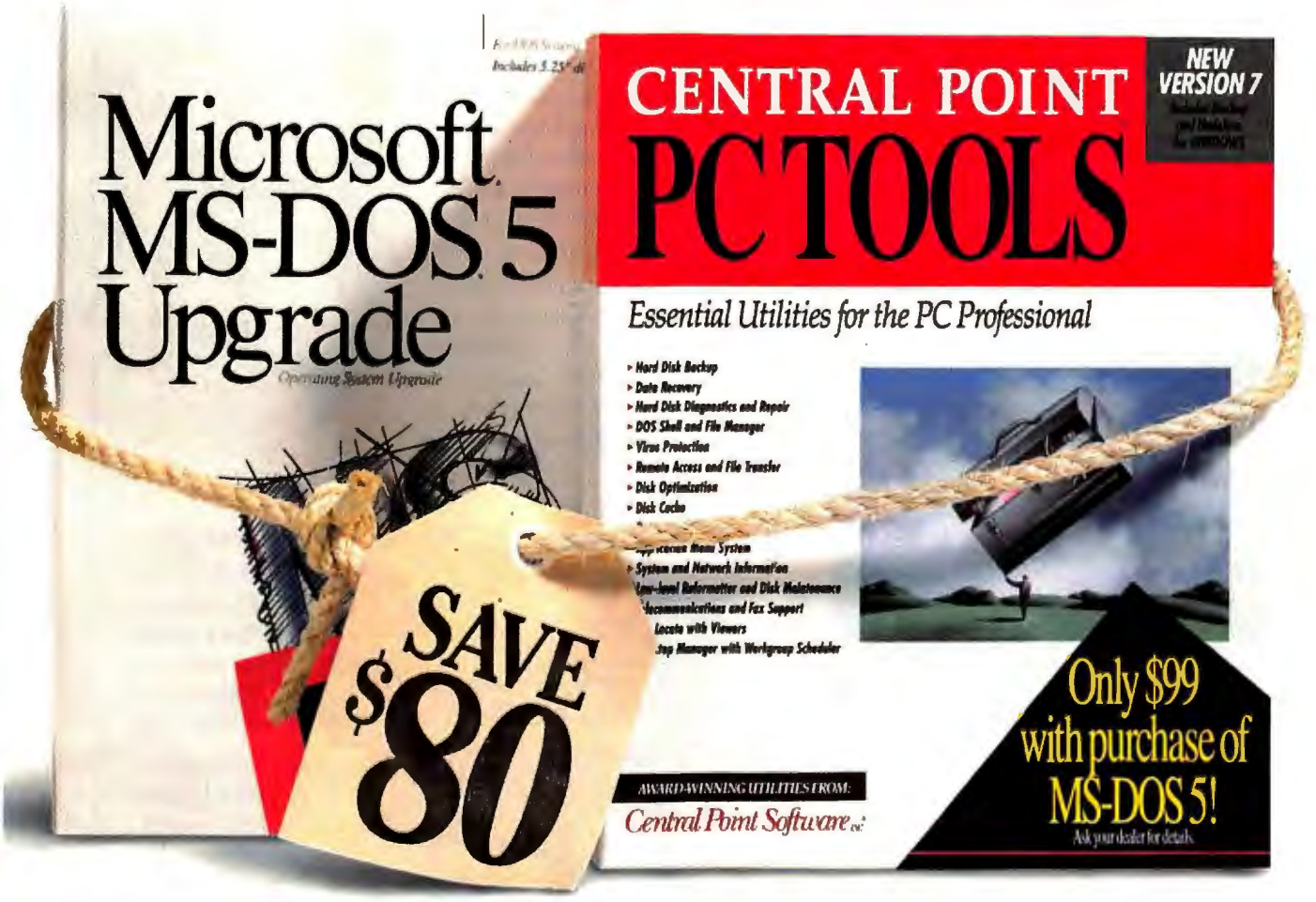

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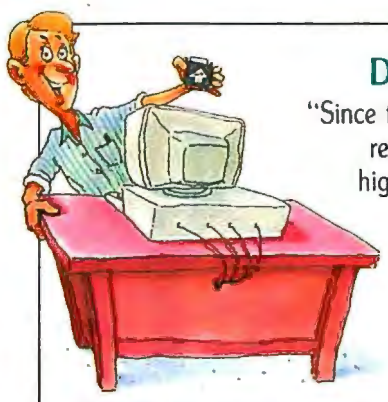

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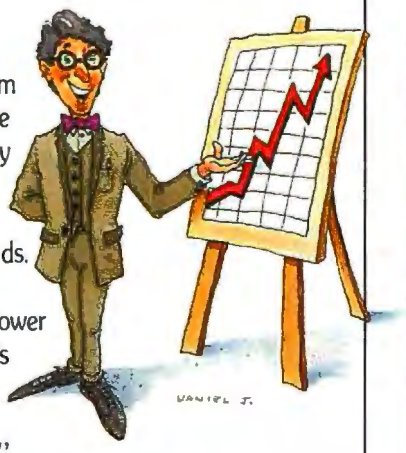

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The second program, Mail, is a somewhat larger TSR that contains the user interface for sending mail, reading mail, and composing mail messages. Once you have used the simple text editor to write your note, you can attach a file (e.g., a spreadsheet or executable), and you can carbon copy the note to a list of people. When you send an E-mail message, Mail triggers Postman to actually deliver the note.

Postman takes up only about 24 KB, while the larger Mail program uses 48 KB. Mail is easily unloaded from memory when you need the extra RAM to run a large application, but you should leave Postman in memory to receive your mail unless you really want to unload it.

A quick Alt/Right-Shift hot key brings up Mail. A set of text-mode icons tells you what's in your in basket and out basket. The user interface is simple: Press *S* to send mail, *X* to exit the program, and F1 for help. Use the cursor keys to scroll through your in basket, and press Enter to read an item.

Pressing *S* brings up a small text editor. Compose your note, and when you are finished, Mail asks you for a cc list and the name of a file if you want to use the attached-file feature. Mail then hands the note to Postman (by putting it in your out basket) for delivery.

If Postman and Mail don't use the file server, how do you send mail to someone who isn't logged on at that moment? When Postman can't deliver a note right away, it wakes up every 10 minutes thereafter and tries again. When the other person logs on and runs Postman, the two workstations communicate, and your out basket is emptied.

Programming Techniques

I used Borland's Turbo C 2.0 to write Postman/Mail, and because I coded some in-line assembler, you'll also need Microsoft's Macro Assembler or Turbo Assembler if you want to modify the programs. The TSR/hot-key routines are a little complicated, but it shouldn't be necessary for you to touch that part of the program.

Postman first adds a name to the NetBIOS name table, and then it issues a NetBIOS `Receive` command. The mail messages (and any attached files) that one Postman sends to another are a series of NetBIOS datagrams. Postman runs as a background process, completely independent of whatever applications you might run in the foreground.

Try Postman and Mail. You'll save server disk space and the housekeeping chores that go with it. ■

MAC/Tom Thompson

Identify the Problem

There's nothing more aggravating than the appearance of one of those cryptic alert windows that tersely states, "I/O error, code = 42," smack in the middle of your work. Whether you're developing code or calculating the quarterly budget, messages like this leave you wondering what on earth "42" means (other than the meaning of life).

That's when the System Errors desk accessory can come to your aid. It provides a handy list that pairs each code with an explanation of the error. When an alert appears, you note the number, open up System Errors, and scroll to the appropriate number.

I find System Errors valuable while writing Mac code, but it's also handy for troubleshooting other Mac problems, because the explanations give you a good place to start. System Errors is free and is written by Bill Steinberg.

UNIX/Ben Smith

Elm: An E-Mail Interface

Elm is a Unix E-mail system user front end—that is, a personal E-mail manager that you can use to send, read, and respond to your mail messages and addresses.

Elm filters out unnecessary overhead E-mail information you receive and also allows you to simplify mail addresses that you send. It incorporates address and mailing list aliases, mail header parsing for aliasing and replies, and mail folders for each correspondent. Elm can be compiled to work with all popular routers and delivery agent programs.

Elm was originally written by Dave Taylor for Hewlett-Packard, which has released it into the public domain. The source code is well maintained to correct problems and deficiencies. You may see the Elm interface implemented on the BIX mail system within the next year or so. It is elegant, efficient, and intuitive.

Editor's note: *Software Corner programs are available in a variety of formats. See "Program Listings" on page 5 for details. We solicit your contributions for this column. If you've written a program or utility that you think others might find useful, let us know. We'll pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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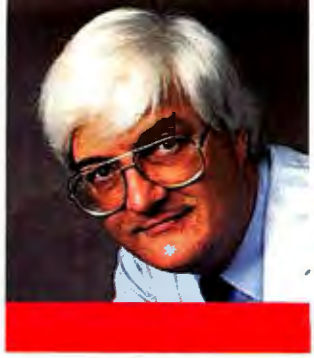

BARRY NANCE

GETTING THE MOST FROM NETBIOS

NetBIOS programming adds a new dimension to LAN-aware applications by allowing you to quickly send and receive data records and messages between workstations. Unlike sharing files on a file server, NetBIOS programming does not require disk space, housecleaning, and subdirectory permissions. Many network operating systems accomplish their file I/O redirection by establishing NetBIOS sessions. You can transcend the limitations of the LAN operating system by programming your own NetBIOS dialogues.

I remember feeling both excited and anxious as I prepared to test my first NetBIOS program, which passed messages from workstation to workstation. It did not work at first, and I spent many hours debugging it.

No one should have to go through the pain I did to write NetBIOS-aware software. By learning from my experiences, you can avoid a few pitfalls. You can also benefit from a programming tool that I wrote—NetBIOS Microscope—that will help you understand NetBIOS better.

Name Calling

One of the first things to verify when writing NetBIOS code is that your program adds and deletes NetBIOS names correctly. If you run the program and two workstations seem to have gone out to lunch, don't just reboot them. Go to a third workstation and run NETTEST .EXE, my NetBIOS Microscope tool for inspecting NetBIOS operations (the note at the end of this column explains how to get a free copy of the source and executable code). You can use NETTEST to eavesdrop on other NetBIOS name tables or just use the source code as a working model. It contains functions for adding and deleting names, calling, listening, sending, receiving, and hanging up.

You start by selecting NETTEST's `Adapter Status` menu option and specifying that you want information about each test machine. If the computers are up and running but unable to communicate, NETTEST tells you the contents of the name table on each test machine. You'll then know if your program at least performed a correct `Add Name` operation. If you want to deliberately cause an `Add Name` failure to see how your program behaves, use NETTEST to add that exact name on one workstation and run your program on another. You'll see a collision, since NetBIOS doesn't allow duplicate names on the LAN.

If the name isn't present in the local name table on the test machine, or if the command times out, start looking for the problem in the part of the program that constructs the name and adds it to the local name table. If that code looks OK, backtrack to see if the problem occurred earlier in the program. If the `Adapter Status` command times out, the `Add Name` operation probably executed properly, but your program damaged NetBIOS or crashed the workstation. If you can't find the problem in or prior to the code that does the `Add Name`, assume the name was added correctly and look for the problem later in the program.

NetBIOS Datagrams

If you designed your program to pass datagram messages silently, with no screen message or other outward sign to tell you what's going on, put some temporary code into the program that shows when message transmission or receipt occurs. Do your testing on two adjacent workstations so that you can watch both screens at the same time.

Suppose you determine that workstation A is sending a datagram but workstation B isn't receiving it. The first place to look is the code that does the `Send Datagram`:

- Does it properly fill in the NCB_NUM field (the "name number" of the local workstation)?
- Is the NCB_LENGTH field nonzero?
- Does NCB_BUFFER_PTR point to the data you want to send?

The next place to look is the `Receive Datagram` call:

- Is the NCB_NUM field properly filled in?
- Do NCB_BUFFER_PTR and NCB_LENGTH correctly express the address and length of the input (receiving) buffer?
- Is the `Receive Datagram` call

Advice on using NetBIOS to bypass the file server, and a free program that lets you do it

ILLUSTRATION DAVE CUTLER © 1991

returning an error code?
- Is the `Receive Datagram` call outstanding at the time the program issues the `Send Datagram` call?

NetBIOS doesn't guarantee delivery of datagrams. If a few datagrams disappear on their way from one workstation to the other, you'll need to insert a sequence number into your datagrams and incorporate logic in your program to detect lost message packets. You can use a technique similar to that used in the popular XMODEM protocol.

If a datagram does not show up within a reasonable time, you ask for it again by returning a NAK (negative acknowledgment) datagram to the sender. If you design your program to return an ACK or a NAK for every datagram, however, you might as well use a NetBIOS session to carry your messages instead of datagrams. Most NetBIOS implementations limit datagrams to 512 bytes, while session messages can be up to 64 KB long.

Another error can occur when the two communicating workstations sit on separate LAN segments and the bridge does not transfer NetBIOS messages. For example, if you internally bridge two segments at your NetWare file server and use IBM's DXMT0MOD.SYS NetBIOS device driver, the NetWare bridge won't transfer the NetBIOS frames. You must use Novell's NetBIOS emulator instead.

In Session

If you've issued the `Call` and `Listen` commands on the two workstations, but the workstations still can't establish a session, check the NCB_CALLNAME and NCB_NAME fields in the NCBs issued by both workstations. For the `Call` command, make sure the NCB_CALLNAME field contains the name of the listening workstation. For the `Listen` command, make sure that the first byte of NCB_NAME is an asterisk if you're listening for a call from anyone, or that NCB_NAME is the name of the caller. NetBIOS names are always 16 bytes long, padded on the right with spaces.

If your program has a complicated design that creates multiple sessions, you may find that it exceeds the number of available sessions. Look at the installation and configuration documentation for NetBIOS. You might be able to use command-line parameters to increase the number of available sessions.

Avoid using the NetBIOS `Reset` command to configure a different number of sessions, though. On a PC LAN Program (PCLP) or DOS LAN Requester workstation, `Reset` deletes names from the NetBIOS name table.

I made the mistake of using `Reset` when working on my first NetBIOS program. On a NetWare LAN, using the Novell NetBIOS emulator, it worked well. The program also worked on a PCLP LAN—until the program terminated and DOS tried to display a DOS prompt. I saw nothing but network errors instead of C:\ prompts until I realized just what I had done.

Once you've created a session, make sure you save the value of NCB_LSN (local session number). You will need it in subsequent references to the session.

Sending and Receiving

Once your NetBIOS session is under way, you should be able to verify that the workstations are sending and receiving messages correctly. Having problems? Perhaps NCB_LSN isn't properly set, or

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the NCB_BUFFER_PTR and NCB_LENGTH fields don't properly describe the input or output buffers. For the Receive operation, make sure that you set NCB_LENGTH to the size of the input buffer. Neglecting to specify a buffer length is an error that's commonly made; if NCB_LENGTH is zero when your program issues a Receive call, you won't be able to receive any data.

The Send and Receive operations time out according to the NCB_STO and NCB_RTO values given at the time the program issues the Call and Listen commands. If your program seems to work only intermittently, check these fields for incorrect settings. A Send operation that times out will cause the session to abort. A Receive operation that times out merely completes with an error code 05 ("timed out"). When you specify a POST routine in a network control block, your program continues executing after you issue the NCB to NetBIOS. NetBIOS calls your POST routine when the event, usually a Listen or Receive, completes (the NETTEST source code contains a POST routine you can study). Remember these things and your POST routine will handle the event correctly:

- Interrupts are masked (turned off).
- The ES:BX register pair contains a far pointer to the NCB.
- The other CPU registers, including the data segment (DS) register, have no particular value.
- The NCB_CMD_CPLT field contains the final return code.
- Performing DOS function calls may not be safe.

You're not committing a programming error by continuously polling one workstation from another, but doing so *can* cause you problems. Suppose that you want to know when a remote workstation user presses a key, or when a modem character has arrived at the remote machine. If you send a constant stream of inquiry packets to the remote computer, you will dramatically and unnecessarily increase network traffic. Design your dialog box to ask the remote computer only once about the event and then process the responses as they occur.

Don't forget that *both* workstations should issue a Hang Up command to dismantle the session. And, unless you want to leave the names you've added in the local name table, make sure your program issues a Delete Name command after the Hang Up operation completes. If you leave the names in the table and the user runs the program again, the Add Name operation will fail when it encounters the previously established names.

Direct PC-to-PC message passing is a better strategy than file sharing for many applications, and it's just as easy to design and program. ■

Editor's note: *You can obtain the NETTEST source code and executable code from Demolink and BIX. It's also available on floppy disk (see page 5 for details).*

Barry Nance does R&D and technical-support work for Insurance Software Systems, a software development company in Hartford, Connecticut. He is also the IBM Exchange editor on BIX, where you can reach him as "barryn."

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

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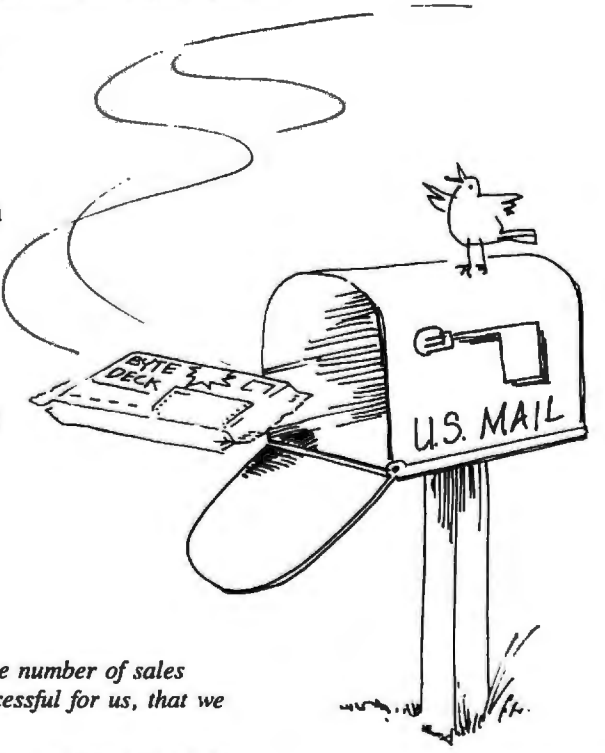

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MARK J. MINASI

THE CASE OF THE MISSING MEMORY

DOS 5.0 and Windows 3.0 are a new pair, so it's no surprise that it may take a while for them to settle in together completely. This thought came to mind as I was involved in a phone discussion with someone who had attended one of my seminars.

"This DOS 5.0 memory stuff is bogus," the caller said.

"Pardon?" I replied. I must admit that I often regret providing postseminar telephone support, but that's business. The Power Windows seminar, however, makes my phone busier than Domino's Pizza during the World Series. "Bogus how?"

"I thought it was neat that DOS 5.0 came up with 629,000 bytes free. So I ran Windows and created a DOS box. And you know what I got for free space? 584,000 lousy bytes. What a rip-off!"

He (his name turned out to be Jim) explained further that, under DOS 3.3, he'd had something like 570 KB free before Windows, and about 557 KB free in a DOS box created under Windows. The Windows overhead, he said, had seemed to be around 13 KB for a DOS box.

"Hang on a minute," I said, closing Solitaire: I could see this would involve a little work. I opened up a DOS box and checked my memory, and sure enough, MEM reported about 13 KB less free space in a DOS box than DOS reported before loading Windows. So what could be causing this?

Plenty of Suspects

The first place to look was at our old friends, TSR programs and device drivers. They might not be responsible for the original problem, but if I could free up some more memory *before* he got into Windows, maybe Jim wouldn't mind the Windows memory bite so much.

"Have you checked your TSRs and device drivers?" I asked.

"Of course," he said. "I've got them all loaded high into UMBs." UMBs, you will recall, are upper memory blocks, Microsoft's new name for what we used to call high DOS memory.

"But have you checked that the UMBs make sense?" I replied. You see, the memory managers that appeared before DOS 5.0—Qualitas's 386Max and Quarterdeck's QEMM-386 are the two best known—came with extensive optimization programs that attempted to ferret out every byte of used and unused space between 640 KB and 1024 KB.

Writing those programs is a job and a half, particularly with video RAM. VRAM is situated somewhere between A0000 and BFFFF in the PC's address space. That wouldn't be a big deal, except that the memory is paged—now you see it, now you don't.

Reconciling the DOS 5.0 and Windows memory managers

ILLUSTRATION: DAVE CUTLER © 1991

Some Super VGA boards in particular can confuse the heck out of the memory manager optimization programs, because they may have VRAM that gets activated only when in graphics mode. As the system isn't generally in graphics mode when it's booting up, the optimization program—which runs by booting the system and then watching to examine *who's* using *what* memory—misses the memory and attempts to stick a UMB in the same place that the VRAM buffer will appear.

You, unsuspecting, load a TSR into that UMB. All is fine until you run a graphics program. The video buffer then wakes up, and either makes hash out of your TSR or produces garbage on the screen, or some combination of the two. I think Qualitas and Quarterdeck have worked this one out, but I'm sure it produced some hair-pulling in Bethesda and Santa Monica.

Where DOS 5.0 comes in here is that it doesn't have even a basic system optimization program. When the EMM386 memory manager loads up, it attempts to find and avoid the trouble spots, but there are plenty of places that fall through the cracks. So take some advice: If you want to use UMBs, you'll have to do the hard work yourself.

First, get out your documentation and find the locations of the ROMs and RAM buffers on your adapter boards. I know that this is a pain, but do it. You then tell EMM386 explicitly which areas it can use with `i=` and `x=` parameters. Explicitly lock out the whole video area, and don't try to recover space from the system BIOS.

For example, one of my systems has a VGA board with a BIOS at addresses C0000–C7FFF and a hard drive whose BIOS lives at CC000–CDFFF. I set up the following EMM386 invocation in CONFIG.SYS:

```
DEVICE=EMM386.EXE X=A000-C7FF
I=C800-CBFF X=CC00-CDFF
I=CE00-EFFF RAM
```

This may be a surprise to some of you, because the DOS 5.0 manual neglects to mention that it's OK to have multiple i= and x= parameters.

Did this yield benefits for Jim? Not on his machine, but he found something interesting: It seemed that EMM386 shied away from the 64-KB range from E000 through EFFF. The only thing I know that ever used that area was the IBM PCjr software cartridges, so it's difficult to understand why EMM386 would avoid the area. (How many copies of DOS 5.0 are running on Juniors, I wonder?)

Matching Page Frames

When you modify EMM386 as above, you might find that it complains that it "cannot place the page frame" or some such. It's referring to the 64-KB page frame, a buffer that any EMS-emulation product needs to create somewhere in the UMB area to provide EMS services to programs. Place the frame explicitly for EMM386 with the frame= parameter. Place it as high or as low as you can, so as to avoid fragmenting the UMB pool. I generally put it at E000, causing the EMM386 invocation to get a bit bigger:

```
DEVICE=EMM386.EXE X=A000-C7FF
I=C800-CBFF X=CC00-CDFF
I=CE00-EFFF RAM FRAME=E000
```

You may know that Windows takes over the EMS emulation from EMM386 when it starts up, so it needs to know similar things to what I've just gone through with EMM386. It can't hurt to make things explicit for Windows with a few commands. There are equivalents for i=, x=, and frame=, with the names emminclude=, emmexclude=, and emmpageframe=. They all appear in SYSTEM.INI under the [386enh] section. You can have multiple include and exclude statements. The SYSTEM.INI statements that would correspond to the above EMM386 invocation would be the following:

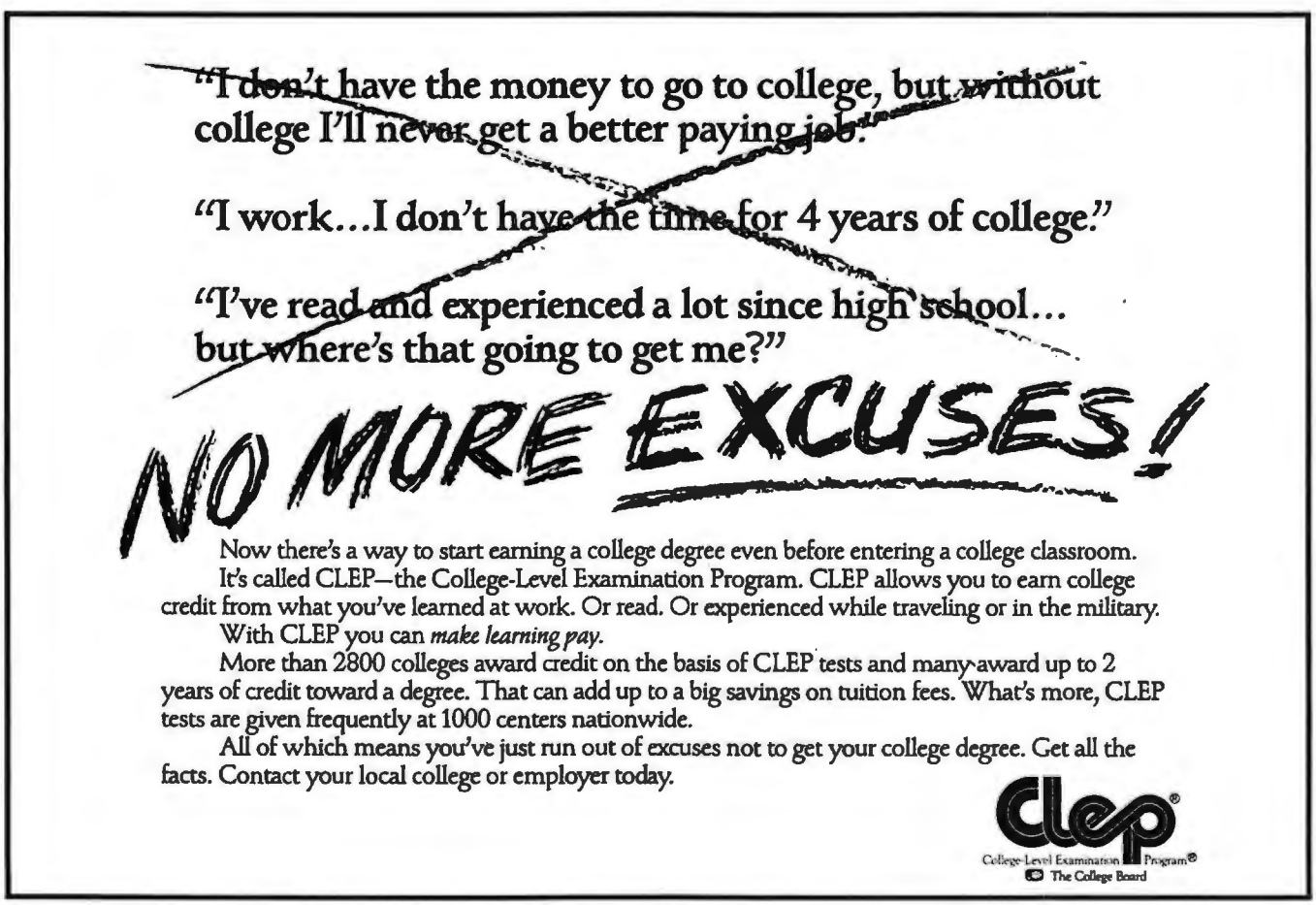
```
emmexclude=A000-C7FF
emminclude=C800-CBFF
emmexclude=CC00-CDFF
emminclude=CE00-EFFF
emmpageframe=E000
```

"This is a real puzzler, Jim," I said. "Have you tried playing around with the program information file settings?" I didn't think that it would get him anywhere, but if he had a goofy PIF, that could cause the problem. (By the way, here's a PIF tip: Be sure to shut off Monitor Ports. It's unnecessary for 99 percent of the video boards out there—100 percent of the VGAs—and can slow down your screen in graphics mode by a factor of 3!)

"Let me check your UMB settings. Are your ROM addresses handy?" They were—and that was what finally started us toward the correct answer. Jim had the following situation with his memory usage in the UMB area between 640 KB and 1024 KB:

640–768: VRAM, as usual
768–800: video ROM
800–832: free—there were UMBs in there with some small TSRs
832–896: taken with ROM on some oddball interface cards

continued



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SpeedEdit for PM	255
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896–960: free—used for the EMS page frame
960–1024: taken with system BIOS

Then I remembered reading about some buffers—Microsoft documents refer to them as *translation buffers*—that Windows uses to transfer data between extended and conventional memory. The buffers have to lie somewhere below 1088 KB. They can go into UMB space *or* into conventional (low 640 KB) memory. Windows will try to place them in UMB space, but if there isn't space there, Windows must put them into conventional memory, which results in a loss of memory for every DOS box.

Now, under DOS 3.3, Jim was using the space between 640 KB and 1024 KB for ROMs, VRAM, page frames, and the like—he ran a third-party memory manager, because DOS did not include a memory manager yet. But he was not using the high memory area between 1024 KB and 1088 KB, so Windows put the translation buffers *there*. But now that he's running DOS 5.0, *DOS* is filling up the HMA. So there's nowhere else for the translation buffers to go but in conventional memory.

I offered Jim a choice: "Can you live without EMS emulation for your DOS applications?" He allowed that he could, as his spreadsheet and disk caches used extended memory these days, and they were the biggest EMS users anyway. So we changed `RAM` to `NOEMS` and removed the `frame=` parameters from the EMM386 invocation. Then we deleted the EMM...statements from SYSTEM.INI and rebooted. But nothing changed.

A trip through the Windows manual yielded no insight, but in SYSINI3.TXT I found descriptions of the SYSTEM.INI commands `reservepageframe=no` and `noemmdriver=yes`. Both of those commands went, again, into the [386enh] section of SYSTEM.INI. And Jim got a bunch of his memory back.

Now, before you try this out, this will help you only if you're losing more than about 13 KB overhead in your DOS boxes, and it can't possibly be of any value unless you—like Jim—have your UMB area packed to the rafters. ■

Mark J. Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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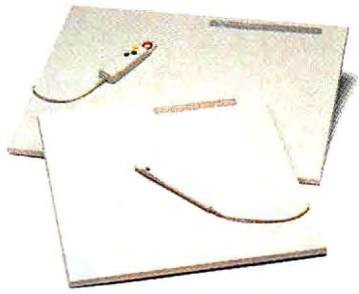

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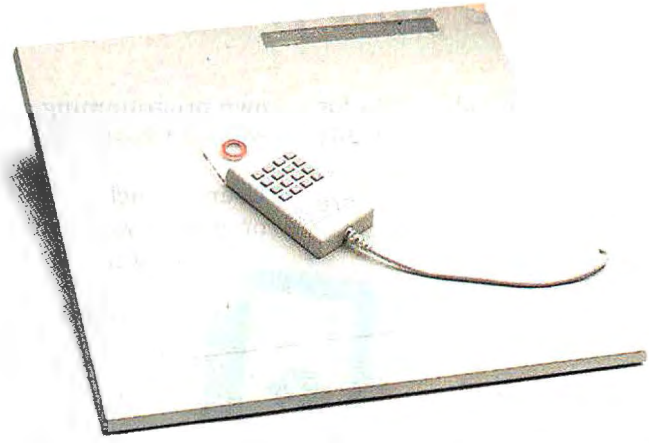

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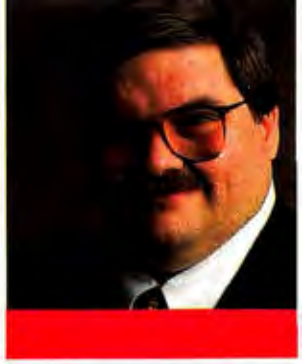

DON CRABB

PORTABLE PAINS AND PLEASURES

I generally pride myself on being able to ride the ragged edge of disaster when working with computer technology. For the most part, I don't get nicked. But Murphy and his bag of bad karma finally caught up with me earlier tonight, just as I was preparing for a week-long trip to Monterey, California, to attend Apple's Higher Education Forum.

Compatibility Problems

I was cramming about a week's worth of living (both professional and personal) into the last 24 hours spent at my Chicago manse, before leaving to catch a flight to the left coast. Fortunately, I have made a science out of multitasking my way through writing, packing, phone calling, and other miscellaneous tasks. Unfortunately, I tempted both the muses and Murphy by brilliantly deciding to upgrade my Outbound Portable (a Mac clone that's about half the size of Apple's Mac Portable) from System 6.0.5 to System 7.0.

A piece of cake, I thought. After all, I spent the spring and part of the summer writing my new book about System 7.0 for Mac managers, so I knew a thing or two about System 7.0. Also, I've been an Outbound Portable convert since the beginning of time, so I knew the issues there. No problem, right?

Wrong. As it turned out, the Outbound Portable is just plain incompatible with the System 7.0 installer. About 6 hours later (it was now 4:00 a.m. on Monday, and my flight was leaving at 11:35 a.m.), all I had managed to do was kill the Outbound Portable, and the body had long cooled.

Well, isn't this just great, I thought. I now had no portable Mac to take with me to Monterey, so I'd get nothing done during the week there. Naturally, my bosses and editors would be sympathetic once I started missing deadlines. They're all very reasonable people. Right. What kind of klutz upgrades his laptop machine the night before an important trip? (Hint: Look in the upper right corner of this page.)

Once I was past the self-recriminations, I got upset at the problem's source: the Outbound Portable's failure to work properly with System 7.0. Believe me, I tried everything to make it work—installing on its silicon drive, on the hard drive, booting from an ultraminimalist System on a 1.44-MB floppy disk.

The Outbound Portable, which has 4 MB of RAM, a 16-MB silicon drive, a 40-MB hard drive, and Mac Plus ROMs, was a toast point. It wouldn't boot under any circumstance. No matter how odd my installation process might have been, no Mac anywhere should have responded in such an unreasonable manner, I concluded.

Then, of course, it hit me. Like a ton of bricks, or like an 18-pound Mac Portable, which I had buried under a bunch of boxes in my office. That machine had lain fallow for over a year because my Outbound Portable had simply worked better. Until now.

I slapped around some boxes, yanked out the Mac Portable, plugged it in, and fired it up. Within 30 minutes, I had installed System 7.0. I then hooked up the Mac Portable to my home AppleTalk network and used System 7.0's built-in File Sharing to download all my data and application files that I would need for my trip.

This is where System 7.0 proved its mettle to me—I was able to get it up and running and copy all my files (30 MB) in well under an hour. The Outbound Portable, sadly, was still sitting there on a table, refusing to boot from any known start-up device, including the network.

A Realization Sets In

I've learned something from this unfortunate bit of business. A Mac clone, even one as otherwise well executed as the Outbound Portable, is still a clone. Clone computers don't make that much difference in the Unix or DOS worlds (because those operating systems are either nearly public domain or quite simple, and thus easy to build clones for), but they do in the Mac world. Even an Apple-authorized clone like the Outbound Portable isn't a real Mac, as my System 7.0 experience proves in spades.

Other Mac clones might do better in the future. However, I don't expect to buy any of them unless they've got the Apple seal of approval or they're being OEMed back to Apple, like one of the

Don has problems with his Mac-clone portable and beta-tests new Apple portables

ILLUSTRATION: DAVE CUTLER © 1991

new Apple notebook computers that Sony is manufacturing.

New Mac Notebooks

I've been an unofficial beta tester for the three notebook Macs being introduced this month. The most intriguing one to me is the so-called Notebook Classic, which is built by Sony from Sony and Apple parts. It tentatively lists for $1995. Not that I'd buy one—I need the horsepower of the high-end model, with Mac IIci–like credentials. No, I'm fascinated by the Notebook Classic because of what it represents: Apple's first foray into consumer electronics.

It's small, it's lightweight, it's truly portable, and it's as fast as most 286 notebooks and some older 386 laptops. It comes in a gray plastic case that exudes quality even in the beta machine I have. Yet it still has a 16-MHz 68000 CPU, a thin-film backlit LCD, and a 20-MB hard drive. And the Notebook Classic runs System 7.0 without a peep.

With it and the other two notebook Macs (Apple produces the 68020- and 68030-based machines itself), Apple has just made it very hard for clone companies like Outbound Systems or Mac remanufacturers like Colby Systems and Dynamac Computer Products to stay in business. In the process, it has given MacFolk a real set of notebook Macs to choose from, while also giving generic notebook computer buyers serious competition for the Dells, ASTs, Compaqs, Zeniths, and Toshibas of the world.

Tip of the Month: Extensions Manager

If you run into INIT compatibility problems under System 7.0, you can choose to bypass all your INITs by holding down the Shift key during the boot sequence. However, if you want more fine control over loading INITs, perhaps by just selectively loading several of them, you'll want an INIT manager.

In the past, you had to rely on third-party products for this, shareware like INIT cdev 3.0 or INITPicker. You can still do that with their System 7.0–compatible variants, or you can use the freebie that Apple provides, called the Extensions Manager (Apple now calls INITs by the name "Start-up documents," and they live in the Extensions Folder of the System Folder).

The Extensions Manager lets you turn off or on the initialization code that executes in Control Panels, Chooser devices, and INITs. Since with System 7.0 there are only a few folders where system extensions can be located, the old-style INIT managers that were written before System 7.0 was released do not work very well.

Apple wrote the Extensions Manager with System 7.0 in mind. The main features of the Extensions Manager are the following:

- Fast file catalog scan.
- System 7.0 folder structure–aware. Still compatible with System 6.0.x.
- Context-sensitive help (i.e., Balloon Help).
- Start-up icons do not get lost when disabling a system extension.
- Updated for free by Apple while it makes sense to do so.
- System 4.2–to–System 7.0 compatibility.

If you don't yet have the Extensions Manager, get on-line (AppleLink, America Online, BIX, or CompuServe) and get it.

continued

Statistics

"...my worst fears were realized..."

It was on an early April morning when I found myself crowded into a small conference room to watch a demonstration on JMP, SAS's new statistical graphics package made specifically for the Macintosh. Since I had no idea what a statistical graphics package was capable of doing, I was prepared to watch the demonstration, take notes on meaningless jargon, and then leave knowing little more about how to use a statistical graphics package than I had before.

Indeed, when the demonstration began, my worst fears were realized when I heard such statements as, "With the model leverage plot, there is the model analysis variants table, and, with each effect, there is an analysis of each effect," and "The Y's by Y's platform produces an outlier plot showing the Mahalanobis distance of each point from the multivariate centroid." To make matters worse, several members of the group attending the demonstration would *oh* and *ah* over these statements and ask questions that rivaled them in sheer incomprehensibility.

As the demonstration progressed, however, I became fascinated with the number of things JMP offered that, judging from the reactions of the more knowledgeable members of the group, were absent in other statistical graphics packages. Even more amazing was the fact that I found myself understanding the function of nearly every feature in JMP, even though I had no idea what the statistical jargon associated with each function meant.

And that, in a nutshell, is the beauty of JMP.

from the University of New Mexico CIRT Newsletter, June 1990

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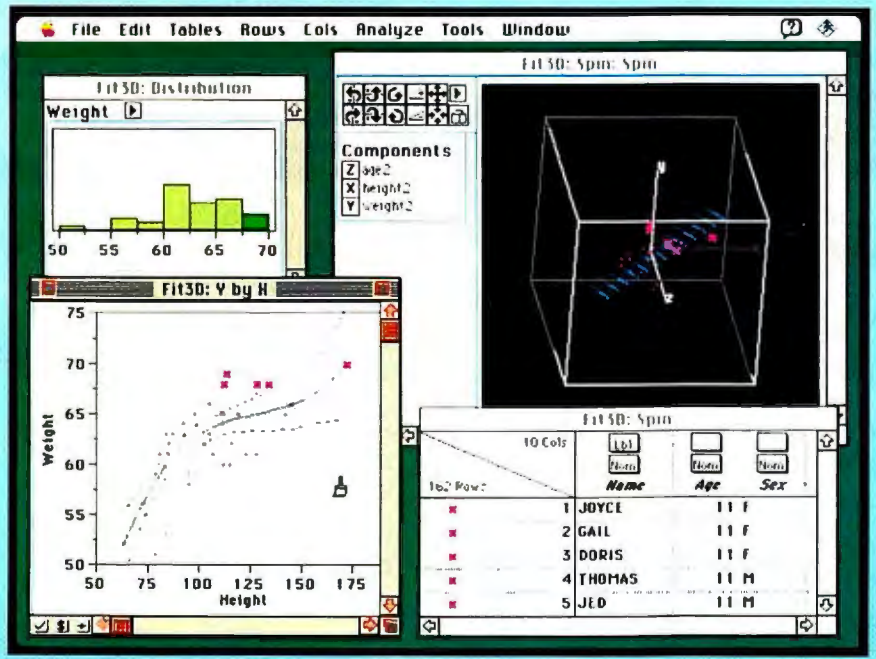

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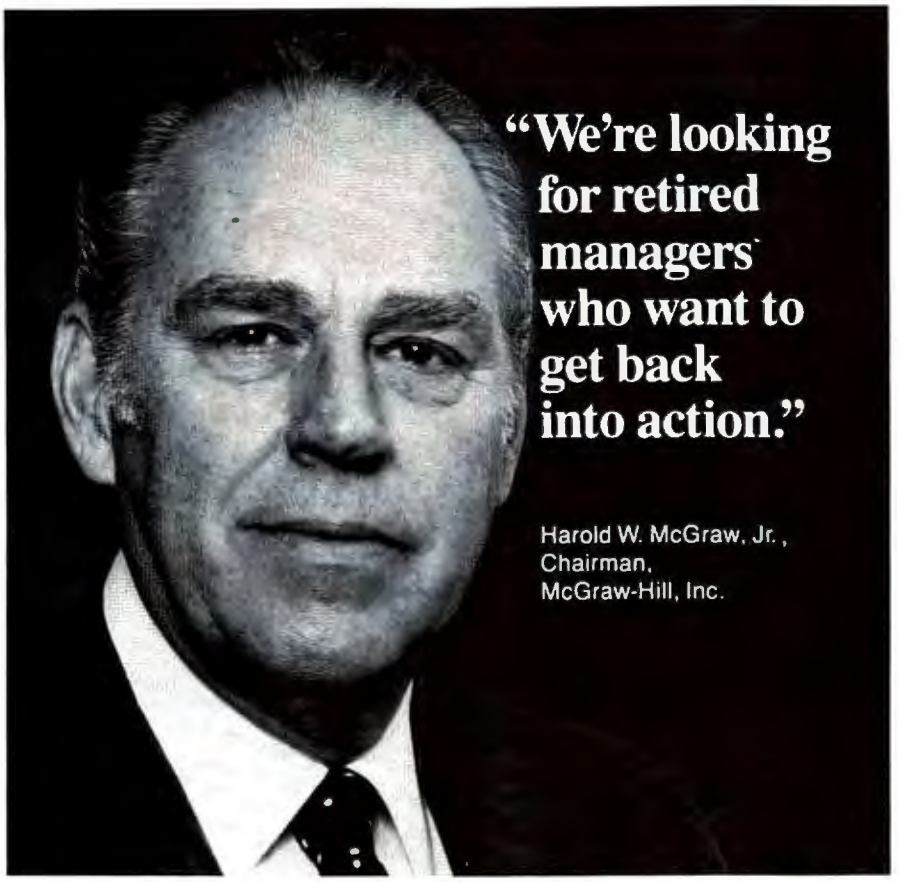

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M2

You might also find that your local Apple dealer has already gone to the trouble to do that for you. The Extensions Manager may also appear in the Personal Upgrade Kit and Group Upgrade Kit soon, but at press time, it was not in those kits.

Another reason to use the Extensions Manager is that some older (before System 7.0) INIT managers turn off INITs and cdevs by changing their file type to xNIT and xdev, respectively. If the System Folder contains INITs and cdevs that have been turned off this way, the Compatibility Checker that you run before installing System 7.0 won't see them for what they are. The Checker can't flag or fix what it can't find, so turn on all INITs and cdevs before running it to avoid problems later. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be contacted on BIX as "decrabb."

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

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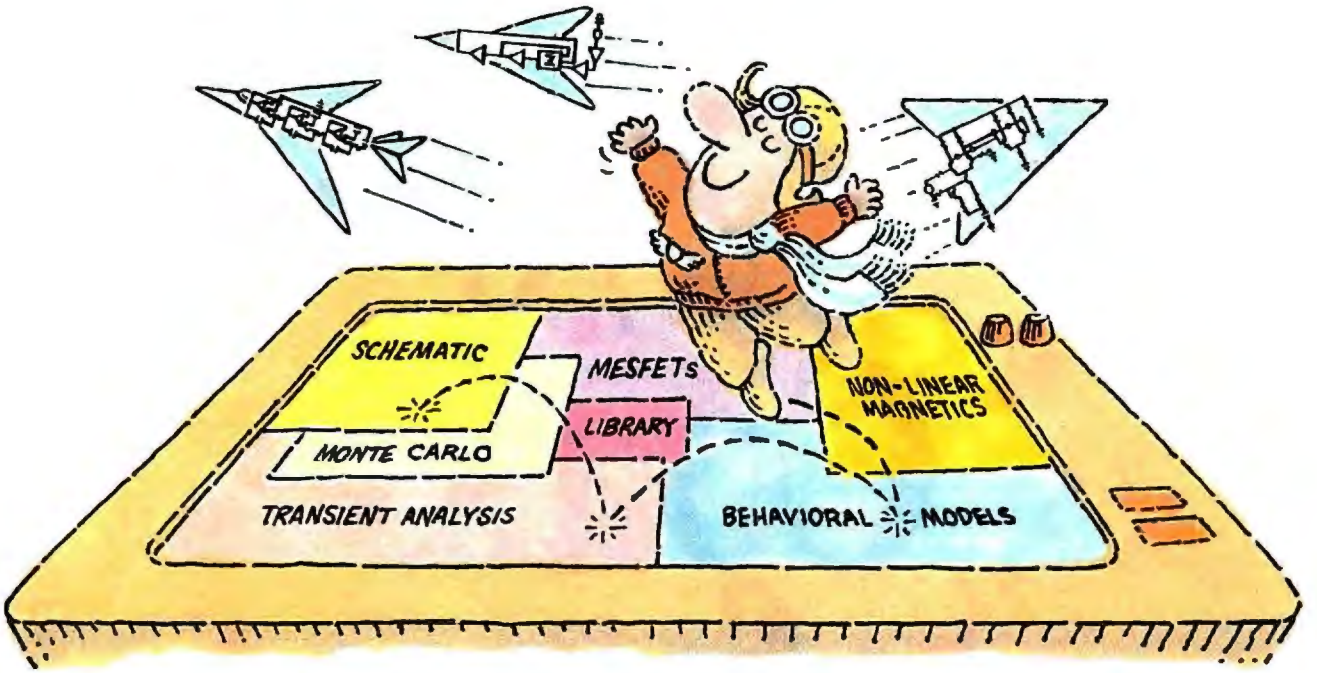

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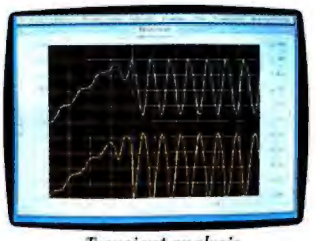
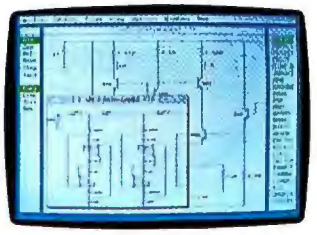
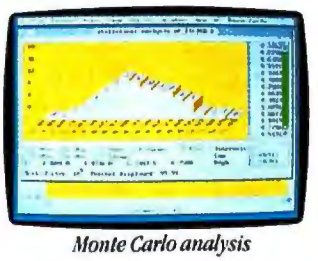


Transient analysis



Schematic editor



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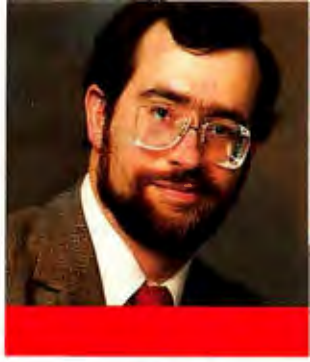

DAVID FIEDLER

ANONYMOUS ON THE NET

In last month's episode, I reported having a problem with the `getty` daemon on my system, which didn't seem to work reliably with the Telebit modem for computers dialing in at all speeds. The problem became more urgent when I got a notebook computer for out-of-office experiences; I simply had to be able to dial in to read my E-mail.

I was trying to fix it by installing a freely available `getty` package, which sounded like it might be the answer to problems I hadn't even encountered yet! But I couldn't get this program to run properly, no matter how many debugging options I enabled.

Of course, there's no guarantee that any program off the network will work properly or even compile. The fine print did say that it had been tested with many Unix and Xenix systems, but it didn't mention my particular version.

I "knew" that my modem registers were set up a certain way, which theoretically meant that I shouldn't be having these problems. Well, I checked the program (`dialTBIT.c`), and it turned out that they weren't set up the way I thought they were. My vindication came when I changed the program; everything then worked the way I predicted. The moral is the old one about assumptions.

I've been talking about Internet for a while, but until recently, I didn't have much direct experience with it. Because my company doesn't have its own Internet connection, my initiation had to wait until I discovered Netcom Online Communications Services. Netcom serves as a dial-up Unix site and Usenet/UUCP connection, but it also lets qualified people access Internet.

Internet service providers are few and far between, and most of them cater to large companies with large communications budgets. Some (e.g., CERFnet and PSI) let smaller companies dial up for interactive access. Netcom is the only communications outlet I've been able to find whose pricing structure caters to individual users as well as small companies.

Theory and Practice

I was pleased to find out that on a well-run system, using Internet works just the way you might expect from reading the documentation. And it's fairly simple to get started on Internet doing what most people want to do: finding software.

As I've mentioned in past columns, a great deal of freely available software is posted through Usenet news messages. However, if you miss a package when it's posted, you miss it forever, unless you can locate it on one of the few source archive sites (assuming you can connect directly to the archive using UUCP, which generally means a long-distance phone call and a maximum transfer speed of about 15 minutes per megabyte). Some archive sites have mail servers to which you can send E-mail requesting files. The site will mail the files back to you via the network. These methods mean a certain amount of delay, although they are open to almost anyone with UUCP-compatible software and a modem.

While UUCP at a thousand or so bytes per second is a vast improvement over 1200-bps modems, a direct connection to Internet gives you far more. Imagine a real-time network connection to computers all over the world. You can log into other machines (not just Unix machines) and reliably transfer files at over 5000 bytes per second!

This is why researchers have found Internet and its predecessors to be an invaluable resource for connecting with colleagues by E-mail, searching through data files, and sharing results. It's why so many people refuse to accept jobs in which they would lose Internet access. It's also why the infamous Internet worm was able to travel so rapidly.

Internet is therefore run on fairly strict rules. It's not a worldwide BBS for playing games with; it's not a platform to run computer science experiments on; and it's not "fair game" for system crackers (who can expect a visit from representatives of various government agencies if they fool around).

But there is a provision for someone without accounts on a half-dozen Internet computers to legitimately look in certain places. It's called anonymous FTP. FTP stands for file transfer protocol; it's also the name of a file transfer program that uses that same protocol (much the same way that the `uucp` and `xmodem` programs and protocols have their names). When you use FTP to gain access to

Here's how to take advantage of the freely available Unix resources worldwide

ILLUSTRATION: DAVE CUTLER © 1991

Listing 1: *The transcript of an FTP session.*

```
/u8/fiedler 205$ ftp wuarchive.wustl.edu
Connected to wuarchive.wustl.edu.
220 wuarchive.wustl.edu FTP server
(Version 6.5 Thu Jun 20 14:41:10 CDT 1991) ready.
Name (wuarchive.wustl.edu:fiedler): anonymous
331 Guest log-in ok, send E-mail address as password.
Password: fiedler@netcom.com -this is not displayed
230 Guest log-in ok, access restrictions apply.
ftp> cd mirrors/msdos/screen
250 CWD command successful.
ftp> binary
200 Type set to I.
ftp> get nansi30.zip
200 PORT command successful.
150 Opening BINARY mode data connection for nansi30.zip (14379 bytes).
226 Transfer complete.
local: nansi30.zip remote: nansi30.zip
14379 bytes received in 3.2 seconds (4.4 Kbytes/s)
ftp> bye
221 Goodbye.
Connection closed.
/u8/fiedler 206$
```

Listing 2: *The* sendcode *Bourne/Korn shell script.*

```
for i in $*
do
uuencode $i < $i | elm
    -s $i infopro!david
done
```

Listing 3: *The* getcode *program. It assumes that you have saved your E-mail messages as files with a* .uu *extension.*

```
for i in *.uu
do
vi $i
uudecode $i
rm $i
done
```

another computer, you are automatically logged into a special directory reserved for sending and receiving files (e.g., /usr/spool/ftp/pub).

What to Do and How to Do It

So how do you log into a computer without an account? Many machines (well, several hundred at least) have set up accounts whereby you may log in as user "anonymous," at which point you are allowed to travel about anywhere *below* the log-in directory and pull off files of interest. Listing 1 shows a typical FTP session. Note that you're requested to enter your network mail address as a password. Doing this is considered good network etiquette, along with not using FTP privileges during working hours at the remote site.

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It's hard to tell from the printed page, but when you type the ftp command, you're talking to the other machine instantly. This is quite startling for anyone used to connecting to computers via dial-up. Notice that one of the first commands I execute is binary, which allows non-text files to be transferred correctly. This is important with so many files compressed into .z, .arc, .zip, and other formats. The ftp command has lots of options and subcommands, so you should look at the documentation available on your system. But you already know enough to get started, and you can always type help while running ftp.

Once the files you want are on your system, you will probably have to uncompress, unshar, unzip, or un-something them. Since my own system is an E-mail hop or two away from netcom, I generally use a modem file transfer protocol (e.g., zmodem) to get the files or mail them to my account on my own system. Since binaries can't be transferred by regular Unix mail, they have to be put through an ASCII translation program known as uuencode (the source code listing is available in electronic format; see page 5 for details). See listings 2 and 3 for some short programs that I use for this purpose; the editing step in the getcode program is necessary to remove the mail header and trailer from encoded files.

Where the Files Are

So how do you know which files are where on Internet? First, try to get a copy of the file called "anonymous FTP list," which is posted monthly to the Usenet newsgroup comp.misc by odin@pilot.njin.net. This file lists all Internet sites that accept anonymous FTP, with their full names and numerical network addresses, as well as a brief description of what kinds of files and software can be found there.

The next thing you should do is a remote log-in (telnet or rlogin) as "archie" to quiche.cs.mcgill.ca; this will gain access to the amazing Archie database server that comes close to knowing every file available at every possible site. You can use Archie to find out, for example, where the most recent version of all filenames containing the string "gnu" are. Once you know which system has the files you are looking for, simply use ftp to connect and retrieve them.

But even without Archie, if you have a good idea that a site may have the files that you are looking for, you won't have to prowl around that system for hours. Most sites keep a file called something like ls-lR in their ftp home directory; this file lists all files available on that system. I wish you a plentiful harvest. ■

David Fiedler has been a consultant and writer on Unix topics for over a decade and has started several Unix publications. His company, InfoPro Systems, produces corporate image and marketing videos for high-tech firms. You can reach him on BIX as "fiedler."

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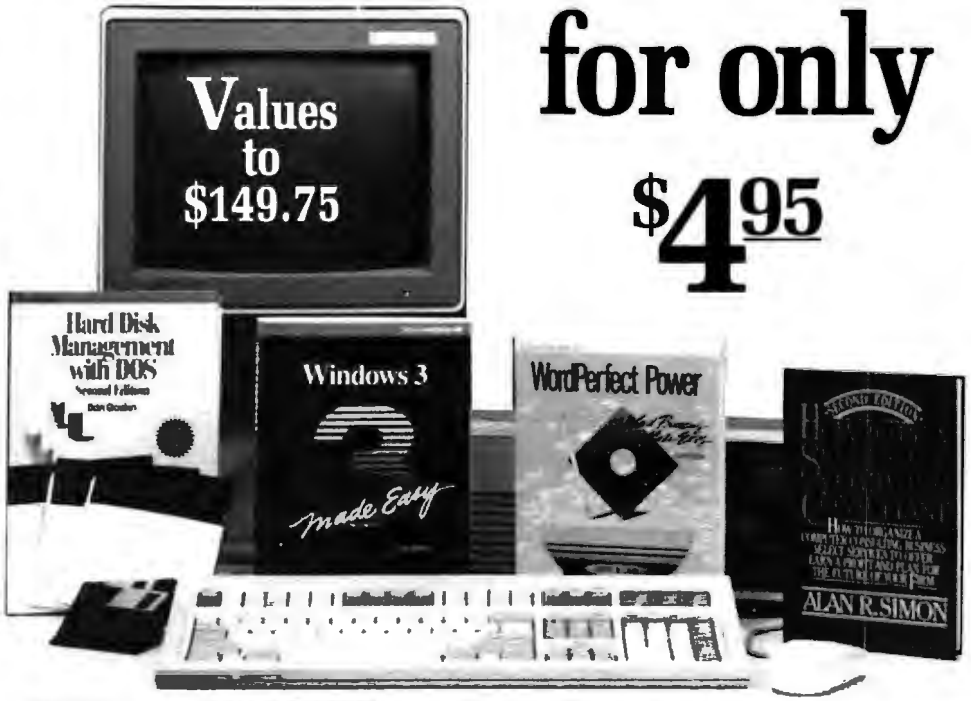

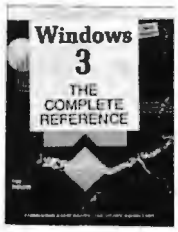

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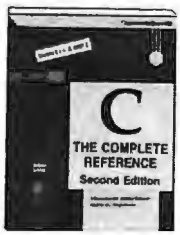

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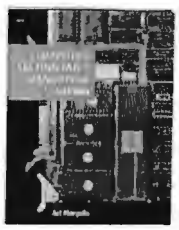

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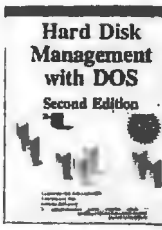

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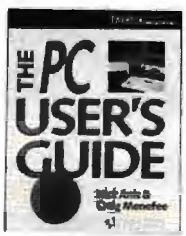

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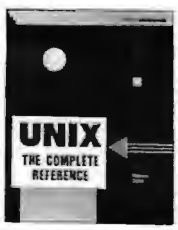

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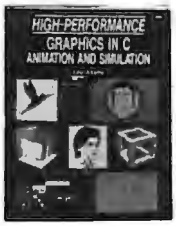

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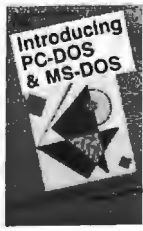

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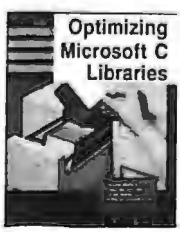

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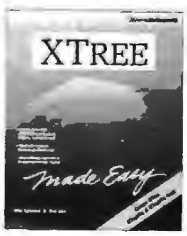

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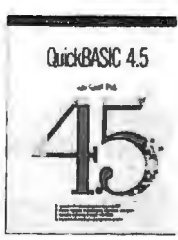

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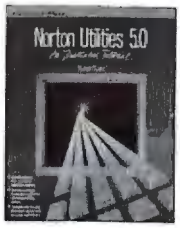

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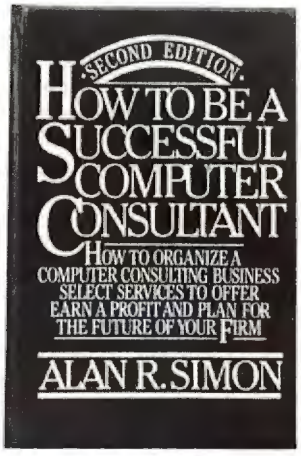

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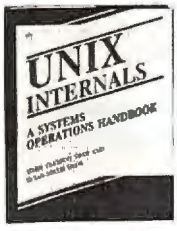

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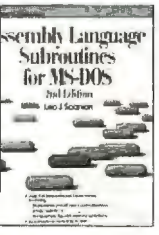

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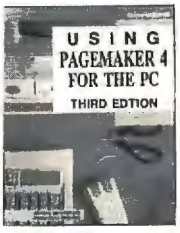

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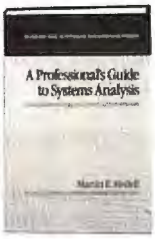

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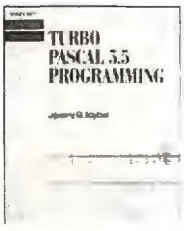

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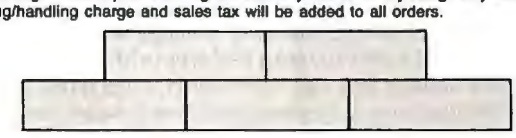

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ASK BYTE

16550 or Fight

I am in the process of upgrading my company's modems from V.32 to V.42bis, which means that we will theoretically be able to transfer data at 38.4 Kbps. I have read that at this high transfer rate, it's possible to lose data between the modem and the 386/20 CPU because the 16450 universal asynchronous receiver/transmitter (UART) is unable to keep up with the transfer rate.

I have been told that an I/O card equipped with a 16550 UART would be able to reliably handle 38.4 Kbps. I have received various advice from a few dealers. What can I do to reliably transfer data at 38.4 Kbps? Is my 16450 UART acceptable, or should I purchase an I/O card with a 16550 UART? Or is the only reliable alternative to purchase an expensive and RAM-hungry coprocessor board?

Jeffrey S. Glenn
Concord, NH

As usual, the answer depends on your application. Assuming you are using your 386/20 in a single-tasking environment and do not run a lot of TSR programs or device drivers, your 16450 should be fine.

The 8250A and 16450 UARTs you find in most modern PC-compatible serial cards should run reliably at transfer rates of up to 57.6 Kbps. Problems arise when the serial chip is running so fast that it writes characters into its single-character buffer faster than the CPU can pull them out. If the CPU is tied up with other tasks, or a TSR has popped up and left the CPU interrupts disabled for a long time, the CPU will not respond quickly enough. In that case, the UART is forced to overwrite its buffer and a character is lost.

The 16550 adds a 16-character first-in/first-out buffer. If the CPU has not pulled a character out of its receive buffer by the time the next character arrives, the first character is simply moved aside in the buffer, not overwritten. For very fast serial transmission, the 16550 is a better chip.

If you do have an application where the 16550 is required, note that the UART requires that the software recognize and use the 16550's extended buffer. Check with your communications software vendor before springing for a 16550-based I/O card.—S. A.

Environmental Concerns

I have a Gateway 2000 386SX and am running Windows 3.0 in enhanced mode. I'm happy with both products, but I have run into a problem (which I have devised a solution for) that I don't fully understand. A batch file that I use to run an application first sets an environment variable, runs the application, and then exits, clearing the environment variable. Here's a simplified version of the batch file:

```
set foo.chr=c:\foo4.chr
c:\bar\bar.exe %1
set foo.chr=
```

When I run this batch file from DOS (without Windows 3.0), it works as expected. But when I run it from within a Windows DOS session, the `set` command gets an "Out of environment space" error message.

If I manually set the environment variable prior to running the batch file, everything works fine for the duration of that DOS session, including running the bad batch file several times. This puzzles me, since the variable is cleared after the batch file is run once.

My solution is to set the environment variable in the AUTOEXEC.BAT file prior to running Windows 3.0. My questions are as follows: How does Windows 3.0 determine the amount of environment space to allocate for each DOS session? Can I set the amount of environment space for each session directly? Finally, what is the difference between setting the environment variable manually and setting it within the batch file?

Paul M. Smith
Geneva, NY

The quick-and-easy way to hack around this knot of environment problems is to add the following line to your CONFIG.SYS file:

```
SHELL=C:\COMMAND.COM /P /E:256
```

The `/E` *argument to the* `SHELL` *command instructs DOS to allocate additional space for the main environment. I've asked for 256 bytes instead of the default allocation of 160. You can specify up to 32 KB of environment space, but 256 bytes is usually sufficient. Windows uses whatever allocation is set aside for the main environment.*

Actually untangling these problems is a little more difficult. When you launch a DOS session from Windows, it's not exactly like firing up another copy of COMMAND.COM. Windows adds another variable, `windir`*, to the environment of each session. This relatively small addition usually goes unnoticed. However, your system environment is close enough to being completely filled that the additional variable puts it over the edge.*

If Windows actually runs out of environment space when adding `windir`*, it stretches the environment by adding another paragraph (i.e., 16 bytes) of memory. If* `windir` *fits within the current allocation, as it does in your setup, Windows does not extend the environment allocation, leaving fewer bytes for your environment when you run your batch file from a Windows DOS prompt.*

Programs like Windows can change the size of the environment for child processes. The only way to change the size of the main environment (besides using the `SHELL` *configuration command) is to invoke the command processor by using* `set` *at the command line. You cannot exceed the allocated environment space from batch files or from other programs because of DOS's memory layout.*

If you extend the environment from the command line, it stays extended; that is, deleting environment variables does not make the allocated space get any smaller. That's why adding your variable once from the command line makes your batch file work no matter how many times you run it.—S. A. ■

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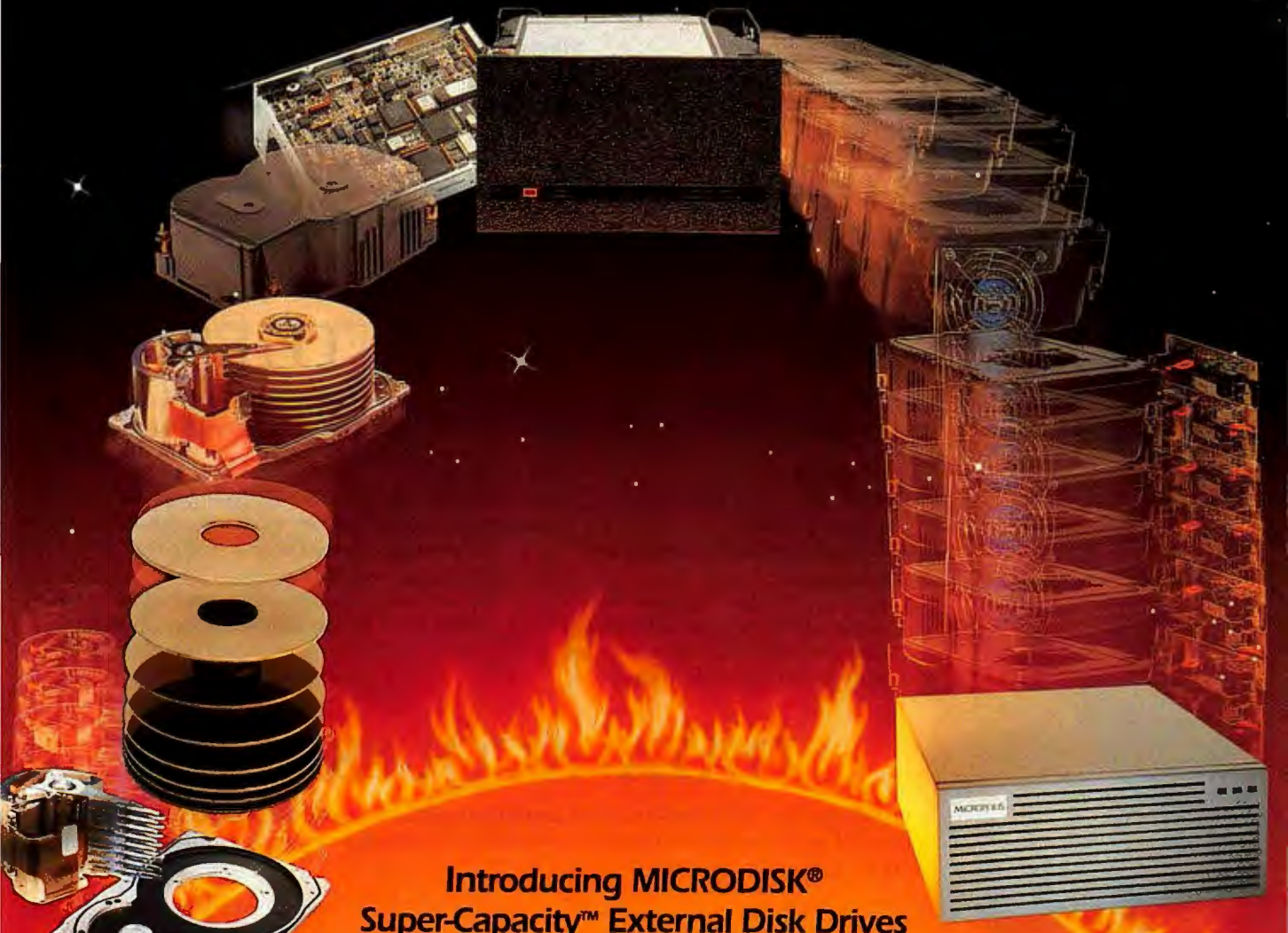

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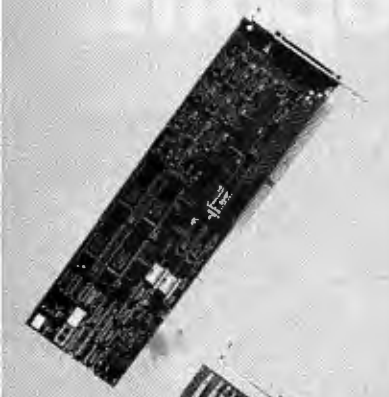

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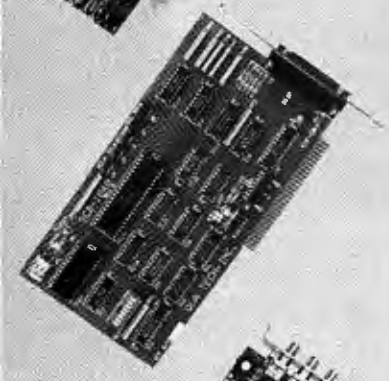

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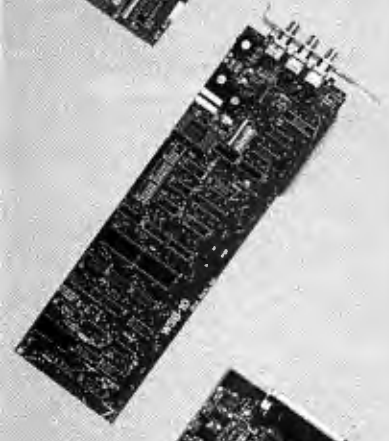

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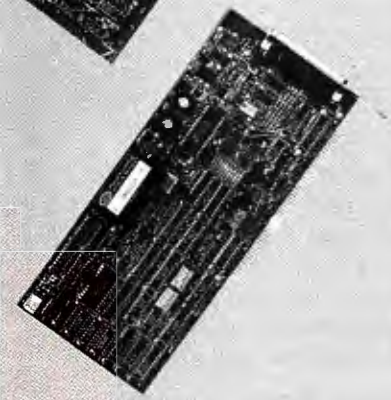

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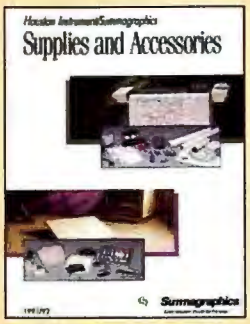

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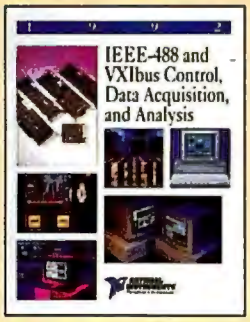

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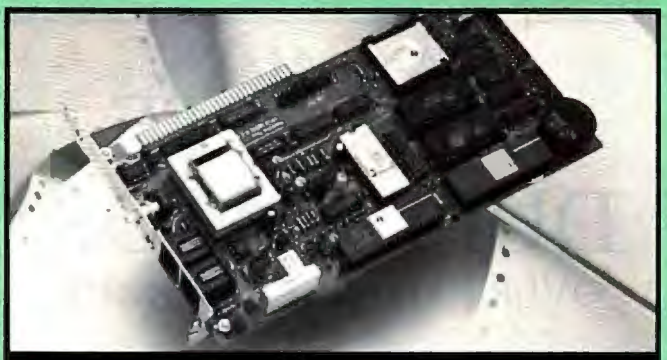

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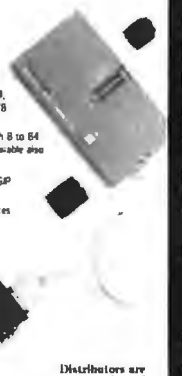

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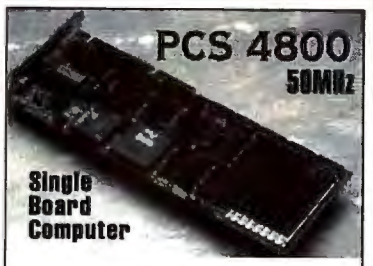

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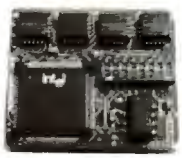

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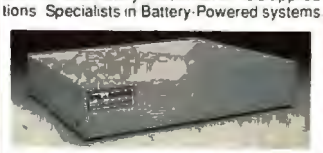

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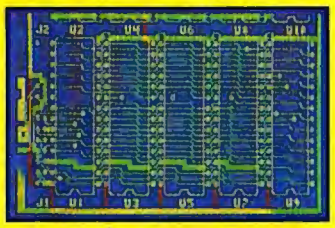

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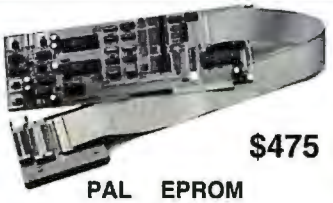

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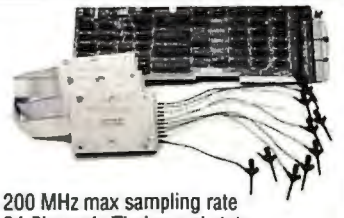

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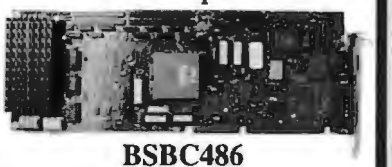

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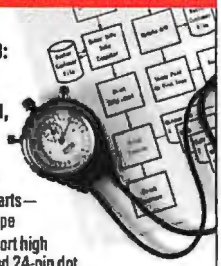

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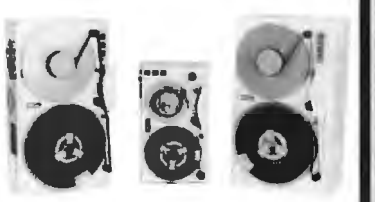

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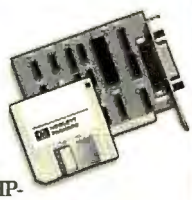

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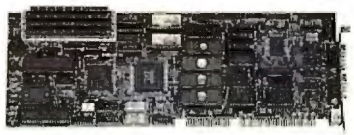

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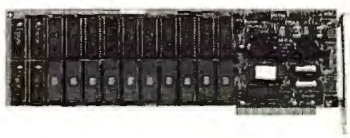

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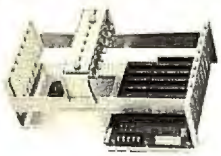

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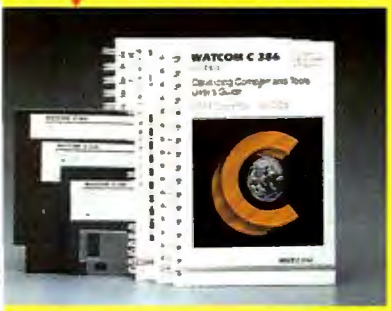

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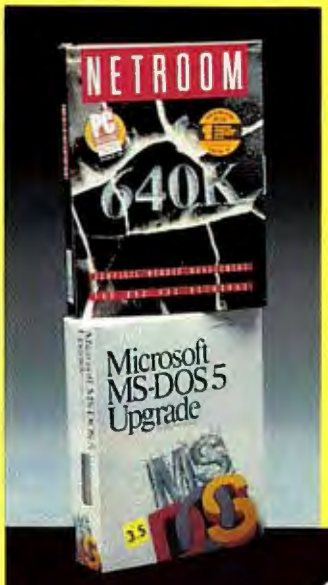

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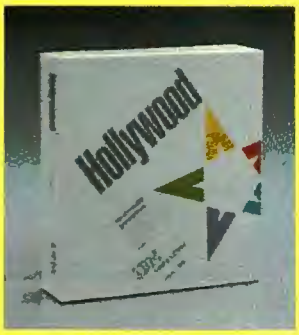

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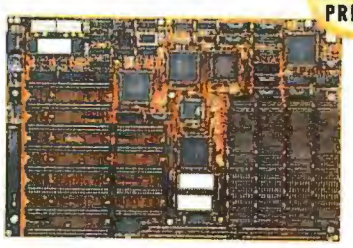

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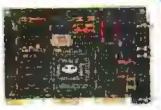

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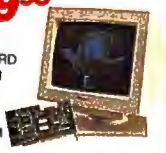

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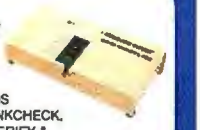

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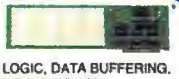

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should only add that write access also gives the user the privilege to create and delete files and directories.

Each directory on an AFP server volume is associated with an owner and a group—that is, it carries an owner ID and a group ID. Furthermore, each directory also carries flags that indicate the rights enjoyed by the owner, the group, and the world (i.e., everyone else).

More Names

Once you have logged into an AFP server, you'll most likely want to manipulate the files and directories of that server. Before you do, you should be aware of one of the peculiarities of path names on an AFP server.

Each member—be it a directory or a file—of an AFP file system must carry two names: a long name and a short name. Long names can be up to 31 characters and have no format requirements. Short names can be up to 12 characters long, and they have to adhere to the MS-DOS *<filename>.<extension>* format. Each file or directory within a directory must possess a unique long name as well as a unique short name. Hence, an application can use either the long name or the short name to locate a file.

Three versions of user authentication are supported by AFP servers.

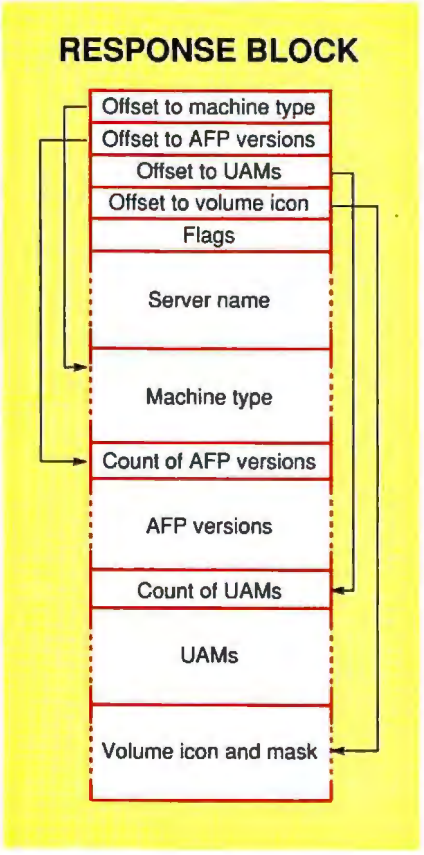

Figure 2: *The format of the response to an* `FPGetSrvrInfo` *command. All offsets are 16-bit values, while the counts are 8-bit values. The flags value is also a 16-bit word, the low 2 bits of which are significant: Bit 1 set indicates that the server supports the* `FPCopyFile` *command, and bit 0 set indicates that the server supports* `FPChangePassword`.

The reason for this twisted naming convention is simple: It gives an MS-DOS system a chance at being able to navigate an AFP volume. If short names were unavailable, any MS-DOS system that you bridge to a network supporting an AFP server would be unable to manage the AFP server's directory reliably.

If you've ever worked on an AppleShare network, you may find all this talk of long names and short names disturbing. It implies that any time you create a file or directory the system will ask you for two names. Of course, that's not what happens; one name appears to be sufficient. How, then, are long names derived from short names, or vice versa?

Apple's AFP documentation specifies a curious but otherwise reasonable algorithm for handling this dilemma. Whenever an application creates a file or directory on an AFP server, the `create` command specifies the name type as either a short name or a long name. If the new item is being created with a short name, then—provided that the short name is unique—the long name is simply set to whatever the short name is. If, however, the new item is being created with a long name, then—provided that the long name is unique—the short name is *derived* from the long name. If this derived short name is also unique, then the `create` command succeeds; otherwise, the user gets what amounts to an "object already exists" error.

How is the derivation accomplished? Interestingly, the AFP documentation never stipulates that. It merely requires that the server create only unique short and long names for each object in a directory. In most cases, the short name is simply the first eight characters of the long name. For example, if I create a file named `reallybigfilename` on a Macintosh volume and then copy it to a Novell server that is connected to both an IBM PC network and AppleShare, the MS-DOS users see a file named REALLYBI. This, at least, assures MS-DOS users of an AFP system that they will see filenames that are legal.

Bringing It Together

Armed with all the preceding information, I'll put everything together now and take you step-by-step through the log-in process. Logging into an AFP server is a multistep affair. First, your application must determine the AFP server's network address. You do this using NBP's `LookUpName` function.

Next, your application must determine which version of AFP the server understands and which user authentication methods the server supports. This can all take place in a single call—`FPGetSrvrInfo`. This call returns a slew of information from the server to the caller. The information is packed in a response block whose format is shown in figure 2. For log-in purposes, the caller is most interested in the supported AFP versions and UAMs (yes, a single server can support multiple AFP versions and UAMs).

Once your application has selected the AFP version and UAM, it informs the server of its choice by executing the `FPLogin` call. (Part of the job of the `FPLogin` call is to issue an ASP call to open a session with the server.) If your application has not selected an authentication method, the log-in process ends here. Otherwise, the log-in process continues as I described in the section detailing the user authentication techniques. Assuming that the entire process succeeds, you have established a session with the AFP server and can now begin slinging AFP commands down the network at it.

This month's program is a simple application in Mach2 Forth that locates all the AFP servers on your network. You can select a server to log onto and issue many of the AFP commands in table 2. ■

Rick Grehan is the director of the BYTE Lab. He has a B.S. in physics and applied mathematics and an M.S. in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

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

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ASQ 1.3 from Qualitas is a memory management tutorial and system analyzer which teaches you about your system's hardware, configuration, and memory. ASQ 1.3 analyzes your system and suggests ways to improve it.
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HUGH KENNER

Tales from the Venture Woods

Computer pioneer Gordon Bell counts the many ways a high-tech company can go belly-up

Hey, Anthrax. Anthrax? Look, Anthrax, you know I wouldn't waste your time on a turkey deal. I've got this great idea for a sitcom. Wait, don't hang up yet. Look, it's got everything. It's got lawyers, and boardroom mayhem, and high-tech goof-offs, and . . . wait, hear me out.

We've this hotshot, see, he's thirty-something, and he's got this hot idea for a piece of blockbuster software. It'll be the next Lotus 1-2-3. No, nobody's written it yet; that's the first thing to do, get it written. I mean the *software*, dummy, not the *script*; we can write the script overnight. The software's called FlatIron, see, because it gets the wrinkles out of spreadsheets. So he's got the concept, see. But just writing the thing will take money. So he starts up a company—there's our boardroom drama—and the gimmick is, it goes belly-up in seven days. But behind the last credits we see the fire still in his eyes, and next week he'll do it again, and next week, and. . . . Belly-up every episode, but always a next time, a new company. And . . . Hey? Anthrax?

Hung up. Well, that's an agent for you. Thing is, we'd be a long time running out of plot twists. For I've just found this book by C. Gordon Bell with John E. McNamara: *High-Tech Ventures: The Guide for Entrepreneurial Success*. Bell, father of the PDP-11 and the VAX, was with DEC for 23 years as vice president of R&D. Since then, he's been "involved with about 20 start-ups," which may have fared variously; he troubles to name six. *High-Tech Ventures* is meant to guide readers whose entrepreneurial desire is alight. Others, like me, may enjoy fantasizing 30-minute scripts from its thumbnail case histories and its unrelenting analyses of just about every way there is for an enterprise to flop expensively.

Here's a tale that's apocryphal but illustrative. A marketing type describes to an engineer a wallpaper remover that will instantly leave your wall paperless, spotless, and ready to paint. "Great!" says the engineer. "We'll get rich! What's in it?" And the marketer says, "Darned if I know what's in it. That's your department."

There you have one extreme of the market-driven approach, which too often, says Bell, means *marketing-department-driven*. Marketing-department specs typically include a lower price than any competitor can match and performance better than any existing product, plus unique features meant to knock off all competition. (That can mean, in practice, just enough differentiation to let government buyers steer around competitive procurement.) And, voilà, an x-ray diagram of vaporware, stuff that's endlessly promised but never gets delivered. For, by marketing's stipulation, delivery time should be yesterday. (Hereabouts a whole sitcom episode lurks in one of Bell's briefest footnotes: "Marketing wants it yesterday, engineering will have it tomorrow, and science is still working on it.")

What happened to Ovation, however, was no sitcom. The company was founded in 1982 to build "the next generation of integrated software": word processing, spreadsheet, database, communications. It went through $7 million in two years and

ILLUSTRATION GREG HALLY © 1991

slumped into Chapter 11 with nothing whatever to sell. Marketing and sales were "running at full tilt . . . in hopes of generating indeterminate future revenues on a product that didn't exist and ultimately never would." Ultimate vaporware.

Be engineer-driven, on the other hand, and you may well find yourself out of touch with what customers want. (If you're *very* lucky, though, they may learn they want something once it becomes available. Hardly anybody wanted a Pascal compiler, and nobody who had one wanted another one, before Borland marketed its lightning-fast wonder.)

Or a firm can be cash-driven; certainly by being strapped, but also by the unlikely state of having *too much* cash. Then, long before it has something to market, it may be forming bad habits, such as not flying economy class, not booking into Days Inns, not "buying nonmatching, used, or auctioned-off furniture." But a small bankroll can foster small and focused development teams to work on less-than-grandiose projects that can go on sale sooner.

On the other hand, your ability to raise cash may reflect the ability of Dom, Mick, and Sherry to raise competing cash for similar ventures. The time of an idea has come: Such news does have a way of getting around. And "anything worth doing is worth duplicating," with the net result that your firm and Dom's and Mick's and Sherry's may all be driving down one another's valuation. (So no Sensible Sam will be sending a penny of investment toward any of you.)

Be engineer-driven, and you may be out of touch with what customers want.

By analogy, big companies can hemorrhage from internal competition. "In the early 1960s, IBM found that every computer products group" was building a computer in its own way. "Gene Amdahl proposed that any group using components from another group be rewarded and given special recognition." His idea was squelched as "un-American."

Then there's "negative productivity," a principle for which Bell says he'd be proud to claim a Nobel. People are variously productive; but some routinely produce bad results that others must redo. Someone *really* negatively productive "can keep a whole team busy with damage control," the lot of them producing no output whatsoever. Such people should be "terminated immediately"; it's fatal to think you can manage them by close supervision. Bugs will just be moved around. One time such a man left Company X for another firm. Although Messrs. X claimed not to have influenced his decision, still, (wink) "outplacing negatively productive people with a competitor can do wonders for a firm's competitive lead."

However quotable, all that is anecdotal; and the backbone of Bell's book isn't anecdotage but the gist of the Bell-Mason Diagnostic, "a rule-based, human-applied expert system" that brings more than 600 rules to bear on assessing the health of a high-tech enterprise, and presents its findings in a circular pattern you can take in at a glance. The quadrants of concern are Product, Sales, People, and Finance, and a threefold partitioning of each yields a graph like a wheel with 12 spokes: Engineering, Product, and Manufacturing; Business Plan, Marketing, and Sales; CEO, Team, and Board; Cash, Financeability, and Control. The further out you score along each spoke, the better, so you're aiming for a graph like a maximum-size 12-sided polygon.

But not at first. At the first stage, concept, money spent in areas like Sales or Manufacturing or Board is largely wasted. So, early on, you want a small four-bladed propeller of a graph, strong just in Business Plan, CEO, Cash, and Engineering. In the next two stages, seed and product development, the main polygon enlarges and fills out; for instance, you expect it to swell along the Marketing axis. By the fourth stage, market development, if all has gone well, you have your regular dodecagon, to gladden geometers and shareholders alike.

For each stage, the Bell-Mason Diagnostic, like a medical checkup, offers warnings of perilous underdevelopment or overdevelopment. A few paragraphs back I adduced the sad fate of Ovation, and the graph for Ovation at the end of stage three is especially appalling: absurdly bloated in Marketing, Sales, and Cash; scrawny in CEO, Team, and Control; pathetic in the areas of Engineering and Product: a hydrocephalic paralytic on a life-support system. Bell claims that a system like his might have given the Board early warning, well before they'd kissed the whole $7 million good-bye. They might even have managed to turn the mess around and attained private jets.

And speaking of jets, the book's bibliography cites something I haven't seen, Norman Augustine's *Augustine's Laws* (Penguin, 1987). There are 52 of these laws, "governing the production of high-technology, expensive, and unreliable military products." Example: "By the year X, only one airplane can be built because it will absorb the entire GNP." Such "laws" are said to be empirically derived, and Augustine's book is "essential for any company dealing with the military." So we've never been as far from sitcom as you may have thought.

And Mason is Heidi Mason, "founder and, until recently, chief executive officer of Acuity, a strategic marketing and public relations firm in Silicon Valley."

Short Takes

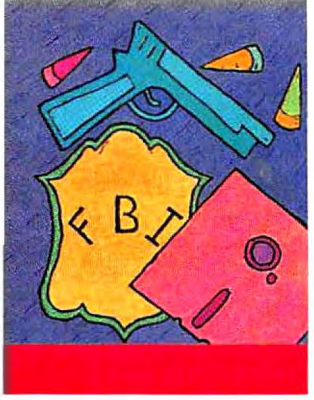
An outfit called Esc (6197 Hwy. E, Abrams, WI 54101) offers Bindex, a "complete" keyword index to BYTE, at $49.95 for either 1990 (all on a DOS disk) or 1991 (quarterly installments). Keying in "Kenner" on the 1990 disk yielded dates and pages for not only all last year's 12 Print Queue columns but all pertinent letters and other mentions, 20 items in all. Any one of "Cuckoo," "Stoll," "spy," or "espionage" turned up only *The Cuckoo's Egg* piece from the March issue. Just the thing if you're tantalized by memory of a 300-word Nanobyte item; give Bindex a useful keyword and wait half a second.

And if you've something you might dream of marketing as shareware, $29.95 to HomeCraft, P.O. Box 974, Tualatin, OR 97062, will fetch you Steve Hudgik's 243-page *Writing and Marketing Shareware*, which covers everything the title claims and has a useful demonstration disk. It even tells you how to write a press release and advises on setting prices. "There are authors who have become millionaires marketing their software as shareware," Hudgik says. His book won't point you toward a private jet, but maybe toward a few honest bucks. ■

High-Tech Ventures: The Guide for Entrepreneurial Success, C. Gordon Bell and John E. McNamara, Addison-Wesley, 1991, $29.95, ISBN 0-201-56321-5.

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.



STOP BIT

JOHN PERRY BARLOW

THE LAW COMES TO CYBERSPACE

On May Day of 1990, I received a visit from the FBI in my Wyoming home. Special Agent Richard Baxter of the Rock Springs Field Office was looking for information about something he kept calling the "New Prosthesis" League, a band of computer terrorists apparently bent on giving away the recipe for Macintosh computers. Or something.

Like most BYTE readers, I was aware that someone calling himself NuPrometheus had shipped around some Mac ROM source code, but I had dismissed it as a practical joke aimed at irritating the humorless folks at Apple. Which, of course, it did.

Who makes the rules in the new computer frontier? And who enforces them?

Agent Baxter's specialty was livestock theft, and the only chips he knew much about were the kind cows make. So before I could convince him that I was not the perpetrator, I had to spend 3 hours educating him on the nature of the crime. It was a pretty surreal experience for both of us.

I realized over the course of this interview that I was looking at the general condition of law-enforcement preparedness in the area of computer crime. And I never like what happens when slightly insecure and well-armed men feel in over their heads.

I posted an account of Agent Baxter's visit on The WELL. There it was read by Mitch Kapor, in whom it struck a resonant chord. Mitch had also been questioned in connection with NuPrometheus—he'd been sent one of the disks—and had found the encounter as disorienting as I had.

Several days later, Mitch called me from his bizjet. He wanted to know if he could literally drop in and discuss Agent Baxter and whatever else I might know about federal efforts to nab cyberpunks. By then I knew enough to think that the government was charging into the computer underground without much sense of how the Constitution might apply there.

We talked about an electronic publisher named Craig Neidorf, who was looking at a possible 31 years in jail for the interstate transport of stolen goods as a result of what strongly appeared to be the exercise of his First Amendment rights.

We talked about a massive 14-city raid called Operation Sundevil, in which Secret Service agents had seized 28 computers (including 10 BBSes) and 23,000 disks under sealed warrants. And I knew that none of this equipment and data had ever been returned, even though no arrests had resulted.

We talked about Steve Jackson Games, a role-playing-game publisher in Austin, Texas, which had almost been driven out of business after the Secret Service confiscated all its equipment, including the hard disks upon which its next product (a game called GURPS Cyberpunk) resided.

Over the course of the afternoon, and without knowing it at the time, Mitch and I started what is now called the Electronic Frontier Foundation (EFF). At first, we thought we might be able to sort things out with a few trips to court. But we hadn't been at this very long before we realized that we had taken on something a lot bigger than a few random police excesses.

As we wrote in the mission statement we issued upon announcing the EFF in July 1990: "While well-established legal principles and cultural norms give structure and coherence to uses of conventional media like newspapers, books, and telephones, the new digital media do not so easily fit into existing frameworks. Conflicts come about as the law struggles to define its application in a context where fundamental notions of speech, property, and place take profoundly new forms."

We've had a very busy year since those words were written. We intervened on behalf of Craig Neidorf (an embarrassed federal prosecutor withdrew the charges after four days in court), filed suit on behalf of Steve Jackson Games, lobbied at the state and national levels for sane laws relating to computers, fostered a number of conferences and roundtables, addressed numerous gatherings, established several on-line conferences, worked with the press to reduce "hacker hysteria," met with many computer security and law-enforcement officials, and worked for policies that would lead to a National Public Network.

A lot remains undone. The electronic frontier remains wild and sparsely populated. But, with Internet growing at a rate of 25 percent per month, it is likely to be flooded soon with newcomers who are not bound by its unwritten customs and etiquette—the electronic equivalent of The Code of the West—which have prevailed since its inception at MIT in the early 1970s. But we have opened the frontier, and they will come, whether we're ready for them or not. ■

John Perry Barlow, cofounder of the EFF, is a well-known hacker and author of lyrics for Grateful Dead songs. You can reach him on BIX c/o "editors."

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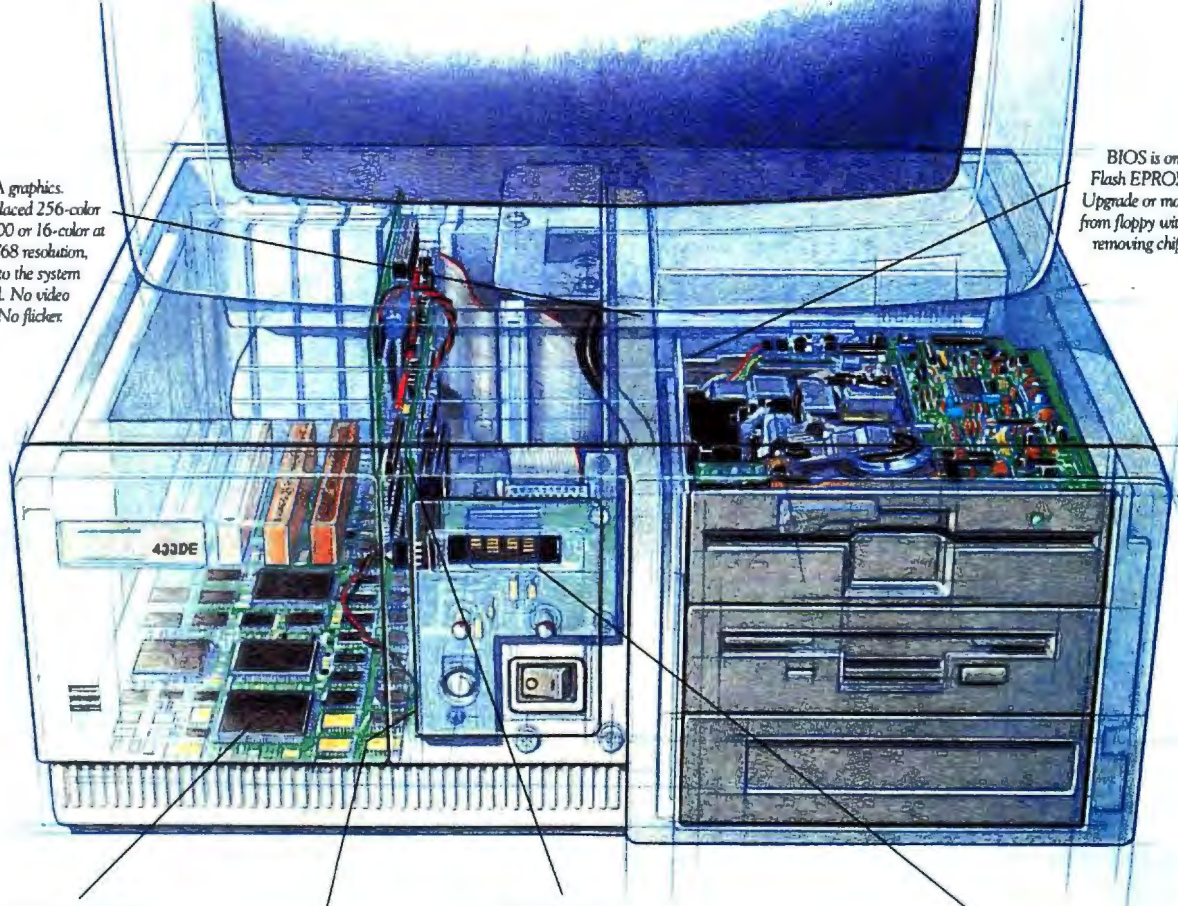

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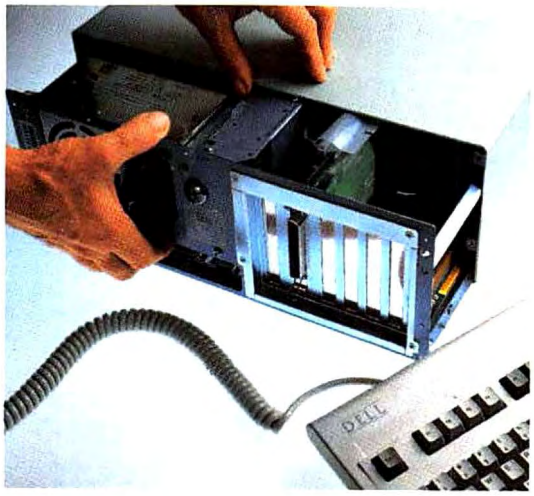

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