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BYTE

DECEMBER 1990 A McGRAW-HILL PUBLICATION

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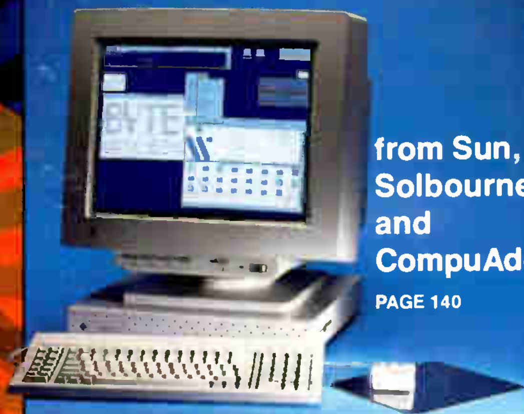

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STATE OF THE ART IN

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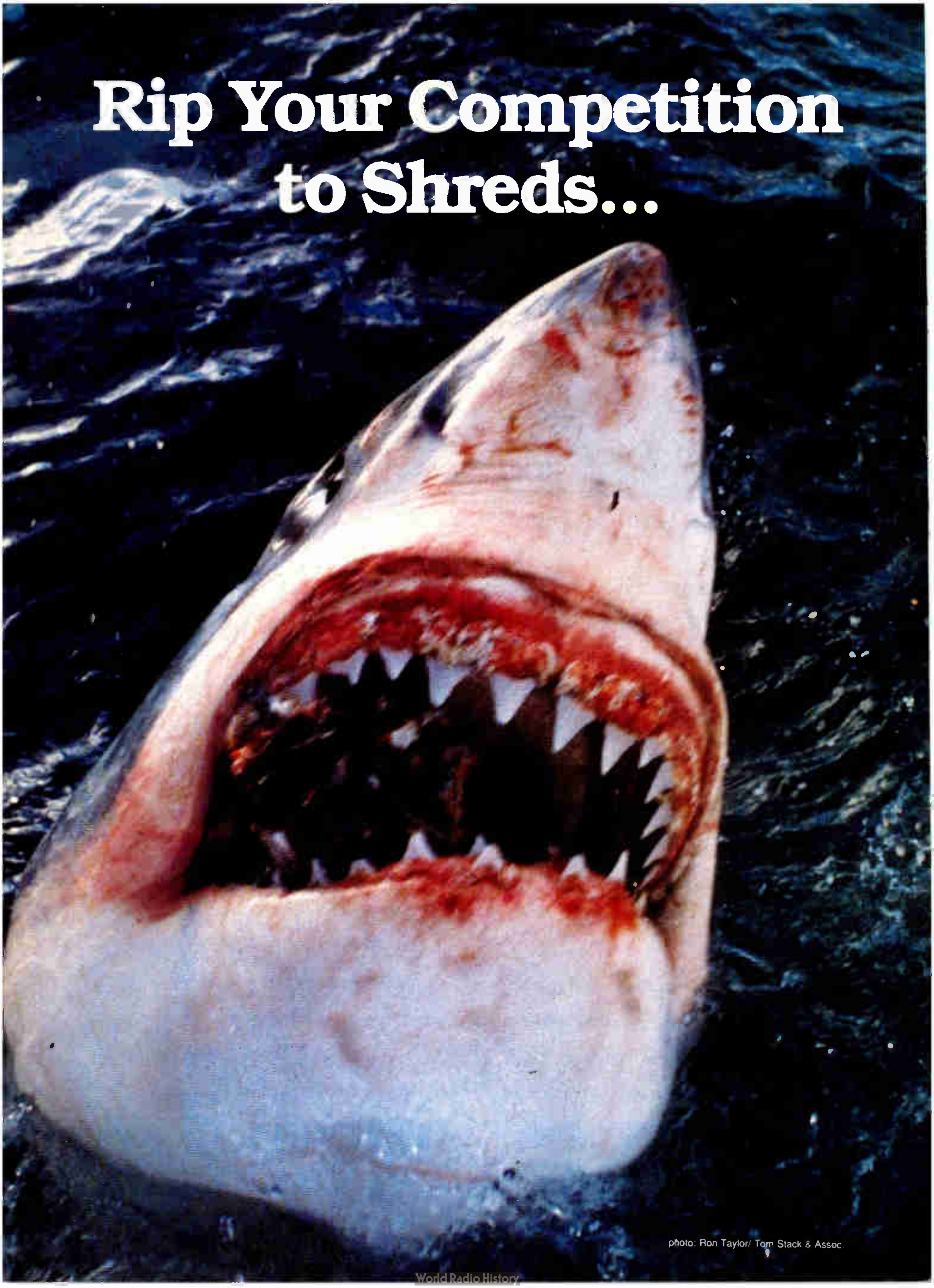
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December 1990
Volume 15, Number 13

COVER STORY

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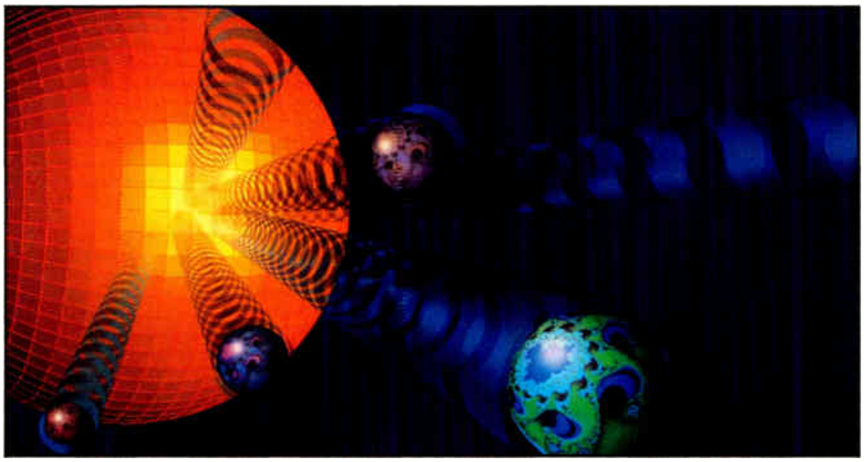
From wire-frame models to photo-realism: Advanced graphics put workstation-quality graphics on your desktop.



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HANDS ON

INTEL 386SL CHIP COURTESY OF INTEL CORP.

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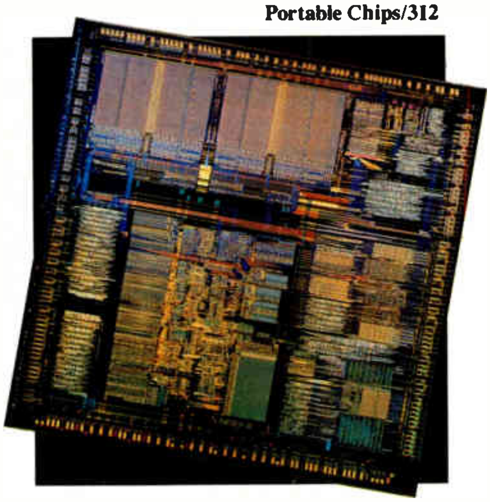

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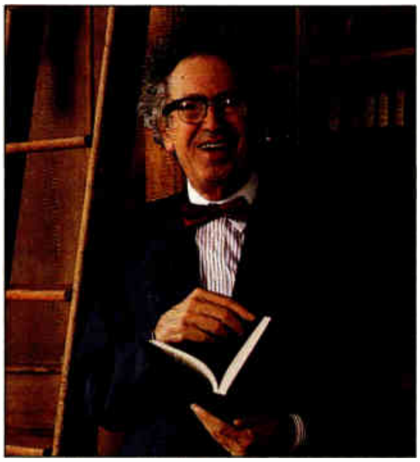

HUGH KNOWS BOOKS (AND COMPUTERS)

Our Print Queue author has a distinguished career outside the computer world

BYTE readers know Print Queue columnist Hugh Kenner as our thought-provoking reviewer of books. But some of you may also know him as a noted literary critic and James Joyce scholar. His interest in computers dates back to 1973 and was sparked by a long-standing interest in math.

"I got one of the very first HP-35 units, having written a book about Bucky Fuller and being interested in the math behind his geodesic domes. The HP-35 was followed by the programmable HP-65, then by the HP-41C. By the late 1970s, I was well into programming; my book *Geodesic Math* [University of California Press, 1976] exhibits examples," says Kenner.

In fact, Kenner had to choose between mathematics and physics or English language and literature when he started at the University of Toronto in 1941. "I have never regretted the latter decision—I'd have been a merely competent mathematician, but I'm better than that at what I elected instead—but the former has always stayed available," Kenner explains.

Built His First PC

A charter BYTE subscriber, Kenner did not immediately jump onto the personal computer bandwagon. "The HP [calculator] I could hold in my hand could do as much [as the early personal computers] more simply. I got interested, though, about the time disk drives were announced. What I wanted was a way to revise my writing without retyping.

"A longtime Heathkit builder, I got an H-89 kit, which my 11-year-old daughter helped me assemble. (No connection Lisa soldered has ever failed. Same aptitude as 11-year-olds once displayed with needlepoint.) When the 16-bit Z-100 was announced, someone at Brady Books thought to ask me to write a user's guide. The Z-100 has since been joined by a Zenith SupersPort and a Kaypro 386. All four machines are still in use."

First BYTE Article a Travesty

Kenner's first BYTE article was a collaborative effort with computer scientist Joseph O'Rourke—a language statistics program called Travesty. "It drew as much reader response as any program BYTE had ever run," he recalls. That led to Kenner writing reviews of computer books, which led to Print Queue.

Although Print Queue resides in the back of BYTE, it generates more mail each month than any other column, except for Jerry Pournelle's Computing at Chaos Manor. Pro or con, Kenner makes his readers think and respond. ■

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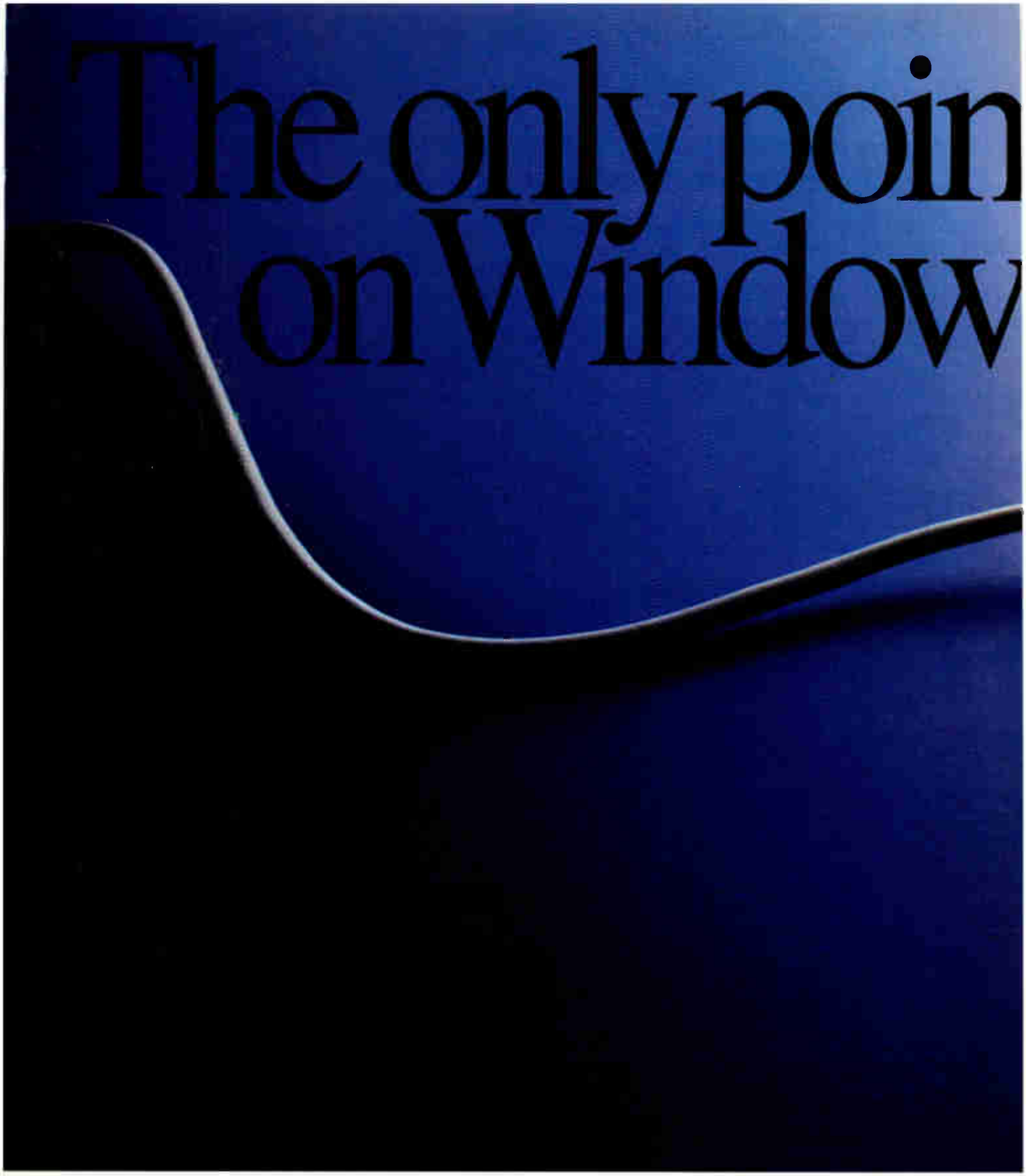
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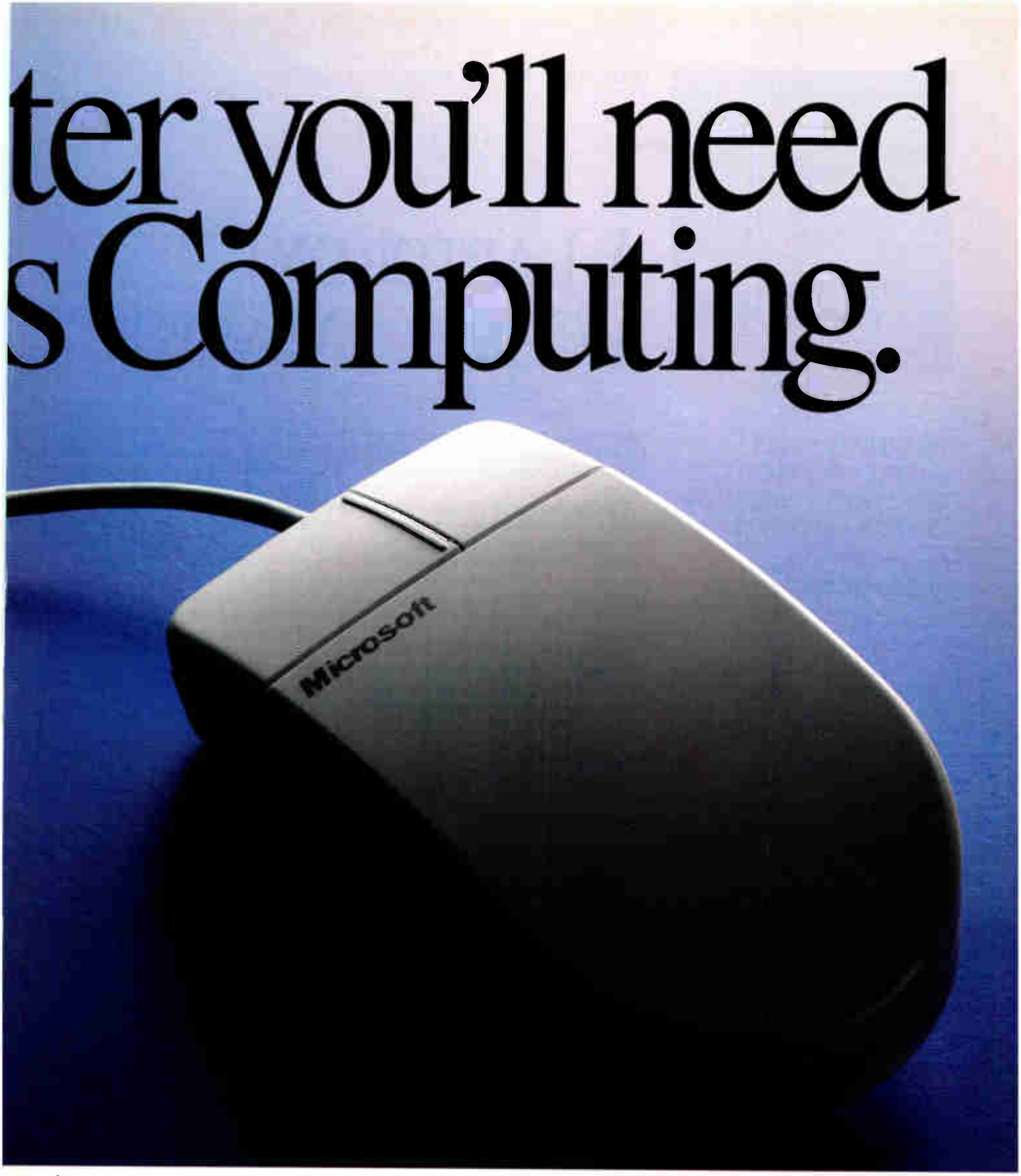
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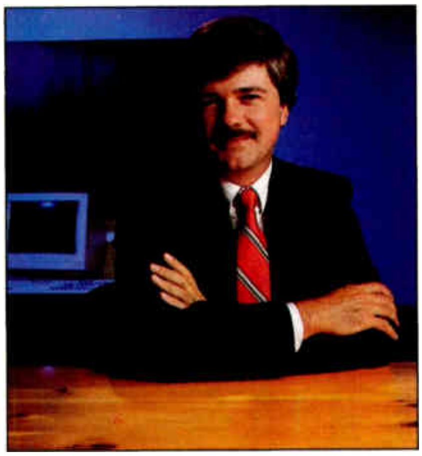


A LAPTOP ON A CHIP...ALMOST

When they're not duking it out in the courtroom, companies like AMD and Intel are redefining laptop technology

Last month, I wrote about the current crop of laptops—and they are indeed spectacular. But the game's not over yet, by a long shot. The best of current technology offers you a full spectrum of choices, from i486-based lunchbox luggables, to 386-based portables and notebooks, to fabulously lightweight and fast 286 notebooks, to tiny hand-held 8086-based units.

Soon, very soon, you can expect hand-held 286 machines—an AT in the palm of your hand—and a plethora of 386-based notebooks.

The Hand-Helds

In October, AMD (Austin, TX) announced its "AT on a chip," a single chip that contains an AMD 286 microprocessor and all the ancillary chips required to build a basic IBM AT. More accurately described as "most of an AT on a chip," the 286ZX and its low-power sibling, the 286LX, need only a DRAM chip, a keyboard controller, and a system bus to make a working computer. (This contrasts with the 10 to 100+ chips some other designs use.)

The 286ZX chip is designed for desktop machines, and the 286LX is designed for laptop and notebook computers. The 286LX adds some battery-saving features to improve laptop performance, such as a CPU shutdown mode that turns off the 80C286 section of the chip. A standby mode shuts down all system clocks except those that are needed for DRAM refreshing. It barely sips power, which should stretch out battery life to the max.

This compacting of elements reduces many of the engineering headaches that arise when cramming a 286-based VGA computer into a notebook form factor, so you can expect to see many more of these laptops and notebooks on the market. That, in turn, should help keep prices reasonable.

It also augurs well for 286-based hand-helds. Now that's a machine I want to use—a full-blown go-anywhere AT that fits in a pocket. Don't laugh; they're being developed right now.

The Notebooks

Longtime readers may recall that I'm no big fan of the 386SX for desktop computers because it has a narrow bus that needlessly cripples I/O. (*Needless* is the key word. The SX was not designed to fill a consumer need, but purely for marketing reasons. By promoting the SX, which it alone manufactured, Intel hoped to kill off the perfectly adequate 286, which other companies—such as AMD, Harris, and Fujitsu—also sold.)

In portables, bus width isn't much of an issue. For one thing, you tend not to stuff a portable full of plug-in cards. For another, now that there's a reasonable body of 386-specific software, a portable SX gives you increased compatibility with your desktop system's software, albeit with the performance hit of the SX's CPU-to-memory bottleneck.

SX chips have been used in laptops for quite a while, and they are starting to show up in notebook computers in some numbers.

From SX to SL

Enter the 386SL. Intel describes it as a "386 processor expressly designed for the emerging notebook-size personal computer market."

The 386SL is a 20-MHz 386 core combined with a main-memory subsystem controller with a 32-megabyte address space, an EMS 4.0 memory controller, an AT/Industry Standard Architecture bus controller, a cache controller, and support for the 80387SX math coprocessor. A companion chip, the 82360SL ISA peripheral and power management chip, supports CPU, memory, and peripheral functions, as well as providing programmable features to manage power to prolong battery life.

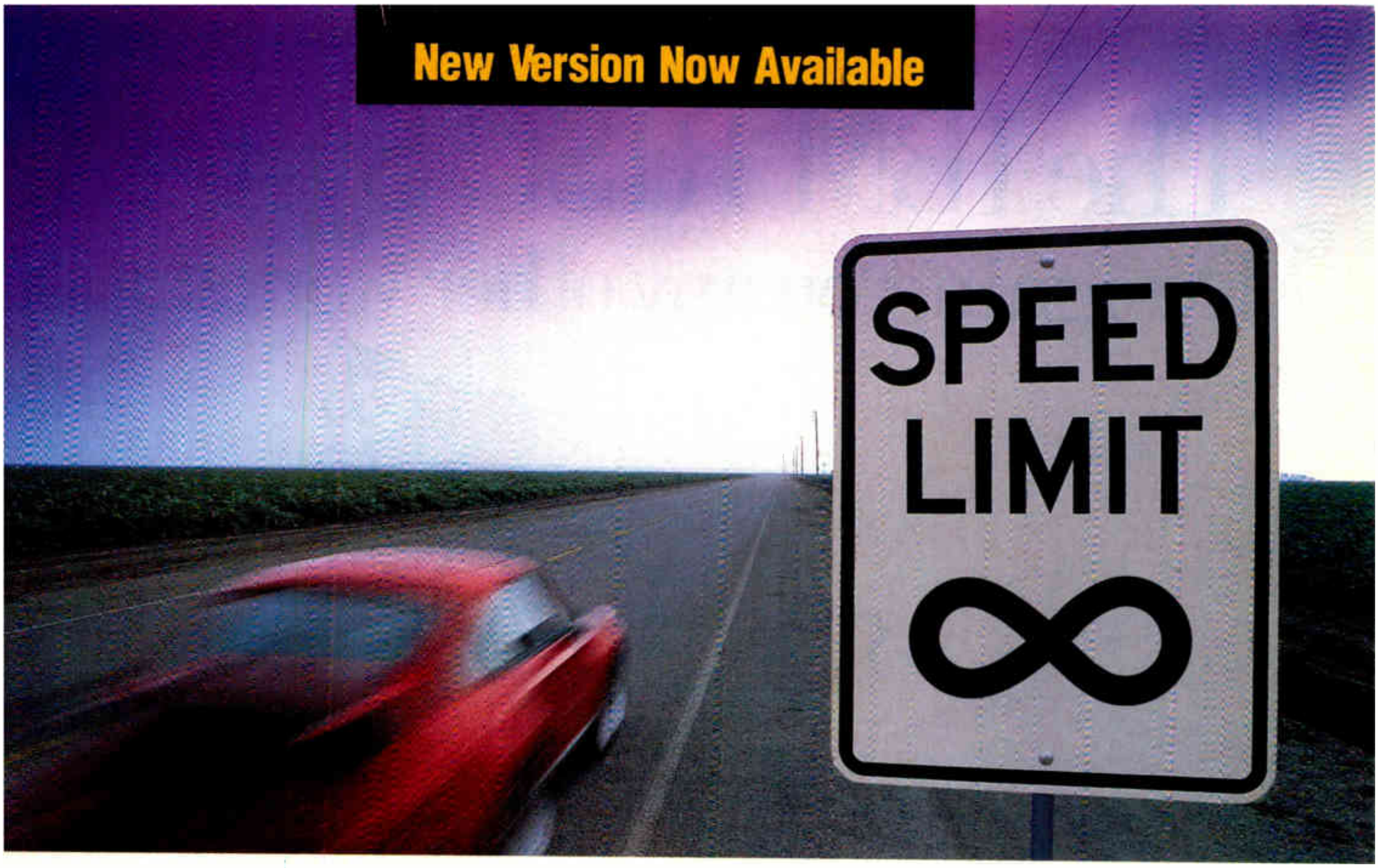
Intel also provides a family of low-power support logic chips for modems, keyboards, memory, network adapters, and the like. Intel is setting itself up as a virtual one-stop source for laptop silicon.

We can't meaningfully test these new chips until they're installed in a real-life system, but Intel believes that the compact, highly integrated 386SL is about 20 percent faster than an ordinary 20-MHz 386SX. This means that the SL line can deliver "true" 386 performance levels even in low-power, compact systems. The SL may be the chip the SX should have been all along.

How compact will SL systems be? The SL chips themselves come in several configurations, the smallest being an amazingly dense 227-lead land grid array. The two main chips contain a total of 1.1 million transistors, and they are fabricated using 1-micron technology. Intel says that a complete 386 AT can be built on a board measuring just 4 by 6 inches (about 10 by 15 centimeters). Incidentally, that's about the size of a Sharp Wizard....

West Coast news editor Owen Linderholm has been following these developments all along. His report on the AMD ZX and LX chips appeared in October's Microbytes, and his excellent feature on what's new in laptop chip sets appears in this issue on page 312. Check it out.

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



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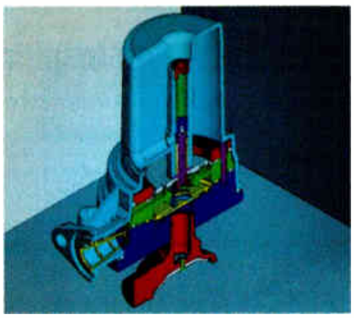

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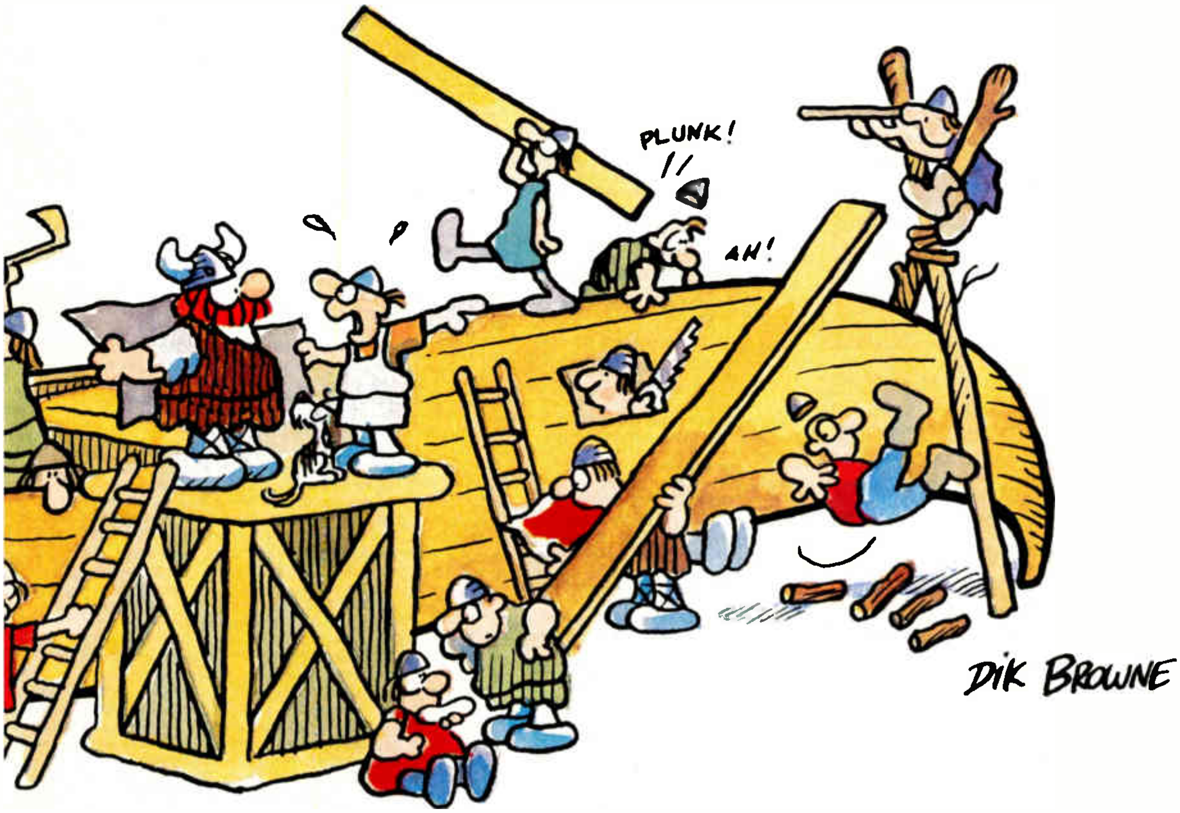

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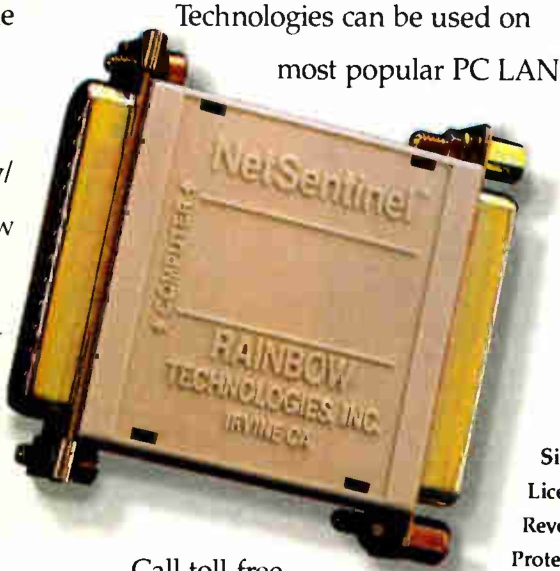

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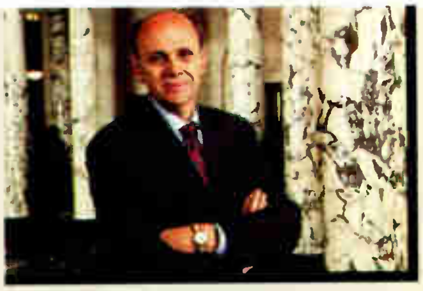

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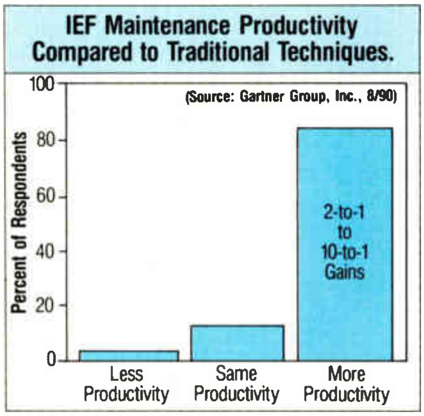

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MICROBYTES

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

Monitor Noise Causes Stress, Researchers Say

The near-ultrasonic noise produced by some computer monitors and VDTs can actually lower worker efficiency and might even cause health problems in women who use them, according to a new study. Researchers Caroline Dow and Douglas Covert, professors at the University of Evansville (Indiana), say they found that a 16-kHz pure-tone sound caused significant amounts of stress in the college-age women participating in the study. They say this tone is similar to sounds made by most of the commonly used computer monitors.

"In these experiments we have made the link between stress and a specific attribute of the VDT," Dow says. In their controlled experiments, Dow and Covert demonstrated that the 16-kHz tone, which is at the top of the range of most human hearing, can cause a significant reduction in a worker's accuracy of intellectual performance and also spur short-term increases in speed. The two researchers say that lowered productivity and a brief increase in the speed of work are symptoms of high stress.

Women appear most susceptible to the problem because they tend to hear better than men in higher-frequency ranges. As a result, the professors say, women can be aware of the tone while men aren't. Dow and Covert also say that women are especially affected by the sound at the peaks of their estrogen levels. High estrogen levels are typical of the first trimester of pregnancy. Even whisper-quiet sources of the tone appear to cause stress among women, they say. Dow says the tone could be a factor in some of the cases of gynecological problems, including miscarriages, that some people have associated with computerized workplaces.

Industrial-environment researchers have generally discounted gender in considering the effects of the 16-kHz tone. Some previous studies, however, have shown that the sound could cause psychological distress in some men and a greater number of women when the sound was at high-volume levels.

The two professors offer three suggestions. Try to use a high-definition monitor; they have scanning rates that are well above the range of human hearing. (Dow won't speculate on which resolution is best; the higher, the better, she says. She also points out that some monitor cases are designed so well that they muffle any sounds.) Ear plugs offer temporary relief, especially ones designed to reduce the intensity of high-pitched sounds. Another suggestion is to install an electronic circuit that produces the same 16-kHz pure tone but operates 180 degrees out of phase; the two sounds will cancel each other out. The two professors admit that some engineers are skeptical about this process, and there is no evidence yet that not hearing the sound actually eliminates the effects.

Is your monitor stressing you out? Dow suggests turning your tube off for 15 minutes and then seeing if you feel more relaxed.

— *David Reed*

New Hardware, Software Squeezing Graphics

Graphics, especially color images, can strain the CPU capacity, bus bandwidth, and storage space of most personal computers. But new developments in data compression will help facilitate the use of images on not-that-exotic desktop systems.

C-Cube Microsystems (San Jose, CA) is putting its CL550 image processor chip, based on the Joint Photographic Experts Group (JPEG) compression algorithm, onto $995 add-in boards for Macs and IBM PC compatibles. These boards will be able to compress images by as much as 75 to 1, the company says. The new Compression Master boards can squeeze image files to one-twenty-fourth their original size with no visible loss of quality, C-Cube says.

A 300-dpi 24-bit color scan of an 8½-by 11-inch page can take 28 MB of disk space—which means that it takes only a few such scans to fill an 80-MB disk—but after being fed through the Com-

NANOBYTES

Users apparently pushed the right buttons when **protesting Apple's decision** to disable the scripting capabilities in the standard Hyper-Card 2 package. Apple and **Claris**, now proprietor of the hypertext program, announced that the new HyperCard would be delivered to users in a run-time-only version; in other words, you couldn't develop your own stacks (programs). Those hyperscripting tools were going to come in an optional package. After a furor on several on-line services, including BIX's Macintosh Exchange, the decision was nixed. HyperCard product manager Mike Holm says now that a full version of HyperCard will indeed be bundled with new Macs; however, it will not enter scripting or programming mode without the user making a minor change: removing an opaque button over the scripting choices on the Home stack. Claris plans to have a shrink-wrapped HyperCard 2.0 upgrade available in the near future for a retail price of $49.95.

Microsoft (Redmond, WA) has collected a set of **device drivers** for printers, displays, pointing devices, and other peripherals that work with **Windows 3.0**. The drivers were written by hardware developers and then certified by Microsoft. The Windows Supplemental Driver Library includes drivers for HP's LaserJet Series II and III printers that Microsoft says improve printing performance from within Windows. This first version of SDL also includes printer drivers from AMT, Bitstream, Brother, Canon, IBM, Kodak, Okidata, Olivetti, Seiko, and Star. The "enhanced" display drivers, including ones for Super VGA systems, come from ATI, Chips & Technologies, Compaq, Graphic Software Systems, Video Seven, and Western Digital. Novell has provided a network driver. You can order the SDL from Microsoft by calling (800) 426-9400; the cost is $20.

NANOBYTES

Interleaf (Cambridge, MA) says it will soon bring to market some desktop publishing products that implement its **"active document"** technology. Announced last March, active documents are electronic documents that can "access, evaluate, and act on information," Interleaf says. The first incarnation is in the new Interleaf 5 series, a set of six programs for specific job categories (e.g., writer, engineer, and illustrator). Active electronic documents can evaluate and act on information they receive. For example, Interleaf and **Lotus** have created an "intelligent link" that lets Interleaf documents display information from Lotus 1-2-3 files as Interleaf automated tables or charts. You activate the link by copying an icon representing the spreadsheet and pasting the icon into an Interleaf document. Interleaf plans to offer a Lotus toolkit for creating intelligent links in a spreadsheet. The Interleaf 5 products for Unix workstations are scheduled to begin shipping in limited numbers this month. Versions for DOS and VMS are scheduled to ship next spring; Mac versions will ship next summer.

Motorola (Austin, TX) has packaged a new version of its 68030 for use as an **embedded controller**. The new 68EC030 performs comparably to the regular 68030, the heart of high-end Macs and workstations, and it's object code–compatible with its ancestors, the 68000 and the 68020. The 40-MHz chips cost $75 each in quantities of 1000.

Quark (Denver) is taking **XPress**, one of the leading Macintosh desktop publishing programs, to OS/2. As part of its development agreement with IBM, Quark also is developing software to "enhance integration and connectivity of multiple vendor systems," the company said. These efforts include groupware and data-exchange software. Quark recently demonstrated a prototype of XPress running under Windows 3.0. However, company founder Tim Gill says that Windows lacks the connectivity and networking features needed for large-scale workgroup publishing, and hence the focus on OS/2.

pression Master, the page would take up just a little more than 1 MB. This sort of file compression is especially important if images will be traveling across a network.

C-Cube has also developed a programming interface, called the Image Compression Interface. ICI is a set of calls that can be written into Mac or PC applications to let them access transparently a Compression Master board installed in the system or any other compression board that adheres to the ICI standard. If no board is present, the compression is done in software, through JPEG version 8.2 algorithms supplied with C-Cube's Compression Workshop software. Because both the JPEG and ICI specifications are open, any software or hardware vendor can build to the standard.

Several software companies have announced support for ICI, and some on the Macintosh side said ICI support has already been written into their applications, including Adobe Photoshop, Quark XPress 3.0, Aladdin Systems' Stuffit DeLuxe, Studio/32 from Electronic Arts, and Salient DiskDoublerPlus. Autodesk said it intends to support ICI in Animator.

An early adopter of the C-Cube squeezing technology is Macintosh peripherals maker SuperMac Technology (Sunnyvale, CA), which announced at the recent Seybold Conference that, starting in January, it will include still-image compression software with all its color graphics cards and storage systems. The new SuperSqueeze software is based on JPEG algorithms obtained from C-Cube and will comply with C-Cube's Image Compression Interface. People who purchase SuperMac products now will be eligible to receive the SuperSqueeze software for free. Others can buy it for $49.

Radius (San Jose, CA) is also putting the squeeze on graphics. The company announced at Seybold a software implementation of the JPEG standard. The Radius software, for the Mac II platform, will compress still images only. The new software can compress a 0.75-MB, 24-bit full-color image to 25K bytes in less than 6 seconds on a Mac IIcx and in less than 3 seconds on a Mac IIfx, the company says.

The Radius software will be priced at "around $300." The company's software approach is more flexible than hardware JPEG implementations like the C-Cube chip, Radius claims. The firm points out that an image-compression board takes up a Mac II slot and costs $1000 or more. Furthermore, revisions to the JPEG standard will be less painful for users of software-based compression products, Radius says; it is cheaper to buy a software upgrade than it is to buy a new add-in board. However, the hardware solution is still the faster method of image compression.

— Andy Reinhardt and Jeff Bertolucci

AT&T Promises Multiprocessing Unix Next Year

AT&T's Unix System Laboratories (USL) plans to start enhancing Unix System V release 4 next year, with the most significant change involving multiprocessing. AT&T is working with Sequent and other companies to develop a symmetrical multiprocessing version of Unix System V release 4 that can handle up to 10 processors. This release, called SVR4 MP, is slated for the first half of 1991, AT&T said.

Although it will be developed on Intel processors (the i486 and the i860), versions also will be available for MIPS, SPARC, and Motorola (88000) CPUs. A later version (SVR4 ES/MP) will be able to handle up to 30 processors. One of the companies that plan to use the multiprocessing Unix is NCR, which announced several multiprocessing computer systems recently.

A new version called SVR4 ES will be more secure, USL said, and will conform to the B2 level of security as outlined by the U.S. National Computer Security Center. This level is designed to be more resistant to computer viruses and to make it more difficult for operators to create security loopholes either accidentally or intentionally. This version is scheduled for the first half of 1991.

The new SVR4 will be better at disk management, AT&T says. USL developers are working to increase performance by storing parts of files on different physical hard disk drives.

AT&T would not disclose pricing for these new versions of Unix, saying that price information usually precedes product availability by about 60 days. AT&T representatives would not commit to a single graphical user interface for the new Unix, and they offered only muted support for Open Look, the GUI that AT&T had originally proposed for System V. Some people had expected AT&T to

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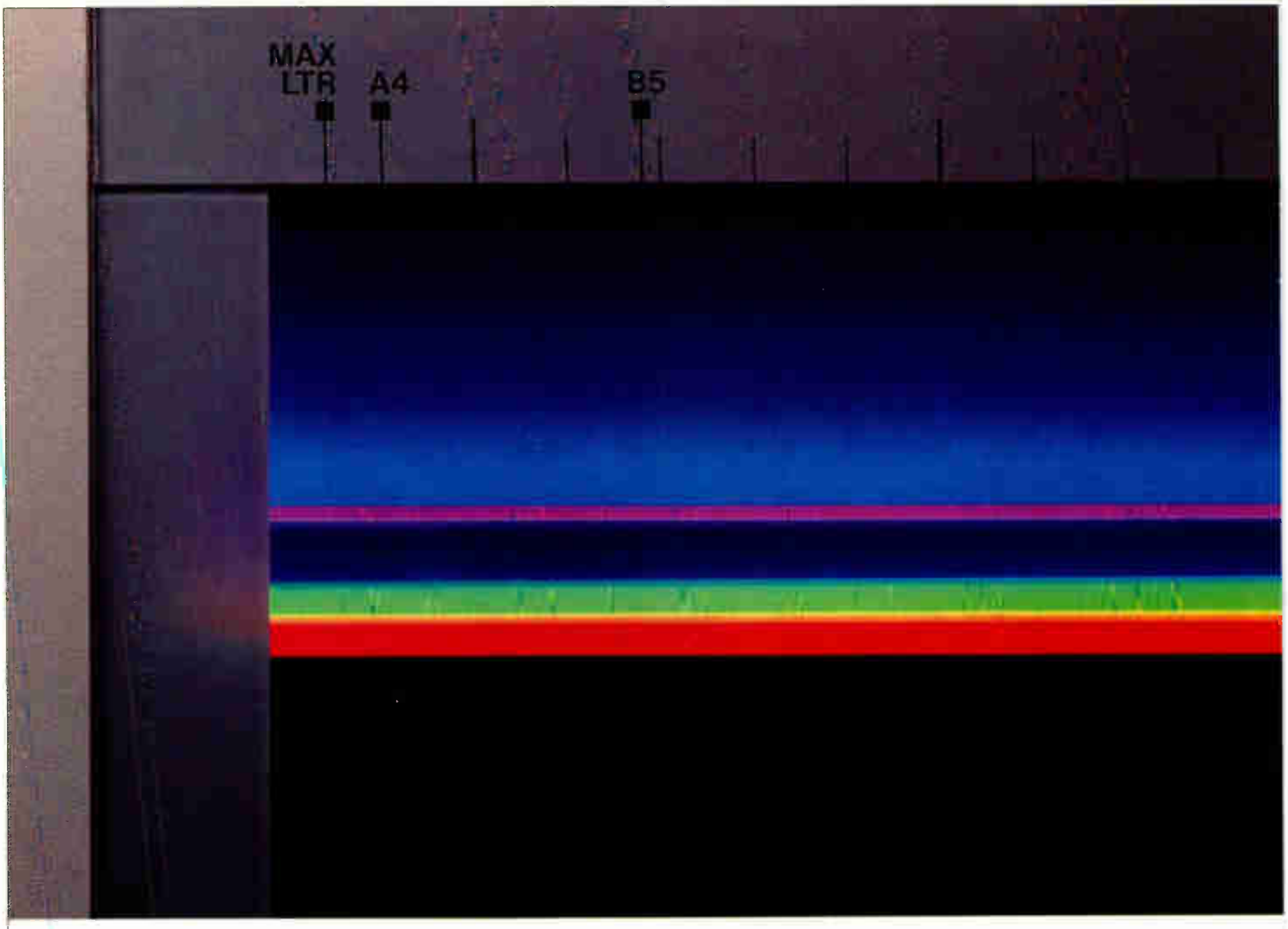

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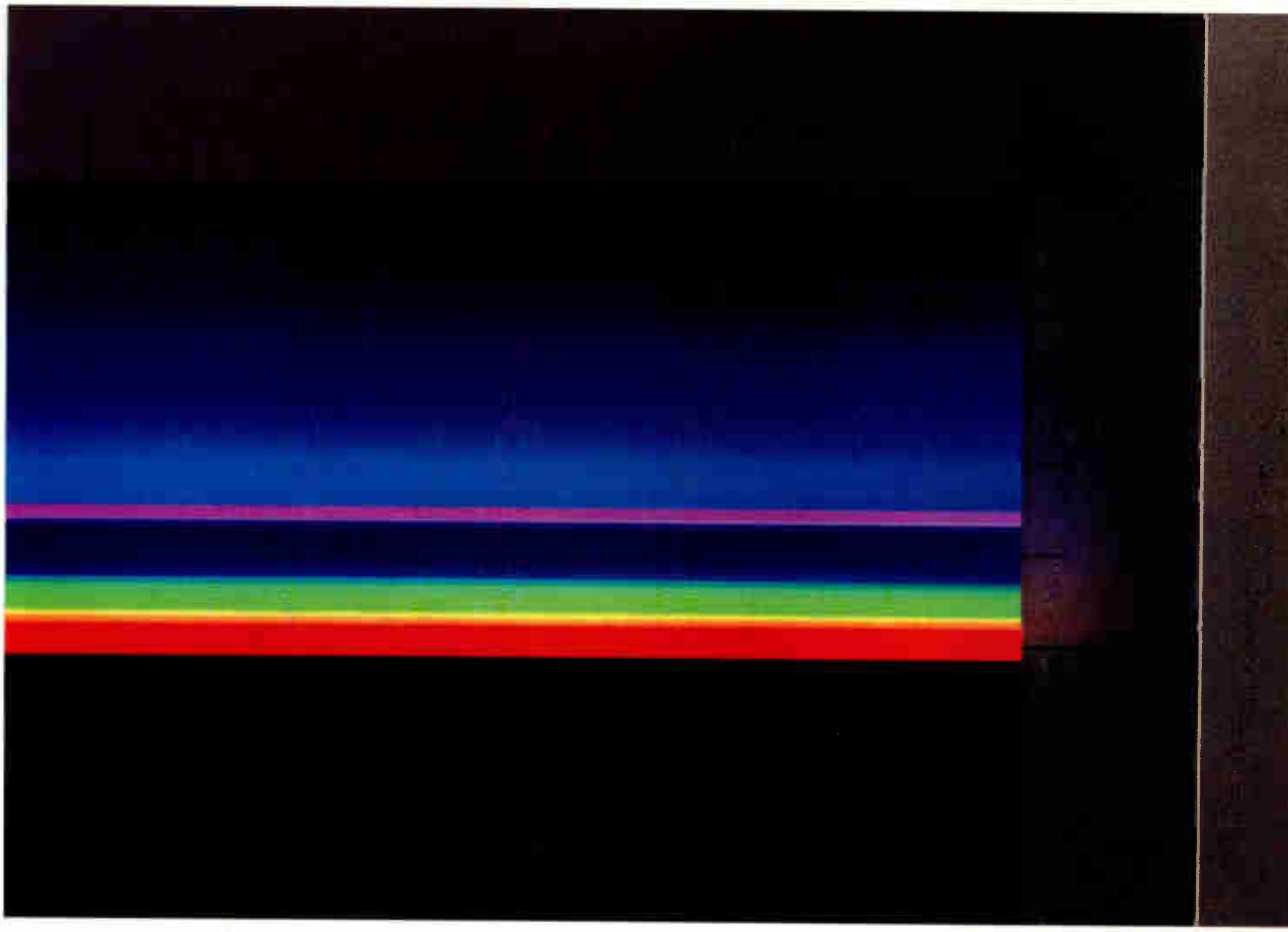

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A demonstration of the Epson ES-300C will be an illuminating experience. Other scanners simply pale by comparison.

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NANOBYTES

Maxtor (San Jose, CA) has developed a new 3½-inch hard disk drive that the company claims is **the biggest** in the business. The new LXT-535 can store 535 MB. The drive comes with a SCSI or an AT interface. Average seek time is 12 ms, Maxtor says. The OEM price for the LXT-535 is $1450; for the LXT-437, $1250.

IBM's M-Motion Video Adapter/A board will soon work with Windows 3.0. The Micro Channel device for converting video input to VGA images currently comes with software that runs only under OS/2 and DOS. However, IBM recently introduced in Japan a Windows-based M-Motion board, and the U.S. market should see a similar product in the near future, IBM multimedia chief Peter Blakeney told BYTE.

Qualitas (Bethesda, MD), the company that makes the 386Max high-memory manager for 386-based systems, has developed a new version of the product specifically for 386-based PS/2s. The new BlueMax ($155) addresses a particular problem experienced by PS/2 users: Because IBM uses 64K bytes of high memory for the BIOS to support OS/2 and other future capabilities, there's not enough high memory to hold network adapters, TSR programs, and an expanded-memory page frame. BlueMax removes those portions of the IBM BIOS that are used only by OS/2 and reloads the BIOS to use only 64K bytes of high memory instead of 128K. The result is that network interfaces and EMS drivers can be loaded into high memory, with room left over for a few TSR programs.

Graphic Software Systems (Beaverton, OR) has come out with a kit for writing **34010**-based applications drivers to the Direct Graphics Interface Standard. The DGIS 3.0 Software Development Kit comes with the DGIS firmware, C subroutine calls, sample programs, documentation, program utilities, and a 34010 board for testing the drivers. The kit costs $695. GSS also has the first graphical interface for 34010-based products working with OS/2 Presentation Manager.

acknowledge support by now for Motif, the GUI used by the Open Software Foundation's Unix. Instead, AT&T is talking about establishing a common application programming interface for all GUIs. Theoretically, users who buy programs written to this generic API can choose for themselves which GUI they would like to use.

— Rich Malloy

No RISC: Multiprocessing Architecture Will Emulate 386, i486, Run Current Applications

RISC technology has been promoted as a performance savior for desktop computing. But if users of non-RISC systems convert to RISC, they can't take their favorite applications software with them. Those programs would have to be left behind or rewritten for RISC.

NexGen (San Jose, CA) says that it can surpass RISC performance levels without making current software obsolete. The company is designing a new complex-instruction-set computer architecture that will be able to run most software now working on IBM PC-compatible computers. NexGen says the multichip processor at the heart of its multiprocessing architecture will be binary-compatible with DOS, OS/2, and The Santa Cruz Operation Unix.

NexGen says that its systems architecture is the first to support "true symmetric, scalable multiprocessing in a personal computer environment." A machine built around the NexGen design will be able to have four CPUs. These machines will perform at speeds "greater than twice that of a 486, SPARC, or MIPS" system and comparable to that of an IBM RISC System/6000, said Peter Janssen, vice president of NexGen.

Although the company has been "thrown in the basket with" chip makers trying to clone Intel's 386, "we're doing a superscalar architectural design of a microprocessor," Janssen said. NexGen's multiprocessing system will be based on a proprietary chip set that can emulate the 386/i486 instruction set. That VLSI chip set incorporates an instruction decoder, an integer executor, a numeric processor, a memory and cache controller, an address preparation unit, and instruction and data tag chips. The processor talks to the rest of the system with a 64-bit multiprocessor bus; the designers say that the bus can operate at 267 MBps. Integer and floating-point instructions can execute concurrently. Most integer instructions are handled in a single cycle, Janssen said. The memory system can feed the processor 8 bytes of instructions or data during every cycle. The instruction and data caches use ordinary static RAM.

NexGen hopes to sell its design initially to OEMs. Resultant multiprocessing server systems could show up early in 1991, Janssen said. Workstations and servers built around the NexGen processor will be able to "swap disks and I/O boards with PS/2s and EISA machines," he said. Although computer makers Compaq and Olivetti have made equity investments in NexGen, there's no contractual obligation to use the company's new technology, Janssen said.

— D. Barker

NCR's New Environment Built on Cooperation

NCR has concocted a "general-purpose information processing environment" that's a model of cooperation. In fact, that's what NCR calls its ensemble of client/server-based workgroup software: Cooperation.

Cooperation provides not only a graphical desktop interface, network support, and E-mail, but also sophisticated network file management, wide-area-network support, terminal emulation and host links, database engines and front ends, document conversion, work-flow automation, an executive information system (EIS) shell, and network management functions. Many of these things are available in competing "office environments," but Cooperation, based on open standards and software from other companies, also includes open application programming interfaces, development tools, and a library of reusable objects to simplify custom programming.

NCR's system, designed to run on 386-based PCs, starts with DOS and then adds Windows 3.0 and Hewlett-Packard's New Wave 3.0, for an iconic workspace that can treat data files as objects and invoke "agents" to automate complex or repetitive tasks. The servers will be running OS/2 LAN Manager (or, In a world that changes economic systems overnight, can we really afford personal computer systems that take weeks to set up, months to learn, and years to deliver on their promises?

No. But, fortunately, afford a

In the 1980s, American companies invested nearly $90 billion in PCs, yet office productivity has shown disappointing gains.

Not everybody was disappointed, however. According to a new independent study by Diagnostic Research, Inc.*, companies that invested in Macintosh® computers are enjoying dramatic results. Managers gave Macintosh productivity ratings that were 37% higher than for MS-DOS systems and 32% higher than for PCs running Windows. Which is like getting back 17 extra weeks a year.

In a global economy of snowballing competition, the story behind those figures may be of interest.

In 1984, Apple introduced Macintosh on the simple premise that computers should work the way people do.

Now, as others rush to market with Macintosh look-alikes, Apple turns out to have been the practical, dependable, results-oriented computer company all along.

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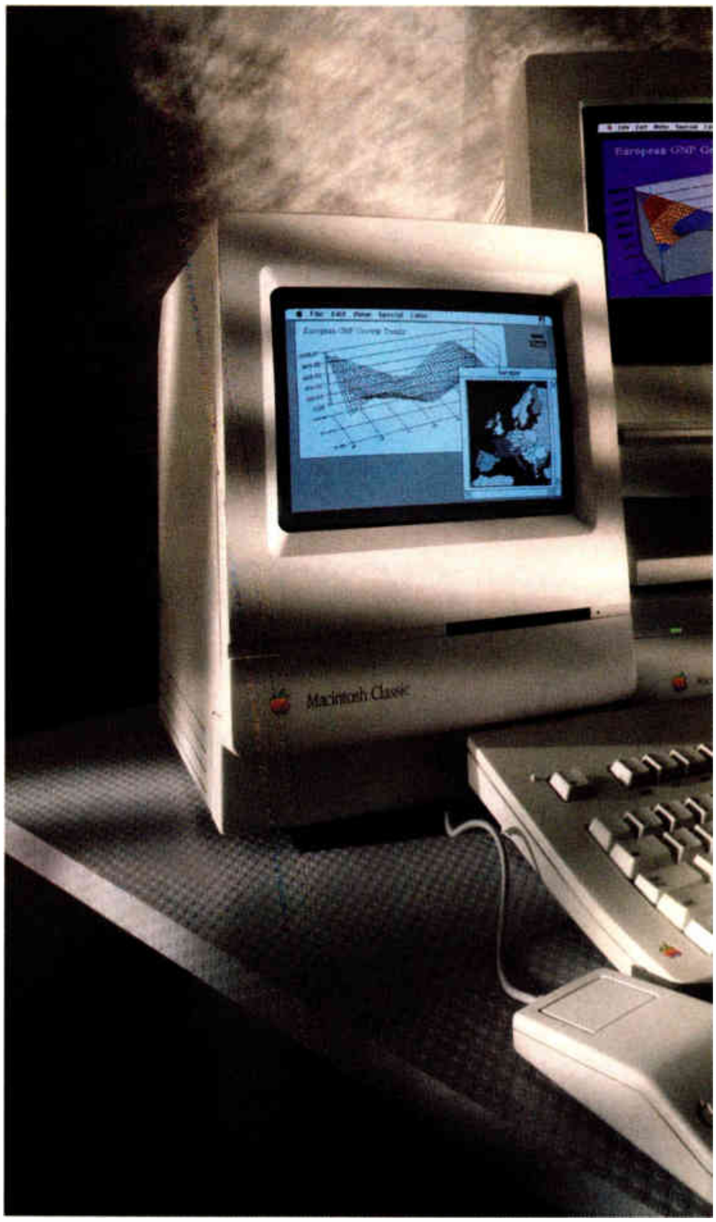

The new Macintosh Classic, Macintosh IIsi, and

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This one has everything that makes a Macintosh a Macintosh. Built-in networking. A SuperDrive™ disk drive, which reads both Macintosh and MS-DOS files. And a $999† price that includes the built-in monitor, 1MB of RAM, keyboard, mouse, and system software. A 40MB hard disk is optional. Its processor is an 8 MHz 68000 chip. And it outperforms the popular Macintosh SE.

The Macintosh LC.

The new, low-cost Macintosh LC introduces exquisite

** The figures are included in a 1990 study conducted by Diagnostic Research, Inc., among Fortune 1000 managers and business computer users familiar with Macintosh and MS-DOS or Windows systems. Call and we'll send you*
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NANOBYTES

New subsidiaries of **Nakamichi** Peripherals Corp. of Japan are gearing up to deliver their new 3½-inch rewritable optical disk drives to OEMs and end users. **Mass Optical Storage Technologies** (Cypress, CA) is the developer and manufacturer of the 3½-inch optical disk drive and will sell it on an OEM basis. **Ocean Microsystems** (Campbell, CA) will sell the drive to end users. MOST's RMD-5100 drive offers a capacity of 128 MB on single-sided disk cartridges that are roughly the same size as familiar 3½-inch magnetic media. MOST says that the drives have an average access time of 35 ms, comparable to many hard disk drives. The Ocean Vista 130 drive, slated to be available to users by the end of this year in limited stock, will cost $3395 for XT/ATs and compatibles, $3595 for PS/2s, $3195 for Macs, and $3990 for AT-bus systems running Unix or Xenix.

Trying to encourage software development for its **i860** RISC microprocessor, **Intel** and five of its i860 customers have formed a support group for the 64-bit chip. The **Mass860** group will offer software developers porting assistance as well as technical and marketing help. In addition to Intel's Microcomputer Components Group, founding members are Alliant Computer Systems, IBM, Oki, Olivetti, and Samsung. Mass860's **new multilayer application binary interface** (ABI) will enable third-party software to run unchanged across a variety of hardware platforms that support the i860, Intel said; for example, a program that runs on an i860 auxiliary processor on a PC will run in identical binary format on workstations from Oki, Olivetti, and Samsung, and will run under PAX on "supercomputer-class systems" from Alliant, Intel said.

An old name in typewriters, **Smith-Corona** (New Canaan, CT), plans to introduce a line of personal computers aimed at home and small business users. The new PCs will be developed by Taiwan-based **Acer** to specifications from Smith-Corona, and manufactured by Smith-Corona in Cortland, New York.

someday, Unix System V release 4) and the Mezzanine network file management software from Saros. Cooperation comes with a set of applications from other companies: Gupta's SQLBase Server, FutureSoft's DynaComm terminal emulator, Mastersoft's Word for Word file-conversion utilities, Channel Computing's Forest & Trees EIS system, and Software Products International's Access SQL.

The secret to Cooperation is that it is an amalgam of third-party applications. NCR has integrated them into a tightly coupled environment that can be installed on any IBM-compatible computer—both a technical and a political accomplishment.

One drawback to Cooperation, compared with typical PC network configurations, is its cost; the software modules (which provide user and network services and applications) are expensive by PC standards and require expensive computers. But NCR officials maintain that the per-user cost is still less than that of minicomputer and mainframe software or the cost of hiring consultants to integrate complex PC applications.

Cooperation client machines must be 286- or 386-based PCs with at least 6 MB of RAM. Clients run DOS, Windows, NewWave, and whatever other client modules have been purchased. Servers have to be 386 or 486 machines with 12 MB of RAM and at least 200 MB of disk storage. NCR said the servers have to be Micro Channel systems because they require the bus bandwidth, but the company couldn't explain why an EISA-bus machine wouldn't suffice. Servers run OS/2 and LAN Manager 2.0, in addition to the chosen modules of Cooperation. The cost ranges from $23,000 (for a 12-user system) to $58,000 (for 24 users). NCR expects Cooperation to be generally available in March.

— Andy Reinhardt

Motorola to Go Superscalar with Future Chip

At the recent Microprocessor Forum, Motorola disclosed not a new product so much as its ambitious plans for a new product. This non-announcement concerned the Motorola 88110, which is a future member of the 88000 family of RISC processors; if Motorola is right, the 88110 chip will be one of the performance leaders of the decade.

The 88110 will be a superscalar design, meaning it will be able to execute more than one instruction per clock cycle. Motorola will put the CPU, FPU, graphics execution units, memory manager, and instruction and data cache all on the same chip. The 88110 will use 80-bit-wide data paths internally throughout the chip. The design will incorporate speculative execution techniques to anticipate the tasks that it will be given to run. Motorola says it can produce this chip sometime in 1991 and that it will be between three and five times faster than the 88100.

The chip maker has made what some microprocessor experts consider bold predictions. Motorola said it can retain object-code compatibility while adding a highly parallel superscalar design and dynamic instruction scheduling, and implementing this at 100-MHz clock rates with extremely wide data buses. Motorola designers say that by the end of the 1990s, the company will be producing multiprocessor chips that contain 100 million transistors and are capable of operating at 300 MHz.

Motorola officials say that the 88000 architecture will provide a broad range of processors that can control anything from a toaster to a supercomputer, all with the same basic instruction set.

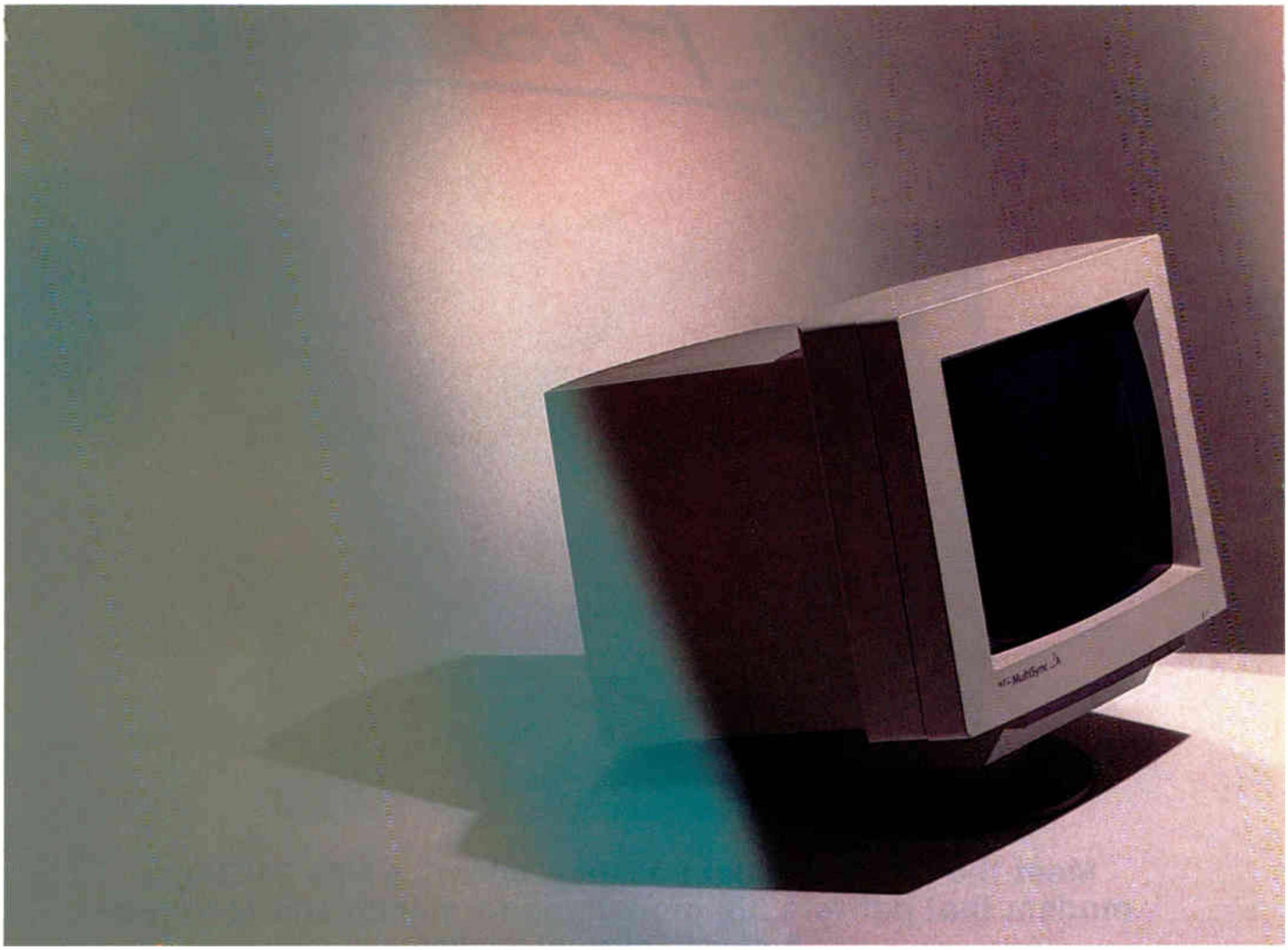
— Owen Linderholm

Mixed-Media Magazines on Disc Are on the Way

With some help from hypertext tools and multimedia development programs, four companies are readying or have released new interactive magazines on CD-ROM. The platters will provide everything from software demos to music videos to ads with electronic buttons you can press for more information.

These kinds of publications, which tend to make heavy use of graphics, sound, and hypertext links, are easier to design now than a year or so ago because of sophisticated programs for manipulating images and linking information. Verbum, for example, has constructed its Verbum Interactive disk entirely with off-the-shelf software. "A couple of years ago," says Michael Gosney, president and publisher, "it

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



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

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

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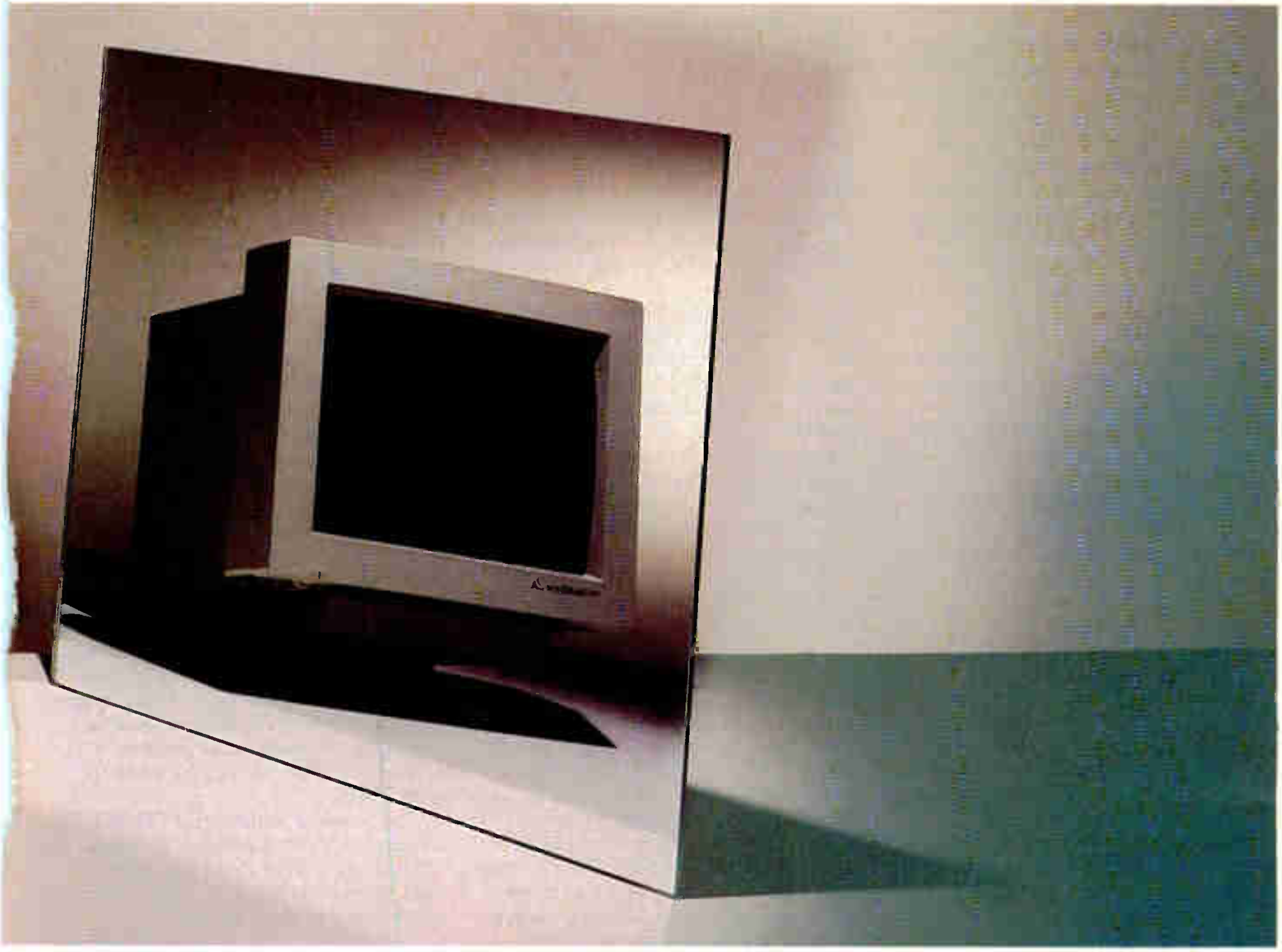

It's even available in a gray-scale version—the MultiSync GS2A—which delivers everything the 2A does, in glorious shades of gray.

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

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Circle 203 on Reader Service Card

NANOBYTES

If our offices are at all representative of Real Life, **no two Macs** within a 10-foot space are alike. To help live with the differences caused by an ever-increasing variety of Macintoshes, **Farallon Computing** (Emeryville, CA) has come up with DiskPaper. With this $149 software, networked Mac users will be able to view, copy, and print a document regardless of their type of Mac, color capability, application, or font availability, Farallon says. And with appropriate sound-input hardware—like Farallon's MacRecorder voice digitizer or the built-in sound capabilities of the new Mac LC and IIsi—users can attach sound notes to their documents. A DiskPaper file contains "multiple representations" of a document, including QuickDraw, PostScript, or bit-mapped images. DiskPaper sends the appropriate representation to the receiver's Macintosh. (Whereas a Mac Plus on a network might receive a black-and-white bit-mapped image of a complex color drawing created on a Mac IIfx, another Mac IIfx on the network would receive a color QuickDraw image. But other than the lack of color, the Mac Plus image would be identical to the one received by the IIfx, Farallon says.) DiskPaper is scheduled to be ready this quarter.

Things are slow this year, but **semiconductor companies** can expect a healthy increase in sales during the next two years, according to one forecast. Sales in 1991 to 1993 will perk up due to the "continuing pervasiveness" of semiconductors in the electronics industry, according to the **Semiconductor Industry Association**. The group predicts more than $75 billion in semiconductor sales in 1993. As for predictions of a gloomy economic situation, SIA statistical programs director Doug Andrey said that the semiconductor growth rate doesn't necessarily follow that of the economy as a whole. The industry experienced double-digit growth rates in the late 1970s, when the economy was in a recession, Andrey said. But then the chip industry had its worst years in 1984 and 1985, when the general economy was doing well, he said.

would have taken hundreds of hours of custom programming." But now, the different elements of a magazine can be built with an assortment of Macintosh design and illustration tools, including Adobe Illustrator, Aldus FreeHand, PixelPaint Professional, Studio 8, Swivel 3D, StrataVision 3D, and LetraStudio. Verbum assembles the final product in MacroMind Director 2.0. "The beauty of the Mac platform," says Gosney, "is that all these programs work together."

Gosney plans for Verbum Interactive to be a showcase of creativity and a resource of information about multimedia, hypermedia, and animation. It will be modeled on the firm's paper-and-ink magazine, *Verbum*, which covers computer-based publishing and graphic design. Verbum Interactive will feature multimedia art work, a database of multimedia products and services, and interactive advertisements.

Subscriptions to Verbum Interactive, which works with the Mac II, cost $49.95 per disk. Verbum plans to produce an edition that runs under Windows 3.0.

Discovery Systems is putting software, demos, games, multimedia interviews, sound files, clip art, hypermedia tools, and "talking" letters to the editor, sent via voice mail, on its Nautilus CD, says Marsh Williams, project manager. Readers can purchase software contained on the disk. Nautilus prototypes were built with SuperCard, but Discovery plans to develop its own code to assemble the magazine. The magazine "runs" on a Mac with 2 MB of RAM. Issued 13 times a year, it costs $9.95 per disk. The company plans a Windows edition for early 1991.

Still in the prototype stage, Antic Publishing's as-yet-unnamed CD-ROM magazine, according to Antic president Jim Capparell, will capture the look and feel of "riffling through the pages" of a traditional magazine, but with added dimensions of sound, animation, and video. Capparell likens a multimedia magazine to a Hollywood production; Antic is even referring to the CD-ROM magazine's editors as "producers."

Antic's disk will be available for the Macintosh and IBM platforms, as well as for Commodore's new CD TV, which combines a compact disk drive and computer in one machine. Subscriptions will cost in the $10 to $25 range.

The least computer-oriented of the new CD-ROM magazines, underControl's Grip, will focus on current events and music. Grip will incorporate animation, video, news, editorials, and material gleaned from 8mm decks, VCRs, cameras, videodisks, and frame grabbers. Cofounder Nick Cutillo says underControl is receiving material from around the world, including a video of the collapsing Berlin wall. Built in HyperCard, Grip will require a Mac II with 2 MB.

The potential audience for CD-ROM magazines is still comparatively small. "Obviously it's not a very big market," says Verbum's Michael Gosney, "but we expect it to grow rapidly."

— Mark Clarkson

LAN Leaders Call for Network Benchmarks

Officials from companies prominent in computer networking have called for some industry standards for testing LANs. The new Performance Testing Alliance met during NetWorld '90 to discuss developing LAN benchmarks. The PTA includes Novell, AT&T, IBM, 3Com, and Banyan.

"The thing about LANs is that they're so complicated," said Drew Major, Novell systems architect. "It's a lot easier in many ways to test a minicomputer. It's all centralized in one box."

While all the companies at the PTA meeting supported the idea of standard benchmarks, the development of those benchmarks might create considerably more friction. The PTA will have to find a way to test every layer of a network. Its benchmarks will have to be portable. And the benchmarks will need to isolate specific components, testing different configurations and loads.

— Jeffrey Bertolucci

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People the World Over Choose Gateway 2000!

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

In Atlanta...

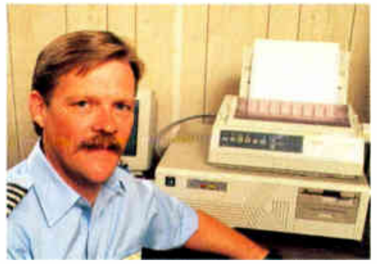
ZSoft, the well-known graphics software company, often demonstrates its software at trade shows on Gateway 2000 computers. Dave Steier, ZSoft code librarian and software demonstrator, said he prefers showing products on Gateway systems. "They're terrific," Dave remarked. "I just got back from a show where I was using Gateway 33's and they're screamers." Don Womick, Jr., a programmer for ZSoft, bought a Gateway 2000 20 MHz 386 for his personal use because he liked the Gateway systems at work. "With Gateway," said Don, "I was able to get the performance I need at a price I could afford."

ZSoft employees Dave Steier, left, and Don Womick, Jr., with Don's Gateway 2000 20 MHz 386 system.

Don and Dave both commented on the excellent service they received from Gateway. "Everyone is uniformly polite, friendly and helpful," Dave said.

At the Grand Canyon...

Papillon Grand Canyon Helicopters uses Gateway 2000 computers in its operation. Rick Carrick, chief pilot, started using PC's a few years ago to run point-of-sale software and to perform weight and balance calculations on aircraft, a critical safety and efficiency procedure. Initially he experimented with several computer firms. "I called Gateway because I liked their ads," Rick admitted. "But I've become a loyal customer because their machines are indestructible and they have excellent customer service."



Rick Carrick, Papillon Grand Canyon Helicopters, and his indestructible Gateway 2000 286.

Papillon Helicopters has another Gateway 2000 computer now – a 25 MHz 386 – and Rick said he's in the process of replacing all of the company's PC's with Gateway 2000 systems.

In Zurich...

Michael Paravicini runs a Gateway 2000 33 MHz 386 system. Michael is a management consultant for Price Waterhouse in Zurich. "I was impressed by Gateway's price-features comparison," he remembered. "My system cost far less than you'd expect to pay for a comparable computer." Continuing, he said, "It was also the responsiveness they showed when I sent a fax request for a quotation. Out of ten U. S. companies I contacted, Gateway was the most prompt and efficient in responding. I still haven't heard from some of the others."

Michael Paravicini, Price Waterhouse, and his Gateway 2000 33 MHz 386 system.

PC Magazine's survey about service and reliability confirms what these customers are saying:

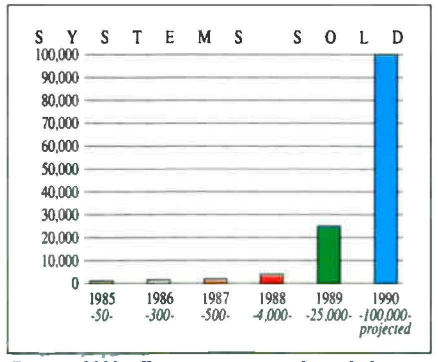
"Gateway shared top billing with such heavy-weights as Compaq, IBM, and HP for those who would buy their products again...Overall, Gateway's high marks bode well for the company's future, as does its commitment to customer service."

PC MAGAZINE

PC Magazine
September 25, 1990

From the Heartland

The combination of price, quality and service makes Gateway 2000 the best value in the industry. But value alone doesn't explain how a little company in the Midwest, just celebrating its fifth anniversary, managed to outdistance hundreds of other companies, selling more systems through the direct market channel than any other PC manufacturer in the country.



Gateway 2000 sells more computers through the direct market channel than any other PC manufacturer in the country.

"It was the cows," laughed Ted Waitt, Gateway 2000 President and CEO. "Of course." Computer magazine readers will remember the company's early ads featured a picture of the Waitt cattle farm with the headline, "Computers from Iowa?"

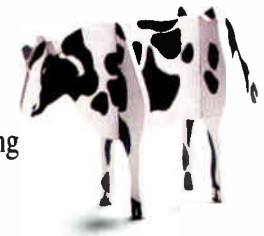
"We can't run that ad anymore," continued Ted, grinning, "because we built a new plant 14 miles down the road in South Dakota. But the cows really worked for us. They made the phones ring. From then on, though, we built our business on value – good prices on quality systems with old-fashioned, personal service."

5TH ANNIVERSARY GATEWAY 2000

Ted mentioned another reason for Gateway's success. "We take a long-term approach to customer service." he said. "When you buy a computer from Gateway 2000, you become part of our family and we're going to be there for you as long as you own that machine."

"In the computer industry, longevity should be measured in dog years."

As Ted talked about the company's fifth anniversary, he laughed again. "In the computer industry, longevity should be measured in dog years," he chuckled, "because everything's moving so fast. That makes Gateway 35 years old! But seriously, we've come a long way in five years. And I owe it all to the great people at Gateway and to our customers."



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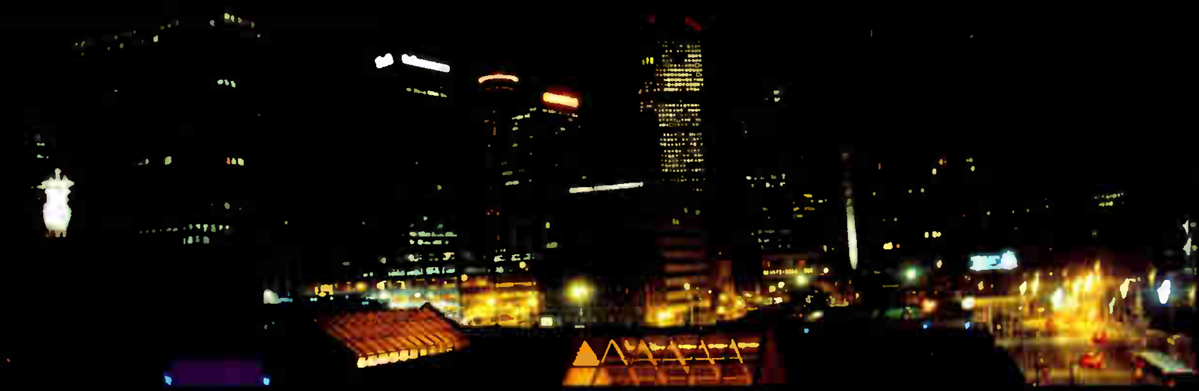

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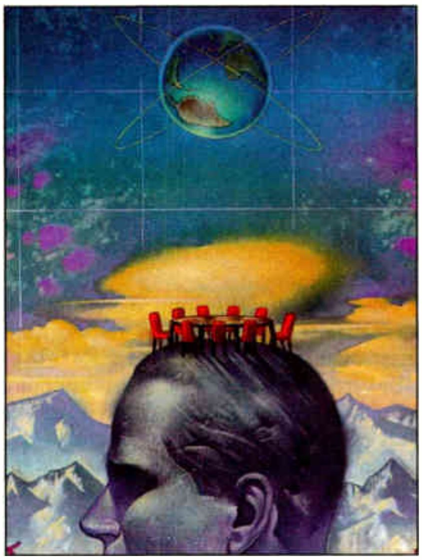
LETTERS

and Ask BYTE



Fifteen Years and Counting

I found the September issue bittersweet. I read it thinking that it was one of the most enjoyable issues of any computer periodical I've ever read. (I subscribe to many magazines, so that's quite an impression.) However, I was astonished to find that the principal man behind the Apple II, Macintosh, and NeXT computers—who is, of course, Steven P. Jobs—was not on your list of influential people in personal computing. This omission was particularly hard for me to bear in light of the many people on the list whom I would not even consider in Jobs's class. In my opinion, Jobs should be considered the most important force in bringing personal computers to the masses.

I believe a gross injustice has been done.

Kevin Weidner
Pleasantville, NY

Steve Jobs consented to participate in the BYTE Summit but was unable to do so due to last-minute scheduling conflicts.
—Bob Ryan

I thank you for the excellent September issue. The coverage all around is superb, and I thoroughly enjoyed the 63 [experts] writing about the PC's present and future. I have learned a lot.

F. A. Mulla
Nakuru, Kenya

One would hardly expect Don Crabb's Macinations column to minimize graphics-based computing, but his enthusiasm seems to have carried him over the brink in his September column. I thought back, as he suggested, to the time when I read what I thought was a really good book and found it was not the graphics that drew me into it (in fact, it had no pictures at all!). Rather, it was the skill of the writer.

Can it be that Crabb has fallen into the very trap that he so eloquently warns of in the very same article? As Alan Kay points out in your Summit, "technology is just an amplifier." Contrary to Marshall McLuhan, the message is really the message. Even so, I read Crabb's column every month and appreciate it.

I want to congratulate you on your 15th anniversary. I agree with Esther Dyson's comment ("I don't want to babysit this computer. I want it to act *for* me, not *with* me"). *That's* the future of computing: not a more servile or fun servant, but a more able one. Graphical user interfaces (GUIs), networks, fancy input and output, and all the rest must work toward this goal. If I want a video game, I'll look to Nintendo, not Apple or IBM or Microsoft.

Gary Fisher
Allendale, MI

Congratulations on your 15th anniversary. I enjoyed the anniversary issue a great deal.

I came away from reading Alan Kay's comments ("The BYTE Summit") feeling that Kay is brilliant and innovative but that his revolution is not for me (nor, I think, is it for many of my colleagues).

I found it very telling that Kay said, "The PARC stuff we did was originally designed for children." Now the icons make much more sense to me. I can admire Alan Kay without wanting to think like him or work like him.

I think that there are many people in computing who have very good reasons for not using GUIs. When we make our choices, we opt for speed, flexibility, and compactness. I know many people who choose DOS (delphic as it is) because it is a fast "shorthand" interface.

Like everyone else, I am impatient for improvements to DOS; I want to be able to give directions and files longer, more descriptive names and to be able to work with files that are associated with the programs used to create them. I also want to be able to switch from one program to another and then back again instantaneously. Occasionally, I would also like to be able to work in true WYSIWYG mode. I know, however, that I do not need a GUI to achieve these goals, and I will always opt for a solution that is economical and agile and that doesn't make me wait.

Richard Zakin
Oswego, NY

Your September issue completely overwhelmed me. I couldn't read it all. But I admire you for the risk you took with your prognostications. I am looking forward to your 25th anniversary issue in 2000 to see how embarrassed you are. Predicting the future is seldom accurate. But keep it up.

Robert LaFara
Indianapolis, IN

Alvy Ray Smith's suggestion ("The BYTE Summit") that people would prefer to communicate with pictures instead of words was a thought-provoking one, and it is certainly a logical extrapolation of the direction in which our nonliterate, TV-oriented culture is moving.

To take Smith's idea a bit further, when we get a sufficient number of these new icons (including, I assume, pictures that represent "justice," "sadness," "truth," etc.), we will certainly need standards so that we can all use the same pictures for identical concepts. I am curious, however, as to how we will organize the manuals to quickly find the appropriate icon to represent a specific thought—a dictionary, if you will.

I am sure that the problem is soluble.

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

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

After all, the Chinese have been using pictures to represent concepts for a long time now.

Sydney B. Self Jr.
Sudbury, MA

Copyright Controversies

The opportunity for full protection of intellectual rights must be available to all, contrary to what Mitch Kapor has learned from his "very, very good" experiences with software ("Litigation vs. Innovation," Stop Bit, September).

Innovation is not ethereal and does not just appear to the most enthusiastic of the bunch. It is the result of hard work and of dedication to R&D, all of which deserve to profit from success in the marketplace. But that success does not have much chance in an environment where the results of effort can be stolen by any thief or ring of thieves who declare themselves innovators.

The only way that developers can be protected is by the courts. The glut of intellectual-property litigation that scares Kapor is perhaps a result of innovation thieves being brought to justice.

Brian Livingston
Norman Wells, Northwest Territories, Canada

I agree with Mitch Kapor's remarks on software copyright, but I think that he does not sufficiently address the issue of visual copyright, per se.

When you attempt to copyright or patent the user interface of your program, that is an act of theft. How is it that the user interface belongs to the users? Surely I hear a multitude of enraged cries from programmers: "It's our interface; we designed it."

It is a common delusion of the more arrogant sort of software developer that the value of the user interface consists in its inherent excellence, that his or her user interace is somehow easier to use, and all that. Nonsense! The value of a user interface consists almost entirely in the fact that users have learned to use it, all too often with unnecessary difficulty.

When user interfaces are "user friendly," that generally means that they have borrowed the conventions of street signs, Coke machines, and the like. So the principle holds—the value of a user interface is the value of the skill of the users.

In proof of this, there are any number of minor user interfaces whose few users will proclaim their excellence at the top of their lungs. Yet these interfaces have little or no cash value, because so few people know them.

I might add that the less arrogant developers are positively compulsive about allowing the user to redesign the interface at will, via elaborate customization programs.

Andrew D. Todd
Springfield, OR

When U.S. District Court Judge Robert Keeton ruled in the Lotus case (Microbytes, September), he affirmed the right of programmers the world over to the fruit of their labors. Keeton's narrow interpretation of the copyright law has provided plenty of opportunity for other programmers to build on the work of predecessors.

But the test of this limited concept will come only as more and more programmers use standard interfaces such as IBM's Systems Application Architecture common user interface. How does one not infringe on creative "expression" when everyone is using the same standard style? I do not pretend to know law, but I do know that I, for one, would like some protection for my work if I were to use such a standard, as I desire to do. Please let us know, IBM and Microsoft.

Bill Hartzell
Garland, TX

Monitor Fallout

I'm glad to see BYTE publishing articles on electromagnetic emissions from video displays ("Of Monitors and Emissions," September). Bill McGinnis's article is good; it takes the reader right inside the CRT.

Still, as a Ph.D. physicist, I was disappointed to notice McGinnis's failure to distinguish between electromagnetic fields that are radiated away from the source and those that are not. All ionizing radiation (e.g., visible and infrared light) and all broadcast nonionizing radiation (e.g., microwaves and radio-frequency radiation) radiate energy away from the source, thereby producing radiation emissions. But extremely low-frequency (ELF) fields (which include frequencies from 50 Hz to 100 Hz) do not radiate energy through the air away from the source.

Emissions that are radiated through space can affect creatures far from the source. These effects do not occur for nonradiated fields such as ELF.

I have never encountered the distinction between *radiation* and *emission* that McGinnis points out. Those who make this distinction must be scientists or engineers in a specialized discipline with which I am not familiar.

Marjorie Lundquist
Milwaukee, WI

I agree that very few far-field emissions exist in the 30-Hz (wavelength 10 million meters) to 300-Hz (wavelength 1 million meters) region. But the point of the article was not to limit shielding considerations to the far-field condition. There are fields coming from most video terminals that are identifiable as either electric or magnetic.

The interest in emissions in this frequency range centers on two main considerations: How large is the field, and how can it be reduced? The first question can be answered by qualified personnel using measurement equipment. The second question can be addressed by identifying emissions sources and applying appropriate shielding techniques to them. My article was intended as a guide to sources of emissions and possible remedies.

The distinction between radiation and emissions is very common among members of the Electromagnetic Compatibility Society and is gaining acceptance from some in the IEEE. The main reason for promoting these terms is the misunderstanding of the term radiation *by many people. Too often, the first thought is of some nuclear event, which is incorrect. It is something like the "flammable/inflammable" problem. Now, tanker trucks are marked "flammable," since the other term was so misunderstood.*

I invite all to use the word emissions *where it is appropriate to help reduce the misunderstanding of* radiation.

—Bill McGinnis

Wrestling with Resolutions

I read with some astonishment a statement that the resolution of images dropped to 72 dots per inch or 75 dpi when they were imported using the Clipboard ("Word Processors That Build Character," September). I cannot say that this is not true in the DOS world, but I can definitely say that it is not true in my experiences with the Macintosh.

My regular word processor is FullWrite Professional 1.1. I also use WriteNow 2.2, Microsoft Word 4.0B, and MacWrite II 1.0. I use a Hewlett-Packard Deskwriter for most of my printing. I have used several of these applications to compose a departmental newsletter for a university. The masthead of the newsletter contains a 300-dpi scanned image of the university's logo, which is pasted into the newsletter from the Clipboard.

I could not remember any difficulty printing the newsletter at full resolution. After I read your article, I conducted a test to make sure that I was not mistaken. Each of the word processing programs

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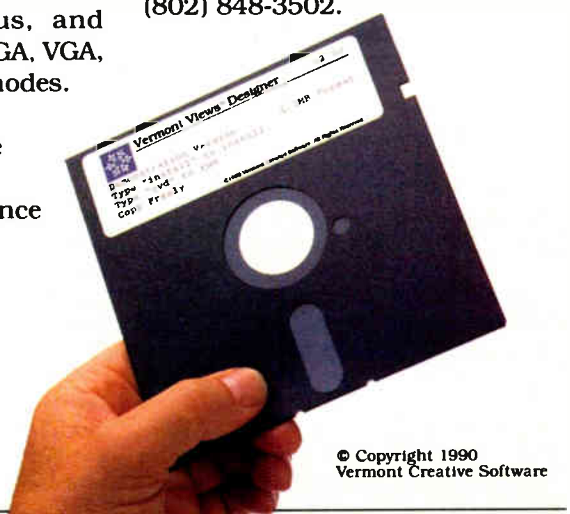

printed a 300-dpi bit map pasted from Canvas 2.1 at full resolution. In fact, the only problem that I have with resolution occurs with drawings created in Full-Write's drawing environment. For those drawings, the resolution is limited to 72/75 dpi.

Matthew F. Ware
Greensboro, NC

When I tested FullWrite, I used Apple-Scan 1.0.2 (Apple's 300-dpi scanner software) as my 300-dpi image source and copied the scanned images directly to the Clipboard. The 72-/75-dpi images came through fine. The 300-dpi images retained all their information; FullWrite simply interpreted them as 75 dpi and displayed them at four times normal size.

After receiving your letter, I tried bringing some 300-dpi AppleScan images into Adobe's Photoshop and then placing them in FullWrite. Oddly enough, that seemed to work fine. In this case, we're both right—it apparently matters where you get your 300-dpi graphics from. I've made a note to take another look at this with future releases of FullWrite or the scanner software.—Howard Eglowstein

ASK BYTE

Direct to Disk

I have a Western Digital WD-1006V-MM2 hard disk drive controller card and a Seagate ST255 hard disk drive. I'd like to program the hard disk drive operations directly, without the help of DOS or the ROM BIOS. Where can I get detailed information about my hard disk drive controller?

Igor Bujanovic
Zagreb, Yugoslavia

You can get technical literature about Western Digital controllers by contacting

Western Digital
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15345 Barranca Pkwy.
Irvine, CA 92718
(800) 832-4778
BBS (714) 756-8176 (protocol 8N1)

In Europe, the nearest office to you is Western Digital Germany (Zamdorfer Strasse 26, D-8000 Munich 80, Germany.
—S. W.

PC or Not PC?

I am writing to get your advice before shopping for my next computer system.

My primary decision involves which type of computer I should choose: an Apple Macintosh or an IBM PS/2 or compatible. After I have decided on one, shopping for the right model to suit my needs (and all my desires, if I can afford them) should be relatively easy.

On the IBM AT, my weekly computing environment includes MultiMate Advantage II, Lotus 1-2-3, FoxPro, Microsoft Paintbrush, PC Tools, Turbo Pascal, NewsMaster, and Print Shop.

On the Macintosh II, my environment includes Microsoft Word, Microsoft Excel, FoxBase+/Mac, Mac Paint, Turbo Pascal, Think C, and Aldus Page-Maker.

I have more expertise on the IBM; I have an AT, a Microsoft Mouse, and an Epson LQ printer. Nevertheless, I prefer the Macintosh interface, and the Mac has grown up; it's not just a desktop publishing machine anymore.

However, both my paid summer internships thus far have required IBM experience (e.g., Lotus 1-2-3 and Word-Perfect), and the job market stresses the IBM machines, too.

Ideally, I would like the best of both worlds in my next computer—a Mac with an add-in card for IBM compatibility, for example. But have all the bugs been worked out of this technology? Would you recommend the use of such technology?

At the high end, I can afford a PS/2 Model 80 or a Macintosh IIci, with just enough money left over for a 24-pin printer.

Should I go with Apple or IBM?

Oscar Rozario
Leysin, Switzerland

There's no clear answer to your question; if there were, one or the other type of computer probably wouldn't exist. I'll give you a couple of guidelines to help you decide.

When you're trying to decide on either architecture or capacity, don't start by picking the machine; first pick the applications you want to run. Some types of applications are best represented on Apple architectures, while others have more support on the PC. You have a specific applications list in mind; that's an excellent start. Remember that your list will change with time, but you'll probably lean toward similar applications in the future.

On the PC, you've got MultiMate Advantage II, certainly an industry-standard word processor with no parallel on the Mac. There are good reasons to stay with MultiMate, and each one might seem to vote for the PC. PC Tools has many uses, but the primary one is to make life on the PC easier. For that reason, I would tend to discount that package when making the decision. Similarly, you would overlook Symantec's SUM or similar Mac products. Lotus 1-2-3 is another product with no exact parallel on the Mac, except that spreadsheets are more alike than word processors, and you could switch. The Mac has several good ones. Then there are cross-platform products. You've named FoxPro, Microsoft Word, Excel, and PageMaker. All of them are available on the Mac and on the PC under Windows. Even your paint programs are a good cross. Several Windows paint programs have capabilities similar to Macintosh paint programs.

Second, after you go through your applications list, look for products that you could replace with something on another platform. Do you have to exchange files or disks with someone else using that product? Will you be networking the machine? Factor that in, and start adding up the score. Remember that you rarely spend any actual time working with DOS, so don't let that scare you away from the PC. As for the user interface, you say you prefer the Mac; lots of people do—so many that Mac-like shells have become very popular on other environments. Windows 3.0 is a strong product in its own right, yet it feels enough like a Mac to encourage many products to be supported on both platforms.

I suggest that you take a look at Windows 3.0 and play around with it for a while. You have two products on your PC applications list that require a PC. All your Mac products have exact or close PC parallels. In your case, a PC running Windows might be the way to go, particularly since your job field seems to favor using PCs.

That said, make sure you have enough computer. Windows and Windows applications tend to be resource hogs, so don't be stingy. A big hard disk drive (80 megabytes or bigger) is a definite must—the bigger and faster, the better. I further suggest a minimum of a 25-MHz 386-based machine with 4 MB of RAM if you plan on using Windows as a multitasker. If you go for the Mac, the IIci would serve you well—again, with lots of RAM. Ideally, you would own both types of machines. (I own both Macs and PCs and wouldn't give up either.) Add-in cards with Intel coprocessors for the Mac simply haven't been as big a win as everyone hoped. They're generally slower than folks would like and fairly expensive, and the compatibility is good, but not perfect.

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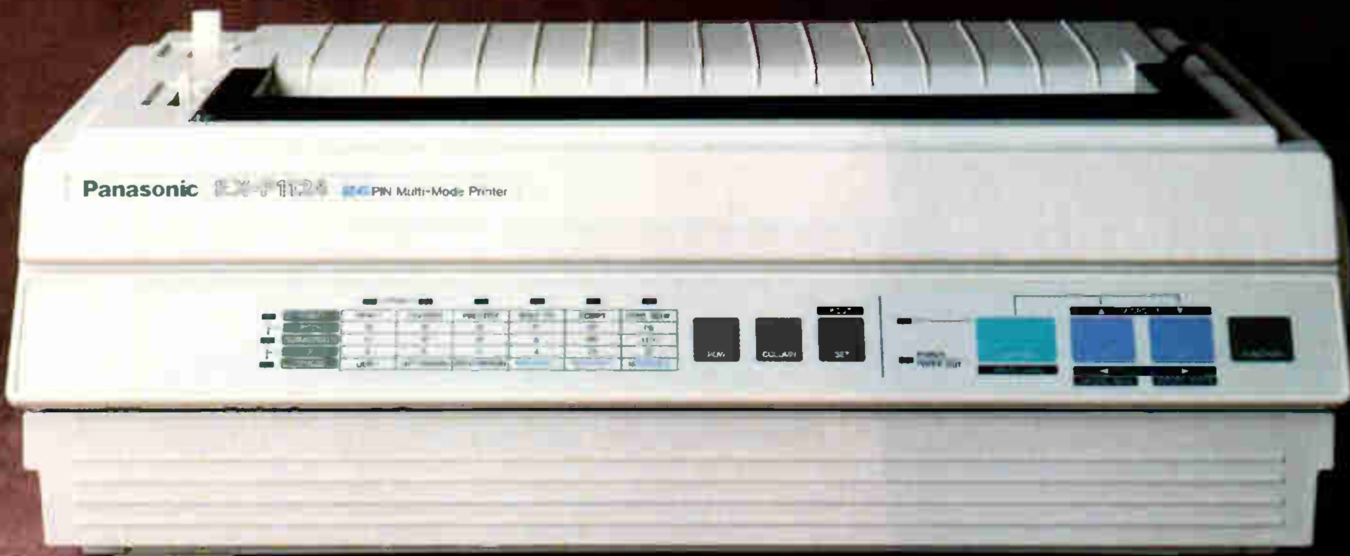

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For running the occasional PC package on your Mac, SoftPC is an interesting hack. Using the Mac's 680xx, it emulates the 80x6 and PC BIOS to run DOS applications. It works amazingly well, but it, too, is slower than the real thing.

To sum up, the choice between architectures is a hard one, one that should be driven by the applications you want to run and the environment you need to run in. Pick the software first, and then fit the hardware to it. Once you get your new computer, start saving up for one of the other kind. It's getting more and more obvious that anyone serious about computing needs access to both a Macintosh and an MS-DOS machine these days.

—H. E.

What Good Is a Backup?

I have an IBM PS/2 Model 80 with two ESDI hard disk drives (one is 100 megabytes, the other 300 MB), an external 5¼-inch 1.2-MB floppy disk drive, a mouse, and a 60-MB MaynStream (from Maynard Systems) tape backup system with version 2.2 of the tape backup software.

My trouble is related to the tape backup system and the 100-MB hard disk drive. At the beginning of the month, I made an image backup of my C drive, and when I tried to restore the data after a disk crash, the software returned an `Unable to find partition` error message. I called the technical-support group of the company that sold me the MaynStream.

The people I spoke with told me that I should perform a low-level format on the hard disk drive, repartition it into its original configuration, and try again. I'm using DOS 4.01, and the drive had only one partition, so that was easy. After reformatting, I reinstalled DOS and tried again. I still got the same error message.

I then brought the tapes to the technical-support people. They tried the same thing on one of their machines with the same result. Desperately—it is very precious data—I contacted some people who also use MaynStream tapes, but they had never encountered such problems.

Is the data on the tape lost, or is there a way to restore it? I never had any problems before with the MaynStream, and it still works when I use the normal backup and restore utilities. What is the purpose of a backup system when you can't restore the data on it?

Vereecken Luc
Leuven, Belgium

The good news is that your tape is probably recoverable. Unfortunately, it's going to cost you gobs of money. Maybe I should explain why.

There are two ways a tape backup system can work. The file-by-file backup will walk through the file system and sequentially copy each file that it encounters onto a contiguous piece of tape. The file structure on the tape is created and maintained by the tape software and has nothing whatsoever to do with the computer's file system. The advantage here is that if the original disk is lost, any machine, regardless of operating system, should be able to recover the data as long as its hard disk drive is big enough. Image backups work by scanning through the hard disk, sector by sector, and copying an exact image of each sector without regard to its contents. On a DOS machine, this will include the boot sectors, file allocation tables (FATs), directories, and files, as well as the location of any locked-out bad sectors. To restore an image tape, the hard disk drive has to be formatted in the same way, with the bad sectors identified and locked out in the same way they were before. Otherwise, the tape software may try to restore data onto a bad sector that wasn't marked bad when the backup was made.

If the restore disk has a different geometry or a different sector map than the original, the software won't be able to figure out where to put the data and will report the kind of error you found. I suspect that by reformatting the drive, you either marked additional bad sectors or freed up previously bad disk spots, thereby making the disk look different than it was.

To recover your tape, someone is going to have to restore all the sectors, determine what your drive geometry must have looked like, and reconstruct an entirely new disk based solely on the FATs and directory information stored on the tape. It's an elaborate process, and it's not cheap. I spoke with Maynard technicians, who, while sympathetic to your plight, couldn't offer any quick solutions.

To answer your last question next, it's never been remotely obvious to me why anyone would offer an image backup program when the chances of recovering data were so minimal. In fact, Maynard no longer provides an image backup facility with the MaynStream, and most other vendors have dropped them, as well. In the future, don't use the image backup facility—erase that software from your disk and stick with the file-by-file stuff. And to be doubly safe, use your software's verification feature, or run a full tape verify to make sure that the tape is readable.

The Maynard folks suggested that you might want to send your tape to one of the many file recovery services. They suggested X-Late (P.O. Box 161, Lake Elmo, MN 55042, (612) 770-8087) as one company you might try. Prices vary, but recovery costs could run up to $100 per megabyte of data, depending on how much work is involved.—H. E.

Sparing the Sperry

I have a five-year-old Sperry 286 computer. It has an EGA, a 5¼-inch 1.2-MB floppy disk drive, and a 30-MB hard disk drive. The hard/floppy disk drive controller circuit is on the motherboard.

I want to add a 3½-inch 1.44-MB floppy disk drive. I have tried updating the installed Sperry DOS to MS-DOS 3.3 and PC-DOS 3.3. In both cases, I could address drive B and do a DIR that sort of worked. But I could not make the 3½-inch drive format a floppy disk no matter what I tried. Neither the Norton Utilities nor PC Tools would recognize drive B.

I suspect the outdated BIOS chips, but because I deal primarily with generic clones, I have no idea where to look to find out.

Could you help me with information on this upgrade? If new chips are required, I'd like to know where I can find them.

Vern De Fehr
Fresno, CA

Due to the age of your computer, your suspicions concerning the BIOS ROM are probably correct.

Sperry Computers was bought out by Unisys (P.O. Box 500, Blue Bell, PA 19424). Unisys still supports Sperry computers. You can order parts by calling (800) 448-1424. The parts technicians will need to know the model number on the motherboard of your Sperry 286.

—S. W.

FIXES

• Instant Recall 1.2 does contain "tickler" functions. The features table in "Strictly for Personal Information" (September) failed to note that.

• In the October article "A Knowledge Engineering Toolkit," we listed the London address for Logic Programming Associates. LPA Prolog and MacProlog are also available from Quintus Computer (1310 Villa St., Mountain View, CA 94041, (800) 245-6442 or (415) 965-7700). ■

ZORTECH C++ DEVELOPER'S EDITION V2.1

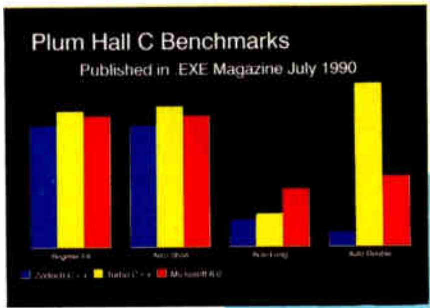
Multi-Platform C++

MS-DOS • WINDOWS • OS/2 • DOS 386 • UNIX 386

MS-DOS

Zortech's industrial strength compiler provides all the benefits of C++, but with with the speed and code size you would expect from the best C compilers.

The quality of the original Zortech C++ implementation together with the continuous improvement achieved since its launch in June 1988 produces fabulous benchmarks. Just look how far it's ahead of the nearest competitor.



Zortech C++ provides state of the art, USEFUL features, most of which are added in direct response to customer requests.

You can effortlessly cruise through the DOS 640K barrier using Zortech's Virtual Code Manager (VCM™). This allows you to develop applications up to 4MB in size whilst in real mode, without changing your C/C++ source code. Zortech's much acclaimed 'handle pointers' provide an elegant solution to processing EMS memory.

Zortech C++ also uses the Rational Systems™ DOS Extenders allowing you to easily compile and debug really large programs, even large MS-Windows 3.0 applications. If you want to purchase a Rational Systems license for your own applications, your Zortech code is Plug & Go.

Zortech's new C++ Workbench provides a cross platform development environment for C++. It has really useful features including powerful source and grep browsers, to look at your handiwork.

In response to hundreds of requests, MS-Windows 2.1 support was added into the base DOS C++ Compiler in version 2.0. Now with Zortech C++ V2.1 development of C++ applications for Windows 3.0 is a reality not a promise.

Along with the C++ compiler comes a top quality ANSI C compiler. In fact, after reviewing 14 C/C++ compilers in its May 1990 issue, Computer Language Editor J. D. Hilderbrant said:

> *"The pressure to name an overall winner in the compiler sweepstakes is nearly overwhelming... it's an easy choice. We pick Zortech!"*

Thousands of our customers had existing C code they wanted to recompile, so we made it simple. In the words of BYTE Magazine:

> *"I fed a Microsoft C specific version of the Micro-EMACS editor source to Zortech's compiler, and less than one hour later, I had a new (and smaller) program."*

Our C++ Debugger, which understands C and Assembler too, is CodeView™ compatible, but that's where the similarities end. This feature packed tool can examine your program from 19 viewpoints and uses overlapping windows with full mouse support, icons and dialog boxes.

Debugging large programs is no problem with our DOS Extender, Virtual and Remote debugger versions. Quite simply, there's no better C++ debugger to use and no better C++ to debug.

Our C++ Tools package is the most comprehensive set available. All 25 class libraries are extensively documented and come with the full source code.

The Zortech C++ Developer's Edition V2.1 includes C and C++ Compilers, C++ Debugger, C++ Tools and the FULL Library Source Code (excluding Flash Graphics). That's right, you don't have to pay hundreds of dollars extra for source code - it's in the box!

MS-WINDOWS

Improved support for MS-Windows (including new Windows 3.0 support) is provided in the base C++ DOS compiler, at no extra cost. With Zortech, you can now even compile from within Windows!

Support for new extended keywords _loadds and _export as well as the ability to create DLL's make programming in Windows with C++ practical. We provide extensive documentation and 50K of sample code to illustrate development of applications in this exciting new environment.

Do you need MS-Windows class libraries? Call for details of third party Zortech Validated Products.

OS/2 NEW

The OS/2 Developer's Edition option now provides a C++ Compiler and source level Debugger designed for C++. In the words of OS/2 Magazine:

> *"Zortech C++ serves as a direct replacement for the Microsoft C Compiler in developing applications, allowing programmers to use object-oriented techniques in OS/2 development."*

DOS 386 NEW

Now MS-DOS developers can build true 32 bit C and C++ applications for 386 processors using Zortech's powerful development system. The Zortech C++ V2.1 Developer's Edition for DOS 386, contains 32 bit versions of the C and C++ Compiler, Flash Graphics library, C++ Debugger and full standard library source code together with all the familiar features provided with the standard DOS Developer's Edition.

Using Phar Lapp's much acclaimed 386/DOS Extender Technology, you can build applications which access 4 Gigabytes of linearly addressable memory. Your applications will also be Plug & Go for use with Phar Lapp's 386 DOS Extender which may be purchased seperately.

UNIX 386 NEW

Not a day passes at Zortech HQ without numerous requests for a UNIX version of Zortech C++. Now, DOS and OS/2 developers can reach new markets by easily moving their code to SCO UNIX 386 and binary compatibles.

The Zortech C++ V2.1 UNIX 386 Compiler generates the same tight, fast code that Zortech's DOS and OS/2 users have come to expect. UNIX specific versions of Flash Graphics and the C++ Workbench are also provided.

In line with the traditional Zortech Policy, owners of the Zortech C++ V2.1 UNIX 386 Compiler will be able to inexpensively upgrade to the forthcoming Zortech C++ V2.1 UNIX 386 Developer's Edition.

ZORTECH Inc., 4-C Gill Street, WOBURN MA 01801 Tel: 617-937-0696 Fax: 617-937-0793 Orders: 1-800-848-8408

ZORTECH Ltd., 58-60 Beresford Street, LONDON SE18 6BG Tel: +44-81-316-7777 Fax: +44-81-316-4138

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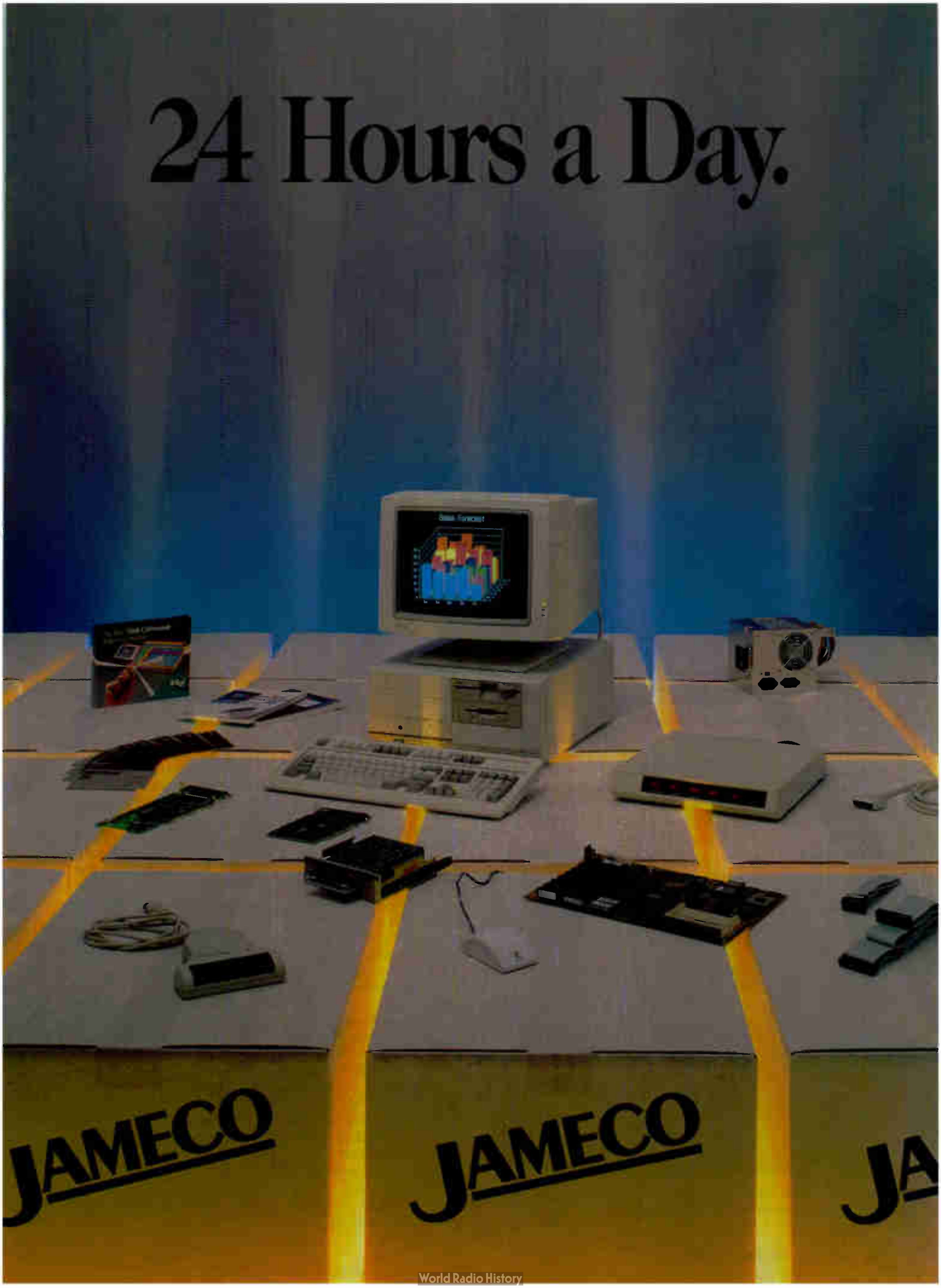
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Light Portables Take Flight

NEC Technologies has launched the UltraLite 286V, a 6½-pound 12-MHz notebook computer. The system comes with 1 MB of RAM (expandable to 2 or 5 MB), a 3½-inch 1.44-MB external floppy disk drive, and a 20-MB hard disk drive.

The system also features a 10-inch backlit screen with 640- by 480-pixel VGA resolution. The removable battery cartridge system provides up to 2½ hours of power; the system also comes with an auto-sensing/auto-switching AC power supply that works with both U.S. and international power systems.

The system measures 9½ by 12⅕ by 1⁷⁄₁₀ inches. Options include a 2400-bps modem, a send/receive fax modem, and a SCSI adapter.
Price: $3999.
Contact: NEC Technologies, Inc., 1255 Michael Dr., Wood Dale, IL 60191, (708) 860-9500.
Inquiry 1271.

The Samsung S3600 is a 12-MHz laptop with a 40-MB hard disk drive and a VGA-compatible screen.

The Samsung S3600, like the NEC UltraLite 286V, comes with a 286 processor, 1 MB of RAM, a 3½-inch 1.44-MB floppy disk drive, and a VGA screen. But the Samsung weighs in at a hefty 16 pounds, including its battery.

The S3600 comes with a rechargeable nickel-cadmium battery that provides 3 hours of power, a battery charger, and a power management feature similar to the UltraLite's.

Options include LapLink III software, a 2400-bps modem, and a carrying case.
Price: With 40-MB hard disk drive, $3499.
Contact: Samsung Information Systems America, Inc., 3655 North First St., San Jose, CA 95134, (800) 624-8999 ext. 851.
Inquiry 1272.

Mitac's 20-MHz 386SX comes with Windows 3.0 installed along with a mouse and more.

386SX Systems with Windows on the Side

The Mitac MPC2386E is a basic 20-MHz 386SX system with an option for Super VGA graphics. The system comes with Windows 3.0, a mouse, and 1 MB of RAM (expandable to 4 or 8 MB).

The system is sold without any disk drives but has room for both 5¼- and 3½-inch floppy disk drives.
Price: $2395.
Contact: American Mitac Corp., 410 East Plumeria Dr., San Jose, CA 95134, (800) 648-2287 or (408) 432-1160.
Inquiry 1273.

The Eltech 2200 is another 20-MHz 386SX system that comes with Windows 3.0 installed. It includes 2 MB of RAM (expandable to 8 MB), 5¼- and 3½-inch floppy disk drives, a 40-MB hard disk drive, a VGA card and monitor, a mouse, and DOS 4.01.
Price: $2199.
Contact: Eltech Research, Inc., 47266 Benicia St., Fremont, CA 94538, (800) 234-4331 or (415) 438-0990.
Inquiry 1274.

Going for the GoldStar

GoldStar Technology's GT212 is a 12-MHz 286-based system with 1 MB of RAM and 16-bit VGA capability for under $1000. The base system has an Intelligent Drive Electronics interface and VGA capability built into the motherboard. It also includes a dual floppy disk drive controller; serial, parallel, and mouse ports; and DOS 4.01. The system measures 4 by 15 by 15½ inches.
Price: $995.
Contact: GoldStar Technology, Inc., 3003 North First St., San Jose, CA 95134, (408) 432-1331.
Inquiry 1275.

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

The HP LaserJet IIID laser printer offers low-cost printing for high-volume users.

HP Does It Again for Less

Hewlett-Packard's LaserJet IIID is its second printer with the HP PCL 5 printer language and HP Resolution Enhancement technology. This 300-dpi, 8-ppm LaserJet is compatible with the III and IID and replaces the IID, according to HP.

Like the IID, the IIID offers double-sided printing and the same internal bit-mapped typefaces as the IIP (i.e., Courier and Line Printer). Two font-cartridge slots give you the option of plugging in fonts, typefaces, and PostScript cartridges.

Also like the IID, the IIID comes with two letter-size paper trays for an input capacity of 400 sheets. An automatic envelope feeder is available for the IIID. In addition, the IIID comes with 1 MB of memory and two slots for memory upgrade boards.

HP's Resolution Enhancement technology adjusts the position and size of dots to smooth the jaggies of 300-dpi printing. The PCL 5 printer language uses Intellifont font-scaling technology from Agfa, which allows the printer to scale typefaces on the fly.

Price: $3595.

Contact: Hewlett-Packard Co. Inquiries, 19310 Pruneridge Ave., Cupertino, CA 95014, (800) 752-0900.

Inquiry 1276.

SupraDrive 500XP for the Amiga.

Hard Disk Drive Gives RAM to the Amiga

The SupraDrive 500XP for the Amiga 500 combines a 20-MB hard disk drive and installed RAM. The drive consumes less than 4 W of power and does not require fans or external power, according to Supra.

The RAM is installed on the 500XP board in DRAM chips in configurations of 0.5, 1, or 2 MB of RAM with 256K- by 4-bit DIP DRAM chips, or in configurations of 2, 4, or 8 MB with an add-on RAM board using 1-megabit by 4-bit DRAM chips. The drive plugs into the Amiga's expansion port.

Price: $679 for a minimum configuration (20-MB hard disk drive with 0.5 MB of RAM).

Contact: Supra Corp., 1133 Commercial Way, Albany, OR 97321, (800) 727-8772 or (503) 967-9075.

Inquiry 1277.

Low-Cost Video Printer from Sony

The UP-3000 prints with 256 levels of color from a palette of over 16 million colors per pixel at more than 500 TV lines of horizontal resolution in a 4- by 3-inch format.

The printer has a one-frame memory and uses RGB 8-bit digital signal processing and advanced color-dye-transfer thermal printing technology. In normal scanning mode, the printer produces a picture about the size of a 35mm photo on an A6 page. It has an RS-232C interface and accepts and outputs RGB analog, composite video, and S-video signals.

Price: $3999.

Contact: Sony Corp. of America, 9 West 57th St., New York, NY 10019, (212) 418-9427.

Inquiry 1278.

Sony's UP-3000 turns video to color hard copy.

An 8514/A VGA Monitor

The ViewSonic 4 is a multiple-frequency VGA monitor that has a multiscanning frequency of from 20 to 38 kHz and a presetting function. The monitor features auto-sizing controls and a nonglare 14-inch screen on a tilt-and-swivel base.

Price: $599.

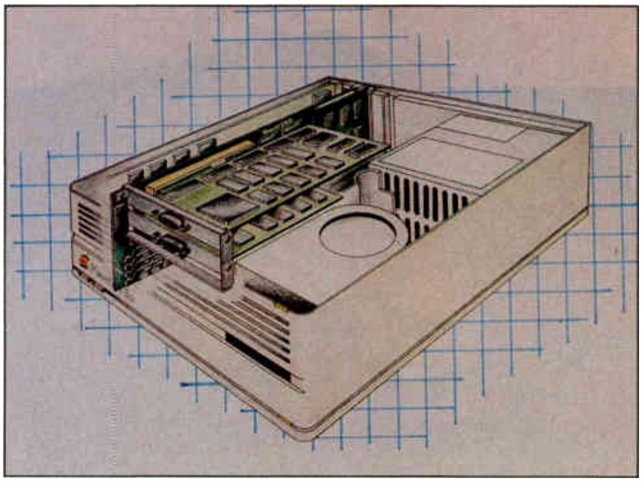
Contact: ViewSonic, 12130 Mora Dr., Santa Fe Springs, CA 90670, (213) 944-3041.

Inquiry 1279.

Orange Micro Lets You Mix Apples with DOS and OS/2

The Orange386, a single-slot coprocessor card that works in any Mac II, features an on-board 16-MHz Intel 386SX. With the card in place, you can run OS/2 and DOS applications in a Mac window as if they were Mac applications, according to Orange Micro.

The Orange386 has two AT slots so you can install any IBM add-on card on it; you can also add an 80387 math coprocessor. Other features of the Orange386 card include PC interface hardware for serial, parallel, 1.2-MB floppy disk drive, and Intelligent Drive Electronics ports. This lets you connect almost any PC-type peripheral to the card.
Price: $2295.
Contact: Orange Micro, Inc., 1400 North Lakeview Ave., Anaheim, CA 92807, (714) 779-2772.
Inquiry 1280.



The Orange386 puts a powerful PC in your Mac.

Basic VGA for Less Than $99

A full 16 bits on a compact VGA card is what you get for $99 with ATI's VGABASIC-16. The card uses a proprietary application-specific IC that makes it over three times faster than competitors' cards, ATI says.

The VGABASIC-16 is compatible with CGA, EGA, VGA, Hercules, and MDA. It has a 16-bit bus design but also supports an 8-bit bus. It measures 6¼ by 2¾ inches, which, ATI says, makes it the smallest VGA card in the world.
Price: $99.
Contact: ATI Technologies, Inc., 3761 Victoria Park Ave., Scarborough, Ontario, Canada M1W 3S2, (416) 756-0718.
Inquiry 1281.

Mac DSP Boards Meet Your Floating-Point Needs

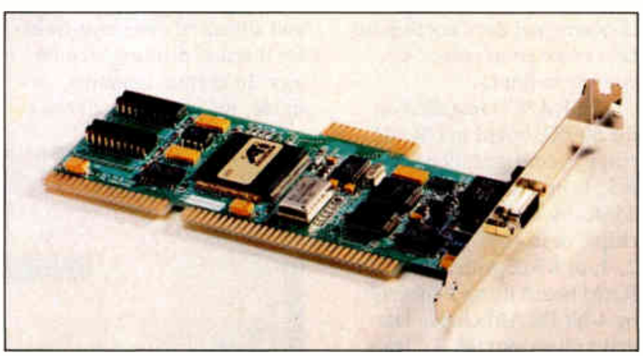
Spectral Innovations is offering floating-point digital signal processing (DSP) boards for the Mac II and SE/30.

The boards provide a peak performance of 32 MFLOPS and feature NuBus and processor direct slot (PDS) compatibility. The bus interface for the board includes a 5-MBps DMA mode that lets you transfer programs and data between Mac and MacDSP local memory without interrupting MacDSP program execution.

The boards, based on AT&T's DSP32C DSP, have an integrated DMA controller that performs IEEE-compatible 32-bit floating-point arithmetic. The higher-end board, the MacDSPAP, is designed for memory-intensive array-processing applications such as image processing, 3-D modeling, graphics animation, and PostScript acceleration. It provides from 64K bytes to 1 MB of zero-wait-state RAM.

The lower-cost board, the MacDSPXI, is designed for signal-processing applications where cost is a factor. This board features built-in 16-bit A/D and D/A converters with a sample rate of 128 kHz, and it performs at up to 24 MFLOPS.

Both boards are available with C development environments, which include a compiler, an assembler, a simulator, and a linker. The boards are also compatible with Spectral Innovations' signal analysis program.
Price: MacDSPAP, $4994; MacDSPXI, $2895; C development environment, $1500.
Contact: Spectral Innovations, 4633 Old Ironsides Dr., Suite 450, Santa Clara, CA 95054, (408) 727-1314.
Inquiry 1282.



The VGABASIC-16 delivers 16 bits on a card that measures 6¼ by 2¾ inches.

Oscilloscope Card with a 256K-byte Storage Buffer

Soltec says that its SCC-1220 digital storage oscilloscope card is the first integrated scope with a 256K-byte storage buffer.

The card has a sampling frequency of from 40 MHz to 1 Hz. It is capable of simultaneous sampling on two channels at up to 20 MHz per channel. All features, functions, and setup parameters are selectable from menu-driven software called PC-Calc.

You can capture single events unattended by setting the trigger on the card. You can also zero in on prototype faults, which enables fault analysis, according to Soltec.

The card installs in a single slot in an XT or AT.
Price: $1300.
Contact: Soltec Corp., Sol Vista Park, 12977 Arroyo St., San Fernando, CA 91340, (800) 423-2344 or (818) 365-0800.
Inquiry 1283.

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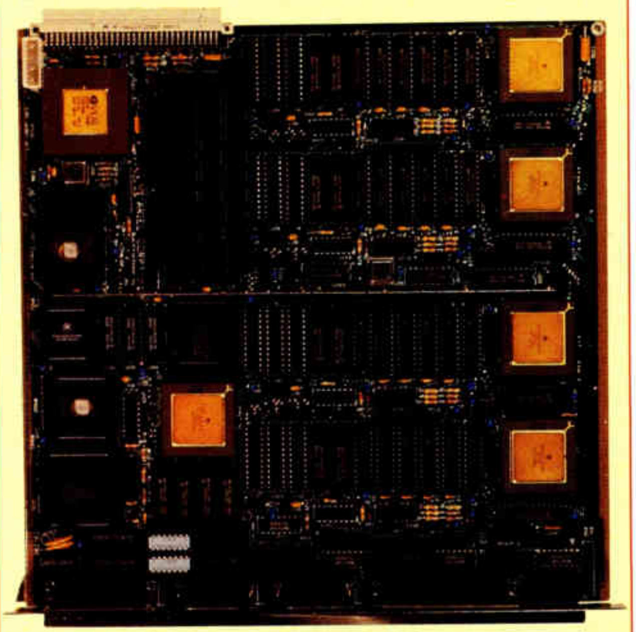
Click and Play from the MacJukebox

The MacJukebox, which consists of an infrared interface box, a Macintosh Plus, software, and cables, lets you remotely control your infrared peripherals (e.g., TVs and compact disk players). The interface box includes an infrared receiver, a transmitter, and the connections to hook it up to the serial port of the Mac Plus.

Using the software provided, you can control infrared peripherals with the click of a button after you've converted command sequences to macros, and you can link the macros to a set time or event. The software also gives you extensive organizing capabilities, such as listing all your CDs by artist or song title. Then when you click on a song or series of songs, your selections will play in sequence just as on a jukebox.

Price: $1599; without the Mac Plus, $599.
Contact: DanCraft Enterprises, 5520 West 118th Place, Inglewood, CA 90304, (213) 643-8782.
Inquiry 1284.

DSP on the NeXT



The QuintProcessor board can add up to 67.5 MIPS performance to the NeXT machine, according to Ariel. The board features five 27-MHz digital signal processors. The DSP chips are the same as those installed on the NeXT system's processor. Four are used as slave processors for computation, while the fifth is an I/O processor that manages DRAM, SCSI storage, and interprocessor communications.

The QuintProcessor is compatible with Ariel's BUG-56, a debugger bundled with the NeXT.

The QuintProcessor has five DSP ports and can be connected to Ariel's digital microphone for recording and signal analysis.

Price: $6995.
Contact: Ariel Corp., 433 River Rd., Highland Park, NJ 08904, (201) 249-2900.
Inquiry 1287.

Second Wave's line of expansion chassis systems gives you the ability to expand your Mac Portable, Plus, SE, or II. With the Home Base, for example, you are able to add two slots to your Mac Portable.

Expansion Chassis Systems for Macs

Second Wave's line of Expanse expansion chassis systems lets you add to your Macintosh. The Home Base, the chassis for the Mac Portable, fits under the machine and contains two slots for standard SE option cards, enabling you to get more out of your Portable when it's parked on your desk at home or in the office.

Other Expanse chassis systems include the Plus, which adds four SE slots to the Mac Plus; the SE chassis, which adds four SE slots to the Mac SE; and the SE/30 chassis, which adds four NuBus slots to the Mac SE/30. Other chassis are available for the Mac II family.

All the chassis connect to the Macs through an interface card and cable assembly. Each chassis has a power supply, a cooling fan, and the slots. The NuBus chassis can accommodate internal disk drives, according to Second Wave.

Price: Home Base, $995; SE Plus, $795; SE, $995; SE/30, $1295.
Contact: Second Wave, Inc., 9430 Research Blvd., Echelon II, Suite 260, Austin, TX 78759, (512) 343-9661.
Inquiry 1285.

Speak into the Microphone

Micro IntroVoice is a modular speech-processing system that comes with a microprocessor and has the ability to recognize up to 1000 words. The manufacturer reports a recognition accuracy of more than 98 percent.

Micro IntroVoice listens to command or data input. It then responds by sending keystrokes via the serial port and text to the on-board synthesizer for audio prompting.

The voice system works with any IBM PC or compatible, according to the manufacturer. It comes with software, sample vocabularies, a battery charger, and a serial cable.

The NEC V-25 microprocessor operates at 8 MHz and comes with 128K bytes of RAM.

Price: $1295.
Contact: Voice Connexion, 8258 Kingslee Rd., Bloomington, MN 55438, (612) 944-1334.
Inquiry 1286.

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Other Carry-I products include the 8000 series XT & AT book-size personal computers and the 6000 series XT and AT book-size LANstations, ETHERnet pocket LAN adapter and Carry Mouse.

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Operate your own BBS
with the world's most popular, expandable, flexible

Multi-User Online Bulletin Board System

The Major BBS® starter system:

A complete BBS software package for your PC, PS/2, XT, AT, 386, 486, or compatible. Includes electronic mail with binary and ASCII file "attachments", SIG conferencing or "forum" areas with configurable security level access control, file upload/download, message keyword searching, "quickscans" for fast access to new messages, message and file "threading", real-time multi-user "chat" and teleconferencing, "classified ad" and "user registry" databases, etc. Also includes accounting, Audit Trail, and timed usage-metering features, and hundreds of convenience features for the Sysop (System Operator), such as a full-screen configuration editor, the ability to import/export files to/from floppy without system shutdown, "SIG-Op" privilege delegation, and much more. Supports up to 2 simultaneous users (from a database of thousands) on a single CPU. Works with standard Hayes-compatible COM1/2/3/4 internal or external modems, or with serial ports up to 38,400 bps. Minimum RAM requirement 512K. Minimum disk requirement 20MB. Requires PC-DOS or MS-DOS 3.1 or later.

The Major BBS Standard Edition ..... $ 59

When you're ready to expand:

No LAN or multi-tasking OS necessary! Double the number of simultaneous users that your system can support, from 2 to 4, or 4 to 8, or any number up to 64 simultaneous users on a single CPU, for a flat $300 software license fee per doubling. The upgrade process is quick, automatic, and fully upward-compatible – i.e. you can install an update or upgrade onto your existing system without disrupting any of your user account files, E-Mail messages, configuration variables, or any other aspect of your system. For up to 16 users, 640K RAM is sufficient; above 16 users, more than 640K may be necessary. Prerequisite: The Major BBS (any edition).

Users, per doubling (up to 64) ...... $ 300

If you need multi-modem hardware:

Our Model 2408 consists of up to 8 Hayes-compatible modems on a single circuit card, for the PC/XT/AT/386/486 family. Each modem operates independently at 300/1200/2400 bps (automatically switching to match the caller's bps rate). Built-in serial ports are not COM-port based, so this card can co-exist with other COM port hardware in the same machine (drivers for software other than The Major BBS are not included but may be written). RJ-11 telephone cables are included. MNP Class 4 (error correction) modems are available as an option.

	non-MNP	*MNP Class 4*
2408 w/2 modems	$ 1536	$ 1696
2408 w/4 modems	$ 2090	$ 2388
2408 w/6 modems	$ 2644	$ 3080
2408 w/8 modems	$ 3198	$ 3772

When you're ready for source code:

With the C source code to The Major BBS, you can add 3rd-party software, such as The Major Database (a general-purpose, configurable database manager), various multi-player real-time adventure games, dial-out utilities, global command utilities, accounting enhancements, and much more. Also, you can maintain your own copy of the BBS, or you can modify it to suit your own unique requirements. The Major BBS C source code package is fully documented, and it includes the Galacticomm Software Breakthrough Library, plus all of the

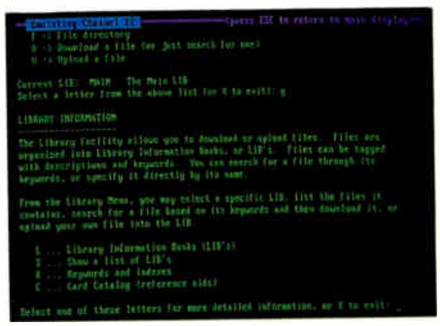
utility object libraries, linker control files, and DOS "batch" files you will need, along with a detailed Programmer's Guide. Works with Turbo C 1.5, 2.0, or 2.01, Turbo C++, or Microsoft C 4.0, 5.1, or 6.0. Prerequisite: The Major BBS Standard Edition.

Standard Edition C source code ..... $ 285

For the ultimate in *file transfer flexibility:*

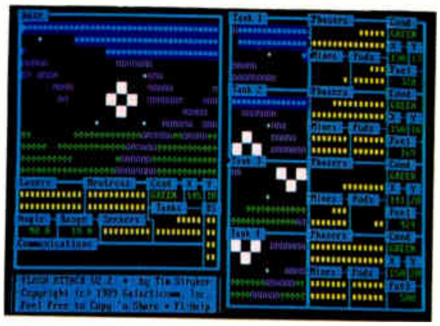
The File Library Edition of The Major BBS has everything that the starter system does, plus built-in ZMODEM, KERMIT, Super-KERMIT, YMODEM-g, and YMODEM (batch) file transfer protocols. Also, it offers super-fast pre-indexed keyword file searches, library-wide searches as well as constrained searches, special file upload/download accounting options, alternate DOS "paths" per sub-library, split paths for CD-ROM support, a transparent "DOS-only" sub-library option, and much more. This package is for you if the focus of your system will be the upload and download of large amounts of files. You can easily upgrade from the starter system to the File Library Edition, without losing any of your data files or configuration work you have already done. Prerequisite: The Major BBS Standard Edition.

File Library extensions .... $ 199
*File Library C source extensions** ... $ 159



If you decide to offer *online games and amusements:*

The Entertainment Edition of The Major BBS has everything that the starter system does, plus Quest for Magic (a multi-player interactive text adventure game), Androids! (a multi-player arcade-style ANSI-graphics game), Flash Attack (a futuristic tank and laser battle for multiple players with IBM PC's), and the Action Teleconference Link-Up, which includes private "chambers", action verbs (grin, wink, nudge, etc.), the ability to link to other systems for huge multi-system teleconferences, custom entry/exit strings, user-configurable profiles, and much more. This Edition supports the Flash™ Protocol (where most of the game functionality is on the user's end of the phone line), for which dozens of incredible new multi-user games are now being developed. Upgrading from the starter system to the Entertainment Edition is quick



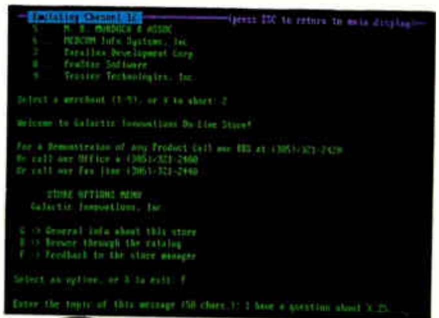
and easy and involves no loss of data or function. Prerequisite: The Major BBS Standard Edition.

Entertainment extensions .... $ 149
*Entertainment C source extensions** .. $ 129

If your requirements include *order entry and catalog sales:*

The Shopping Mall Edition of The Major BBS has everything that the starter system does, plus online shopping. Your online mall can have multiple "stores", each run by its own separate "merchant", if desired. Each merchant has control over his or her own product line, pricing, discount structure, store welcome message, sales tax handling, etc. Also, each merchant may create up to 6 different payment methods (e.g. VISA, MC, AMEX, C.O.D., "bill me", etc.), and up to 6 different shipping methods (e.g. UPS, FedEx, US Mail, etc.), each with its own rates (flat rate, percent of sale, 1st-ounce/add'l-ounce, or 1st-pound/add'l-pound). Users may browse product catalogs at no obligation, or order products and services directly online! Orders generate invoices that are posted to the individual merchant as attachments to E-Mail. To upgrade from the starter system to the Shopping Mall Edition takes only a few minutes. Prerequisite: The Major BBS Standard Edition.

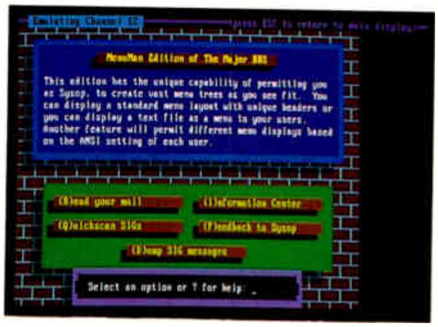
Shopping Mall extensions .... $ 249
*Shopping Mall C source extensions**. . $ 189



For super-flexibility of *menu trees and ANSI screens:*

The MenuMan Edition of The Major BBS can do everything that the starter system does, and in addition you as Sysop can create your own menu trees, with menus leading to menus leading to menus, as deeply "nested" as you like. The "leaves" of your menu trees can be ordinary ASCII or ANSI files, which are simply dumped to the user's display (with or without automatic screen breaks), or they can be any of the built-in functions of the BBS such as scanning the user's incoming E-Mail or firing up a SIG quickscan. Includes commands like *GO <pagename>*, *FIND <topic>*, *USERS*, and for the Sysop, the equivalent of the DOS commands *DIR*, *RENAME*, *COPY*, *DEL*, *MKDIR*, and *RMDIR*, as well as a set of privileged commands for editing and extending the menu trees, remotely, while the BBS remains fully online. Upgrading from the starter system to the MenuMan Edition takes only minutes. Prerequisite: The Major BBS Standard Edition.

MenuMan extensions .... $ 149
*MenuMan C source extensions** .... $ 129



As your system grows larger...

The GalactiBox™ is our 16-slot "expansion chassis", for large-scale systems. It has the unique ability to address individual modems by slot number rather than just COM port address, so you can use up to 16 standard internal modems in it, side by side, without conflict. Includes built-in 150W power supply, interface card for your XT/AT/386/486, cables, and full documentation. Up to 4 boxes may be attached to one CPU, for a total of up to 64-channel expansion capacity. Prices shown below are for standard 300/1200/2400 bps Hayes-compatible internal modems. We also have 9600 bps V.32/V.42 MNP Class 5 modems available, call for prices.

GalactiBox (unpopulated) .... $ 1992
GalactiBox w/4 modems .... $ 2416
GalactiBox w/8 modems .... $ 2840
GalactiBox w/16 modems .... $ 3688

...and that's not all! For advanced applications, we also offer an X.25 direct-connect software option, a protected-mode development toolkit, and special licensing arrangements for up to 256 simultaneous users! And don't forget the smorgasbord of 3rd-party add-ons available, such as The Major Database from Galactic Innovations. Custom programming and integration services are also available. Your system can grow in power and sophistication, far into the future, with The Major BBS.

Here's How To Order:

Just dial (305) 583-5990 and say, "I'd like to place an order!" We can generally ship your order within 48 hours. We accept major credit cards, or we can ship C.O.D. Prices shown do not include shipping or insurance.

For more information, you may either call the main order number and ask for a sales engineer, or dial (305) 583-7808 with your modem (8-N-1) for a free demo of most of our products. This demo system also contains an online Shopping Mall with many of the 3rd-party add-ons available for The Major BBS, operated by the 3rd-party vendors themselves.

Give us a call today!

VISA MasterCard AMERICAN EXPRESS

**The C source code extensions are necessary, if you wish to combine multiple extended Editions together, or add 3rd-party software, or develop your own modifications. Prerequisites, in each case, are the Standard Edition C source code, and the corresponding extended Edition.*

GALACTICOMM

Galacticomm, Inc. 4101 S.W. 47 Ave.
Suite 101, Fort Lauderdale, FL 33314

Modem: (305) 583-7808
Fax: (305) 583-7846
Voice: (305) 583-5990

Circle 116 on Reader Service Card

CONNECTIVITY

Connectivity in a Box

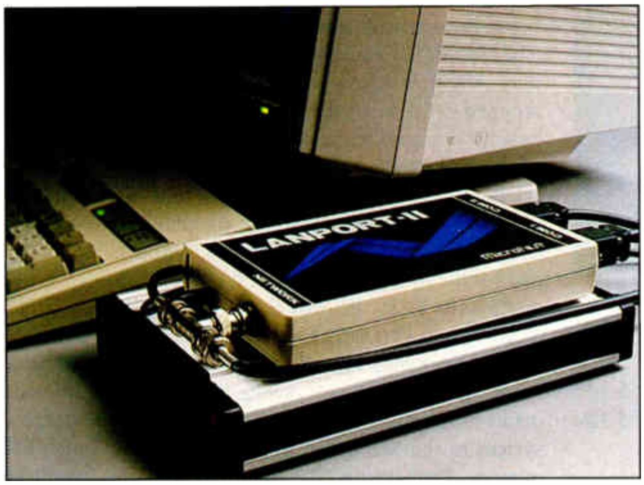
The LANPORT-II box, which is smaller than most external modems, lets you dial in to your Novell network from remote sites. You can hook LANPORT-II anywhere along your network cabling, according to Microtest.

The LANPORT-II box (which measures 4 by 7½ by 1 inch) includes a built-in network interface, RAM, ROM, asynchronous communications firmware, two serial ports, and software. It's compatible with terminal emulation programs such as Procomm and Crosstalk, and it works with PCs, Macs, mainframes, and other ASCII terminals.

Three levels of security are included in LANPORT-II. When you call in to the network, LANPORT-II answers the call, prompts you to log on, and requests your password. Once you're logged onto the file server, you're presented with a menu of options, and LANPORT-II becomes transparent.

LANPORT's two serial ports operate at up to 19,200 bps, allowing multiple users to share modems. With LANPORT's network interface, you don't need a dedicated communications server on the network, as you do with other remote communications devices. With the optional On-Link feature, you don't need a computer up and running on the network to use LANPORT-II—you can power up remotely.

Price: $495 to $695.
Contact: Microtest, 3519 East Shea Blvd., Suite 134, Phoenix, AZ 85028, (602) 971-6464.
Inquiry 1288.



LANPORT-II lets you dial into your LAN without the need for a PC communications server.

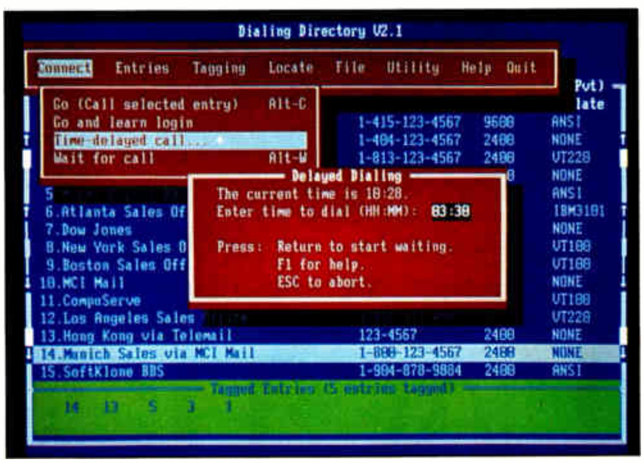
Putting Windows on the Network

Windows Workstation 3 bridges the Windows 3.0 user interface and your Novell NetWare LAN. The software consists of seven utilities that enhance the network features of Windows 3.0.

The Workstation Print Manager brings network printing capabilities to Windows applications. Secure Station provides transparent security for network workstations and offers file encryption/decryption capabilities. The Workstation Intercom lets you receive and send messages to users and groups of users across multiple file servers. You use the Workstation Clock to set multiple alarm messages and events to occur at user-specified times and intervals.

Windows Workstation 3 is compatible with Novell NetWare 286 2.1 and higher. To run the utilities you need Windows 3.0 and at least 1 MB of RAM on each workstation.

Price: $695 for a 10-user license.
Contact: Automated Design Systems, Inc., 375 Northridge Rd., Suite 270, Atlanta, GA 30350, (404) 394-2552.
Inquiry 1289.



The Mirror III dialing directory features pull-down menus and can be operated with a keyboard or mouse.

Getting the Most from Your Fax

Ricoh's DX-1 Fax Adapter and communication software, compatible with PCs, Macs, and laptops, lets you use your Group 3 fax as a printer, scanner, copier, or just a fax. DX-1 software is available for controlling the fax, scanning, printing, and copying capabilities.

Price: $799; DX-1 software, $275.
Contact: Ricoh Corp., 5 Dedrick Place, West Caldwell, NJ 07006, (800) 637-4264 or (201) 882-2000.
Inquiry 1290.

Mirror III Gets a Boost

The communications program for PCs called Mirror III is now enhanced with several new features, including a dialing directory interface and mouse support, according to SoftKlone. Also new are scripts for several on-line services, including BIX. Version 2.0 also offers ZMODEM and XMODEM file transfer protocols and support for MNP 5.

To take advantage of the MNP session/data compression protocol, you must have an MNP modem. However, users without MNP modems can still use Mirror III software.

Additions and extensions to the Prism communications programming language include mouse support for Prism scripts, parameter passing, drawing enhancements, and several new commands.

Price: $149.
Contact: SoftKlone, 327 Office Plaza Dr., Suite 100, Tallahassee, FL 32301, (904) 878-8564.
Inquiry 1291.

INSTANT MAINFRAME. JUST ADD SCO.

Not too long ago, a few dozen people sharing the same programs, resources, and information on a single computer at the same time meant only one thing—a mainframe.

Powerful, big, expensive, and proprietary.

More recently, the same people could be found doing exactly the same things—simultaneously sharing programs, resources, and information—on a minicomputer.

A lot cheaper, a lot smaller, yet powerful enough to do the same jobs. And just as proprietary.

Then along came the latest generation of personal computers. And now, the same people are more and more likely to be found doing exactly the same things—simultaneously sharing programs, resources, and information—on a PC.

And not a whole officeful of PCs networked together, either, but *a single PC powering the whole office at once.*

A *lot* cheaper, a *lot* smaller, yet still easily powerful enough to do the same jobs. Built to non-proprietary, open system standards that allow complete freedom of choice in hardware and software.

And running the industry-choice multiuser, multitasking UNIX® System V platform that gives millions of 286- and 386-based PC users mainframe power every business day.

The UNIX System standard for PCs—SCO.™

The SCO family of UNIX System software solutions is available for all 80286-, 80386-, and 80486-based industry-standard and Micro Channel™ computers.

Today, SCO UNIX System solutions are installed on more than one in ten of all leading 386 computers in operation worldwide.

Running thousands of off-the-shelf XENIX® and UNIX System-based applications on powerful standard business systems supporting 32 or even more workstations—at an unbelievably low cost per user. And with such blazing performance that individual users believe they have the whole system to themselves.

Running electronic mail across the office—or around the world—in seconds.

Running multiuser PC communications to minis and mainframes through TCP/IP and SNA networks.

And doing some things that no mainframe—or even DOS- or OS/2™-based PC—ever thought about, such as running multiple DOS applications. Or networking DOS, OS/2, XENIX and UNIX Systems together. Or running UNIX System versions and workalikes of popular DOS applications such as Microsoft® Word, 1-2-3®, and dBASE III PLUS.®

Or even letting users integrate full-featured multiuser productivity packages *of their choice* under a standard, friendly menu interface.

Today's personal computer isn't just a "PC" anymore, and you can unleash its incredible mainframe-plus power for yourself—today.

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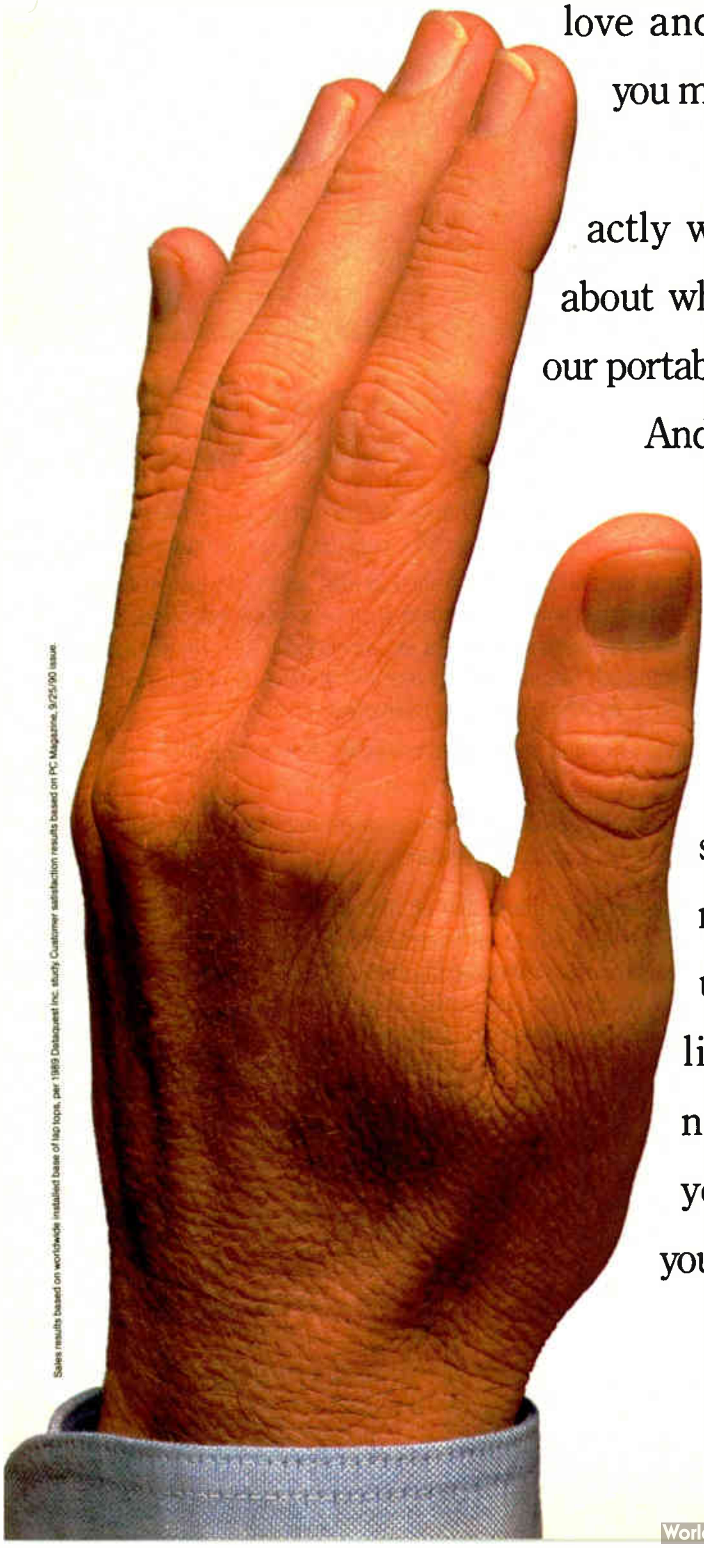
Circle 273 on Reader Service Card

TWO REASONS WHY TOSHIBA SELLS



At Toshiba, we think that designing a portable computer to fit real live human beings can make the difference between a computer you love and a computer you merely tolerate.

So that's exactly what we think about when we design our portable PCs.

Chances are, you're already used to our comfortable, full-function keyboard. That's because the keys are the exact size and shape you expect them to be.

And the public has told us we were right in our thinking. In fact, according to PC Magazine, Toshiba portables rank number one in customer satisfaction.

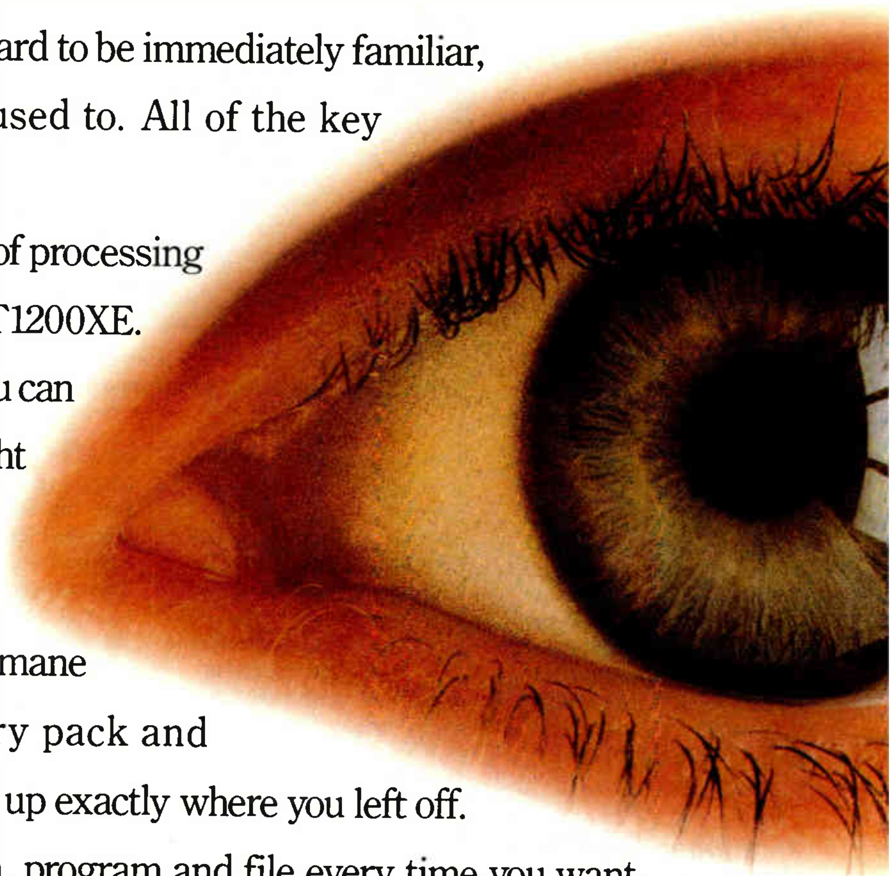
Take our T1200XE notebook PC, for example. You'll notice how our unique screen technology makes it easy to read under virtually all lighting conditions, no matter where you decide to get your work done.

The T1200XE takes up about one square foot of desk space (or lap space) so there's always room to work.

For a free brochure or the name of your nearest Toshiba dealer, call 1-800-457-7777.

Sales results based on worldwide installed base of lap tops, per 1989 Dataquest Inc. study. Customer satisfaction results based on PC Magazine, 9/25/90 issue.

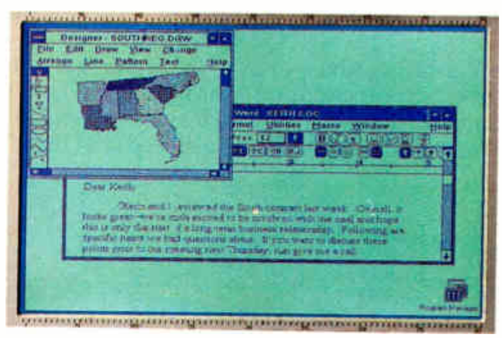
More Portables Than Anyone Else.



Next, you'll find the keyboard to be immediately familiar, since it's what you're already used to. All of the key spacing and sizes are standard.

You'll also discover plenty of processing power packed into the 286-based T1200XE. And the 20MB hard drive means you can keep all your programs and files right where you need them. With you.

Plus, you'll undoubtedly appreciate the T1200XE's other humane features like a slim line battery pack and AutoResume,™ which lets you pick up exactly where you left off. No grand reopening of the system, program and file every time you want to start work again.



Toshiba designed the large, easy-to-read display with real, live humans in mind. So now you can work without a lot of eyestrain, neckstrain or backstrain.

The only thing you'll notice we've skimped on is size and weight. After all, what good is a portable if you can't take it with you?

With notebooks like the T1200XE it should come as no surprise that Toshiba sells more portable PCs than any other company in the world. After all, you're not the only one who recognizes a good thing when they see it.

In Touch with Tomorrow

TOSHIBA

Circle 314 on Reader Service Card (RESELLERS: 315)

CONNECTIVITY

Mac DAT Runs Alone

Mirror Technologies has introduced the T1200 DAT Drive, an external 1.3-gigabyte digital audiotape drive for Macs. The T1200 supports unattended backup and network backup and conforms to the digital data storage (DDS) recording format standard.

With the included SoftBackUp software, you can program the T1200 for 2 hours of unattended operation. This means that it can perform backup for up to 2 hours and then shut down, freeing the system or network for other activities.

Price: $2997.
Contact: Mirror Technologies, Inc., 2644 Patton Rd., Roseville, MN 55113, (612) 633-4450.
Inquiry 1292.

Mirror's T1200 DAT drive offers Mac users unattended backups, 1.3 gigabytes of storage, and high-speed access to data.

Integrated System for NetWare Communications

FlexCom offers a hardware/software asynchronous communications solution for NetWare-based LANs. The system supports dial-in and dial-out access on each communications line and provides a separate processor for each dial-in or remote-access user. With FlexCom, you also get as much as 550K bytes of RAM for applications, EGA-level graphics, and up to 1 MB of expanded or extended memory.

Version 1.1 of the software features reduced memory overhead for dial-in users, extended management capability for dial-out lines, user-extendable activity logging, and line-by-line modem initialization.

The server base units can handle from two to 36 lines, and a rack-mounted version handles up to 44 lines. Each server includes a network adapter (Ethernet, Token Ring, or ARCnet) and comes with the FlexCom/Manager administration software. Two communications processor kits are available for the server base unit. The kits come with FlexCom/CPX software and pcAnywhere III remote-access software programs.

Price: $3000 and up, including all hardware and software.
Contact: Evergreen Systems, Inc., 120 Landing Court, Suite A, Novato, CA 94945, (415) 897-8888.
Inquiry 1293.

Accton's pocket-size adapter plugs into your portable's parallel port and turns it into an Ethernet workstation.

Pocket-Size LAN Adapter

You can convert your portable computer into an Ethernet workstation with a pocket-size LAN adapter from Accton Technology.

The EtherPocket adapter, which measures 3⅝ by ⅞ by 2¼ inches, is used in place of a network interface card. It comes with its own power adapter and attaches to the portable's parallel port.

Price: $499.
Contact: Accton Technology Corp., 46750 Fremont Blvd., Suite 104, Fremont, CA 94538, (415) 226-9800.
Inquiry 1294.

Low-Cost and Practical

The PM 9600 SA modem (a 9600-bps stand-alone modem) features automatic correct connection with remote mode, V.42 and MNP 4 error correction, V.42bis and MNP 5 data compression, and command and data rates of from 75 to 38,400 bps. It is also Hayes compatible.

Price: $699.
Contact: Practical Peripherals, Inc., 31245 La Baya Dr., Westlake Village, CA 91362, (818) 706-0333.
Inquiry 1295.

1-2-3/G Ships Server and Node Editions

Lotus 1-2-3/G, the graphical version of the 1-2-3 spreadsheet program, is now available in standard, server, and node editions.

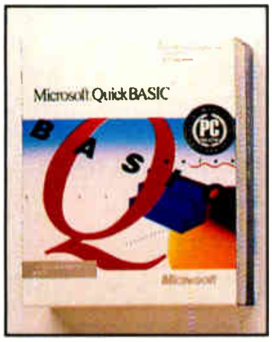
Lotus 1-2-3/G retains the familiar 1-2-3 commands but runs under OS/2 and adds a goal-seeking technology called Solver. Solver automates the what-if process and shows you how to achieve desired results.

The server edition supplies administrators with tools for easier network management, according to Lotus. The node edition lets you have an additional concurrent 1-2-3/G user on the network. It includes a single license for network use.

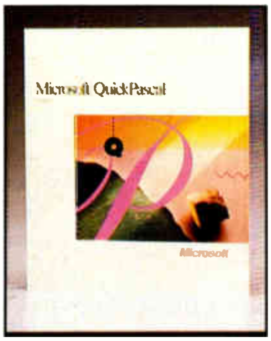
1-2-3/G runs on a PC with at least 5 MB of RAM for network versions. It runs under OS/2 1.1 or higher and is compatible with IBM, 3Com, and Novell networks.

Price: Server edition, $895; node edition, $595.
Contact: Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142, (617) 577-8500.
Inquiry 1296.

Buy one quick.



List: $ 99
Ours: $ 69



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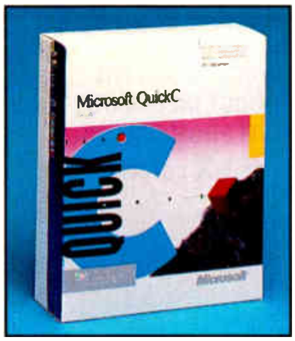

List: $ 99
Ours: $ 69

List: $ 199
Ours: $ 139

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An unbelievable limited-time offer! Buy Microsoft® QuickBASIC,™ the easiest way to learn how to program. Or QuickPascal,™ the fastest way to learn and program in Pascal. Or QuickC,™ the easiest way to master C and write powerful C programs. Or QuickC Compiler with Quick Assembler,™ the only integrated C and Assembly development environment for MS-DOS.®

And get one of the great software products shown, worth up to $90 (SRP), free!*

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1163 Shrewsbury Avenue
Shrewsbury, NJ 07702

Microsoft®

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*While supplies last. Coupon offer redeemable through Microsoft.

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386 CONTROL PROGRAMS

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

386 DEVELOPMENT TOOLS

	LIST	OURS
386 ASM/LinkLoc	1295	1159
386/DOS Extender	495	439
C-Terp 386	239	189
Lahey F77L-EM/32 (w/ OS/386)	1290	1035
MetaWare High C 386	895	849
Novell C Network Compiler/386	995	799
PC-lint 386	239	179
WATCOM C 8.0/386 Prof.	1295	1099
w/ 386/DOS Extender	1790	1399
WATCOM C 8.0/386 Standard	895	719
WATCOM FORTRAN 77/386	1095	CALL
Zortech C++ 386	995	849

ADA

	LIST	OURS
Academic IntegrAda	249	225
Ada Scope Debugger	495	445
Ada Training Environment	895	805
Adagraphics	695	629
IntegrAda	795	719
Meridian AdaStudent	50	45
Meridian Ada Developer's Kit	1195	1095

ASSEMBLY LANGUAGE

	LIST	OURS
Advantage Disassembler	295	279
ASMFlow	99	89
MS Macro Assembler	150	105
OPTASM	150	129
Re:Source	150	129
Sourcer w/ Pre Processor	170	149
SpontaneousAssembly	395	189
Turbo Debugger & Tools	150	105
Visible Computer: 80286	100	89

BASIC COMPILERS

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

BASIC LIBS/UTILITIES

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

C COMPILERS

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

C++

	LIST	OURS
C++/Views	495	419
Intek C++	495	CALL
NDP C++	495	479
Rogue Wave Math.h++	200	179
Rogue Wave Tools.h++	200	179
Turbo C++	200	139
Turbo C++ Professional	300	205
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Zinc Library	200	179
Zortech C++ Database	299	255
Zortech C++ Debugger	150	129
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Zortech C++ Developer's Edition	450	399
Bundled w/ C++/Views	945	595
Zortech C++ Tools	150	129
Zortech C++ Video Course	500	449

C-COMMUNICATIONS

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

C-FILE MANAGEMENT

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

C-GENERAL LIBRARIES

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

C SCREENS

	LIST	OURS
C-Worthy	399	CALL
Greenleaf DataWindows	395	315
QuickWindows Advanced (C)	169	149
Vermont Views	495	395
Vitamin C	225	165
VC Screen	149	125

C-UTILITIES/OTHER

	LIST	OURS
Bar Code Library	389	319
Clear for C	200	169
C Shroud	198	149
Heap Expander	80	70
MKS LEX & YACC	249	197
Objective-C	249	225
PC-lint	139	105
PCYACC Professional	495	459
TimeSlicer	295	279

CASE TOOLS

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

COBOL LANGUAGE

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

CODE GENERATORS

	LIST	OURS
Logic Gem	99	69
Matrix Layout 2.0	200	159
PRO-C	399	339

DATABASE DEVELOPMENT

	LIST	OURS
Clarion 2.1	CALL	CALL
Clipper 5.0	795	519
Data Junction Advanced	299	269
dBASE IV	795	489
dBFast/PLUS	345	295
dGE	295	249
Dr. Switch-ASE	180	149
FaceIt	99	90
FlashTools!	89	79
Flipper	195	169
Force 2.1	695	589
FoxPro	795	489
FUNCky Library	195	179
R&R Report Writer	150	129
R&R Code Generator	150	129
Say What?!	50	39
SilverComm "C" Interface	99	89
SilverComm Library 2.0	249	209
The Documentor	295	245
Tom Rettig's Library	100	80
UI2 Version 2	595	479

DEBUGGERS (DOS)

	LIST	OURS
MultiScope	179	135
Periscope I	595	475
Periscope II w/ switch	225	179
Periscope IV 16, 25 MHz	CALL	CALL
Trapper	200	179
w/ optional cable	240	219
Turbo Debugger & Tools	150	105

DOCUMENTING/ FLOWCHARTING

	LIST	OURS
allCLEAR	300	229
Clear for C or dBASE	200	169
C-Clearly	130	115
Flow Charting 3	250	199
Interactive Easyflow	150	125
Paginate	100	79
Source Print	99	74
Tree Diagrammer	99	74

EDITORS

	LIST	OURS
BRIEF 3.0	249	CALL
EDT+	295	269
EMACS	325	265
Epsilon	195	159
KEDIT 4.0	150	125
MKS Vi	149	129
PI Editor	195	175
Sage Professional Editor	295	249
SLICK Editor	195	154
Speed Edit	295	275
SPF/PC	245	199
SYNDIE	495	399
VEDIT PLUS	185	CALL

EMBEDDED SYSTEMS

	LIST	OURS
C6 to PROM	149	119
Link & Locate ++	395	349
Link & Locate ++ Extended	479	395

FORTRAN LANGUAGE

	LIST	OURS
Grafmatic	135	119
Lahey F77L	595	535
Lahey Personal FORTRAN 77	99	89
MS FORTRAN	450	299
Plotmatic	135	119
RM/FORTRAN	595	499

GRAPHICS LIBRARIES

	LIST	OURS
Baby Driver	250	199
Essential Graphics	399	319
Font-Tools	150	119
Graf/Drive Plus Developer's	299	269
GraphiC 5.0	395	319
GSS Graphics Devel. Toolkit	795	685
GX Graphics	149	135
HALO	395	279
HALO Professional	595	419
HALO Window Toolkit	595	419
Icon-Tools/Plus	150	119
Menuet	325	279
MetaWindow	250	209
MetaWindow Plus	325	289
PCX Effects	99	89
PCX Programmer's Toolkit	195	175
PCX Text	149	135
SilverPaint	129	109
Slate w/ graphics	448	415
Turbo Geometry Library	200	179

LINKERS/LIBRARIANS

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

OBJECT-ORIENTED TOOLS

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

OS/2 TOOLS

	LIST	OURS
Brief	249	CALL
CASE:PM for C	1495	1420
Epsilon	195	159
MKS LEX & YACC	349	279
MS OS/2 Pres. Manager Toolkit	500	349
MultiScope for OS/2	449	345
PC YACC	695	625
PI Editor	249	225
Smalltalk/V PM	495	369
Vitamin C (OS/2)	345	279

PASCAL LANGUAGE

	LIST	OURS
Asynch PLUS	149	115
B-tree Filer	125	109
MS QuickPASCAL	99	69
Object Professional	150	109
Power Tools PLUS/5.0	149	109
Topaz	99	89
Topaz Multi-user	149	135
Turbo Analyst	99	89
TurboMAGIC	199	179
Turbo Pascal 5.5	150	105
Turbo Pascal 5.5 Professional	250	175
Turbo-Plus 5.5	199	159
Turbo Professional 5.0	125	109

SOURCE MAINTENANCE

	LIST	OURS
Codan	395	345
Code Check	495	469
MKS Make	149	119
MKS RCS	189	149
MKS Software Mgmt. Team	299	239
PolyMake	179	149
PVCS Professional	495	419
SMS	495	399
TLIB	139	109
5 Station LAN	419	339

WINDOWS (MS) TOOLS

	LIST	OURS
Actor 3.0	895	719
Asymetrix Toolbook	395	CALL
Bridge Toolkit	695	659
Case:W	995	CALL
C-Talk/Views	450	375
dBFast/Windows	395	335
DialogCoder	499	435
Graphics Server SDK	495	419
MS Windows Development Kit	500	349
MultiScope for Windows	379	289
ObjectGraphics	445	365
ProtoView	695	625
Resource Workshop	300	269
WindowsMAKER	795	635
WinTrieve	395	339
WNDX GUI Toolbox	499	449

NEW RELEASES

Resource Workshop

The Workshop, from EdenSoft, is a fundamental tool for Windows development. It provides an integrated resource compiler and editor. Access resources instantly from the project view, edit resources graphically or as text, compile incrementally. Unmatched in features and capabilities.

List: $300 **Ours: $269**

Dr. Switch-ASE

Make any dBASE language program RAM resident, occupying only 16-20K of RAM. Advanced cut and paste for transferring of data to and from dBASE. Full network compatibility.

List: $180 **Ours: $149**

TimeSlicer 6.0

Multitasking linkable library of C functions for Microsoft C 6.0. Develop applications that will run an unlimited number of tasks concurrently. Multitasking at the application level rather than by interfacing with the operating system.

List: $295 **Ours: $279**

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BLAST UNIX/XENIX	495	395
Epsilon	195	169
Interactive Products	CALL	CALL
LPI-COBOL	1495	1199
LPI-FORTRAN	995	799
MetaWare High C	895	849
Microport Products	CALL	CALL
MKS RCS	395	335
MKS Trilogy	119	105
PI Editor	349	319
SCO Products	CALL	CALL
VEDIT PLUS	285	249

ADDITIONAL PRODUCTS

	LIST	OURS
APL*PLUS	695	549
Dan Bricklin's Demo II	199	159
dBx/dBPort	600	459
Guido	249	189
Lattice RPG	1600	1285
MKS AWK	99	79
Opt-Tech Sort/Merge	149	119
PC Scheme	95	79
Personal Rexx	150	139

APPLICATION SOFTWARE

COMMUNICATIONS

	LIST	OURS
BLAST II	250	225
Carbon Copy Plus	199	129
Laplink III	150	99
PC Anywhere III	145	99
Procomm Plus	99	63
SideTalk	120	99

DESKTOP PUBLISHING

	LIST	OURS
Adobe Products	CALL	CALL
Corel Draw!	595	399
HALO DPE	195	139
PageMaker	795	509
Ventura Publisher	895	549

MATHEMATICS

	LIST	OURS
Derive	200	179
MathCAD	495	315
Mathematica 386	695	625

SCIENCE & ENGINEERING

	LIST	OURS
AutoCAD Release 10	3000	CALL
AutoSketch	150	95
ChiWriter	150	129
CSS	495	469
DADiSP	895	759
Design CAD 3-D	400	292
Drafix Windows CAD	695	CALL
EXACT	475	380
Generic CADD Level 3	350	289
LABTECH Acquire	195	179
LABTECH Notebook	995	799
MICRO-CAP III	1495	1269

SCIENCE & ENGINEERING *(continued)*

	LIST	OURS
Orcad PCB	1495	CALL
PC-MATLAB	695	659
PC TEX	249	229
SCHEMA III	495	449
Systat w/ Sygraph	895	759
Tango PCB Series II	595	559
TECH*GRAPH*PAD	395	319
T³	595	479

SPREADSHEETS

	LIST	OURS
Lotus 1-2-3 3.1	595	389
Microsoft Excel	495	319
Quattro Professional	495	329
SuperCalc5	495	319

UTILITIES

	LIST	OURS
386MAX 5.0	130	114
above DISC	119	64
AboveMEM	80	75
Bootcon	60	55
Cache 86	50	39
FASTBACK Plus	189	119
HeadRoom 2.0	130	89
Hijaak Plus	199	149
Hold Everything	199	159
InfoSpotter	80	69
MACE 1990	149	105
Magellan	195	CALL
MKS Toolkit	249	199
MOVE'EM	89	79
Norton Commander	149	99
Norton Utilities 5.0	179	129
PC Tools Deluxe 6.0	149	95
Pizazz Plus	149	79
PreCursor	96	79
SitBack	99	90
Software Carousel	90	72
SpinRite II	89	75
Squish Plus	100	75
Switch-It	100	89
Tree 86	90	69
Turbo EMS 5.0	100	89
UpShot	95	89
XTreePro Gold	129	89
ZENO	269	239

WORD PROCESSING

	LIST	OURS
Ami	199	129
Microsoft Word for Windows	495	349
WordPerfect 5.1	495	CALL

SOFTWARE FOR SUN WORKSTATIONS

	LIST	OURS
Basmark QuickBASIC	CALL	CALL
C Programmer's Toolbox/ Sun	495	449
Edix	425	339
EMACS for Sun	395	369
Informix	CALL	CALL
Lotus 1-2-3 for Sun	CALL	CALL
Mathematica for Sun	CALL	CALL
MetaWare High C	895	849
NeuralWorks Professional II	4095	CALL
Panel Plus (Sun 3)	1595	1355
WordPerfect for Sun	495	CALL

GUIDO 1.0

GUIDO is a powerful library of C functions which enables you to easily add graphical user interface objects to your graphics application, including menus, windows, data entry, text boxes, list boxes, radio buttons, percent bars and more–used independently or combined. Both mouse and keyboard are supported. Also contains an event-driven, object-oriented environment called the GUE, based on the high-level objects included. Requires no other graphics library. Includes manual with demos and examples. No royalties. Supports Microsoft C/Quick C and Turbo C/C++.

SOUTH MOUNTAIN SOFTWARE

List: $249 Ours: $189 **FAXcetera #2089-0004**
w/ source List: $499 Ours: $329

Objective-C

Stepstone

Objective-C offers proven *true* object-oriented technology consisting of language, compiler and libraries. State-of-the-art development tool suitable for building object-oriented commercial applications in DOS, OS/2 and many other popular environments. The Objective-C language is specifically designed for reusability and flexibility, while retaining the performance and character of the industry standard C language. ICpak 101 Foundation Class Library, a basic library consisting of over twenty basic data types and I/O handlers is included.

List: $249 Ours: $225 **FAXcetera #1688-0001**

WindowsMAKER

Candlelight

WindowsMAKER is a code generator that builds complete Microsoft Windows 3.0 applications. Prototype the entire user interface (menus, icons, dialog boxes, child windows, controls, etc.) in a WYSIWYG screen designer. Animate and test on users without a lengthy compile. Then generate Microsoft C code for high performance Windows applications. No runtime fees. C++ compatible. Custom code is perserved during regeneration. WindowsMAKER handles message processing, memory, debugging, compiling, MDI and more. Port DOS or Mac programs to Windows in record time. A power tool for professional C programmers. WYSIWYG point and click programming at its best. 30 day money-back guarantee.

List: $795 Ours: $635 **FAXcetera #2602-0002**

WATCOM C8.0/386

WATCOM C8.0/386 is a 100% ANSI C optimizing compiler and run-time library for the Intel 80386 architecture generating applications for 32-bit protected mode. With C8.0/386, you can go beyond the 640K DOS limit. Library and source code compatibility with Microsoft C simplifies many porting projects. Significant features include: protected mode version of the compiler; VIDEO full-screen source-level debugger; Microsoft library and source compatibility; execution profiler; high-performance linker; graphics library.

WATCOM

Standard	***List: $895***	***Ours: $719***
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CASE Tools Ease OS/2 Cooperative Development

SQL/Workbench, a Presentation Manager application for OS/2 Extended Edition, lets a team that's developing cooperative processing applications benefit from the expertise of one Structured Query Language programmer.

SQL/Workbench can generate and compile Static SQL directly instead of requiring you to program it in C. One programmer keys in the SQL and puts the compiled SQL into the IBM Database Manager for use by all. This way, other programmers can do procedure calls instead of having to embed complex SQL strings into an application.

With the repository, a database administrator can check and validate the best callable procedures from a single source and not have to worry about code spread out among several programmers.

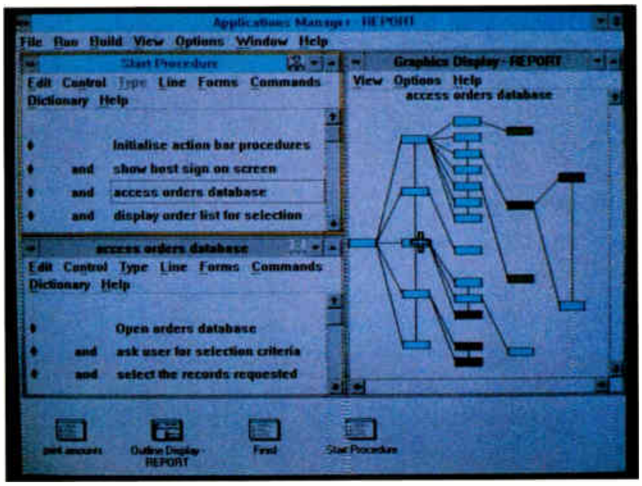
CP/Workbench helps a communications expert define transactions, conversations, buffers, and data types outside the program.

Both work on PC-to-mainframe applications.

Price: SQL/Workbench, $7200; CP/Workbench, $4200.

Contact: Intelligent Environments, 2 Highwood Dr., Tewksbury, MA 01876, (508) 640-1080.

Inquiry 1297.



SQL/Workbench and CP/Workbench, two additions to the Applications Manager family of OS/2 development tools, help ease the creation of cooperative processing applications.

Build Your Own Data Bridge

DBMS/Program lets you build applications that can directly read and write data simultaneously in multiple formats, including most major DOS databases, spreadsheets, statistical packages, and Structured Query Language databases. Created applications can directly process more than 15 Macintosh applications supported by the company's DBMS/Copy Mac program.

Conceptual Software says that an application created with DBMS/Program can merge a database with another database, create new variables in the merged database, assign computed variables for each record in the database for the new variables, and output the result to another package for further analysis.

DBMS/Program supports Excel, Lotus 1-2-3, Quattro Pro, ACT!, dBASE, DataEase, Paradox, PFS:File, Clarion, and Oracle, Ingres, and Informix SQL databases. Over 22 statistical packages are supported, including SAS, SPSS, StatGraphics, and BMDP.

Price: $595.

Contact: Conceptual Software, Inc., P.O. Box 56627, Houston, TX 77256, (713) 667-4222.

Inquiry 1298.

Create Foreign-Language Versions of Your Software

Performance Technology developed PowerTranslate for software companies that want to create, without recompiling, foreign-language versions of their programs or English versions of an application originally written in another language.

PowerTranslate creates a database of all the text that appears to the end user of the program, which you then translate. When you update a program, you need to translate only the modifications that will result in display changes.

PowerTranslate maintains the integrity of program text containing embedded or special codes that shouldn't be altered. Also, it will not modify text that contains a copyright banner.

The program works with C, Pascal, and similar languages.

Price: $595; corporate license, $4995.

Contact: Performance Technology, 800 Lincoln Center, San Antonio, TX 78230, (800) 825-5267 or (512) 524-0500.

Inquiry 1299.

Borland's Pascal Interface Library in a Box

Libraries of reusable objects are one of the touted benefits of object-oriented programming. They do, however, require substantial effort to develop and (when the libraries come from several sources) maintain. In its new version of Turbo Pascal, Borland is jump-starting that process by including Turbo Vision, a library of objects, including windows, pull-down menus, dialog boxes, and scroll bars, all with built-in mouse support. Turbo Pascal 6.0 also supports *object persistence*, the ability to map in-memory structures to disk directly.

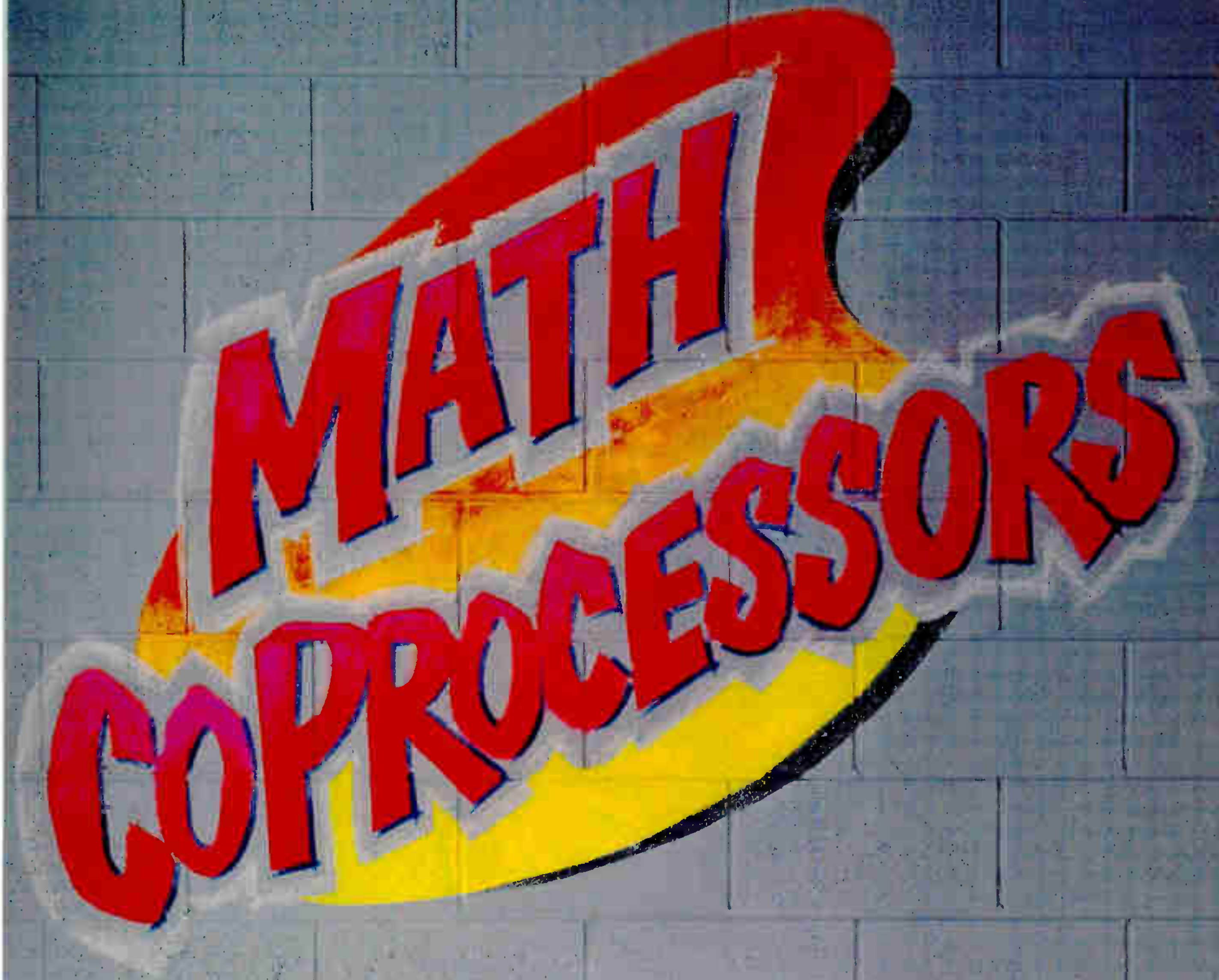
A new compiler in Turbo Pascal 6.0 works in protected mode, letting you free up more memory for the compilation of large real-mode applications. The integrated development environment features a multifile editor with macros, overlapping windows, and built-in support for expanded memory. For bug squashing, version 6.0 offers integrated source code debugging, conditional breakpoints, a CPU window, and a hypertext help system.

With object persistence, objects know how to store themselves on disk, freeing memory and saving time by reducing instantiation. The new version also lets you integrate assembly code with its own in-line assembler.

Price: $149.95; with Turbo Debugger & Tools, $249.95.

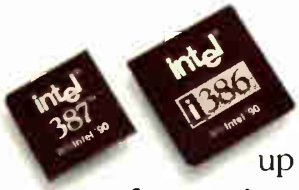
Contact: Borland International, 1800 Green Hills Rd., P.O. Box 660001, Scotts Valley, CA 95066, (408) 438-8400.

Inquiry 1300.



You know what you need to speed up your power applications. There's just one more thing you should know.

Only one math coprocessor is a chip off the old block.



That's Intel's. And our new family of Math CoProcessors is faster—up to 50% for the 287XL.

In fact, working side by side with the Intel microprocessor already inside your computer, an Intel Math CoProcessor can increase the speed of your spreadsheet, graphics, CAD and database programs by as much as 500%. That's good to know.

And the fact that it's made by Intel is also good to know.

Because Intel developed the first Math CoProcessor in 1982, and we've shipped millions since then. Each one is manufactured by Intel in the world's most advanced logic


EL
386
TM

If You Want In A 386 System, Do

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Introducing Features, Flexibility and Fantastic Color.

Then ask us about our new 386/25 and 386/33 systems. The list of standard features includes the latest that high technology has to offer. Features like a 64 KB memory cache for the 386/25, and 128 KB for the 386/33, both expandable to 256 KB, providing the fastest possible memory access. Then there's the integrated VGA controller supporting 1024 x 768 resolution, with 256 vibrant colors and a 50% performance increase all made possible by 1 MB of 32-bit video memory. Plus support for interlaced and non-interlaced monitors. When it comes to features, we set the standard.

No one can beat our flexibility either. An integrated floppy controller and hard disk interface that support up to three floppy drives and two hard drives. Up to 16 MB of RAM on board using the new industry standard 32-bit memory modules leave all six expansion slots available. Our small footprint chassis includes both 5.25″ and 3.5″ floppy drives and 1 parallel and 2 serial ports. And consider this feature, our new 386/25 and 386/33 systems come standard with 5 drive bays to hold up to one additional floppy drive or tape backup and 2 hard drives. So, we can help you add on and update to your heart's content.

Our research and development center is always striving for excellence. Since 1984 we've been designing our own products, and all of our system boards are manufactured right here in the U.S. When building our computers we utilize the latest surface mount and VLSI technology for the ultimate in product reliability and space saving design. Our performance and quality are simply the standard for our competitors to beat.

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- ☐ 100MB IDE hard drive with Cache buffer
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- ☐ 1 parallel & 2 serial ports
- ☐ 101-key enhanced keyboard
- ☐ MS DOS 4.01
- ☐ Microsoft Windows 3.0
- ☐ Hi-Res serial mouse

$2,695.00

386▼33 This powerful system has Cache memory upgraded to 128K in addition to the features listed above for only $2995.00.

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All of these fully-loaded systems include:

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- ☐ 1:1 interleave Floppy/Hard Disk Controller
- ☐ 40MB 28ms Hard Disk Drive
- ☐ 1.2MB 5.25″ & 1.44MB 3.5″ floppy drives
- ☐ 1 parallel, 2 serial and 1 game port
- ☐ 101-key enhanced keyboard
- ☐ MS DOS 4.01
- ☐ 386SX includes Windows 3.0 and mouse

386▼SX at $1895.00 286▼16 at $1595.00 286▼20 at $1695.00

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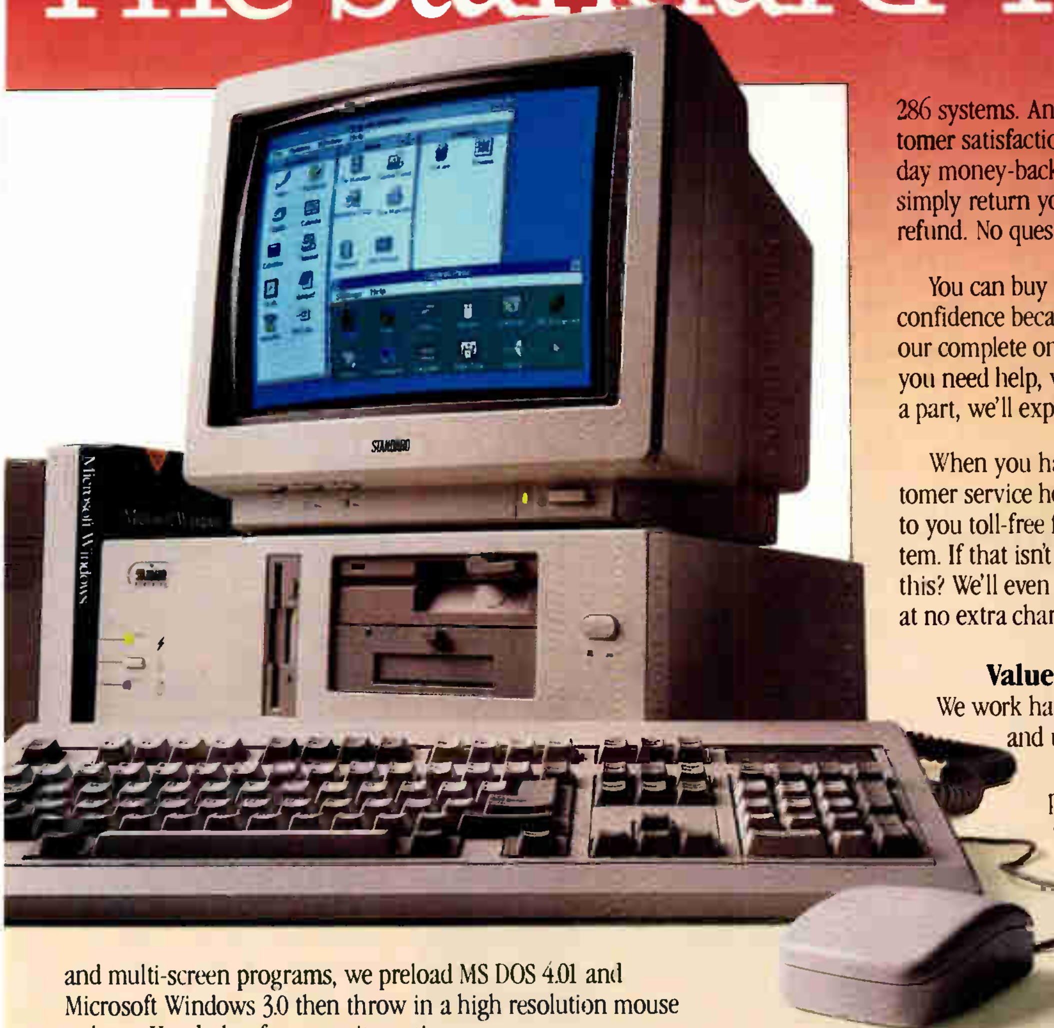

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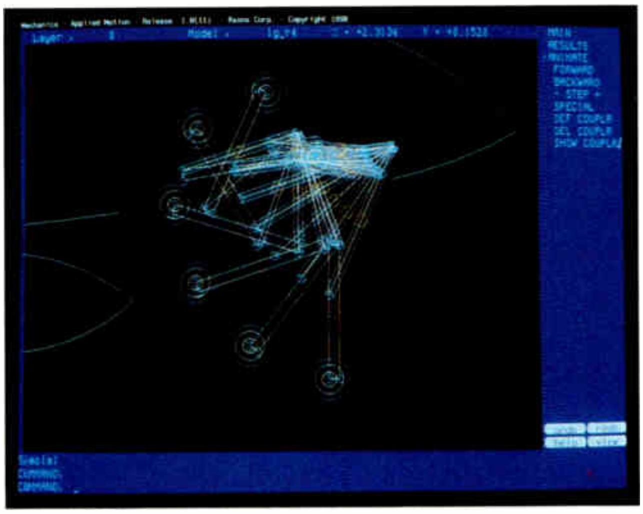
Optimize Mechanical Designs on the Sun

Applied Motion, a 3-D program for mechanical engineers who work on Sun-3 and Sun-4 workstations, includes an automatic design feature that lets them evaluate several alternatives. The program provides static, kinematic, dynamic, and inverse dynamic analyses in a 3-D environment. An engineer who needs to know the reaction loads of joints in a mechanism, for example, can use Applied Motion to compute the loads and, using the design sensitivity feature, minimize them.

Price: $12,000.
Contact: Rasna Corp., 2590 North First St., Suite 200, San Jose, CA 95131, (408) 922-6833.
Inquiry 1306.



Rasna's Applied Motion recommends several alternatives to your mechanical design.

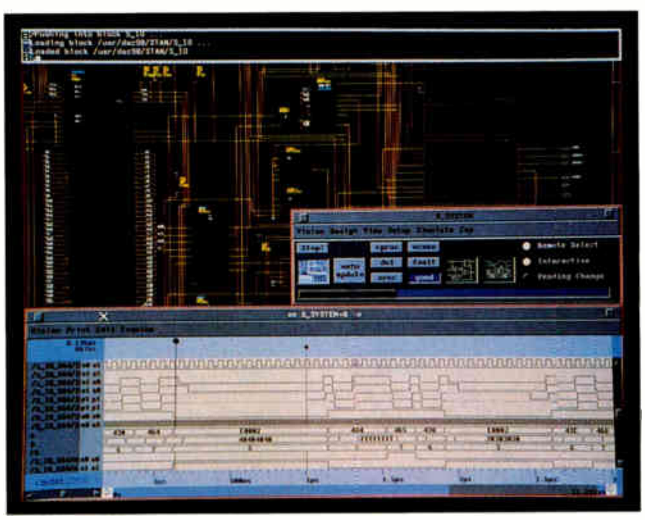
Racal-Redac and Minc Meld All-in-One Circuit Designer

Racal-Redac has integrated its CADAT program for simulating and testing programmable logic devices with Minc's tools for designing them. The program lets you design and test all kinds of digital logic circuit boards in one package.

With Minc's PLDesigner and PGADesigner device-independent tools, you describe how you want the device to work, including constraints such as maximum wattage or board size. The program's rule-driven technology mapping then automatically generates a device-specific design. These designs can incorporate devices ranging from a single field programmable gate array (FPGA) up to 20 programmable logic devices (PLDs) or a combination of them.

CADAT then simulates the design, letting you verify the functionality of systems that incorporate standard logic, application-specific ICs, processors, and PLD/FPGAs without having to build a prototype board. CADAT runs on Sun workstations. Versions are planned for DEC and IBM RISC workstations.

Price: $20,000 and up.
Contact: Racal-Redac, 1000 Wyckoff Ave., Mahwah, NJ 07430, (201) 848-8000.
Inquiry 1307.



The PLD and PGA tool sets let you design, simulate, and verify your logical device and gate array plans in one package.

Three from Dynacomp

Dynacomp adds three new programs—The Equator, Matrix Laboratory, and Molecular Modeling—to its line of math and science software for the IBM PC.

With The Equator, you can save equations on disk and plot them later with a range of values that you choose. The program supports trigonometric and hyperbolic functions and their inverses, square roots, and many other types of functions. The Equator lets you store definitions of variables with their constants. Optional packages ($19.95 each) for The Equator include equations for electrical engineering, statistics, and electromagnetics.

Matrix Laboratory lets you perform operations on moderate (20 by 20) matrices. The program supports such functions as inverse, condition, and square root.

The Molecular Modeling program lets you select elements from a periodic table and bond them. Once you have created the chemical model, you can view and animate it in 3-D.

Price: The Equator, $59.95; Matrix Laboratory, $19.95; Molecular Modeling, $29.95.
Contact: Dynacomp, Inc., 178 Phillips Rd., Webster, NY 14580, (716) 265-4040.
Inquiry 1308.

How to Find the Best Equation to Fit Your Data

The TableCurve curve-fitting program takes your *x,y* data set and fits 221 candidate equations to it, ranking each equation in order of best fit. The program's equation set includes 60 first-order equations, 66 second-order equations, 55 third-order equations, rational polynomials, and polynomials.

TableCurve ranks each equation by the r-squared "goodness of fit" value, but it also ranks equations by floating-point efficiency. This means that you can choose the more efficient of two equations that are closely ranked in r-squared value.

Price: $395.
Contact: Jandel Scientific, 65 Koch Rd., Corte Madera, CA 94925, (415) 924-8640.
Inquiry 1309.

Hayes ESP™

When your high-speed error-control modem outruns your PC system, you stand to lose more than a few characters. You could lose valuable time, not to mention your company's money.

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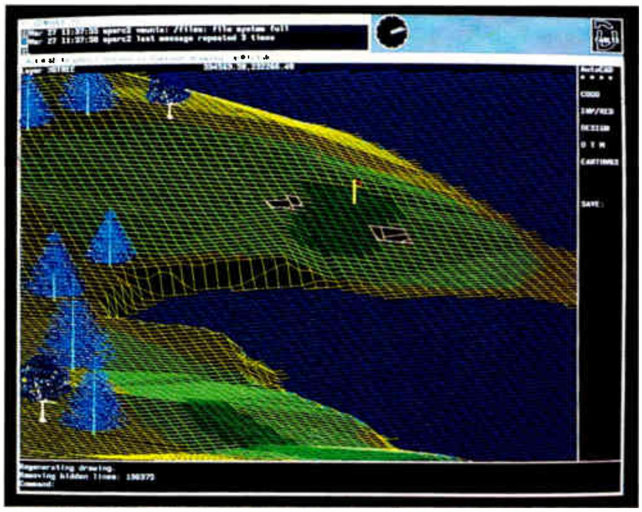
If you're not using Hayes ESP, you could be making a big mistake.

Civil Engineering and Surveying for AutoCAD 11

DCA Software's civil engineering and surveying programs now support AutoCAD release 11. The company offers Survey Collection, Data Input and Reduction, Digital Terrain, Highways, Earthworks, and Landscape modules for AutoCAD, along with Coordinate Geometry, Design, and Advanced Design programs. New features of the programs include a project management system that lets you work with, store, and access information from any drive or directory, a new point database, negative stationing, right-to-left profiling, and dynamic TIN (triangulated irregular network) viewing.

The new point database offers complete point protection, sorting, and editing. With full point protection, you can add new points without worrying about overwriting previous point data. The ability to do negative stationing lets you add to existing drawings by extending from point zero. Dynamic TIN viewing and editing eliminates the step of going through DXF file conversion.



DCA Software offers a host of programs for AutoCAD 11.

The programs also add real-time cross sectioning and profiling and on-line TIN and contour generation.

Price: $495 to $1995 per module.

Contact: DCA Software, Inc., 7 Liberty Hill Rd., Henniker, NH 03242, (603) 428-3199.

Inquiry 1310.

Vellum for Windows and Silicon Graphics

Vellum, the 2-D CAD program for the Mac, is now available for Windows. As with the Mac version, the Windows version includes the Drafting Assistant, Vellum's drawing aid that lets you accurately place objects in relation to one another. Other features include NURB splines, parametrics, and symbol libraries. Vellum will also soon be available on the Silicon Graphics Iris 4D workstation, according to Ashlar.

The company says that it will release a 3-D add-on for the Mac early in 1991 and one for Windows in the second quarter of 1991.

Price: $1995 for Windows and Silicon Graphics versions.

Contact: Ashlar, Inc., 1290 Oakmead Pkwy., Suite 218, Sunnyvale, CA 94086, (408) 746-3900.

Inquiry 1311.

Two 2-D CAD Programs for the Mac and IBM PC

Generic Software has released version 5.0 of its 2-D CAD program for the IBM PC and version 1 of its 2-D program for the Mac, both of which support automated associative dimensioning. With associative dimensioning, when you modify an object, the data associated with that object changes as well.

Other new features of Generic CADD 5.0 include the ability to zoom, pan, and execute other commands while in the middle of a drawing or editing command. It also lets you undo and redo your last 25 commands and offers support for attributes. You can export attributes in .WK1 and .CSV file formats for use in spreadsheets and databases.

Version 5.0's shell lets you exit the program, start another program, and return to your original position without having to restart Generic CADD. The File Selector utility displays a video memory of your hard disk's directory with date, size, and other information about the files.

In addition to associative dimensioning, Generic CADD for the Mac includes an Info Palette that lets you modify a drawing object by editing data rather than the object itself. Snap previewing and symbol previewing let you change elements of a design before committing to the results.

Price: $395; Mac version, $595.

Contact: Generic Software, Inc., 11911 North Creek Pkwy. S, Bothell, WA 98011, (206) 487-2233.

Inquiry 1312.

New AutoCAD Links Directly to Spreadsheets, Databases

AutoCAD release 11 includes a programming language environment that lets you create programs in C that directly link with AutoCAD. Release 11 provides record locking on networks and lets you display several different views of a drawing at one time.

The optional Advanced Modeling Extension (AME) is an integrated tool created with the Autodesk Development System that allows you to create solid objects from primitive shapes. Once you have created the surface model, you can edit it with normal AutoCAD commands, perform Boolean operations, and calculate mass properties.

Release 11's main menu includes a routine for recovering and reconstructing a damaged AutoCAD drawing file. Dimension style tables let you save groups of dimension variable settings by name.

The DOS version of release 11 will not run on anything smaller than a 286 system; it also runs on Sun, DEC, Mac, and Apollo workstations. Versions are available for OS/2 1.1 or higher. At press time, Autodesk had not yet announced whether it would port AME to the Mac.

Price: $3500; AME, $495.

Contact: Autodesk, Inc., 2320 Marinship Way, Sausalito, CA 94965, (415) 332-2344.

Inquiry 1313.

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For additional information, ask for Dan Kalata

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Make DOS Friendly in a Foreign Land

To a novice DOS user, unraveling the mysteries of DOS is difficult enough. Imagine how hard it must be if you can't speak English. A program called StarCOM consists of four programs that let you rename DOS commands to names and abbreviations that make sense in another language.

Developer OurSoft says you can also use the program to rename the DOS command and substitute a more powerful third-party command. StarCOM is not an interpreter, and thus both the command line and a batch file recognize the same command set. StarCOM does its work by renaming the internal command table of COMMAND.COM. The program code of DOS remains untouched.

Price: $59.95.
Contact: OurSoft, P.O. Box 6396, Bellevue, WA 98008, (206) 643-0204.
Inquiry 1190.

Stay in Touch on the Mac

Intouch 1.0, Advanced Software's desk accessory for the Mac, lets you store names and addresses with up to 14 pages of notes attached to each address.

You can use the program for envelope printing and previewing, and it lets you design label and envelope layouts. The program's dial function lets you locate and dial numbers in the database,

Add Context-Sensitive Help to Your Applications

Zaron Software's Help! utility lets you add context-sensitive help and menus for your programs and DOS operations without requiring any changes or recompiling of the application.

When used with standard text files, you can use Help! to create a flat-file help system. When used with HyperWord, Zaron's hypertext word processor, you can create multidimensional help. You can use the TSR program to create a menu system to return text strings and commands to any application, as well as to the DOS command processor. The program is also capable of running a series of programs from script.

Help! includes sample help files and programs, plus a help system for commonly used DOS commands, the company reports.

Price: $49.95.
Contact: Zaron Software, 13100 Dulaney Valley Rd., Glen Arm, MD 21057, (800) 669-3348 or (301) 592-3334.
Inquiry 1191.

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the company reports.

You can search for names and addresses using any text string, and Intouch lets you import and export addresses from other applications. As you add notes about each name in the address, the program time- and date-stamps them.

Price: $69.95.

Contact: Advanced Software, Inc., 1095 East Duane Ave., Suite 103, Sunnyvale, CA 94086, (800) 346-5392 or (408) 733-0745.

Inquiry 1189.

A Program to Watch Over You

Although most people prefer not to work while someone watches over their shoulder, Micro Logic's newest program may change this attitude.

Key Watch lies in wait in your system, watching your keystroke patterns as you work in your word processor, spreadsheet, or database application. Once it detects a repetitive pattern (e.g., reformatting a document or deleting a series of cells in a worksheet), Key Watch sounds a beep to offer its assistance. At this point, you can perform the repetitive motion with a single keystroke. Other actions in which the program can save keystrokes include modifying a series of fields in a database or commenting lines of code in a program.

Micro Logic says the first implementation of the program can't look for repetitions over several different sessions in an application, although that ability will be added in a later version. The purpose of Key Watch for now is to keep you from typing the same thing twice, saving time and effort in the process.

Key Watch runs on the IBM PC with 256K bytes of RAM. It is RAM-resident and requires 3K bytes.

Price: $69.95.

Contact: Micro Logic Corp., P.O. Box 70, Dept. P, Hackensack, NJ 07602, (800) 342-5930 or (201) 342-6518.

Inquiry 1192.

Lightning Strikes Again

The newest version of Lightning, DacEasy's caching program for the IBM PC, lets you specify the size of its buffer, up to 8 MB of conventional, extended, or expanded memory.

In addition to its claim that Lightning 5.5 is the fastest cache on the block, DacEasy says the program lets you choose which drives will be affected and lets you specify full track read.

The program supports DOS 4.0 and drives larger than 32 MB. It also works with Windows 3.0.

The program's Disk Watch feature, a color-coded screen indicator that appears in a corner of your screen, shows the number of disk accesses as they occur.

Price: $29.95.

Contact: DacEasy, Inc., 17950 Preston Rd., Suite 800, Dallas, TX 75252, (800) 877-8088 or (214) 248-0205.

Inquiry 1193.

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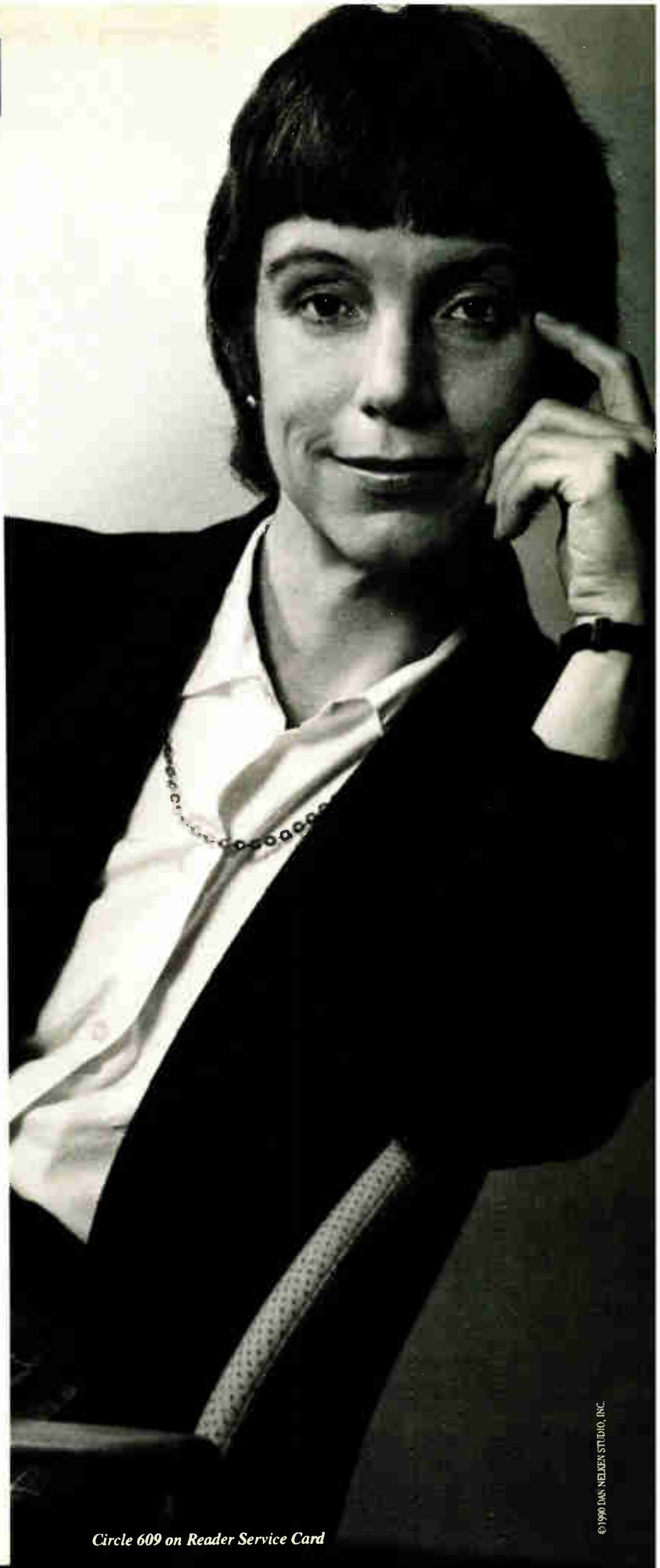

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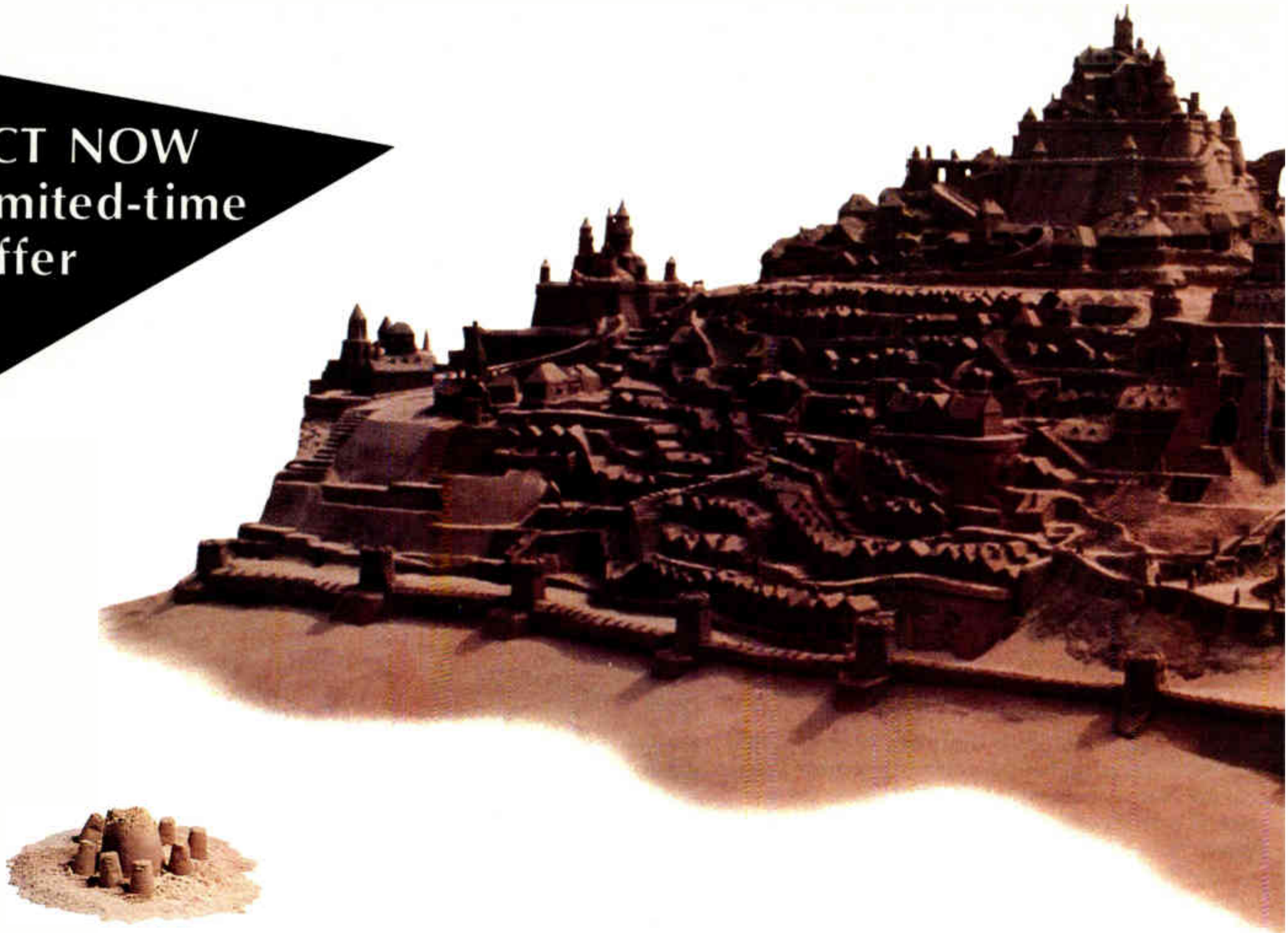

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Take Control of Project Contracts with Artemis Cost

Metier Management Systems, a company that offers several applications for project management, developed Artemis Cost to help you manage a project's contract throughout its life cycle. The program helps you maintain consistency between costs and schedules, develop realistic proposals and budget baselines, and increase productivity with automated cost spreading, rating, and validation, the company says.

Along with its management capabilities, the program lets you perform what-if analyses to assess the potential cost of a change in rate or another factor. The program provides more than 200 standard reports, including Department of Defense formats.

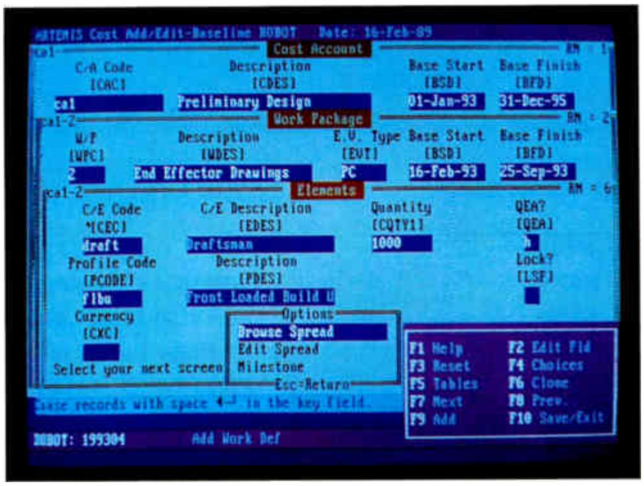
As with other programs for large projects, Artemis Cost lets you define a project according to work breakdown structure, organization breakdown structure, and cost element structure.

The program works with Metier's other programs for the 386: Artemis Project 7.1.6 and Artemis Team, for allocating human resources. Artemis Cost requires either the Artemis 7000/386 command language for customizing the program to fit your company's specific needs or the run-time version. It requires a 386 with at least 1 MB of extended memory.

Price: Artemis Cost, $3830; 7000/386 command language, $6090; run-time version, $1830.

Contact: Metier Management Systems, Inc., 12701 Fair Lakes Cir., Suite 350, Fairfax, VA 22033, (703) 222-1111.

Inquiry 1166.



The screen layouts of Artemis Cost complement the underlying data structures, so that Cost Account, Work Package, and Elements maintain a hierarchical structure.

Take Care of Your Business

Takin' Care of Business, a program for small- to medium-size businesses, lets people without accounting experience monitor assets, liabilities, net worth, capital, and other areas of business finances.

The General Ledger is the foundation of the program. It records your transactions into the appropriate account and lets you generate a variety of financial statements.

The Account Reconciliation module balances your checking accounts, finding the exact amount of any discrepancy. Financial Utilities helps you calculate financial risk by calculating future values, payments, terms, interest rates, and amortization schedules.

The Accounts Payable module automates the payment of invoices, preventing you from missing a discount or payment. Other modules include Accounts Receivable and Payroll, which can handle up to 1000 employees.

Price: Module prices range from $14.95 to $49.95.

Contact: Hooper International, Inc., P.O. Box 50200, Colorado Springs, CO 80949, (800) 245-7789 or (719) 528-8990.

Inquiry 1167.

Act! Now Works on Networks

Contact Software International says it wrote the new version of its contact management program Act! in C++ to provide the hooks to run on any DOS-based LAN and provide portability to other platforms in the future. The company added a TSR critical alarm that pops up while you're in an application such as Lotus 1-2-3.

Act! 2.0 has all the normal features of contact management programs: tracking calls, scheduling meetings, keeping to-do lists, setting alarms, and resolving conflicts. It deals with these in multiples: You can schedule tasks with reminders.

The program's word processor supports automatic mail merge.

Price: $395; LAN version, $995 for five.

Contact: Contact Software International, 1625 West Crosby Rd., Suite 132, Carrollton, TX 75006, (214) 418-1866.

Inquiry 1169.

Financial Planning Without Software Manuals

Granville Publications Software has released a new version of its program for managers who need to plan finances but don't want to buy an expensive spreadsheet and plow through a thick manual.

Up Your Cash Flow 2.0 has seven spreadsheet formats that automatically link related items.

Menus guide you through a financial forecast in minutes, providing a profit and loss forecast/budget, cash flow forecast/budget, projected balance sheet, term loan amortization schedule, payroll analysis, sales by product/product line, and cost of goods sold by product/product line.

Up Your Cash Flow 2.0 lets you forecast and consolidate up to 99 branch operations and separate entities. You can complete a multiple-year forecast, use fixed and variable costs of goods sold, and have different fixed and variable costs for each month of the forecast. The program has 28 predefined expense categories. It also provides for up to 30 user-defined categories.

Up Your Cash Flow 2.0 runs on the IBM PC with 512K bytes of RAM.

Price: $129.95.

Contact: Granville Publications Software, 10960 Wilshire Blvd., Suite 826, Los Angeles, CA 90024, (800) 873-7789 or (213) 477-3924.

Inquiry 1168.

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5200SX	386sx-16	2x16 Bit	VGA GAS plasma	3.5/1.44	40MB IDE	YES	8MB	$2799
5200NV	286-16	2x16 Bit	VGA GAS plasma	3.5 1.44	40MB IDE	YES	8MB	$2299

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Here is your chance to pick up on the biggest bargain in Laptops anywhere. The LT-3500 is packed with features. The 80286-12 MHz CPU runs at 0 wait state, ready to blaze hrough those tough applications. There is also a 40 MB fast HDD & an internal 3.5 /1.44MB diskette drive
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- Free carrying case

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Model 212	286-12 Mhz	1 Meg	40 Meg	$ 102	$ 203	$ 508
Model 216	286-16 Mhz	1 Meg	40 Meg	$ 114	$ 227	$ 568
Model 316SX	386SX-16 Mhz	2 Meg	40 Meg	$ 132	$ 263	$ 658
Model 320SX	386SX-20 Mhz	2 Meg	40 Meg	$ 144	$ 287	$ 718
Model 325	386-25 Mhz	4 Meg	40 Meg	$ 186	$ 371	$ 928
Model 325C	386-25 64K Cache	4 Meg	40 Meg	$ 198	$ 395	$ 988
Model 333C	386-33 64K Cache	4 Meg	100 Meg	$ 252	$ 503	$ 1,258
Model 425	486-25 128K Cache	4 Meg	200 Meg	$ 492	$ 983	$ 2,458
Model 433	486-33 128K Cache	4 Meg	200 Meg	$ 612	$1,223	$ 3,058

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BUSINESS MAILINGS

Qume Releases New Version of Mailing Database

The Qumatic Instant Mailing Lists and Labels program for the IBM PC now offers a menu-driven method for easily importing an established mail list compiled in another application, Qume reports. A new feature of version 2.0 automatically enters the city and state when you type in a ZIP code.

You can sort a database by many different categories, and the program prints out a report itemizing the number of pieces sent to each ZIP code to qualify for the lowest bulk mail rates.

Price: $59.95.

Contact: Qume Corp., 500 Yosemite Dr., Milpitas, CA 95035, (408) 942-4000.

Inquiry 1170.

Qume's mailing database program lets you identify fields that you won't use and automatically skip them.

Add Bar Codes to Your Mailing Labels

ComputaLabel now has an alternative to the film-master method of incorporating bar codes into your mailing label. Its Label Designer lets you combine text and art from a variety of sources and manipulate them with a bar code to make your label appear exactly as you want it. The program relies on PostScript printing technology to support printing at the high resolution (better than 300 dpi) required by some bar code families.

Label Designer lets you design your label so that it's aesthetically pleasing, yet still complies with bar code specifications. You can rotate text, graphics, and bar codes at 90-degree intervals.

The program lets you adjust the code size between 80 percent and 200 percent of the nominal size, as recommended by the Uniform Code Council. Code height is adjustable in up to 0.0004-inch increments. To adjust for print gain when you print the code, you can manipulate bar width by 0.0002 inch, the company reports, for maximum accuracy.

Label Designer works on the Mac with any PostScript output device. It supports a variety of code symbology families, such as UPC, Code 39, and many others.

Price: $395; bar code formats, $250 each.

Contact: ComputaLabel, Inc., The Carriage House, 28 Green St., Newbury, MA 01951, (800) 289-0993 or (508) 462-0993.

Inquiry 1172.

Reduce Postal Costs on Mass Mailings

PostWare PrintForm is for hospitals, utilities, and financial institutions that want to take advantage of postage discounts without sorting thousands of letters by hand.

The program works by capturing a print image form of each letter's address. It assigns ZIP codes, ZIP+4 codes, and carrier routes. The program presorts the letters in first-, second-, or third-class mailstream order and prints them in the new order.

PostWare PrintForm runs on a 386 with 1 MB of RAM.

Price: $15,000 to $30,000.

Contact: Postalsoft, Inc., 4439 Mormon Coulee Rd., La Crosse, WI 54601, (608) 788-8700.

Inquiry 1171.

Share Your Opinion

With Solicit Your Editor, a database for the IBM PC that has the names and addresses of hundreds of newspaper and magazine editors, you can let your opinion be known across the U.S. The program includes an editor and fields for keeping track of what you've sent to each editor.

Price: $49.95; LAN version, $129.95; yearly updates, $24.95 and $74.95, respectively.

Contact: T-Lan Systems, RR 2, Box 1290, Norridgewock, ME 04957, (207) 397-5511.

Inquiry 1174.

Find That ZIP

With ZIP*Phone, telemarketers can key in a phone number's area code and prefix and instantly determine the number's city, state, time zone, and local time. You can use it in TSR mode while writing a document to do things like verifying a ZIP code. You can also use it by entering a partial ZIP code or city name, and the program fills in the rest.

Price: $95.

Contact: Melissa Data Co., 32118-8A Paseo Adelanto, San Juan Capistrano, CA 92675, (714) 661-5885.

Inquiry 1173.

Label Publishing for the Mac

MacLabelPro acts as a companion to your database or word processor, letting you directly merge existing addresses and combine them with graphics and other text elements to produce eye-pleasing mailing labels.

The program is designed to work as a back end to such applications as Works, Excel, Word, FileMaker, Multiplan, and MacWrite. You select the type of label, and MacLabelPro displays a template window inside which you design the label. Once you design the label using the program's layout and drawing tools, each address will print according to that format. MacLabelPro is also available in an IBM PC version.

Price: $99.95.

Contact: Avery Commercial Products Division, 818 Oak Park Rd., Covina, CA 91724, (800) 541-5507 or (818) 915-3851.

Inquiry 1175.

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- AMI BIOS
- 101-key enhanced keyboard
- Shadow RAM Support

	Landmark v.1.14	Norton SI v.4.5
COMPAQ 386/16	20.6	17.6
PRO-386SX	21.2	18.0

386SX	VGA Mono	Super VGA
40MB (IDE)	$ 1239	$ 1449
80MB (IDE)	$ 1399	$ 1629

The PRO-286/16 $545

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- 1MB standard; expandable to 4MB on board (or to 16MB using 16-bit expansion board)
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- Shadow RAM Support
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- AMI BIOS
- 101-key enhanced keyboard

286/16	VGA Mono	Super VGA
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The PRO-386/25 $1065

- Intel 25MHz 80386 Microprocessor
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- ROM Shadowing into faster RAM
- Intel 80387 math coprocessor support
- 5¼" 1.2MB or 3½" 1.44MB floppy drive
- Five 16-bit, two 8-bit, and one 32 bit expansion slot
- Two serial, one parallel ports
- Real-time clock/calendar
- 101-key enhanced keyboard

* MS-DOS, OS/2, UNIX, XENIX, Windows 3.0, and Novell Compatible

* Landmark (v. 1.14): 36.2 MHz, Norton SI (v. 4.5): 28.7, Power Meter (v. 1.2): 5.26 MIPS

386/25	VGA Mono	Super VGA
80MB (IDE)	$ 1769	$ 1989
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- Intel 80387 coprocessor support.
- Shadow RAM Support
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- 5¼" 1.2MB or 3½" 1.44MB floppy drive
- Two serial, one parallel port
- Real-time clock/calendar with battery backup
- 101-key enhanced keyboard

386/33 Cache	VGA Mono	Super VGA
80MB (IDE)	$ 2369	$ 2589
200MB (IDE)	$ 2869	$ 3099

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Lisa Tarpoff, Marketing Manager, Heath Company, Benton Harbor, MI

DESKTOP PUBLISHING/WORD PROCESSING

Import Math Equations into Your Word Processor

K-Talk Communications' MathEdit 2.0 lets you create typeset-quality math equations that you can import into WordPerfect, Microsoft Word, WordStar, MultiMate, PageMaker, and any other program that supports TIFF, PIX, or EPS files.

The program has more than 250 math and Greek symbols. MathEdit's macro facility lets you assign a symbol or entire equation to one keystroke.

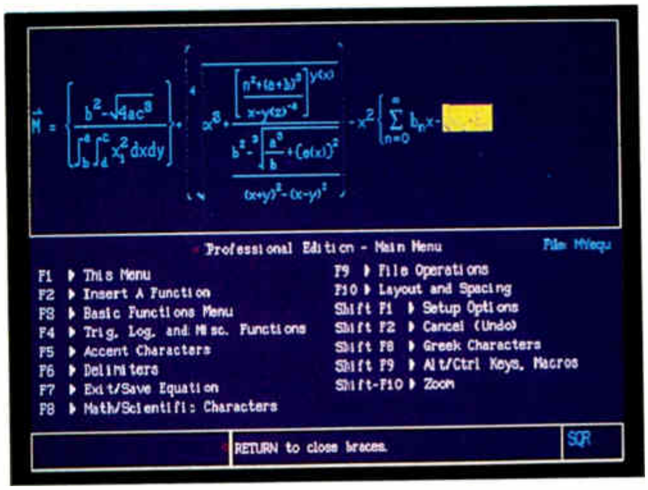
Square roots, parentheses, division signs, and other delimiters automatically adjust to the size that's needed for each equation, according to the company.

MathEdit 2.0 requires 400K bytes of RAM and a graphics card to run on your IBM PC.

Price: $199.

Contact: K-Talk Communications, Inc., 30 West First Ave., Suite 100, Columbus, OH 43201, (614) 294-3535.

Inquiry 1176.



MathEdit lets you create complex arithmetic equations and export them to a variety of applications.

Avalon Publisher for SPARCstations

Elan Computer Group says its new desktop publishing system for the Sun SPARCstation, Hewlett-Packard 9000, and DECstation provides pagination, graphics, page/document layout, and word processing under a Mac-like interface.

Avalon Publisher supports PostScript printers and other typesetters, plus the HP LaserJet family of laser printers. Features supported for page makeup include multiple threads for newspapers; text flow around graphics; text templates; and the ability to name and manipulate objects, paragraphs, and graphics as groups.

The drawing package supports Bézier curves, several types of fill patterns, and the ability to scale various bit-map formats (e.g., raster, raw bit-map, MacPaint, PCX, and TIFF). Graphics can flow with text or remain stationary.

Elan is offering Avalon Publisher with a floating license, which makes it available to everyone on your network but requires you to purchase only enough licenses for concurrent use. The system requires 18 MB of disk space, 8 MB of main memory, and the X11 Windowing System.

Price: $1295; $995 for each additional concurrent license.

Contact: Elan Computer Group, Inc., 888 Villa St., Third Floor, Mountain View, CA 94041, (415) 964-2200.

Inquiry 1178.

Avalon Publisher brings desktop publishing under the X11 windowing system to the SPARCstation, DECstation, and Hewlett-Packard 9000.

Wave4 Bridges Desktop and Dedicated Systems

Bestinfo says its Wave4 publishing system for OS/2 Presentation Manager bridges the gap between low-cost, low-powered desktop applications and high-end technologies like Penta and Atex. With Wave4 and the multitasking capabilities of OS/2, several people can work on the same document, pages, and articles without file corruption or work-flow conflicts.

The program integrates proprietary Hell and Scitex color imaging and PostScript color imaging. For production people, the program supports masking, automatic head fitting and sizing, rotation of images and frames at any orientation, and image zooming independent of the frame or page.

Price: $12,000 to $95,000.

Contact: Bestinfo, Inc., 1400 North Providence Rd., Media, PA 19063, (800) 346-7920 or (215) 891-6500.

Inquiry 1177.

Island's Desktop Publishing for Open Desktop

Island Graphics' Productivity Series 2.0 combines the company's word processing, painting, and drawing programs under one package for desktop publishing under SCO Open Desktop. The program is available for the IBM PC, Open Look on Sun workstations, and OSF/Motif on Apollo and Hewlett-Packard workstations.

Price: $995.

Contact: Island Graphics Corp., 4000 Civic Center Dr., San Rafael, CA 94903, (800) 255-4499 or (415) 491-1000.

Inquiry 1179.

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See Aug. 1990 P. 109, 120

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- Other features the same as 386SX

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386-33	MB	$850
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- 386SX VGA 40MB LAPTOP LT54CC $2400
- 386SX VGA 40MB LAPTOP LT5600 $2450

Prices subject to change without notice.
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HDD	286-12	386SX	386/25	386/33	486/25
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65MB	1569	1849	2159	2429	3489
100MB	1779	2059	2369	2639	3699
150MB	2139	2419	2729	2999	4059
200MB	2179	2459	2769	3039	4099
345MB	3069	3349	3659	3929	4989

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- Built-in 9" Amber Monitor
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- 205W P/S 110/220V. 4 Exp. Slots
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HDD	286-12	386SX	386/25	386/33	486/25
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65MB	1289	1569	1879	2149	3209
100MB	1499	1779	2089	2359	3419
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100MB	2039	2319	2629	2899	3959
150MB	2319	2599	2909	3179	4239
200MB	2409	2689	2999	3269	4329
345MB	3199	3479	3789	4059	5119

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HDD	286-12	386SX	386/25	386/33	486/25
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65MB	1539	1819	2129	2399	3459
100MB	1719	1999	2309	2579	3639
150MB	1999	2279	2589	2859	3919
200MB	2089	2369	2679	2949	4009
345MB	2879	3159	3469	3739	4799

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100MB	1679	1959	2269	2539	3599
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200MB	2059	2339	2649	2919	3979
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Circle 581 on Reader Service Card (RESELLERS: 582)

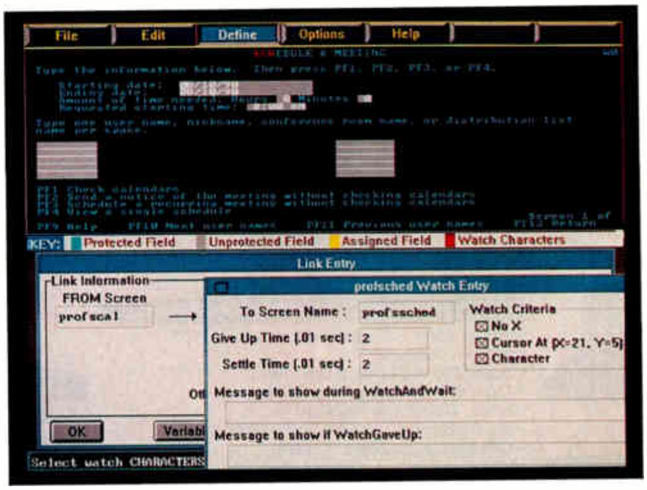
Visual PC-to-Mainframe Programming Tool

Easel says its new visual programming tool simplifies the process of creating a PC application for accessing 3270-based host systems. Called CommBuilder, the tool lets you build an application as you interact with the host computer. Generated code works with Easel/DOS or Easel/2 (for OS/2), the company's graphical application development system.

As you access and interact with a 3270-based system, CommBuilder presents the host screen in a window. After the session is over, CommBuilder automatically generates the communications portion of the Easel code required by the application. You can use CommBuilder on-line or capture host screen images for later coding.

As CommBuilder presents the host screen to you, it uses color coding to identify protected fields, assigned fields, watch characters, and unprotected fields. The tool can interface with Layout/CUA for DOS, Easel's tool that lets you design and generate a graphical user interface for Easel (the company hasn't yet released Layout/CUA for OS/2). You can use CommBuilder to assign links between host screens for programming an Easel application that navigates through several host screens.

CommBuilder runs under DOS and generates code for use with Easel/DOS or Easel/2. It requires DOS 3.0 and 1 MB of RAM.
Price: $1900; Easel/DOS and Easel/2, $7500 each.
Contact: Easel Corp., 600 West Cummings Park, Woburn, MA 01801, (617) 938-8440.
Inquiry 1181.



Working with CommBuilder, you create the communications portion of your PC-to-3270 application by interacting directly with the host screens.

ParcPlace Opens Up Objectworks\C++

ParcPlace Systems has opened up Objectworks, the set of tools that helps you find, understand, and reuse existing C++ code. No longer are you required to use default tools like the Sun C compiler. Objectworks\C++ 2.0 supports traditional Unix tools for C preprocessing, C compiling, and linking, the company says.

Objectworks helps you analyze C++ code, even if it's not your own. The Objectworks\C++ inheritance browser draws class inheritance trees and supports multiple inheritance, so that you can view existing class relationships in graphical form. Also included is an error browser, a C++ Translator using AT&T's Language System 2.1, and a source-level debugger.

The optional Object-Kit\C++ includes AT&T's Standard Library and Standard Library Extension, a collection of 15 general-purpose C++ libraries. It also has the NIH C++ libraries.

Objectworks\C++ 2.0 requires 12 MB for the Sun-3 and SPARCstation.
Price: $3000; Object-Kit\C++, $500.
Contact: ParcPlace Systems, Inc., 1550 Plymouth St., Mountain View, CA 94043, (415) 691-6700.
Inquiry 1182.

STSC Plans APL for IBM's System/6000

STSC, developer of APL, known for its ability to perform complex and ad hoc analyses on large quantities of data, says it will release a version of the language for the IBM RISC System/6000 by the end of this year or early 1991. Currently available for the 386, DEC workstations, and the SPARCstation, APL is used for actuarial work, currency trading, customer tracking, and other applications, the company says.

APL interfaces with languages like assembly and C. STSC says APL excels at matrix manipulation and supports nested arrays within a single element of other arrays.
Price: $3000 and up.
Contact: STSC, Inc., 2115 East Jefferson St., Rockville, MD 20852, (301) 984-5000.
Inquiry 1184.

Spinnaker Adds to Plus

Spinnaker Software developed the Plus Software Slot Developer's Kit for creating new object classes and customized extensions for the Plus programming language. You can use the kit to create applications that can run unmodified on the Mac and IBM PC with Windows or OS/2 Presentation Manager.

Four categories of extensions are possible with the kit. Software Slot Objects add a new object class to Plus, with all properties of the new object defined by you. Once you create and compile the new object, it goes in the same folder as Plus, and you access it like any other object. Another category, External Draw Objects, already have some properties defined in advance, since they are designed to display information on-screen. However, you determine the source and form of the displayed information, whether it be a bar graph, chart, or other data representation.

Two other categories, Software Slot Commands and Software Slot Functions, let you extend Plus. When you use these extensions to add new commands and functions, you can define an unlimited number of arguments and customized syntax, giving you greater flexibility than with external commands and external functions, according to the company.
Price: $695.
Contact: Spinnaker Software Corp., 201 Broadway, Cambridge, MA 02139, (617) 494-1200.
Inquiry 1183.

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42 Meg 39ms RLL - 269.00 122 Meg 28ms SC-749.00
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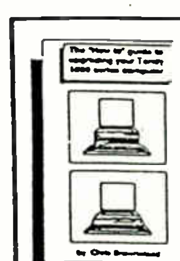

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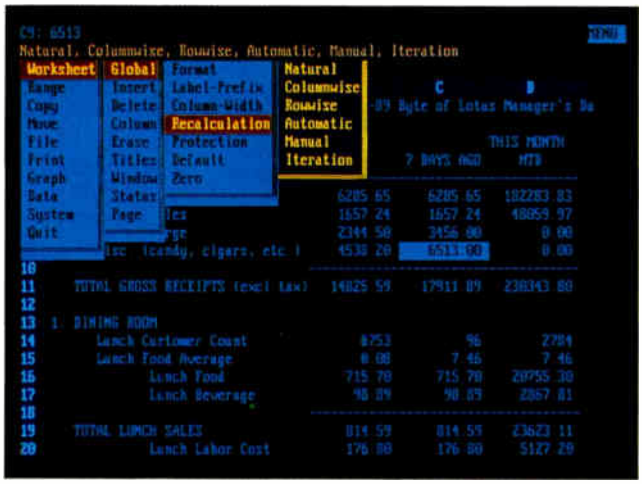
EDITORS AND LIBRARIES

Spreadsheet Functions in Your Database

Raima, developer of C products for the design of databases that combine relational- and network-model technologies, now has a library of linkable functions for embedding spreadsheet capability in your application.

Applications created with the PowerCell Spreadsheet Library let you analyze and otherwise manipulate data without having to export to a spreadsheet, perform the analysis, and reimport the changed data to the database.

The library can function as a stand-alone library, letting you add its capability to other applications. Built-in file access functions let you import and export data from WKS, WK1, DBF, and ASCII formats. The PowerCell Spreadsheet Library supports a variety of operating systems, including DOS, Windows, OS/2, Unix, Xenix and SunOS.
Price: $695 and up.
Contact: Raima Corp., 3245 146th Place SE, Suite 230, Bellevue, WA 98007, (206) 747-5570.
Inquiry 1185.



With the PowerCell Spreadsheet Library, you can develop database applications with built-in spreadsheets.

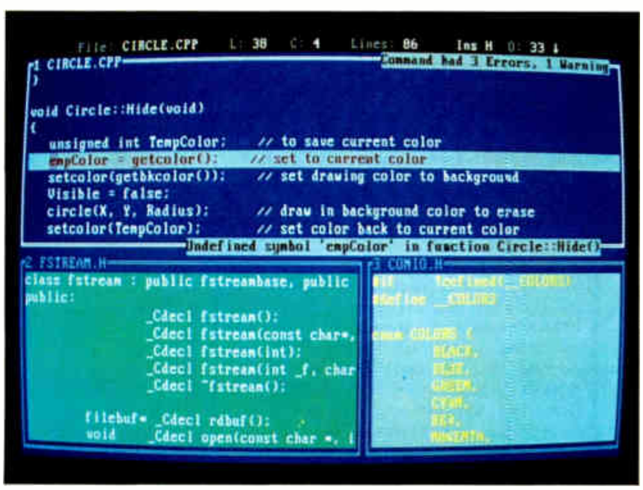
TAGS Function for C, C++ Added to PI Edit

PI Edit 4.0, a software development system for DOS, OS/2, and several versions of Unix, lets you use third-party tools to make, link, debug, or execute your application, all from within the PI Edit environment. A new TAGS function goes through your source code and creates a database from which you can reference any function or element by name, without knowing its location. Initially available for C and C++, the TAGS function should support dBASE and Pascal by the end of the year.

For programmers with a Unix background, the new version has a vi keyboard interface, which lets you toggle between vi and PI modes. While in vi mode, you still have access to all PI's commands, Iliad Group says.

Version 4.0 lets you save your workspace, quit, and return to it in restored condition, saving you time from having to get up to speed at the start of your next programming session.

The MS-DOS version can remove itself from memory when it executes another application, storing itself in EMS or disk memory. Supported versions of Unix include SCO Unix and Xenix, Interactive Unix 386/ix, and AT&T systems.
Price: MS-DOS version, $195; PI for OS/2, $249; PI for Unix, $349 and up.
Contact: The Iliad Group, Inc., 77 Geary St., Fifth Floor, San Francisco, CA 94108, (800) 473-2053 or (415) 563-2053.
Inquiry 1186.



PI Edit 4.0, a software development system, lets you do all your programming in one environment.

Develop for Windows Without a Low-Level Plunge

KnowledgePro for Windows lets you create sophisticated applications that can directly run other DOS and Windows applications without requiring you to delve into a low-level language.

KnowledgePro handles the difficult memory management problems of Windows, letting you concentrate on the application, Knowledge Garden says. Windows screen objects, fonts, icons, and bit-mapped images can be handled using one-line commands. Topics, the basic building blocks of the program, lie in wait for a particular event to occur.

Knowledge Garden says experienced Windows programmers can use KnowledgePro to quickly prototype applications.
Price: Windows version, $695; DOS version, $495.
Contact: Knowledge Garden, Inc., 473A Malden Bridge Rd., Nassau, NY 12123, (518) 766-3000.
Inquiry 1187.

Viewpoint Systems' graphical-user-interface development tool lets you create applications for seamlessly linking Windows 3.0 applications with IBM mainframe data through Dynamic Data Exchange.

I/F Builder 2.1 also lets you cut and paste 3270 mainframe data with an application for further analysis or graphing. The program supports Microsoft Word and Excel for now.
Price: $17,500; run-time component, I/F Manager, $395 per workstation.
Contact: Viewpoint Systems, Inc., 1900 South Norfolk St., Suite 310, San Mateo, CA 94403, (415) 578-1591.
Inquiry 1188.

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COMPUTING AT CHAOS MANOR ■ Jerry Pournelle

WORKING SMART

Diagnostic equipment, portable computers, and better ways of working on the road

This month we had the oddest pair of computer failures I ever heard of. They're also instructive. First, the Cheetah 486: Alex was working with QEMM-386 and Desqview, trying to get the largest possible working memory space—what in CP/M days we called a transient program area—by packing mouse drivers, buffers, and other such stuff up into the area between 640K bytes and 1 megabyte, what we're learning to call high memory; the more you can stuff up there, the larger the TPA you'll have. Alas, sometimes this can be tedious work.

It's tedious because most video board manufacturers do not tell you what areas of high memory they are going to usurp, nor indeed how large their BIOS is. You can learn only by trial and error. In general, the faster the video board, the more likely it is to be a memory hog; and if it uses the Tseng Laboratories' chips and has five crystals on-board, it's likely to be not only very fast and very reliable, but also capricious in its memory wants.

For example, the Micro Labs video board in the Cheetah 486 is extremely fast, has five crystals, uses Tseng chips, and is wonderful for those who want a high-end board for graphics or CAD; but it also grabs high-memory areas without warning, which can crash systems using QEMM-386, as I found out when the Railroad Tycoon game locked up tighter than a drum.

The only remedy is to exclude the right memory areas from QEMM-386 in the CONFIG.SYS, reset, and see if the system crashes. If it does, do a hardware reset, change the CONFIG.SYS, and do a software reset; test for crash; and so forth. Now, of course, you can just exclude vast areas of memory, but that defeats the purpose of using QEMM-386. It's better to do the trial and error.

Failure Modes

Doing this makes you reset the machine often, which shouldn't be a problem; but suddenly the Cheetah 486 wouldn't come up. It reported a memory error on start-up; and it did that every time. Very consistent.

I called Gene Sumrall of Cheetah. Incidentally, Cheetah was recently bought by Northgate Computer Systems. They also hired key Cheetah people, including Gene and Ron Sartore. Northgate's Art Lazare says he'll keep Cheetah intact as a high-end product line, which means that buyers will get Cheetah engineering backed by Northgate technical support and financial resources; that's going to be one formidable high-end system.

Gene was understandably upset. My Cheetah 486 was an early production model, and it had been tested nine ways to Sunday before being sent to me.

"Video board," Gene said. "When something like that happens, it's generally the video board."

"Right," I said, and got out my trusty Video Seven board, which, if not as fast as the Micro Labs board, is about as reliable as they come. It took about 2 minutes to put in the Video Seven board and turn on the machine.

I got the same error reading. Call Gene again.

The Cheetah 486 is built up with a motherboard capable of going up to some incredible speed and a board that carries the i486 chip and its associated glue chips. This lets you swap for a faster system when faster i486 chips become available. Cheetah sent a new CPU board by Federal Express. I swapped. Same error.

By now, Gene was ready to tear out his hair. "Can you take all the boards out," he said.

That was no problem, although I kept wondering what the machine would do with no CPU. However, the Cheetah motherboard has a small LCD that tells precisely what is going on in the boot-up process. We were hung at stage 26 (it should go to FF), and apparently that's well before the system ever gets to the i486 chip. I pulled all the boards.

"Same error," I reported. "Stops at 26."

Long silence. "I'll call you back."

The next step sounded a little weird. "Take the machine, take the boards out of it, turn it upside down, and beat on it," I was told. "Ron [Cheetah guru Ron Sartore] says there may be a little bit of metal shorting the address lines."

Well, OK, I thought. I turned the machine over and tapped it. Then I tried the vacuum cleaner, used canned air from the cleanup kit, and looked at every board slot with a strong light. I thought I found a bit of metal. Gloat. Turn on the machine. "Same problem."

The next step was a new motherboard, and to be sure it was installed right, they sent in Larry Aldridge, the local Cheetah distributor. Incidentally, Larry is also going to work for Northgate, as a director of product development. He delivered the motherboard. Installed it, and turned on the machine.

Same error.

"Power supply," Larry said. "Except that I never heard of this kind failing." He borrowed my voltmeter and fooled around a bit. "Something's pulling down the regulated voltage," he decided. But we couldn't figure what. It looked like there was nothing for it but to replace the power supply, too. Then Larry had an inspiration.

"Keyboard."

"Keyboard?" I shook my head. "OK." We disconnected the keyboard and got out another. Turn on the machine. The LCD went past 26, on up. The hard disk clicked over. The machine booted fine. Clearly, some kind of short in the keyboard was pulling the power low, which made the machine believe it had a memory error.

There was only one problem: that keyboard is a Northgate OmniKey/Plus in the "Pournelle configuration," with the Backspace key next to the *P*, where God intended it to be. There aren't many of those in the world, and I sure hated the idea that one of mine (I have four) didn't work properly.

Inspection showed that the keyboard is held together with six screws. I opened it up. Everything is modular, and nothing falls apart; no problem. As I removed the keyboard from the case, something fell out. A scrap of metal, I think; it vanished behind the cushion of the couch. Meanwhile, other stuff fell out, nutshells, crumbs, bits of popcorn. I shook everything out, vacuumed it, and put it back together, said a quiet prayer, and plugged it back into the Cheetah.

No problem. Everything works fine and has for a couple of weeks now.

Meanwhile, we solved a second problem: the old Zenith Z-248, one of the early 286 machines, still does service in education, but it recently began having

The major moral of the story is clear: if you have a problem, it could be anything. We knew that back in CP/M days.

problems on boot-up. If it ever got past the boot problems it was all right, but as Bill Godbout says, "If the error rate is high enough to measure, it's too high."

Zenith has built-in diagnostics in their ROM monitor, but running that all night didn't find anything. I didn't have time to do much more with the machine, so I sent it to the local Heath/Zenith store. Alas, they couldn't find anything wrong with it at all; but when I got it back here and put it on the bench, the same problem developed. Then, by accident, I moved the 110-volt power cord—and the machine rebooted.

Turns out there's something wrong inside the power cord. You can't see anything wrong by inspection; and, naturally, we didn't send that power cord out to Heath/Zenith with the machine. Sigh.

There are two morals to the story, one major and one minor. The minor one is, go clean your keyboards out. If you're not sure that you can get them back together, it's probably best not to take them apart. But Northgate keyboards are no problem, and you can at least vacuum the others. I've also found that washing keyboards out with warm water (I just take mine into the shower) and drying with *low* heat from a hair dryer will fix sticky keys and generally spruce up their appearance, as well as remove foreign objects.

The major moral of the story is clear: if you have a problem, it could be *anything*. We knew that back in CP/M days.

Diagnostics

All this got me looking at diagnostics. Alex and Barry Workman recommend

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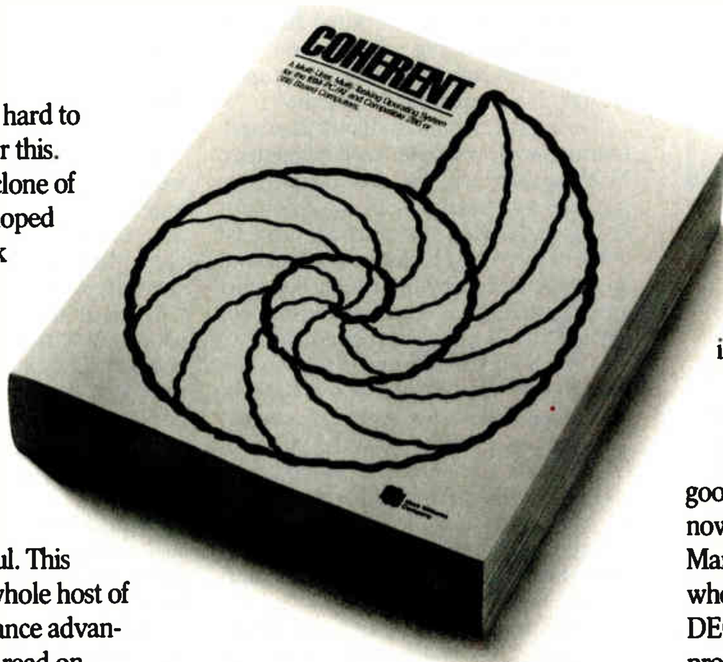

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two products: a software diagnostics package called CheckIt, and a hardware card called Kickstart.

CheckIt, from Touchstone Software, produces detailed reports, does exhaustive memory tests, and generally does about all a software diagnostics package can do. It's the kind of thing that you don't need often, but when you do need it, you need it bad. Of course, it can operate only if the computer is working.

Kickstart I, from Landmark Research International, works on dead computers. Machines that use 286 and higher chips generate what are called power-on self test codes during the start-up process. Some of these may be interpreted and put up on the screen by the BIOS, but most are not, and anyway the machine may not get that far. The Kickstart board displays the POST codes through LEDs on the board itself. You can then look in the supplied documents to see what they mean.

Alas, not all clones use the standard POST codes. Landmark has documented all they could find, but with some clones, all you can do is look up the standards and guess. That will probably be helpful, but it's better if you are getting standard information.

By the time you read this, there will be a Kickstart II, which will check that power is within 5 percent of standard (Kickstart I just looks to see that there is power) and will use an LCD rather than LEDs. Barry Workman says the current one is plenty good: he has to maintain systems for many clients and would hate to live without Kickstart.

The company also makes diagnostic disks to test the alignment of floppy disk drives; if you get a lot of retry errors, you might give that a try. Of course, nowadays the remedy for floppy disk drive problems is to use a head cleaning kit, and if that doesn't work, just replace the drive. They're cheap enough.

Organizing Your Thoughts

It was already plenty good, but Symantec has improved GrandView a lot. New features of version 2.0 include the ability to import and export Q&A Write files—that helps me a lot—and new screen organization. One problem with an outline program is that as you indent farther and farther, you eventually get all the way over to the right, with no room for further work. GrandView has always had a hoist command, which fills the screen with what you're working on, but that's not always optimum either; sometimes you *want* to see some of the other subheads in relation to what you're entering now. Anyway, the new version solves that problem nicely.

In fact, GrandView is good enough that I could use it to write this column. Most of the word processing commands work as you'd expect, and there's mouse support. Like Q&A Write, GrandView incorporates many of the old WordStar Control-key commands, meaning that touch-typists don't have to bother with cursor keys and PageDown and Control-cursor keys, and the other stuff that tries to get your fingers off the home keys.

I only installed GrandView 2.0 last week, but I find that I'm using it a lot more than I did the old one; mind you, I used the old version quite a bit. All my old outlines read right into the new version without problems.

If you do much expository writing and you haven't tried an outline program, you may have the wrong idea about what they do. I certainly did: my previous experience with outlines came from high school, when I was required to write and turn in an outline before I could write an essay.

No doubt the exercise was good for my soul and helped me organize my thoughts in later years, but at the time I hated outlines passionately; consequently, when outline programs first appeared, I dismissed them with my most cynical sneer. I'd probably still be doing that if Jim Baen, my once and future editor and publisher, hadn't persuaded me to give them a try. Jim was right: outline programs really are useful.

You don't use them as my high school teachers demanded, as a kind of preliminary draft when you already know what you're going to say. That may work for some people, but I find it's about as easy in that case simply to tear into the subject, write everything I know, and, with the magic of word processors, edit the resulting mess into coherence. No: an outline program comes into its own when you haven't the foggiest notion of what you're going to say.

As an example, in addition to the report on the U.S.S.R. I did for BYTE, I'm working up a much longer version that I intend to integrate with another essay on the strategy of technology in this new age. That means I have to include first-hand impressions I got in Moscow, information I was given by people while I was there, reports from books and periodicals, and strategic stuff from my earlier works. The result is a haphazard jumble of thoughts in no discernible order.

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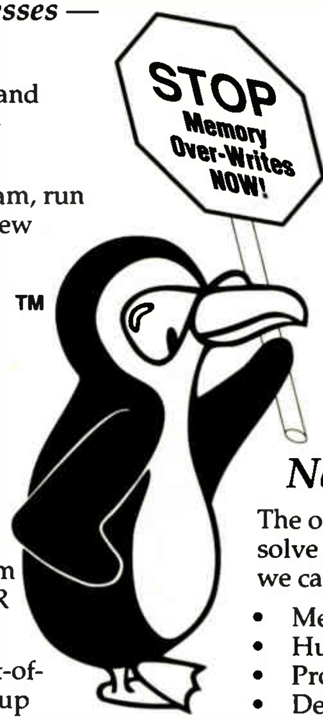

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Lenin's tomb. These kids are proud and walk tall, and that has implications.

Item: when we were in a working-class-district grocery store, we noted that there wasn't much for sale: plenty of potatoes and wheat flour and kasha, some butter, no vegetables at all. While we were there, two military trucks pulled up, and the officers bought several cases of milk and several gross of eggs, paying for the goods with loose cash from their pockets. The troops loaded the stuff onto the trucks and drove away. These weren't commissary officers: it was the company commander, a decorated airborne soldier of the Moscow garrison unit. An odd way to feed an elite military unit, and that too has implications.

And so forth. The neat part about GrandView is that I can write about disconnected items as I think of them. I can take my pile of photographs, leaf through them, and write whatever they remind me of; if during that process I remember something totally unconnected, it's no great trick at all to put that note in an appropriate place. Later, all this gets organized into something that is meaningful—and when it does, I'm more than halfway through the final essay.

If you have to write anything at all complex and you haven't tried GrandView, you're in for a pleasant surprise.

Outline programs aren't quite as useful for fiction, but I find I do use GrandView for character notes.

If you have to write anything at all complex and you haven't tried GrandView, I think you're in for a pleasant surprise. Recommended.

Organizing Your Life

When you reach my age, you forget things. Actually, I suspect my memory never was as good as I like to think it was, but lately it's best described as wretched. The result is piles of little notes, scribbled on all sizes of paper. The important ones invariably get lost, and they surface only after it's just too late to call whomever I was supposed to call or do whatever job the note reminded me of.

I have, to some extent, alleviated the problem by carrying a hardbound logbook and training myself to make most of my notes in that. I also use Scotch tape to glue into the logbook business cards, photos, and the scraps of paper that still turn up. In addition, I have computerized some permanent telephone, address, and memo files I add to from time to time; I print them and paste those pages in the front of each new logbook. The result is a fairly good chronological file of what I've done and who I've seen, as well as my telephone list.

This system has its problems. One is that I go through two or three of those logbooks a year, and on trips I generally must carry at least the current book and its immediate predecessor; they weigh about as much as Sir Zed, the Sinclair

Z88. Second, although I try to make a sort of combination index and table of contents of my logbooks, I don't get around to that very often, so I can spend quite a bit of time hunting for a business card if I can't remember exactly when I got it.

Still in all, my system does work, because it's built around the way I normally do things: it's free-form, doesn't make me design forms and stick to them, and has access by browsing; and despite all my computers and dozens of attempts to computerize my life, I find I always come back to my hardbound logbooks and Scotch tape.

Still, hope springs eternal, and I keep hoping to find electronic ways that will take over at least part of the job; which brings us to Tornado.

This isn't a new product. It was recommended to me when it first came out, but that version didn't work with either SideKick or Desqview, so I didn't see how it would do me any good.

The latest version of Tornado works with both products, although there are a number of cautions about using it with SideKick (not to mention that if you have both Tornado and SideKick resident, you're going to have a pretty small TPA; no great matter, for I seldom use SideKick any longer, and then only in its own Desqview window).

As for Desqview, Tornado will work either as a TSR program beneath some other program in a window or in a window by itself. Micro Logic recommends the latter arrangement, and it seems reasonable to me. It's also possible to have multiple copies of Tornado running at the same time.

Tornado is a character-based free-form memo database. Once it's installed, you can make any text notes you please in any format you like. The result will be a number of little windows, each with some text in them. Their sizes will be appropriate to how much information you have put in them. The arrangement is controlled by you: think of the various note windows as a pile of scraps of paper of different sizes. If you pull a very large one out and put it on top, it will probably be the only one you see. On the other hand, if you put the big one on the bottom, you can lay out quite a few on top of it and then put more on top of them, until you have a jumble of notes, some visible and some partly so.

One note will be on top, and that's the one you can write on. You can also create a note on a new scrap of paper and then leave it on top or bury it into the pile.

Retrieval is simple enough. You can either browse through the notes or have the program search intelligently for some keyword or name. If it finds one, it will bring it to the top; if it finds several, it will bring all of them up and give you the chance to do another search, or, alternatively, to search for all those with your first keyword but *without* some other keyword or phrase.

You can also cause the program to date your notes from the system clock (it will insert the time, too, if you like). Alas, there's no setting to make it date notes "automagically"; you have to remember to press Escape-D when you edit the note. It will also add sequence numbers, although again not automatically.

You can group your piles of notes, so that when you call up one of the group, you use the arrow keys to flip back and forth through the others (as if you'd paper-clipped a bunch of paper scraps together). You can incorporate the contents of one note into another. There's a paste

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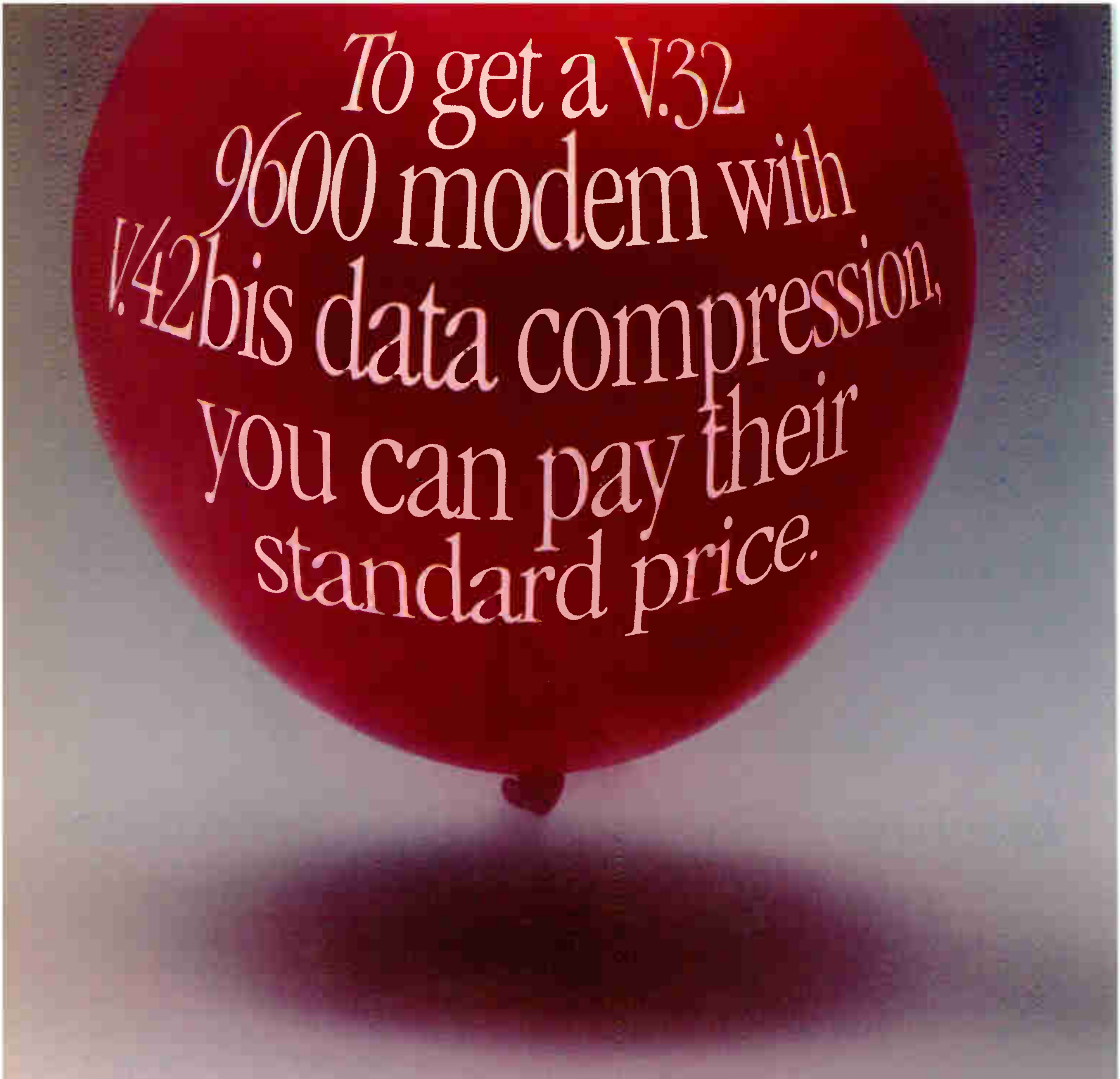
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feature that's useful if you use Tornado inside a word processor; with Desqview, you're better off using Desqview's mark and transfer features.

The broad features of Tornado are easy enough to learn; it took me about half an hour to go through the tutorial program and experiment until I was comfortable with it. The text editor has the WordStar control commands, as well as the more obvious ones involving arrow keys; it's reasonably intuitive. There are a few surprises, but no real problems.

The Tornado manual is adequate and generally well organized. Alas, there's a strong "Clear Only If Known" component to some of the instructions: for instance, they keep telling you that changing the default window (notepaper) size is "easily accomplished," but they don't tell you how to do it, and it's not in either the index or the table of contents. It took no end of fooling around before I realized that you call up any window; press E for edit; Escape; use arrow keys to adjust the window size; press F1 to get "additional menus" from within the edit menu; *do not* follow the instructions to press Escape-E, but instead merely press E; and then press Escape, and when it asks if you're sure (it doesn't say sure of what), tell it Yes.

Even then, your windows will still collapse vertically if there's blank space at the end of them. This is, I suppose, to save space on-screen, but the result is that when you call up the window, there may be more text in it than you can see. It is easy enough to expand the note window, but you have to do it. There are some other "features" that you can find only by poking about.

Still, these are nits. Tornado isn't perfect, but it's pretty good. If you're looking for a way to keep your computer near the phone and make files of the stuff that now finds its way onto little scraps of paper, this program will do the job. Tornado has a big-brother program, Info Select, that works in a similar fashion but has increased capabilities and features. Quite a few associates and colleagues, both beginners and power users, swear by Tornado, and some find it indispensable; in fact, the raves of several friends persuaded me to try it.

So far, I like it fine. I'll let you know in a few months if I'm still using it. It's quite possible I will be.

Quite a few associates, both beginners and power users, swear by Tornado, and some find it indispensable.

The Portable Problem

The most obvious difficulty with using Tornado or any other software for organizing your life is that you can't take it with you. If you don't travel much this is no problem, but, alas, many of us find we're on the road a great deal more than we like—and the need to make and access records and notes doesn't go away when we leave home. If anything it gets

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MusicEase $295
Grandmaster, Inc.
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Spokane, WA 99220
(509) 747-6773
Inquiry 1156.

TravelMate 2000 LT286
with 20-MB hard disk drive ... $3999
Texas Instruments, Inc.
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Austin, TX 78720
(800) 527-3500
Inquiry 1157.

Zenith SupersPort SX
with 40-MB hard disk drive ... $5499
with 120-MB hard disk drive .. $6499
Zenith Data Systems
1501 Feehanville Dr.
Mt. Prospect, IL 60056
(800) 553-0331
(708) 699-4800
Inquiry 1158.

ZQ-5200 .... $239.99
Sharp Electronics Corp.
Sharp Plaza
P.O. Box 650
Mahwah, NJ 07430
(201) 529-8200
Inquiry 1159.

worse. That's when my hardbound logbook, carried with a roll of Scotch tape in a shoulder bag, comes into its own.

Clearly, there are other methods. Some use the Day-Timer system, in which they make notes in a pocket-size diary for later hand transfer to a matching desk calendar/logbook. This works very well if you do it. But after investing considerable money in Day-Timers, I found I'd get hopelessly behind in updating the desk copy, after which there wouldn't be any master schedule and I was thrown back on my memory. I gave it up.

Others use an enormous book that apparently comes with a course on how to organize your life: everything goes into the book, and you don't have to transfer from it to anything else because you carry it all with you. I gather that those who've developed the proper habits like that system a lot; but I don't have the right habits, and I'm unlikely to acquire them, or for that matter to take the course that tells me how.

For a while I was hoping I'd found the solution with gadgets: either the Sharp Wizard or the Casio Boss. Alas, neither really did the job. The Wizard was just a tad too large to slip into a pocket, but that's not fatal: people, including BYTE editor in chief Fred Langa, do manage to carry it. What was fatal for me was the ABCDE keyboard located off to the side of the screen. No matter how hard I tried, I simply could not write real notes with that keyboard.

I worked at using that Wizard. I kept thinking one day something would click, and I'd really love it. Alas, it never happened, and after a while the Wizard began gathering dust. It's on a prominent shelf, so I can't forget to carry it on trips; but somehow I don't carry it, and when out of guilt I do take it, I've forgotten how to use it. I had much the same problem, although for other reasons, with the Casio Boss.

However: comes now the Sharp ZQ-5200; and while it's not all I'd like it to be, it does look to be good enough.

The ZQ-5200 is in a clamshell case about the depth of a 3½-inch floppy disk (twice that when opened, of course) and 6 inches wide. The closed thickness is about that of a cigarette case. It has an LCD screen visible in any reasonable ambient light and a QWERTY keyboard below it. The whole thing is smaller and lighter and a heck of a lot easier to use than the old Wizard.

The ZQ-5200 comes with Traveling Software's Do List and Expense programs, which you could get as an add-on card with the Sharp Wizard. Other built-in functions are the calendar/schedule, world times, telephone directory, memo pad, and the like. The keys are grouped sensibly, with those directly controlling things up on the half with the screen, and text and calculator functions down on the keyboard half. There's no attempt at a numeric keypad: I use the numbers above the QWERTY keyboard. This isn't a problem for me, and I doubt it will be for anyone else.

In general, the ZQ-5200 operates like the Wizard did, but the QWERTY keyboard makes that a lot easier. Moreover, the Traveling Software link system that worked with Wizard works here: it's fairly easy to move data back and forth between the ZQ-5200 and your PC. Never having become a Wizard addict, I can't say for sure, but I'd bet that if you liked Wizard you'll love this.

I certainly intend to carry the ZQ-

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5200 and use it, and I expect to like it. However, I do have one request: I want Traveling Software to get together with Micro Logic and develop software that lets the ZQ-5200 transfer Tornado files simply and quickly. When that happens, I may actually get my life organized and keep it that way.

TravelMate 2000, Part One

We just got it, so I don't know how it will hold up; but Texas Instruments' TravelMate 2000 LT286 makes a terrific first impression. To begin with, it's light. The detachable battery gives it about 3 hours of life; without it, the internal battery can run it for an hour. You must charge the internal battery without attaching the external, though. There's a 20-MB hard disk drive and a bright backlit screen.

What there isn't is a floppy disk drive. You can buy an external 3½-inch floppy disk drive, or you can use the built-in Traveling Software LapLink system to connect to a desktop (or another laptop with floppy disks, which is what I've had to do).

Zenith SupersPort SX

We're in San Diego for the weekend, so I brought both the TravelMate 2000 and the Zenith SupersPort SX. I'm writing this on the SupersPort SX, because given the availability of both at your destination, I think anyone would use it every time. Its screen is brighter, and the keyboard is better. There's a built-in 3½-inch floppy disk drive, the 386SX chip with 2 MB of memory handles Desqview just fine, and the SupersPort SX is just an all-around better machine. Moreover, the battery lasts an honest 3½ hours, and you may get more. I find the SupersPort SX the closest thing yet to my home environment.

What the SupersPort SX isn't is light. By the time you get it into a case—and it's heavy enough that you'll need a case with a shoulder strap—it's a good 17 pounds, and if you put anything else in the case, such as the power converter, that's even more. For all its versatility, it's no heavier than its 286 predecessor—but it's no lighter, either.

On the other hand, I carry it, because much as I curse it while walking 3 miles in the Dallas Airport—I'm sure they use a linear program to maximize the distances you have to walk—as soon as I get to my destination, or for that matter to the Admiral's Club if there's much of a layover, I'm glad I have it. The TravelMate 2000's screen is reasonably bright, but it's nothing compared to the SupersPort SX's; that screen is not merely visible, but easy to read in *any* lighting conditions I've ever encountered.

In fact, the SupersPort SX would be good enough to be your only computer, a proposition I'm about to test: we have acquired part-time use of a beach house here in San Diego, a place I can go to get away from telephones and modems and UPS deliveries so I can write fiction. The SupersPort SX accepts an external monitor and keyboard, and next time we come down that's what I'm going to bring: either a Zenith Flat Technology Monitor or a Princeton Graphic Systems Ultra-14 high-resolution monitor (excellent: more on that one next month) and one of the "Pournelle configuration" keyboards. I'll leave monitor and keyboard here and carry the SupersPort SX back and forth.

After all, I have good reason to know that Zenith laptops are rugged: you may recall that a porter dropped my previous one on the tarmac just before I boarded an airplane for Europe, and it not only survived despite a cracked case but performed flawlessly. Cracked case and all, that machine is still in use. The SupersPort SX, meanwhile, has been carried through three western states, down here to the beach, out into the Mojave, up to Mars Hill (8000 feet) in Flagstaff, and over many a bumpy road; and it works just fine.

The bottom line is that of all the laptops I've tried, I like this SupersPort SX the best, despite its weight; enough so that I put up with the weight.

Meanwhile, Roberta has dibs on the TravelMate 2000, which weighs a bit more than her Toshiba T1000 but is immensely more powerful; and she *isn't* willing to carry a SupersPort. In a few months, I'll have a detailed report on how the TravelMate 2000 stands up to life at Chaos Manor.

American Heritage Dictionary

I'm about out of space, so this will have to be brief: it works fine. I've installed the American Heritage Dictionary program on the SupersPort SX, set up a 512K-byte Desqview window for it, and opened the program. It's memory-resident, invoked with Control-left shift plus a letter (e.g., *D* for dictionary or *T* for thesaurus), and it comes up instantly in its window. I then loaded Q&A Write in the same window and brought up AHED inside that. No problem.

Unlike Word Finder, which can be specially configured to work with Q&A Write so that it looks up the word the cursor is on when you invoke Word Finder, AHED simply asks what word you want to work on; but when you tell it, AHED is fast and efficient.

The definitions are right out of the

actual *American Heritage Dictionary*. Alas, there's little about word origins. However, the AHED program will look up anagrams or search with wild cards (if, for instance, you aren't sure how to spell the word); and it really is fast, much faster than you'd be able to look up the word in the printed volume.

AHED comes with an adequate but not fancy word processing program, Writer; it's a very vanilla little thing with simple commands intended for people who bought the dictionary and didn't have any editor; a lot better than nothing, but under those circumstances, I'd recommend getting PC-Write and paying the shareware fee.

AHED has a Search feature: tell it "fire AND burn" and it will, quickly, find and list all words whose definitions contain both those words. It doesn't take long for a writer to think of a lot of uses for that.

I have a few minor quibbles on interface, and I do wish they'd left in the full etymologies instead of cutting them to the bone, but otherwise AHED is the *American Heritage Dictionary* on-line in all its glory, and it works just fine. If you want a dictionary program, this is as good as any I've seen. Recommended.

MusicEase

I'm no music expert, but I know that printing and publishing music is slow and expensive. I recall one friend who composed for films; he had to hand-draw his scores using the Ozalid process. A good music program would have been a godsend.

Grandmaster's MusicEase lets you enter notes from the keyboard, or, if you have a MIDI, you can play notes that it will record. The samples I have seen, and a couple I have produced, are sure in the same league as hand-engraved.

Writing the program took Gary Rader, the program's music professor author, quite a while, since it involves scanning in dozens of symbols for the weird and wonderful notations musicians need. The program works, and it produces acceptable drafts; the laser printer output looks as good as the stuff in my wife's opera books. I claim no musical expertise, so all I can say is that it looks great; meanwhile, here's my condensation of the description Professor Rader gives of the capabilities:

An unlimited number of connected staves; one or two voices per staff; unlimited number of notes (of unlimited range) per chord; dotted and doubly dotted notes/rests; treble, bass, alto, and tenor clefs; slanted beams; tied slurs; phrase marks; cue notes; grace notes; accidental signs; alternating stems; brackets and braces; and a partridge in a pear tree.

It looks to me as if this program goes a long way toward doing for music composers what word processors did for writers.

Winding Down

There's so much to write about that I can't possibly get to it all, but first things first: John Eklund, curator of the History of Computers and Information Technology exhibit at the Smithsonian, just sent me a picture of Zeke II, my old friend who happens to be a CompuPro Z80, on display in their newest wing. Zeke looks happy enough, but I expect he gets lonesome. If you haven't been to the Smithsonian lately, get over and say hello. I'm trying to get to Washington for a conference on diamond film technology next month, and I'll certainly drop by.

I wanted to write a mini essay on why you should never buy a dedicated word processor because you get so much more bang for the buck from a computer: as for example the Gold Star XT clone, which sells for less than any dedicated word processor I know of, and yet is just as fast and a great deal more versatile. Better yet, get a good 386SX and you can have Desqview too.

We're still working with the new DR DOS; they've about solved the problems of incompatibility with LANtastic. More on that when I learn more.

The new Desqview and QEMM-386 work fine with Windows 3.0; more on that next month.

The book of the month is *Arab and Jew: Wounded Spirits in a Promised Land* by David Shipler (Penguin, 1987); really excellent. The CD-ROM of the month is Ludwig van Beethoven's Symphony Number 9, for the Macintosh, from The Voyager Company, 1351 Pacific Coast Hwy., Santa Monica, CA 90401; magnificently done.

The game of the month is *still* Microprose's Railroad Tycoon; every time I think I've had enough, I find myself playing it again. ■

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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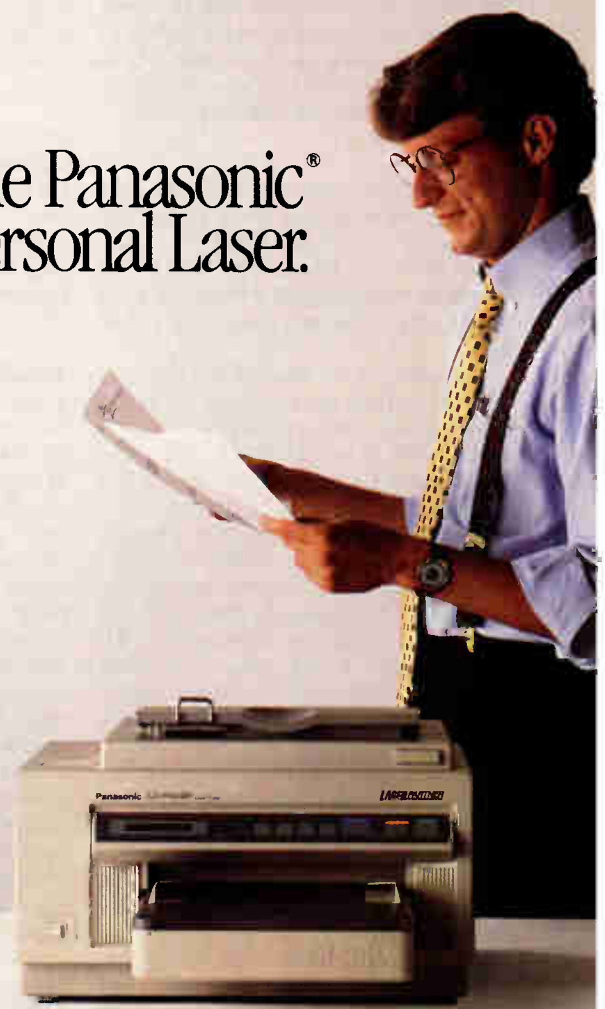

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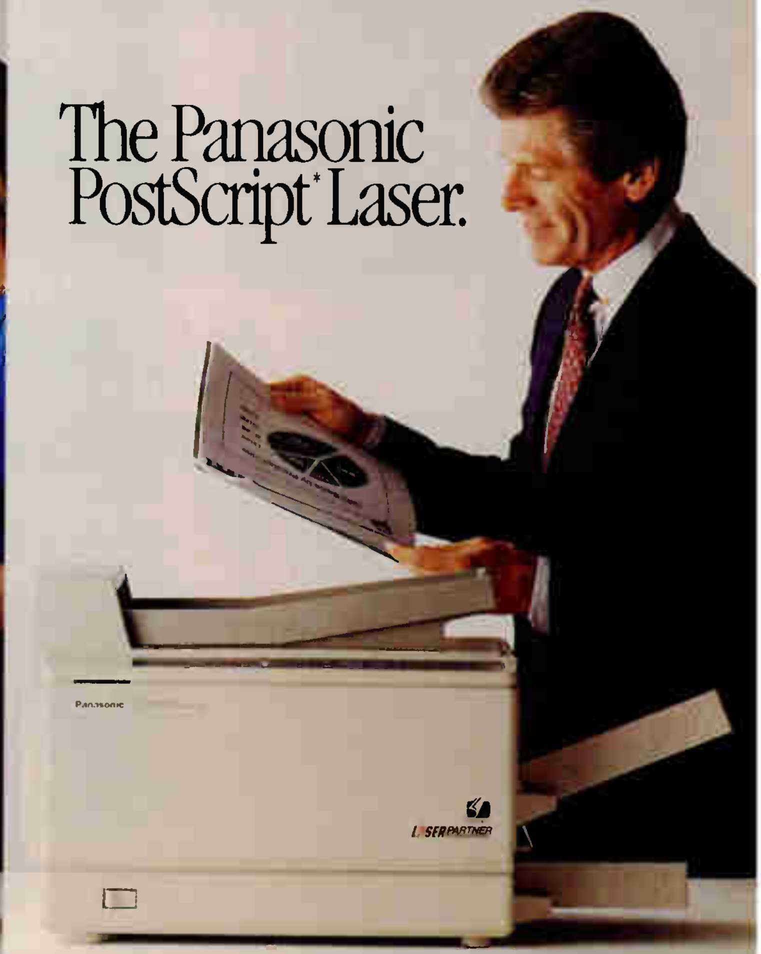

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GETTING BIGGER GROUPWARE

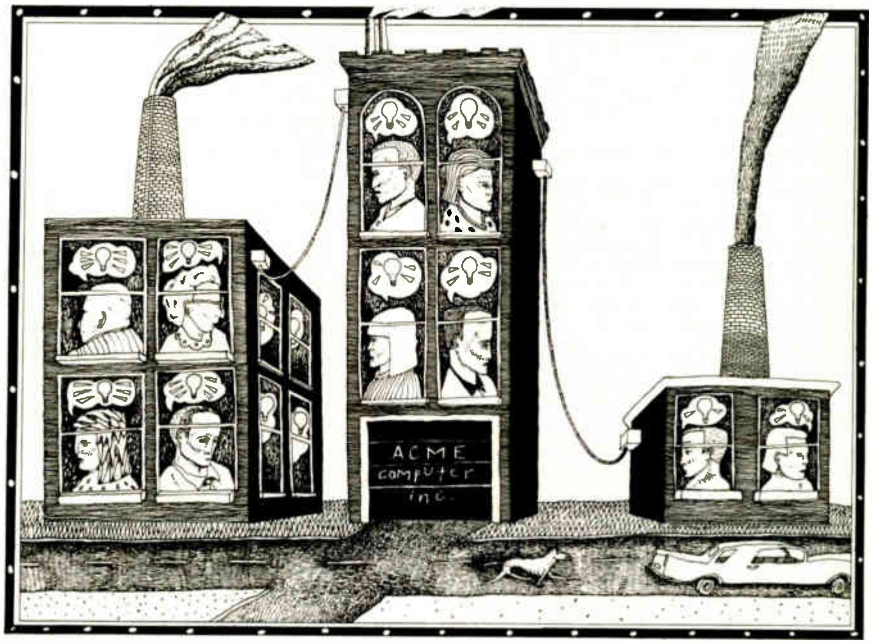
High-end companies make groupware solutions into a fine art. But at what price?

Last month I looked at group productivity and the newer groupware vendors, as well as a way to create your own groupware solution. This month, I'll look at packages from vendors that created the field of groupware. One of these firms, Wang, has made groupware into a fine art.

In April 1989, I discussed earlier incarnations of WordPerfect Office and Higgins. Both packages have been updated since then. I'm mentioning Wang's solution to group productivity for the first time, but it's a direction you may find worth investigating.

Group productivity is a major reason that businesses use LANs. For routine uses, such as word processing, standalone computers work fine. But when several people have to work together, you need to find ways to support the interaction of the group as a whole. Where once you were satisfied when a document was generated, now you find that an entire workgroup must have access to it. This group access and the interaction that goes with it is one reason for the growth in group productivity software.

The primary activity in a workgroup is communication. When several people are assigned to a task, they are expected to communicate with each other so that it will be a communal effort. If a workgroup is set up so that the members are in close physical proximity, then communication can be accomplished by talking. When they are physically separated, they need other means of communicating, such as E-mail. Useful groupware supports this natural communication, while enhancing it with such functions as file transfer and automated scheduling.



In the Beginning and Now

WordPerfect Office and Higgins helped start the trend toward groupware. Although initially they were rather limited in functionality, they did support excellent E-mail services, and their scheduling packages automated what was otherwise a tiresome process. Unfortunately, at that time, neither was a total solution.

WordPerfect Office chained you to a single file server and wouldn't let you attach binary files to its E-mail. Higgins had the same single server limit, and it didn't let you incorporate specific external software into the menu system. Both packages have now been updated and are as full of features as groupware could be.

Then there's Wang, a company long known for being ubiquitous in office automation. Wang looked at group productivity with a fresh slate. It analyzed the work people did and how they did it; it also looked at ways to get those people usually left out of the group productivity solution, such as managers, into the automated group. Looking at the results of their studies, Wang engineers decided a couple of important things:

- Managers can't type.
- Managers are used to dealing with paper forms.

Knowing how to type is usually necessary for successful computer use. But managers are used to pencils. So Wang invented a way to let people use a pencil to run their computers, at least with Wang Office and Wang Freestyle applications. You're still on your own with third-party applications, though; if you go the pencil route, you can't take advantage of non-Wang-compatible software.

Wang Office and Wang Freestyle are complementary office automation appli-

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Use Tools You're Familiar With

Unlike the other groupware packages, the Wang solution includes hardware as well as software. Freestyle requires the use of the attached electronic pencil and tablet, and you can add a scanner, a fax server, and a telephone. A version of Freestyle, called Freestyle/Light, does not require specialized hardware. Wang Office provides the more traditional groupware functions, such as E-mail, but it also supports Freestyle.

Let's say, for example, that I send BYTE editor Ken Sheldon my Comdex travel expense voucher over the BYTE LAN, so that he can approve it and I can get paid for my services. Ken would receive the digitized image of my completed and signed voucher in his E-mail. When he looked at the image and noted the expenses I'd recorded, he could also hear my voice over a Wang telephone attached to the computer, giving all the reasons why I might have exceeded the per diem. Ken could then sign his approval on the voucher using the electronic pencil attached to the tablet. His signature would show up on the screen and would be added to the digitized image.

Once the voucher was signed, Ken could forward it to the proper department for payment, or somewhere else for further action. With Wang Office, you can also use an electronic pencil and tablet to make menu selections. Thus, if he chose to, Ken could complete the whole transaction using those tools rather than having to type anything. Of course, the people on both ends must use the Wang system. As you might imagine, this process isn't simple to implement.

An Alternative GUI

While other groupware packages are built around menus, Wang uses a graphical desktop metaphor. Documents are placed in file folders where they stay on your virtual desktop in the same types of piles that you have on your real desktop. If you're using groupware, though, this may be the only graphical user interface you have.

I was not able to get WordPerfect Office to work with Microsoft Windows. Higgins is supposed to work with Windows and Desqview, but I haven't yet proven this for myself.

Commitment

To be an effective productivity solution, Wang Freestyle and Wang Office require an organizational commitment. While you don't have to buy every part of the

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Wang system, each user must have certain necessities, such as a special telephone to receive voice messages. But once you make the commitment, Freestyle and Office allow groups, even those scattered around the globe, to work together as if they were in the same room.

Of course, you have to make an organizational commitment to WordPerfect Office and Higgins, too. Both packages reside on the file server, and because they are software, they can be run from any IBM PC-compatible computer. Higgins sells its licenses for groups of five; WordPerfect offers individual licenses. You'll need to license every user you plan to have using these packages. If you only automate part of the group, the rest will be hard pressed to work.

WordPerfect Office continues to be the program to beat for ease of integration into the office. Since it works just like WordPerfect, nearly everyone already knows how to use it. In addition, it installs easily, is intuitive, and has clear documentation. Your coworkers will not waste time puzzling over confusing screens or obscure commands.

Higgins is greatly improved over its earlier version. The menu structure is more carefully thought out, and its user interface is much improved. Unfortunately, I couldn't get the software to work with NetWare 386, and the documentation was so weak that I couldn't figure out why. However, I was able to install it on an earlier version.

WordPerfect Office's installation does not work flawlessly with NetWare 386. You have to enter the user names manually because of differences between versions 2.15 and 3.0. At least there is an alternative method, however, to perform the installation.

Finding Groupware

There's no question that a well-designed groupware package can enhance the productivity of your business. If you can get people to use the package, they will find that it makes their communications easier and faster. And if your personnel are physically separated from each other, the benefits of groupware are even greater.

Because all three of these packages can communicate over long distances using wide-area networks, fax gateways, or public E-mail networks, you can form workgroups in places where not too long ago you couldn't. This kind of software really does let groups work better together. Since it prevents the familiar time killers of telephone tag and synchronizing meeting schedules, groupware can make the work more productive as well.

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Wayne Rash Jr. is a contributing editor for BYTE and technical director of the Network Integration Group of American Management Systems, Inc. (Arlington, VA). He consults with the federal government on microcomputers and communications. You can contact him on BIX as "waynerash," or in the to.wayne conference.

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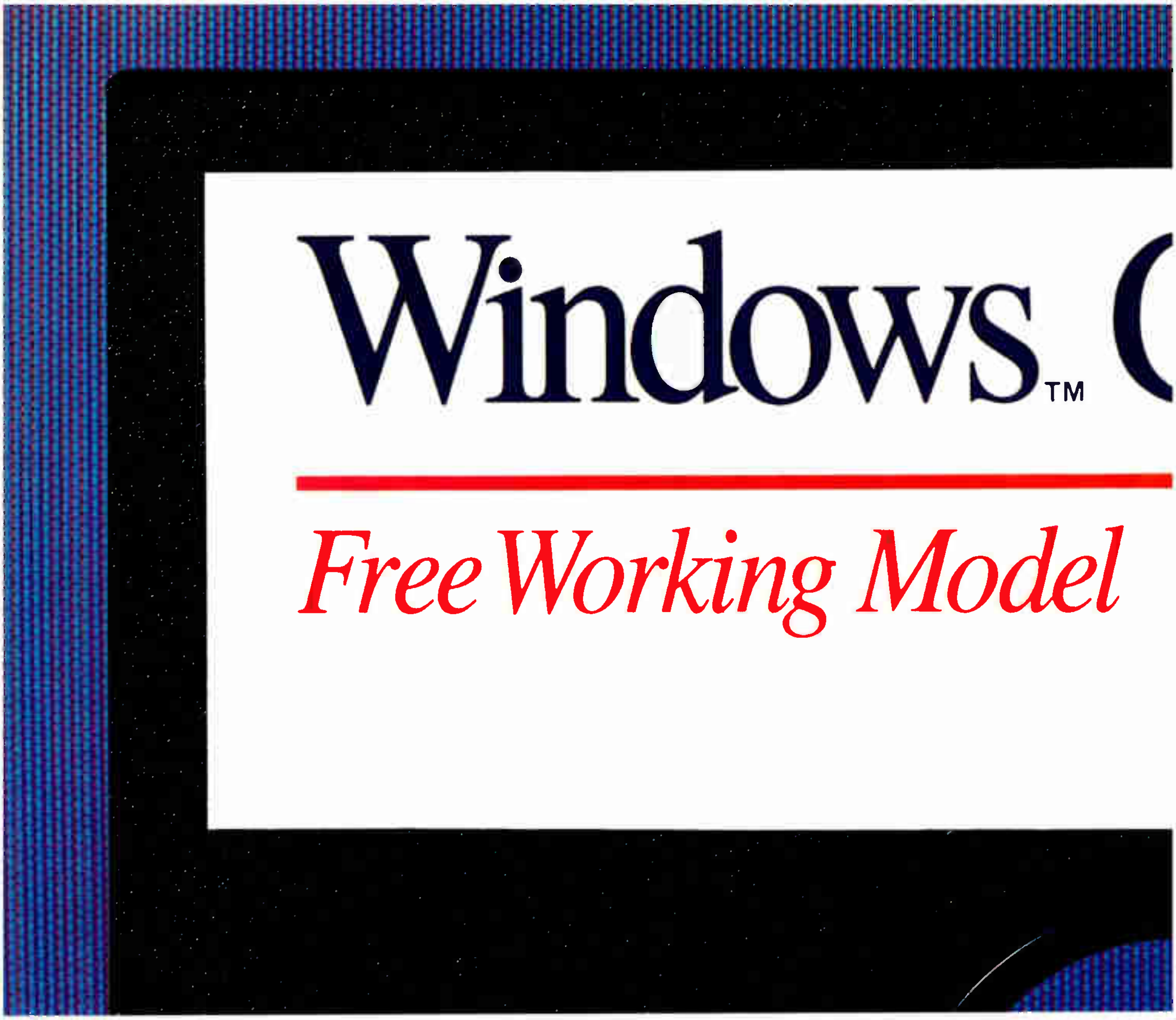

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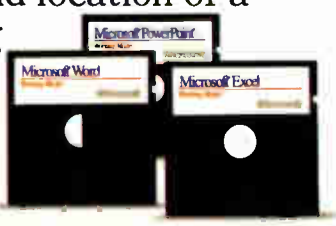

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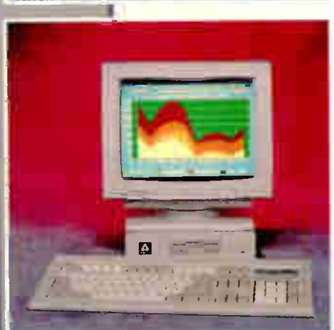

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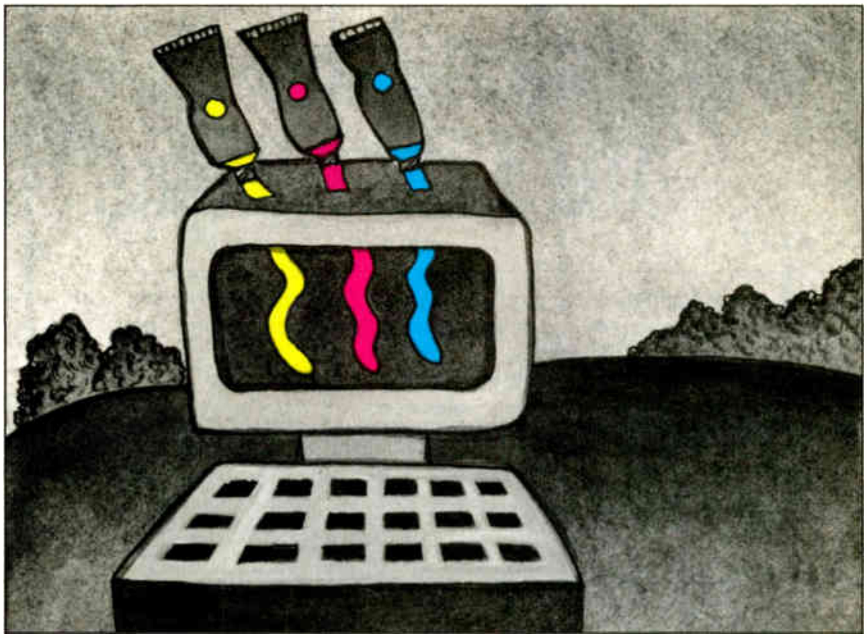
Circle 21 on Reader Service Card

I'VE GOT DIBs

Device-independent bit maps and palette management make the PC a serious color platform



Time was, you could count the number of display options for the PC on the fingers of one hand, without letting go of your teacup. Now, a PC can be equipped with any of hundreds of displays, from portable low-resolution gray-scale LCDs to colossal high-resolution 24-bit color monitors.

Now consider its documentation's view of the Windows bit map: "a matrix of memory bits that, when copied to a device, defines the color and pattern of a corresponding matrix of pixels on the device's display surface." In other words, it's a memory image compatible with a specific display. The Windows 3.0 documentation dryly says: "Each device has its own unique color format. In order to transfer a bit map from one device to another, use `GetDIBits` and `SetDIBits`."

DIBs: Device-Independent Bit Maps

The DI in `GetDIBits` stands for device-independent. Instead of mimicking the planar structure of a given display, the DIB format contains a Bitmapinfo data structure that describes the bit map, plus the actual array of bytes that defines the pixels of the bit map. All well and good, but that is not the end of the story.

DIBs first surfaced in OS/2 1.1 as the Graphics Programming Interface bit map. The designers of Presentation Manager understood the problems of the Windows 2.0 bit map and wanted to avoid them. The OS/2 1.1 Bitmapinfo structure specifies the width and height of the bit map in pels (i.e., picture elements—called pixels in the Windows documentation and pels in the OS/2 documentation), the number of bit planes, and the number of bits per pel within a plane. It can also contain a color table to accommodate devices like the VGA that can display a certain number of colors from a larger palette—in the case of VGA, 256 colors out of 256,000.

The OS/2 1.1 Bitmapinfo structure is fine as far as it goes, but it doesn't go far enough. Bit maps can be very large: A 256-color bit map at 640 by 480 pels is about 300K bytes. That number is independent of the image. Without compression, even an all-black bit map will be that big.

The Windows 3.0 Bitmapinfo structure, which carries over into OS/2 2.0 as the Bitmapinfo2 structure, allows for run-length-encoded images with 4 or 8 bits per pixel. While not as effective as the Ziv-Lempel compression that Graphics Interchange Format (GIF) images use, RLE compression will reduce large areas of a single color to a few bytes.

The new structure also specifies the resolution for which the DIB was created, the number of color indexes actually used by the bit map, and the number of colors considered important for displaying the bit map. Windows 3.0 allows images with 1, 4, 8, or 24 bits per pixel and restricts the number of planes to 1.

OS/2 2.0 adds some extra fields to the DIB format. These govern, among other things, recording order (i.e., direction of scan when a bit map paints), color encoding, and halftoning. Windows 3.0 does not use these fields. Even OS/2 2.0 does not use them all yet. Although it does support halftoning, it has only one option for recording order (bottom-to-top) and one for color encoding (RGB structures).

Getting DIBs

Assuming you have installed Windows 3.0, you can find a small collection of

DIB images in your Windows directory. They have the .BMP extension and serve as wallpaper for the Windows desktop. You can find more DIB images on BIX in the microsoft conference, generally in ZIP files. You can also convert GIF images to OS/2 1.1 bit maps (which are also readable from Windows) using Graham Welland's GIF2BMP, which you can download from the "ibm.os2 listings" area on BIX.

Don't panic if you don't have OS/2: GIF2BMP is supplied as a bound executable file that will run on DOS 3.3 and higher and on any version of OS/2. Many GIF images are in the "photo listings" area on BIX, as well as the "ibm.os2" area and the microsoft conference; you can find thousands of GIF images in CompuServe's PICS forum areas, although downloading them can be costly.

If you have access to clip art in PCX format, you can convert it to BMP format using PC Paintbrush for Windows 3.0. To convert other formats (e.g., IFF, TIFF, and TARGA), you may have to resort to a utility program, such as HiJaak or TGL+. If you are converting TIFF files, be aware that there are several levels and types of TIFF format, and that not every TIFF reader supports every variety of file. For instance, HiJaak is unable to read level 5 color TIFF files.

Palette Management

I mentioned palettes briefly when I was describing the Bitmapinfo structure, but I didn't go into all the implications of supporting a selectable palette. For starters, I'll consider a 256-color VGA display, such as a Video Seven video RAM card with 512K bytes of memory.

Windows 2.x and OS/2 1.x load such a display with a default palette. To paint a bit map without palette management, you have a choice of getting best-match solid colors or best-match dithered colors. The solid-color image will look posterized because of the false colors and loss of shading, and the dithered image will look very grainy. Such restrictions are quite obvious in Windows 2.x and OS/2 1.x GIF viewers and in other programs that try to display 256-color images.

Under Windows 3.0 and OS/2 2.0, programs can control the palette using the system's palette manager. The system reserves 20 colors for its own use so that menus and icons will always be visible; on a 256-color display, the remaining 236 colors are available. If you have the Windows 3.0 Software Development Kit (SDK), you can see the palette change if you run the SHOWDIB and MYPAL sample programs and display some 256-color images; otherwise, you can display images with Windows PBRUSH.

Suppose two windows want different palettes. The palette manager gives priority to the active (foreground) window; background windows can take the leavings. You can see this happen by putting up two images with different palettes and bringing them to the front alternately. You'll see the active image snap into its correct colors, the background image become posterized as the palette changes, and the background image adjust itself to the new palette as well as possible.

On a 24-bit "true-color" display, the palette manager does very little. And on a 4-bit (16-color) display, there aren't any colors left over from the system palette. Applications have to be aware of what sort of display they're running on and what sort of DIB they're displaying to do the right thing—but it isn't all that complicated if you start from the SDK examples.

continued

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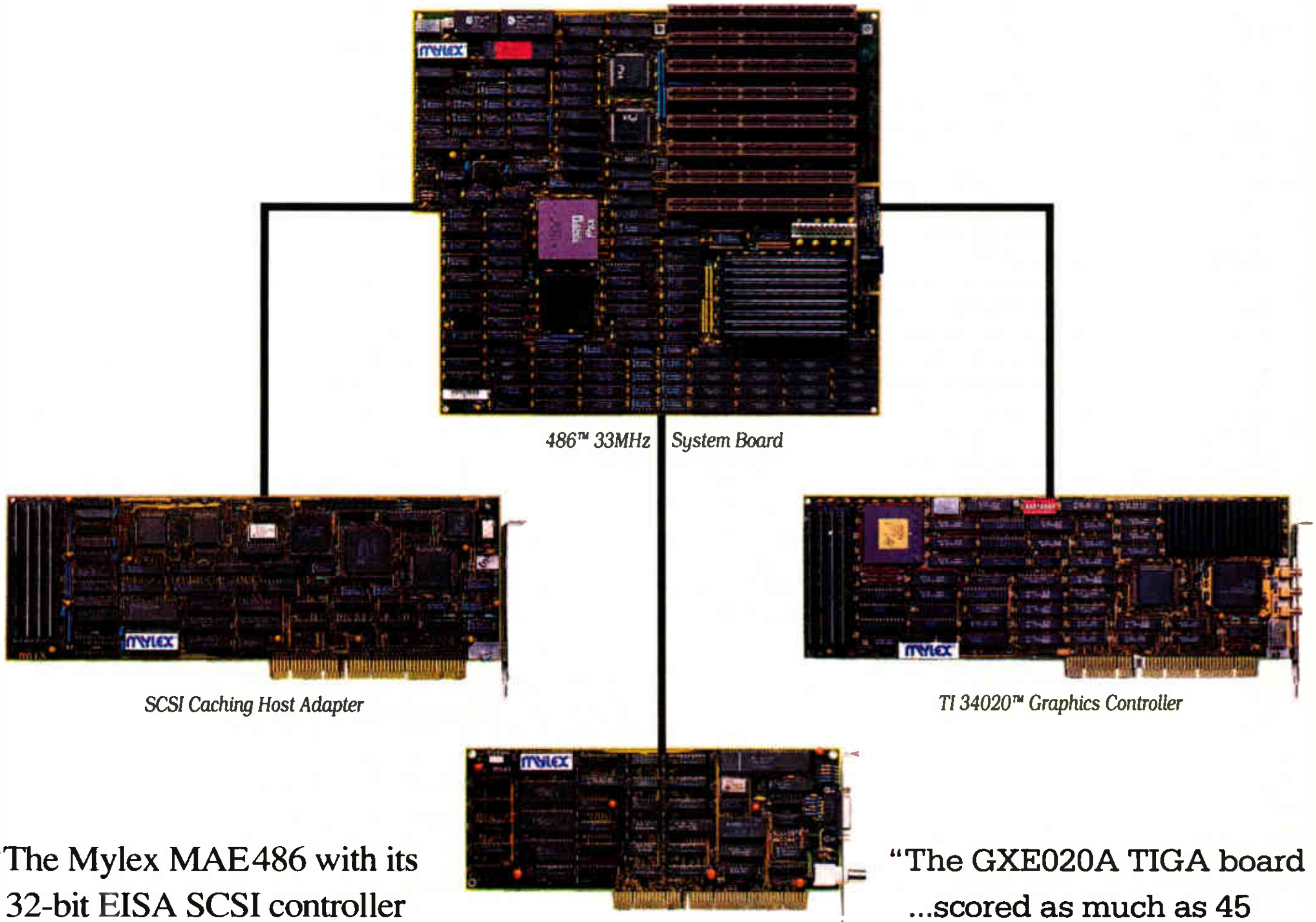

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Circle 193 on Reader Service Card (RESELLERS: 194)

Getting Up to Speed

I recently added DIB display and printing to EnPlot and Room Planner, two Windows 3.0 applications I've written. (EnPlot is a data-visualization and data-analysis program for scientists and engineers; Room Planner is a room-layout package for the hospitality industry.) To do that, I copied the SDK examples, modified the code somewhat to preserve my applications' mapping and background modes, and wrote a few "glue routines." It took me about two days to add DIB support to Room Planner, and another day to add it to EnPlot.

A big issue I had to address was what size the bit map should be on the screen. The natural size of a bit map is its dimension in pixels. But I wanted my applications to be WYSIWYG, and the resolution of a laser printer is about four times the resolution of a screen, so that a bit-map image that is full-screen covers about 1/16-page when it is printed.

Rather than explicitly scale the image to each resolution, I took advantage of Windows mapping modes. Room Planner uses MM_ISOTROPIC mode, with the window extent set big enough to show the room dimensions in units of tenths of a foot; with this system, a bit map that is 100 by 200 pixels will be drawn the same size as a platform that measures 10 by 20 feet, no matter what the device resolution.

There are about half a dozen ways of getting the device-independent bit map from disk to screen. I chose to read in the file (being careful of the 64K-byte limit on far pointers), keep it in memory in DIB format, create a palette for it, and then send it to the screen or printer with `StretchDIBits`, since this is the only Graphics Device Interface function that correctly converts colors (i.e., to shades of gray) and scales the bit map as needed.

When drawing to the screen, I set the background mode to transparent, select and realize the palette, call `StretchDIBits`, and then restore the old palette and background mode. When drawing to the printer, I skip the palette manager calls. After I've drawn the bit map, I release its memory.

If I were drawing the same bit map over and over, I would probably convert the DIB to a screen-compatible memory bit map of the correct size once with `SetDIBits`, and then I would BitBlt the converted bit map to the screen as needed, avoiding multiple conversions and gaining a little speed. As it is, my application may be drawing multiple bit maps that could not all reside in memory simultaneously, so the `StretchDIBits` method is as good as anything.

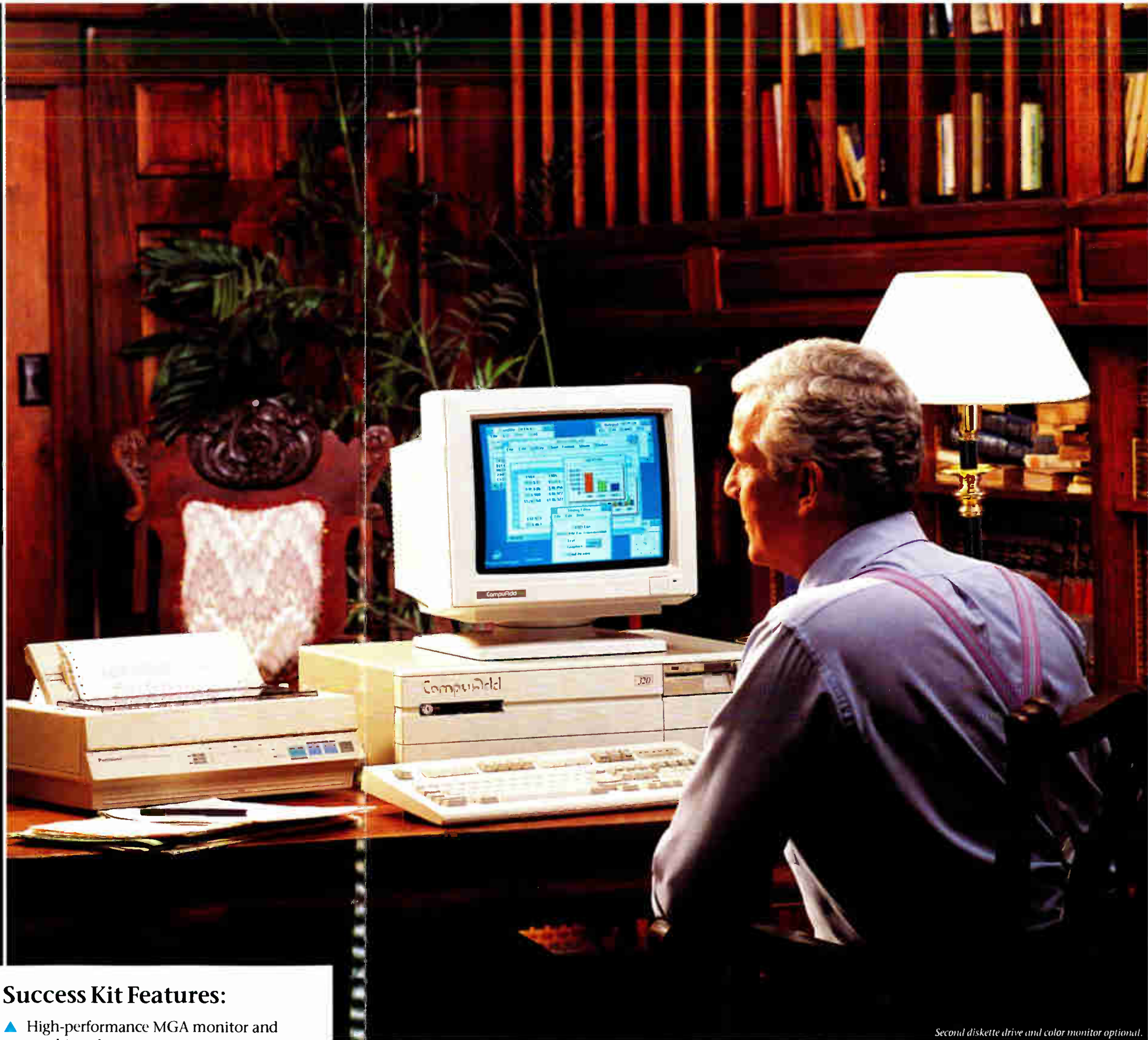
What Does It All Mean?

Now that Windows 3.0 (and OS/2 2.0) support device-independent bit maps and palette management, the PC is ready to become a serious color platform.

Not everyone can afford a 24-bit color display, but an 8-bit Super VGA with palette management behind it can do a more than acceptable job of image display. Color separation, animation, and image-processing software aren't far behind. ■

Martin Heller develops software and writes about technical computer applications. He holds a Ph.D. in physics. He can be reached on BIX as "mheller."

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



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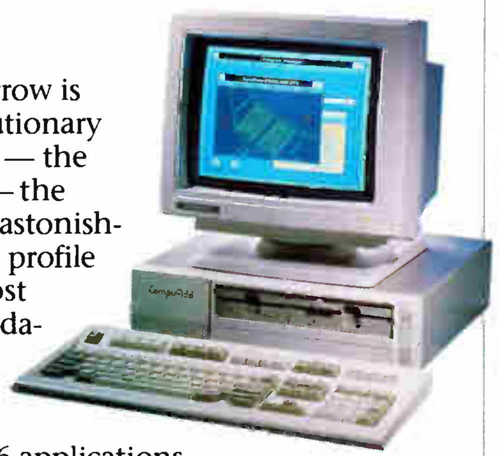

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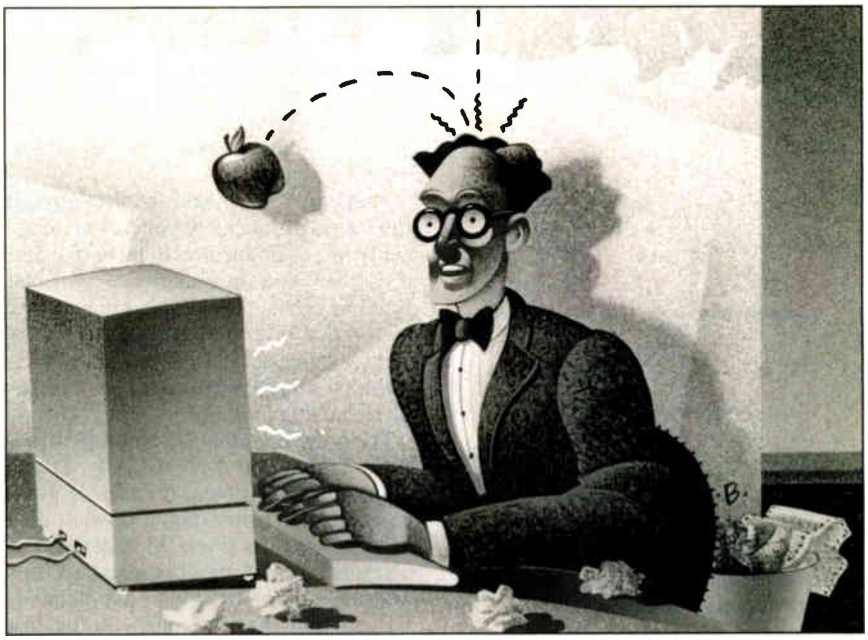
INSPIRATION AT THE YEAR'S END

The Mac markets changed during 1990, and new markets are developing



How time flies. The first year of the new decade whipped by as fast as a screen update on a Mac IIfx. It's time to evaluate what's happened to the computing community, including the Mac's position within it. In the IBM-compatible world, the Rest of Them have been cranking out 486 systems at higher clock speeds, and Windows 3.0 is a major improvement as far as DOS-based graphical user interfaces (GUIs) go.

Apple, after some dithering about, took muster and waged the battle of the market share on two fronts. It took the high ground in March with its introduction of the Mac IIfx, the first-ever Mac clocked at 40 MHz. In October, Apple began the blitzkrieg on the low end with three new low-cost Macs. Just as important, the company slashed prices on the existing models.

Apple's attack plan so far has been impressive, but it's not without flaws. The Mac IIfx's much-touted SCSI DMA will not work with anything but A/UX. System 7.0 still hasn't seen the light of day. The features on the low-cost Macs are so-so, including their pricing. If Apple is indeed in the market-share battle for the long haul, I wonder whether it will have the nerve to reduce prices further if the situation warrants it. In other words, we've gone through another year of some improvements to the Mac and its software, but we're still waiting for the next Mac revolution. I'm getting pretty itchy waiting for it to come.

The one place I see a difference is not in the volleys from the big guns overhead, but when I look in the trenches where the small Mac developers hunker down. Try as we might, we just can't kill these little guys. We entice them with promises of greater profits (Windows 3.0), hotter development systems (NextStep), and other baubles, but they stick to the Mac like glue.

Whatever the reason, it's these folks who make the most interesting Mac software today, and who typically define new software categories. These developers think about more than just adding more features to a word processor or better kerning to a page-layout system. They think about what might be possible with a Mac.

The Mac Gets Inspired

Not surprisingly, one of the newer Mac products I've found is called Inspiration 2.0. It's from a tiny family-owned company called Ceres Software in Portland, Oregon, and it's been around for a year now, largely ignored. I spent a pleasant time conversing with its creator, Don Helfgott. He calls his program a thought processor, but that doesn't do it justice.

Inspiration 2.0 takes the Mac's ability to give you a consistent and meaningful GUI and lets you brainstorm, cranking out ideas by the bushel basket. It then organizes the ideas in a way that helps you realize what, if anything, you've really invented. Inspiration 2.0 is sort of a visual diagraming and outlining tool interweaved with a simple word processor. It's the first computer aid to creative thinking I've tried that actually works—and I've tried them all.

The theory behind Inspiration 2.0 goes something like this. Databases, word processors, and spreadsheets store and access information in ways that don't help us relate information more clearly, because they fail to distinguish between right-brain thinking (i.e., creativity, images, comprehension, imagination,

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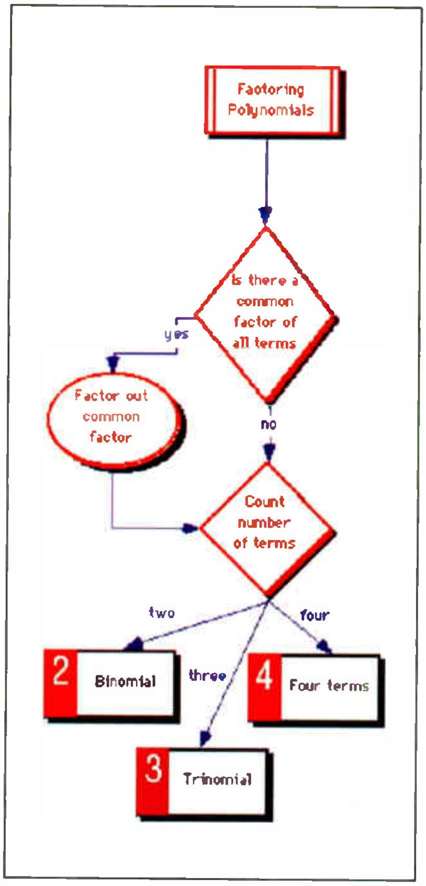

Inspiration 2.0 combines visual diagraming and outlining with a simple word processor. This Inspiration flowchart outlines the general algorithm for factoring a polynomial, as shown in listing 1.

visualization, music, and daydreaming) and left-brain thinking (i.e., logic, sequence, reasoning, and analysis). Inspiration 2.0 works by filling the gap between these two kinds of thinking.

Other programs have promised to accentuate the synergy between the right and left brains. Neil Larson's Maxthink, early versions of Dave Winer's ThinkTank outliner, ODS's Consultant, and a myriad of other shareware have all skipped through this software minefield before. None of them really pulled it off, however, because they just didn't have a good model to implement.

Inspiration 2.0 has a good model, and that's why it succeeds. Rather than trying to be all things to all thinkers, the Helfgotts have pinned down their customers—writers, entrepreneurs, creative directors, analysts, planners, educators, and consultants.

They did not make Inspiration 2.0 some kind of unwieldy general management tool, or imbue it with powerful features that its target audience will not need. In short, they didn't kitchen-sink this product by trying to make it fit the needs of a general presentation tool, a business graphics package, or a free-form charting tool.

The only thing that Inspiration 2.0 assumes is that you think visually. If you never leave the mental domain of numbers and text, Inspiration 2.0 won't do a thing for you. But if you think in terms of relationships and their organization, this program must be tried to be appreciated.

I've spent the last month doing just that. In fact, I've fallen into its organizational metaphors so easily that it's sometimes hard to go back to a more traditional outliner like More or Acta. I'm now using Inspiration 2.0 in my introductory programming class (in which I teach HyperCard 2.0 and HyperTalk) to help my students invent and categorize algorithms and get them into a form that will suggest code to them.

One way Inspiration 2.0 does that is by letting them come at both ends of a programming problem at the same time. My students learn about top-down design and bottom-up testing right from the start, but one thing they often miss is the interaction between the two. Because Inspiration 2.0 can present your information either as a free-form chart or as an outline, you can use the chart to plan your global program segments (top-down design) and the outliner to punch out the code necessary for each segment (bottom-up testing).

In a flowchart created with Inspiration 2.0 (shown at left), the general algorithm for factoring a polynomial has been outlined. To code individual segments of this algorithm, you switch to Inspiration's outline view, where you can bang out and reorganize all the code statements (see listing 1). This sort of view change doesn't really scream to be noticed, but it's exactly the kind of subtle capability that makes Inspiration 2.0 so useful.

Inspiration 2.0 isn't flashy, it isn't full of multimedia bells and whistles, it doesn't fit any traditional business computing category, and it's not expensive. Yet it's exactly the kind of software that made the Mac a ground-breaking machine and keeps me hoping for better things. It's one more reason why the Mac can easily play the power, performance, and usable facility game with any desktop computer.

Tip of the Month: Software Bridge

If you have to work between a Mac and the rest of the world—whether that world includes other Macs or PCs, whether on a network or running stand-alone—you need some good file filters or format converters. And if most of your work is with text on vastly different word processors, you need world-class translators. The only company I know that provides such high-class translators is Systems Compatibility. It makes the Software Bridge for the PC and the Mac.

The Software Bridge costs $129, packing together a set of Apple File Exchange translators that cover 24 different word processor formats in one of 380 possible translator pairings. You can choose from

Listing 1: *This listing was derived from the Inspiration flowchart shown in the figure.*

```
Factoring polynomials
  Is there a common factor of all terms?
     Count number of terms
        Binomial
            Difference of two squares
                a2 - b2 =
(a + b) (a - b)
            Sum of two cubes
                a3 + b3 =
(a + b) (a2 - ab + b2)
            Difference of two cubes
                a3 - b3 =
(a - b) (a2 + ab + b2)
            Trinomial
                Trial and error or AC method
            Four terms
                Factor by grouping
        Factor out common factor
```

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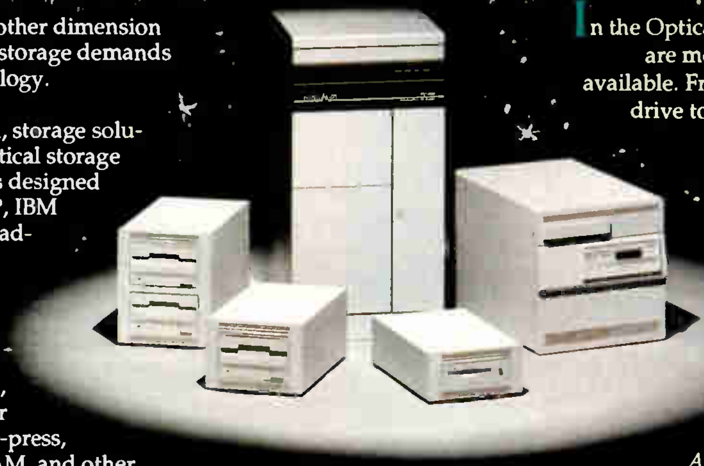

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Word 3.0x and 4.0, MacWrite II, Microsoft RTF, WordPerfect, ASCII, and DCA/RFT on the Mac, with dozens more PC formats supported. You can translate your files between Mac and PC formats or across platforms. The Software Bridge AFE translators all work like the ones from Apple, DataViz, or Claris that you might already be using on your Mac.

Unlike the Apple and DataViz translators, the Software Bridge doesn't leave anything untranslated when it's done with your file. You'll retain the exact same formatting (e.g., boldface, underlined text, indents, tabs, headers, footers, fonts, and styles) in your translated copy as you had in the original. Graphics incorporated into the original Mac documents are also translated exactly into other Mac formats.

The Software Bridge translators automatically identify the file format before making the change, and they never limit you to one-way conversions. I've used the Software Bridge to convert files back and forth many times without any translation artifacts.

I've never been very happy with the file translators that I've used from Apple and DataViz, since they always seem to leave untranslated residue. The Software Bridge for the Mac seems to fix these problems for just about any combination of file formats you might encounter. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. He is also a contributing editor for BYTE. He can be reached on BIX as "decrabb."

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

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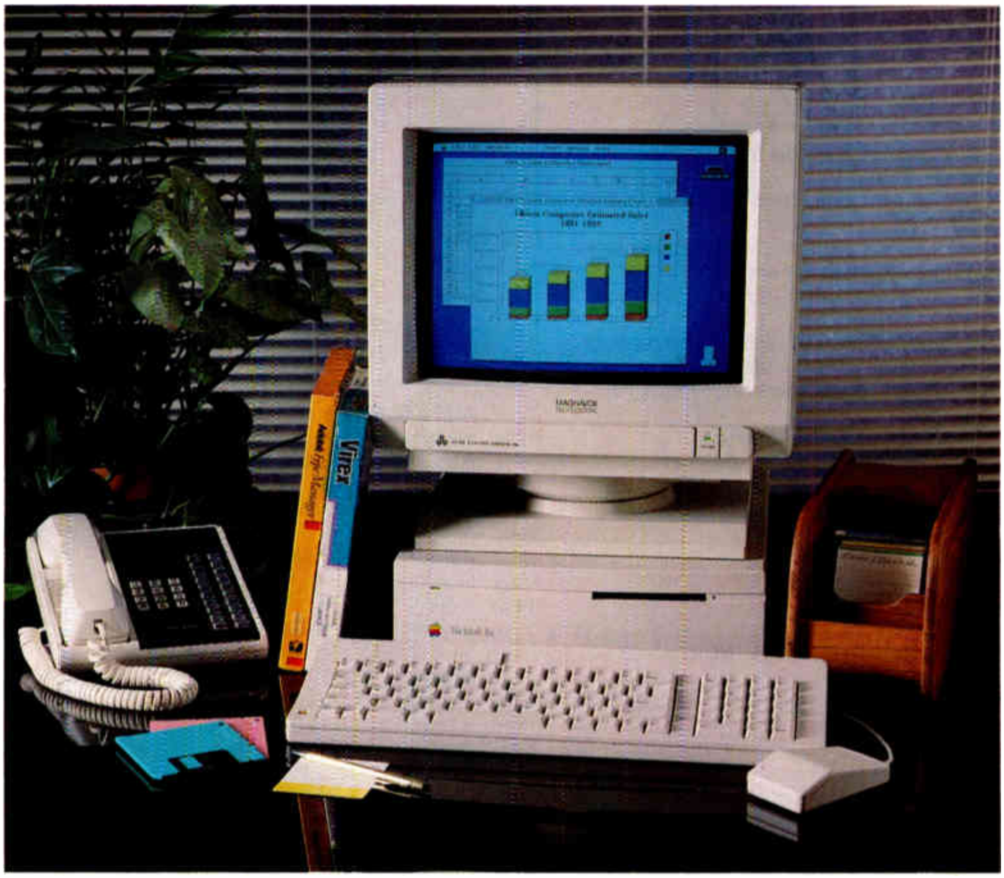

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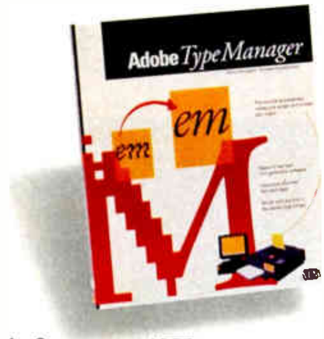

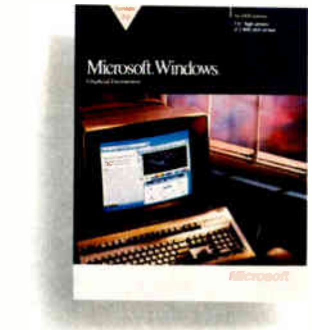

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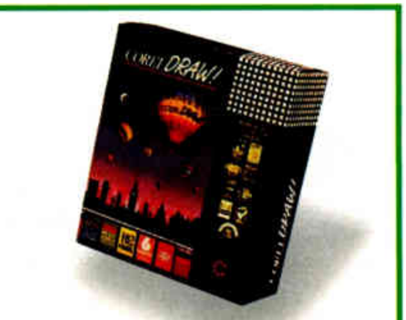

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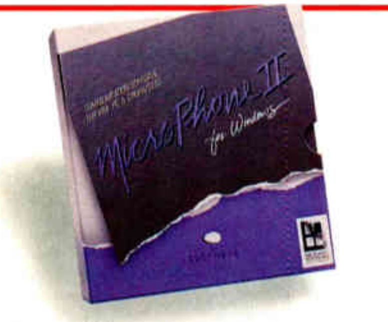

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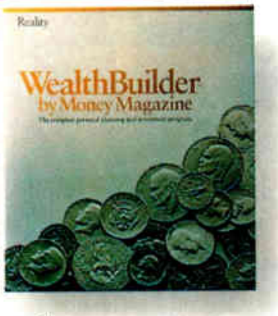

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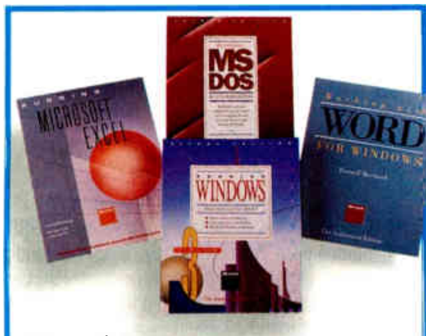

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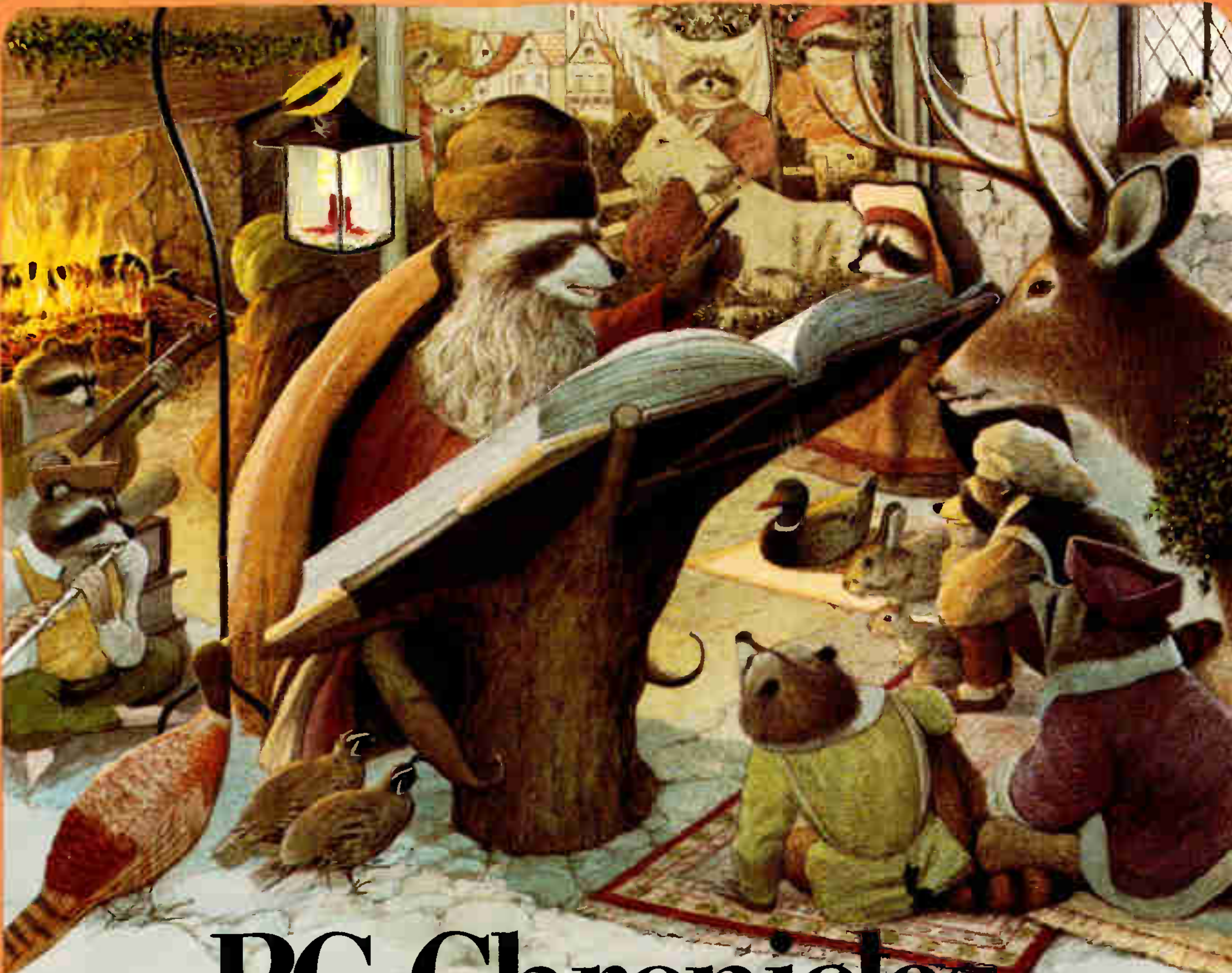

PC Chronicles.

Call me a lyre.
(Or, how we wrote the book on PC mail order.)

Truth tends to be stranger than fiction in the telltail town of Marlow, NH (pop. 564). That's why you'll often find the local color gathered 'round the ancient sage as he recounts in vivid detail how our forest glade was transformed into a PC paradise.

For, in days of yore, buying software and peripherals by mail was a perilous task, fraught with danger and uncertainty. Only those well versed in the black arts dared risk such unpredictable delivery and uncertain compatibility.

Then one day the enlightened Order of the Connection appeared majestically on the scene, bringing the classic virtues of toll-free tech support, prompt shipping, and way-under-retail prices to the brave new world of the IBM PC. Since that glorious day our humble home has served as a beacon of light to noble users in cottages, condos, and corporations throughout America.

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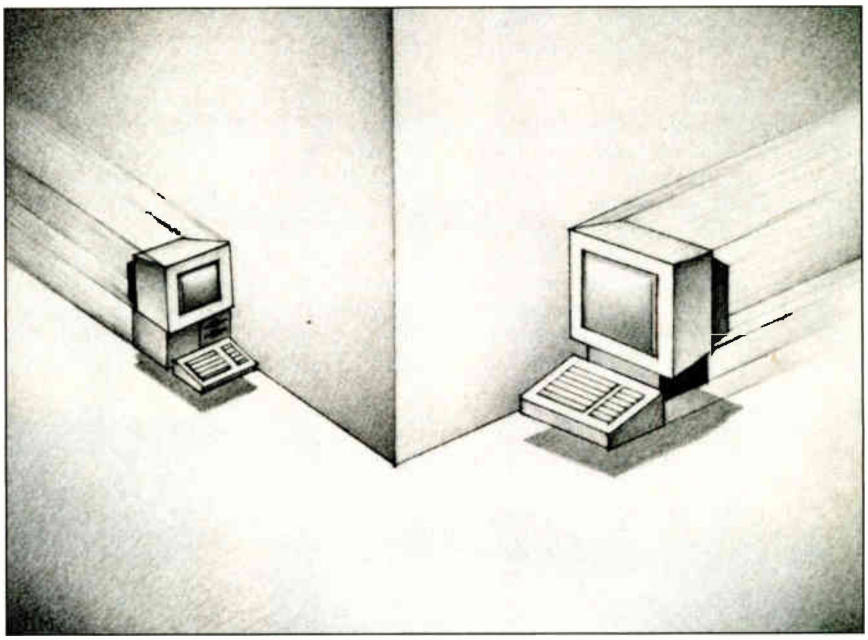
BACK TO THE WORKSTATIONS II

An overview of personal computers, workstations, and how they are colliding in the marketplace



What with all the new high-resolution Unix workstations and the move toward open systems, some people are already proclaiming the death of the personal computer. They have a point, but it's not that Unix will be taking over the world or that you'll be forced to give up DOS after New Year's Day. And PCs as you have come to know them (and in some cases love them) are not going away. They're just going to get better.

No Computer Is an Island

The point is that the world of computers has been changed forever by the introduction of networking. Whether you're using Novell or Network File System (NFS) in your office and BIX or a BBS at home, almost all machines these days can be hooked up to others. It's almost essential for obtaining and sharing the information resources that people are finding necessary.

People generally think of LANs when they're talking about networks. However, today's computers must be able to hook up to wide-area networks, such as Usenet or Internet, as well as general-purpose information networks such as BIX or CompuServe. These allow you not only to retrieve information stored in value-added databases, but also to interact with hundreds of thousands of other users. In many cases, you can ask a question in the morning in a conference (also called newsgroup or forum) dedicated to a particular subject and have answers from knowledgeable users later on that same day.

This capability is often underestimated by people who have never seen it in action. Imagine having the power to access industry experts (and get written responses) without paying any more than normal communications charges!

The future will bring even more intensity into this area, because—at least in North America—everyone is getting wired with fiber optics and coaxial cable (right now, it's just carrying cable TV). This will eventually allow companies to offer high-speed digital data communications to homes and offices, so that you'll be able to just plug your computer onto the network (without a modem) and connect to anybody, anywhere. Sounds futuristic, but it's coming.

The 1-Minute LANager

Despite this movement in the world of dial-up databases, the really exciting things for the office are happening in LANs. As I mentioned in this column a year ago, Sun's version of Unix introduced local-area networking in the form of NFS, which was quickly brought to Berkeley Unix. In a LAN, you hook up machines via Ethernet cable, using industry-standard protocols such as TCP/IP, so they can communicate with each other at a speed approaching that of a hard disk. NFS allows you to access a file from anywhere on a LAN, without having to know which machine the file is located on.

Networking wasn't limited to just one vendor, since other manufacturers (notably Digital Equipment Corp.) also based their products on Berkeley Unix. Even more important, NFS was ported to other operating systems, so PCs and mainframes could also hook up to the LAN. AT&T countered with its Remote File System, which didn't catch on well. But its new version of Unix, System V release 4, will have both NFS and RFS,

ILLUSTRATION: DAVID MONTIEL © 1990

which neatly wraps things up for everybody.

Of course, the power of LANs isn't just in the ability to share databases and print resources, although that's been about the limit of many PC LAN installations. Networks also give you the option of configuring powerful servers that can be accessed by workstations without expensive disks of their own. Thus, these diskless workstations can be made relatively powerful (say, with high-resolution graphics and good CPU performance) while still being economical enough to put one on everyone's desk. This gives people a lot of computing power so they can be more productive.

The Mac Factor

While there are many people who think of PCs as "computers that run DOS," many Macintosh users out there would disagree. In many ways, the Mac has a lot more going for it than PCs and their clones—at least when you're discussing networks, workstations, PCs, and Unix.

The Mac can be a real workstation, even by my rigorous definition, when it's running A/UX 2.0, Apple's latest version of Unix. By all accounts (I haven't had the chance to work with it yet), A/UX 2.0 is the environment that Apple was promising when it first released A/UX: an operating system that runs real Unix, the X Window System, and virtually any Macintosh application.

It does all this, remarkably, without giving up that user interface that has made the Macintosh so popular. Not only that, but an optional software emulator allows you to run DOS applications from A/UX as well. For a great many people, this can be the best of all worlds.

Workstations vs. PCs

So where does this all lead? The workstation market has already been fairly well defined. It's that huge list of products typified by offerings from Sun, HP/Apollo, DEC, IBM, Data General, Sony Microsystems, and a host of others. This group of formidable competitors has been chasing after basically the same customers (although the market for workstations has itself been expanding). Factor that in with the return of reasonable pricing for RAM chips and the plethora of powerful CPUs, and the net result is that workstation prices have dropped dramatically.

In the PC market, you have the same price drop for memory, and certainly more powerful CPUs are common. The i486 and 68040 are probably the leaders in the high-end PC market, while less expensive 386SX chips and 386 clones are rapidly bringing down prices for that level of power. High-resolution VGA boards are already fairly standard in the PC arena. Again, Macs have enjoyed this advantage from the beginning.

Microsoft Windows 3.0 is introducing large numbers of PC users to the elegance and ease of a graphical user interface (GUI), even if it isn't quite as elegant as some users might like. PCs of all types are networked these days, so everyone is familiar with the concepts of LANs, Ethernet, and file servers. And the Unix operating system is becoming so mainstream that everyone from PC users to MIS managers seems to have at least a nodding familiarity with it.

It's the Best of Times

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and plenty of PCs priced over that, cost is no longer the issue. You're about to see PCs turn into workstations, and workstations turn into PCs. The only things holding back the inevitable tide are old habits and operating-system religion. As I write this column, Sun is starting an advertising campaign aimed at PC owners, based on exactly the points I mentioned in my October column.

In the next few months, I expect to finally see some *real* diskless workstations based on PC technology: They'll be inexpensive (under $2500), single-box computers based around a 386 or i486 CPU, with built-in Ethernet, mouse, serial, and parallel ports. They will come with a certain amount of software in ROM, which will drive the ports and display, running X Window or perhaps a higher-level GUI.

The rest of the software will be delivered on disk for installation on the server. This will include DOS and Unix, as well as software that will connect them transparently. I hope and expect to see Apple introduce the same types of products, perhaps by making a lower-cost Macintosh with enough of A/UX built in that the cost and complexity doesn't go too high.

Next, you'll have to go the other way around. That would be something like this: a RISC-based workstation (possibly built around SPARC and SCSI architecture) that has the usual Unix workstation capabilities, plus a separate 386 processor with its own memory and AT expansion slots, and a VGA display that could be just another window on the screen. The 386 would run DOS on its own so it wouldn't slow down Unix (or vice versa), but you could share files between the two operating systems the way VP/ix does now. The price would be competitive with both high-end PCs and current workstations.

Computers from Mars

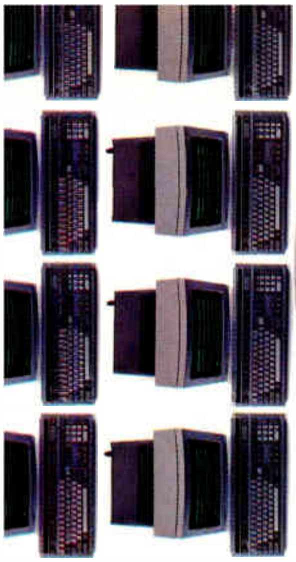
Think I've finally inhaled too much solder smoke? The workstation I just mentioned is already a reality. I will skip the most obvious jokes and simply tell you that the machine is called the Mariner 4i and it's from Mars Microsystems. You can buy the color version for less than $9000 including a disk drive. The DOS module is an extra $2000.

Yes, I know it sounds almost too good to be true. No, I haven't personally tried or seen one yet, although the folks at Mars swear that I'm going to be one of the first to receive an evaluation unit. You can communicate with Mars (I couldn't resist that one) at P.O. Box 1080, Mars, PA 16046, (412) 934-1040, fax (412) 934-1060, or E-mail at uunet!marsmcro!br.

This is one of those occasions where "if it didn't exist, I would have had to invent it," since the Mariner really does exactly fit the scenario as I outlined it. Things are starting to happen almost as fast as they can be predicted, which means we're in for an interesting decade for sure. ■

David Fiedler is executive producer of Unix Video Quarterly *and coauthor of the book* Unix System Administration. *He has helped start several Unix-related publications. You can reach him on BIX as "fiedler."*

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



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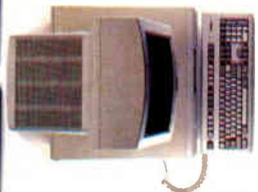

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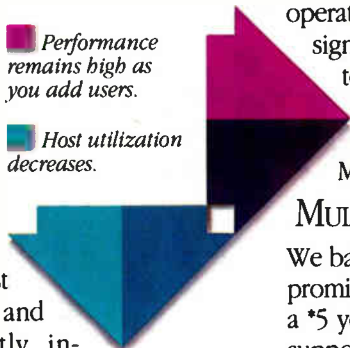

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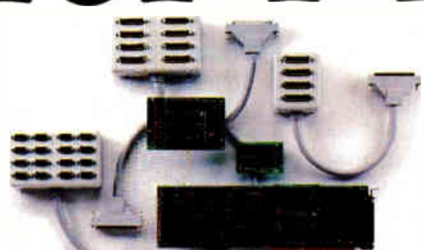

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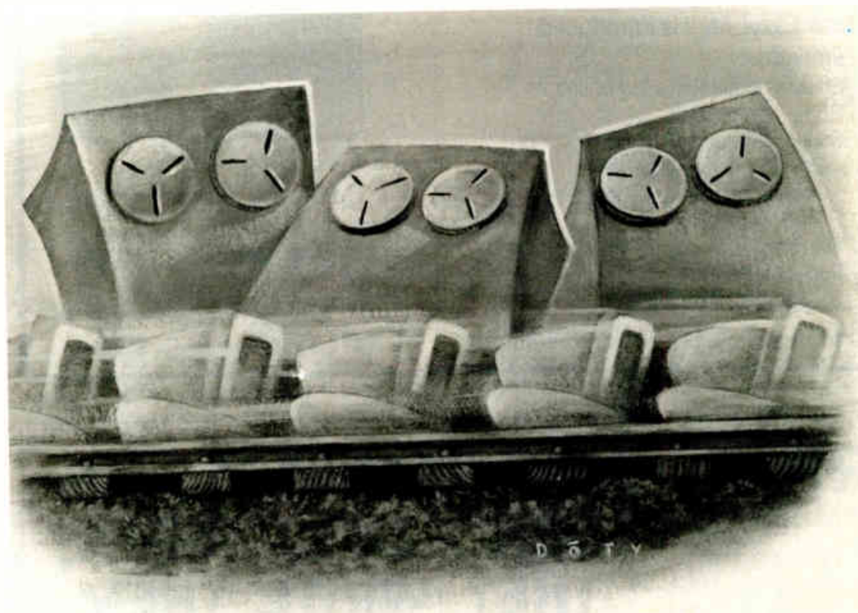
NETWORKS ■ Mark L. Van Name and Bill Catchings

KICKING AND SCREAMING INTO THE PRESENT

DEC's LANworks for OS/2 is the latest of the firm's grudging steps to embrace PC networking standards



Once upon a time, standards for using and linking computers came blasting from corporate MIS departments like missives from above. Those days are gone. Today's standards arise from the microcomputers that sit on our desktops. Minicomputer vendors have been slow to recognize this change, and they've paid for their slowness with decreased sales.

Networking was one area where many minicomputer vendors thought they were safe. After all, Digital Equipment Corp. and others have long had their own proprietary networking products. No need to make VAXes adhere to microcomputer LAN standards; just move the VAX standards to the microcomputers, and all will be well.

This strategy led to DEC's first PC networking products, PCSA (Personal Computer System Architecture) and DEPCA, DEC's proprietary Ethernet PC Adapter. PCSA was basically DECnet, the VAX networking standard, for the PC. To run PCSA on a PC, you needed a DEPCA or a 3Com Ethernet board. With those products, PC users could work with files stored on a VAX, print on VAX printers, and log onto the VAX.

DEC provided these file and print services by using DECnet in conjunction with two PC standards: the NetBIOS and SMB (Server Message Block) protocols. Those two protocols are at the base of PC LAN operating systems like 3Com's 3+Open. By following them, DEC was able to use a standard PC file-service redirector on top of its own DECnet protocol stack. Unfortunately, PCSA can't escape its DECnet origins: Client PCs must run a DECnet protocol stack. Few, if any, PC LAN users run DECnet as their main transport protocol, so their normal LAN software won't work with the VAX; when they run DECnet, they can't use their standard LAN servers.

PCSA's requirement of either a DEC or a 3Com Ethernet board is also a problem for PC users accustomed to being able to shop around for the cheapest or fastest Ethernet card available. PCSA could have avoided this by following the Microsoft/3Com Network Driver Interface Specification, but it didn't. NDIS defines an interface with which Ethernet board device drivers can communicate with higher-level protocol stacks. By supporting NDIS, PCSA would have been able to work with any NDIS-compatible board.

DEC also didn't look too closely at typical PC LAN operating-system pricing schemes when it wrote the PCSA price book. While most PC LAN operating-system vendors, such as Novell, charge per server license, DEC charges for PCSA per client license. DEC actually bundles the VAX server software license with every VAX. You then pay $215 for each PC that you want to attach. A fee of $215 per PC license is cheap as long as you don't hook up too many PCs, but the story changes when you connect a lot of systems. PC buyers who expect to spend $3000 to $5000 per server for software and then hook as many clients as possible to that server will not be happy when PCSA's cost for 50 PCs comes in at over $10,000.

The problem with PCSA was that DEC ignored a simple fact: Microcomputer users outnumber minicomputer users by a substantial margin, and that margin is growing. Therefore, the right way to link a minicomputer to a microcomputer is to bring the microcomputer networking

ILLUSTRATION: CURT DOTY © 1990

standard to the minicomputer, not the other way around.

Another Perspective

Novell figured this out well before DEC, and the result was NetWare VMS. NetWare VMS lets a VAX act as just another server on a NetWare LAN. With it, PCs running client NetWare software can read and write VAX files, print to VAX printers, and even manage VAX servers just as they would any standard NetWare PC server. NetWare VMS even adds a terminal service, which is not available on regular NetWare servers, for those who need to use their PCs as VAX terminals.

Unfortunately, NetWare VMS has a few serious problems. We noted one of the biggest ones in an earlier column: The product is based on older NetWare technology that is now out of date. Newer NetWare features, such as the ability to store Macintosh files on the server, are not present under NetWare VMS. The product's performance is also not great; on our simple file transfer tests, for example, NetWare VMS ran significantly slower than PCSA.

The most potentially devastating problem, however, is that NetWare VMS and normal PC NetWare use slightly different implementations of Ethernet. Consequently, if you have an existing NetWare LAN and you decide to add a VAX to it, you can't use the same client driver software on your PCs to talk to both the VAX and your standard NetWare servers. You can work around this problem by converting all your current NetWare client PCs to DEC's type of Ethernet, but that means running different software on all the client and server PCs. You can also use a NetWare bridge to handle the translation, but that, too, is a hassle.

Little Steps Forward

We expect Novell to fix these problems someday, but right now they're major ones for existing NetWare sites. Meanwhile, DEC is not standing still: It is slowly migrating its products toward PC standards.

One of the first such steps was purely cosmetic: DEC renamed PCSA to LANworks for DOS and replaced DEPCA with its EtherWorks boards. The next step was far more significant: DEC announced a VAX-Macintosh networking product, LANworks for Macintosh, that adheres closely to Apple's current networking standards (see our October NetWorks column). With LANworks for Macintosh, DEC took a giant step toward the microcomputer-dominated future by

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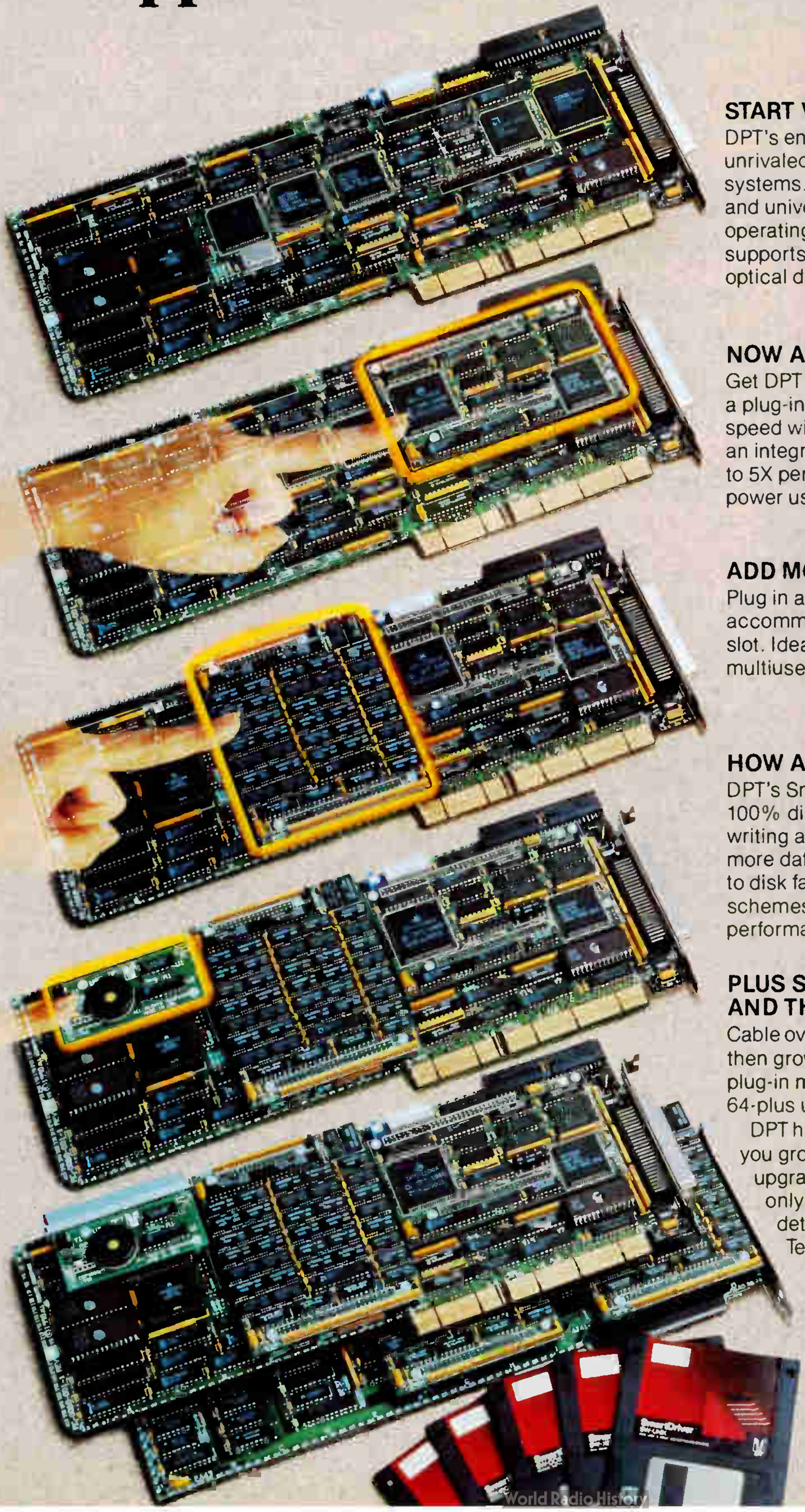

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embracing the existing Mac software networking standards.

As we write this column, DEC is about to announce its first new PC networking product in some time: version 1.1 of LANworks for OS/2. Unfortunately, this new release, while more in tune with PC standards than DEC's previous PC networking offerings, still has a long way to go.

As hard as it might be for a minicomputer company to believe, PC servers will often contain data that VAX users might want to access.

From the PC perspective, the major positive feature of LANworks for OS/2 is that it now conforms to the NDIS standard. It should, therefore, work with any NDIS-compatible Ethernet adapter. The biggest drawback is that LANworks for OS/2 still uses DECnet. At first glance, DECnet's presence seems to mean that, yet again, you must choose between talking to a VAX server and talking to a standard PC server.

Fortunately, that's not necessarily the case. First, it's at least theoretically possible for a client LANworks for OS/2 PC to run two different protocol stacks at the same time and thereby work with both VAX and PC servers at once. For example, by running both DECnet and NetBEUI (NetBIOS Extended User Interface), a client PC could work with both a VAX server and a standard OS/2 LAN Manager server. We don't know of any software that currently provides this ability for OS/2 clients, but it is possible.

LANworks for OS/2 does include a second way for client OS/2 PCs to talk to both VAX and OS/2 LAN Manager servers: Put DECnet on the OS/2 server. This feature is available because you can buy both client and server LANworks for OS/2 1.1 software. (The server package is based on Microsoft's LAN Manager 2.0.) In this approach, the PC server, not the clients, runs both DECnet and NetBEUI. Those clients that are content to ignore the VAX can continue to use their normal NetBEUI software, while those that want to see both the VAX and the PC server run DECnet. The server can handle both types of requests.

This solution is obviously not perfect, but it indicates DEC's grudging acceptance that client PCs might want to talk with both VAXes and other servers. To embrace the PC standards entirely would mean abandoning DECnet on PCs in favor of NetBEUI and/or Novell's SPX/IPX, a move that we don't think DEC is anywhere near ready to make.

Even without that step, however, there's room for improvement in LANworks for OS/2. For one thing, the VAX should be able to be both a client and a server. As hard as it might be for a minicomputer company to believe, PC servers will often contain data that VAX users might want to access.

LANworks for OS/2 also follows the same client-based pricing scheme as DEC's DOS and Mac products. The client software runs $215 per system, while the OS/2 server software is $325 per system. If you want to run a single OS/2 PC as both client and server, you have to buy both licenses.

Still Not Far Enough

LANworks for OS/2 is a small step forward, but it's not enough. DEC seems aware of this, because the firm is working on alternatives to the DECnet protocol stack. We have heard about only one for sure—TCP/IP, which is due early in 1991—but we hope that NetBEUI support is in the works as well. DEC is also developing a LANworks product for its VAX Unix operating system, Ultrix, and the firm plans to bring LANworks for DOS in sync with its OS/2 offering by adding NDIS support to the DOS product.

Clearly, the people at DEC are slowly coming to recognize the importance of adhering to microcomputer networking standards. We hope that they, as well as the other large-system vendors, continue to do so, and do so fast enough to survive the ongoing blitz of the little systems. ■

Mark L. Van Name and Bill Catchings are BYTE contributing editors. Both are also independent computer consultants and freelance writers based in Raleigh, North Carolina. You can reach them on BIX as "mvanname" and "wbc3," respectively.

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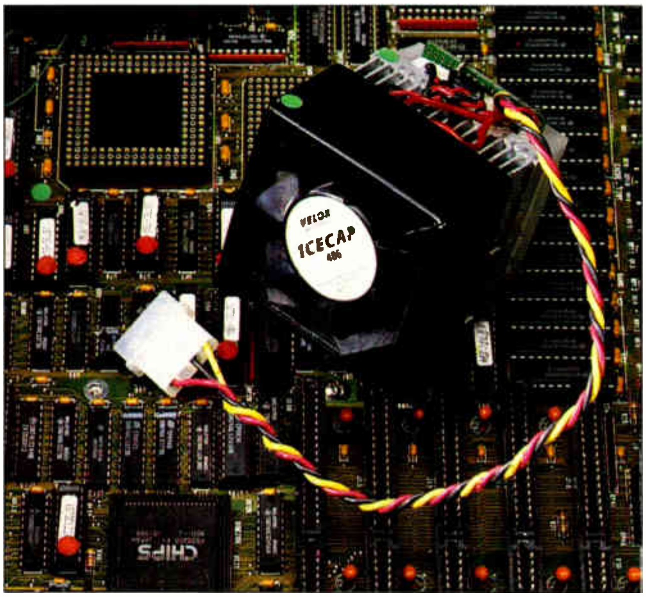


The Experimental Step 486/50 Redefines Cool

Everex has joined the racing circuit with its **Step 486/50**. Although the company won't actually bring this product to market, it is a technological showpiece with a supercooled engine that pushes Intel's i486 CPU to a scorching 50 MHz.

At the heart of the new machine is Velox Computer Technology's ICECap, which is a sophisticated temperature and voltage control system that lets Everex boost CPU clock speed to 50 MHz without overheating the CPU. The ICECap IC module, which encases the i486, plugs directly into the CPU socket and maintains the i486 at a chilly 0°C.

The Step 486/50 isn't exactly a true 50-MHz system. The ICECap sits on a modified Step 486/25 motherboard that clocks the CPU at 50 MHz and the rest of the motherboard at 25 MHz. Everex also had to add extra wait states between the external 128K-byte processor cache and the CPU. Even with these handicaps, however, the Step 486/50 gave an impressive performance. The Step 486/50 held a 28 percent edge over the Step 486/33 on the CPU tests, and it posted roughly 50 percent higher results on the floating-point tests. The FPU tests benefited because more of the tests run within the i486's on-board cache. Had Everex tuned its external pro-cessor cache for 50 MHz, both numbers would have been higher.

Remove the Step system's cover and you can't miss the ICECap. The module rises from the CPU socket like a high-rise office building, towering 3 inches above the motherboard. The system is made up of three stacked components—a thermoelectric cooler, a heat sink, and a fan—and on-board control circuitry that keeps voltage up and temperature down.

For Velox, merely preventing the i486 from overheating isn't enough. The company claims that cooling the CPU to the bottom of its operating temperature range increases reliability and lets the chip run 35 percent faster. Since it doesn't have to worry about overheating the CPU, Velox also maximizes power input at the i486's peak of 5.2 volts. This reduces propagation delay and, Velox claims, improves performance by another 15 percent.

Heat sinks and fans are common, but Velox is the first microcomputer company to use a Peltier effect device—a thermoelectric cooling system based on the principle that passing a current between two physically connected, dissimilar materials produces cooling on one side and heat on the other.

The Velox device has four components. At the top and bottom of the Peltier device, an aluminum oxide "cold plate" and "hot plate" transfer heat from the i486 to the heat sink.

Sandwiched between the plates are two semiconductors that do the work. These semiconductors have opposite electrical properties, and they are arranged in such a way that, when you apply voltage to the system, electrons in both materials flow from the cold plate to the hot plate. This carries heat away from the CPU and into the heat sink. The fan then blows air down into the cooling fins, dissipating the heat inside the system unit case. Velox claims that the ICECap raises the temperature inside an AT case by 1 to 3 degrees.

To keep the CPU temperature constant, a thermal sensor generates a control signal when the chip temperature rises above freezing. The system also includes a dual clock speed generator that ramps up clock cycles as the CPU temperature drops and lets the CPU operate at normal speeds if the ICECap fails.

After running for several days, the ICECap remained surprisingly cool. The motherboard, hacked to accommodate a 50-MHz CPU, wasn't pretty. And the system had trouble running several applications, including PageMaker and Lotus 1-2-3.

In the future, you'll probably see the ICECap in systems from other vendors. In a market full of clone vendors desperate to differentiate their products, the ICECap is sure to attract attention. And for the extra $600 it's likely to add to the price of a 486 system, users may bite.

—Rob Mitchell

THE FACTS

Step 486/50

Everex Systems, Inc.
48431 Milmont Dr.
Fremont, CA 94538
(800) 356-4283
Inquiry 1160.

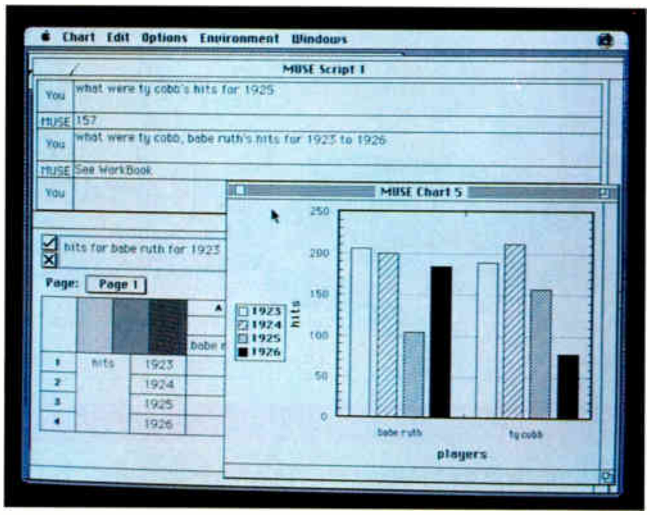
Velox Computer Technology, Inc.
2334 Walsh Ave.
Santa Clara, CA 95051
(408) 727-6100
Inquiry 1161.

Finally There's Muse for the Mac

Muse calls itself a natural-language interface program, but a more accurate description might be "query by English-like commands." You load your data by creating *databooks*, which represent a collection of up to 64,000 homogeneous or heterogeneous data structures, each of which can be tables of information that range into megabytes (with available hard disk storage). You can reference 15 of these databooks at once. One way of thinking of databooks in conventional terms would be as a relational database. Databooks are how Muse stores things.

You import or create data in *workbooks*, which look like spreadsheets with labeled axes. You can manually place information or import it in WKS, WK1, WK3, DIF, SYLK, or DBF formats. It's also possible to import it in comma, space, or tab-delimited formats. You can import fixed-field ASCII. Workbooks may have definitions and relations that apply only to the data within that workbook attached to them.

Muse can create charts from numeric data. It's also possible to create two-dimensional or 3-D (or animated series of both) charts. Other chart possibilities are bar, column, *x,y*, scatter, line, 3-D surface, percentage, pie, 3-D spline, 3-D ribbon, log-log, log-linear, stacked bar, stacked column, high-low-close, contour map, dual-*y*-axis, and combinations. Automatic axis labeling is performed with auto-sizing of the legends. While graphs are displayed on the Mac screen in color, printing them on a LaserWriter substitutes patterns for colors. The resulting charts were as good as anything I have seen from WingZ, DeltaGraph, or Excel.



THE FACTS

Muse
$695

Requirements:
A Mac with System 6.0.3 or higher and 2 MB of RAM. A hard disk drive is recommended.

Occam Research Corp.
85 Main St.
Watertown, MA 02172
(617) 923-3545
Inquiry 1162.

Scripts are the records of questions and answers posed to Muse. It's basically a collection of boxes (with one box for your questions and another box for Muse's answers) stacked on top of each other. You can save or modify them just like plain text.

I looked at an early beta copy of Muse. It would run only on a Mac II with an FPU and 4 MB of RAM, although Occam said that the release version should be able to run on a Mac SE or Plus with 2 MB as a minimum (if slow) configuration. While the beta version I saw is certain to change, the basic functionality of the program came through rather well. The illustration shows how a simple single-variable query produced a single answer in the script window. When multiple-variable queries are made, a workbook window containing the results is produced. I tried different forms of queries, and all produced well-formatted and useful answers.

However, I thought the current system of error checking left something to be desired. If you pose a query with less than the needed number of variables, for instance, Muse simply shoots back "underdefined." It would be far more useful to have some idea of what it was that Muse actually needed for the query to be defined, perhaps with a scrolling list of available choices. I expect to see this resolved in further beta testing.

Muse is the first attempt on the Mac to make data useful by being easily obtainable. Occam seems to be on the right track thus far, and I look forward to seeing a final copy of the product.

—***Laurence H. Loeb***

DAT's a Classy Backup System

The ProLine DATaVault, a toaster-shaped SCSI digital audiotape-recording system (DAT) drive, packs 1.3 gigabytes of data onto a tiny 4-mm cartridge. Pop in Tecmar's new Proserve software, an innovative client-server program suite, and you've got the **ProLine Backup System,** a comprehensive—but pricey—tape backup solution for a NetWare LAN.

Installing the DATaVault on a NetWare 286 server was a mixture of ups and downs. Could I piggyback the drive onto the server's existing Future Domain SCSI host bus adapter? No, I had to use the Tecmar-supplied Adaptec controller—somewhat redundantly, in this case. (It's a standard Adaptec device, though, so if you're already using one of those, you won't have to add a second.) That, in turn, meant I'd have to add a new driver to NetWare. Like its NetWare 386 cousin, the driver links dynamically with NetWare.

The driver's installation program scans the NetWare executable file; reports the IRQ, I/O, and RAM settings that are consumed by Net-

Ware-controlled boards; and recommends compatible settings for the Tecmar/Adaptec controller. So I figured I wouldn't have to run NETGEN and reinstall NetWare.

But, alas, it was not to be. Industry Standard Architecture board conflict resolution remains an uncertain science. The server's TCP/IP gateway, for reasons apparent neither to Tecmar's installation program nor to me, fought with Tecmar's adapter. I tossed out the TCP/IP board (it wasn't a permanent fixture anyway) and ran NETGEN to tell NetWare I had done that.

In spite of the conflict, I applaud Tecmar's clever scheme. In many cases, it should save busy LAN administrators a lot of time and trouble, and it offers a ray of hope to the many NetWare 286 users not in a position to upgrade to NetWare 386.

Once loaded, TAPEDRV .VAP provides an assortment of NetWare console commands. With these commands, you can reset the DATaVault and erase, format, test, or list the contents of a 4-mm cartridge. A second value-added process, PROSERVE.VAP, supplies the server (or backend) component of the backup application. Multitasking with NetWare, PROSERVE.VAP accepts connections from client workstations, queues backup requests, and performs backups.

Client software also comes in two parts. With PROSERVE.EXE, you administer users and queues, schedule attended or unattended jobs, and monitor tape-drive status, tape contents, and a history of backup transactions. A Novell/C-Worthy point-and-shoot interface neatly manages a formidable array of options. You can specify the target file set to be all files, new files, or dormant files.

You can save NetWare bindery, trustee, and file attributes; in the case of a NetWare 2.15 server with Macintosh clients, you can save Mac-related directory information and resource forks as well. There is, however, no client software for the Mac; you'll have to schedule the backup of Mac directories on the server from a PC, and you can't back up a Mac client directly to tape.

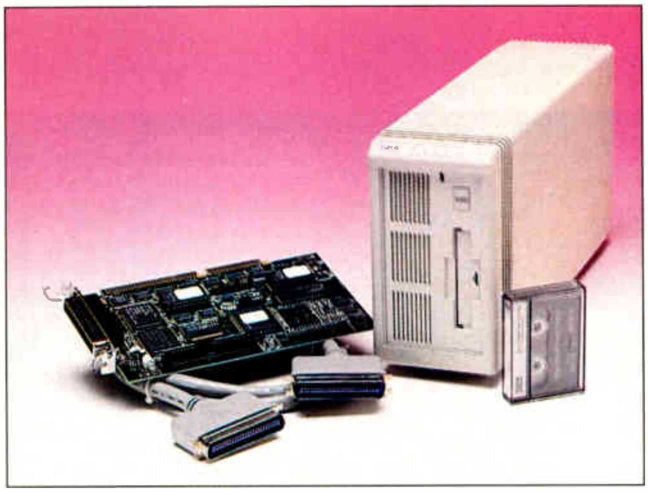
You can move files from a PC straight to tape, thanks to the client-server architecture of the Proserve software. PSCLIENT.EXE, a small (15K bytes) DOS TSR program, communicates with PROSERVE.VAP.

Once it's loaded, a backup job scheduled by means of PROSERVE.EXE can draw files directly from the client PC. Because direct client-to-tape backup obviates the need for a large intermediate transfer area on the file server, it's a feature I prize highly.

Tecmar's deluxe Proserve software is clearly a class act. It does more than I have room to describe, and does it well. In fact, Proserve works with several species of Tecmar tape drive: DC600 (250 and 525 megabytes), DAT (1.3 gigabytes), and 8-mm analog helical-scan (2.2 gigabytes). Given this range of choices, and considering that the current highest-capacity Tecmar tape drive is 8-mm, not 4-mm DAT, why choose the DATaVault? Frankly, I'm not sure. Proponents point out that DAT—compared to 8-mm technology—offers superior error correction, requires fewer moving parts, and can find random files much more quickly.

While I've no reason to doubt those claims, I am obliged to report that the first 4-mm DAT tape I used in the DATaVault developed problems—*after* I formatted it, tested it, and performed two apparently successful backups. Tecmar agrees that it ought to provide a rigorous verification utility; the existing format and test utilities don't touch most of the tape. Although I've since had no further problems with other 4-mm tapes, I'm left wondering whether there's a percentage in being the first one on the block to use one of those newfangled DAT systems.

—Jon Udell



THE FACTS

ProLine Backup System
(includes drive, adapter, cable, server and client software, and documentation)
for NetWare 286, $5995;
for NetWare 386, $6295

Requirements:
File server: AT, PS/2, or compatible running NetWare 286 (2.1x) or NetWare 386 (3.1).
Client: AT, PS/2, or compatible running DOS 3.0 or higher with 640K bytes of RAM.

Tecmar, Inc.
6225 Cochran Rd.
Solon, Ohio 44139
(216) 349-4030
Inquiry 1163.

A Unix Graphics Workstation for the Rest of the World

Amiga enthusiasts keep telling me that the Amiga is a serious computer, that it is for the business and professional user. But old beliefs are hard to shake—at least they were until I saw the **Amiga 3000UX**. This workstation is the most complete implementation of the new AT&T Unix System V release 4.

The base Amiga 3000UX machine includes a 25-MHz MC68030, a math coprocessor, 8 megabytes of RAM, a 100-MB SCSI drive (optional 200 MB), and either a high-resolution monochrome display or the standard Amiga color display. All the hardware parts are already integrated with the system, including a port for additional SCSI devices, a port for an additional floppy disk drive, a port for a parallel printer, and a serial connection for an external terminal, modem, or printer. Although Ethernet (thick- or thin-wire) is an option, the network software is already in place.

Most important, the system includes Unix System V release 4 and the X Window System, including Level 1

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For Europe, circle 249 on Reader Service Card

For Americas & Pacific, circle 250 on Reader Service Card implementation of Open Look. The Unix manual pages are on-line. Bundled with the operating system are two C compilers (the AT&T standard compiler and the GNU optimizing compiler), the popular screen-oriented mail manager `elm`, and several Amiga-specific utilities.

The Amiga 3000UX with release 4 is not a clone, nor a work-alike, nor a toy. It is a no-nonsense workstation that is impressive and compact. I am not saying that if you put the Amiga beside a full-size SPARCstation or a Silicon Graphics workstation you won't be able to see obvious differences that favor these automobile-priced machines. But when you put it beside a NeXT or a Macintosh or a 386 workstation, the differences are in favor of the Amiga. Consider the work (and money) that is required to build a workstation out of a 386-based Industry Standard Architecture or Extended Industry Standard Architecture bus machine; you have to get one part here and another part there. All the parts have to be configured to work together without conflicts in interrupts and memory addresses. The Amiga 3000UX is a plug-and-play operation.

The newest release of Unix System V is significant because it incorporates the BSD features that make it so well suited for workstation computing, including mechanisms for mounting remote file systems and distributed processing. Since AT&T sells only source code rights to Unix (unless you are buying an AT&T computer), users have had to wait until the hardware vendors finished their work on porting the new source codes to their machines. Although many Unix licensees are well along in completing this task, it appears that Commodore will be the first to complete it.

The Amiga 3000UX greatly outperforms the equivalent NeXT and Mac with A/UX. In raw Unix performance, it is roughly equivalent to a 20-MHz 386 system, but it is much more suited to handling the graphics requirements of a graphical user interface like Open Look. At roughly $4000, it is an obvious choice as a low-end workstation.

—Ben Smith

THE FACTS

Amiga 3000UX
Approximately $4000

Commodore Business Machines, Inc.
Computer Systems Division
Brandywine Industrial Park
1200 Wilson Dr.
West Chester, PA 19380
(215) 431-9100
Inquiry 1164.

Caching In on the Hardcard

The Hardcard is a popular way to augment storage capacity because you just open your computer and drop a full-length card into a free bus slot, and you've got another drive.

The new **Hardcard IIXL**, available in 52- and 105-megabyte capacities, includes a built-in 64K-byte read-ahead disk cache that gives the drive a rated average access time of only 9 milliseconds.

I installed the Hardcard IIXL in less than 10 minutes. Once the drive was installed, I loaded it with software and noticed how quiet and fast it was. File copies and directory listings zoomed along at twice the speed of my old, fragmented, 65-ms Seagate, and my applications loaded more quickly. However, a two-level database indexing and a test suite of assorted Windows accessories were only slightly faster on the Hardcard.

On the low-level BYTE benchmarks, running on a slow 286 machine, the drive turned in a rating of 1.97, or about twice as fast as a standard 40-MB hard disk drive in an IBM AT. Running in a Compaq Deskpro 386/33, its rating was 2.90. These numbers compare with a score of 2.20 for the hard disk drive supplied with the Compaq Deskpro 386/25e.

Data throughput for the Hardcard ranged from 465K bytes per second on the 286 up to 930K bytes per second on the Deskpro 386/33, versus a speed of 700K bytes per second for the Compaq 386/25e. Measured seek times averaged between 16 and 19 ms; the Hardcard performed near its hardware access speed of 17 ms rather than the cache-assisted rate of 9 ms, because the BYTE benchmark test defeated the read-ahead cache with random sector seeks. In a real application that uses more typical contiguous sector seeks, the performance would certainly be better.

My only disappointment with the Hardcard IIXL was that its built-in cache and the SmartDrive caching software supplied with Microsoft Windows 3.0 didn't seem to complement each other.

Plus has typically charged more for the Hardcard than the price of equivalently sized hard disk drives. The 52- and 105-MB Hardcard IIXLs break that tradition with suggested list prices of $579 and $999, respectively. Those prices are expected to fall to $399 and $699 on the street, which will make the Hardcard IIXL not only convenient but also cost-competitive. If you are running out of disk space and you have slots to spare, I recommend you take the Hardcard IIXL for a spin. ■

—Andrew Reinhardt

THE FACTS

Hardcard IIXL 50
$579; Hardcard IIXL 105, $999

Requirements:
A 16-bit ISA-bus slot in an IBM PC–compatible 286 or a non-PS/2 386.

Plus Development Corp.
1778 McCarthy Blvd.
Milpitas, CA 95035
(408) 434-6900
Inquiry 1165.

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Sun's newest progeny couples performance with innovative software

Son of SPARCstation

Tom Yager
and Ben Smith

The low-end workstation market is in full swing. You now have more choices for under $15,000 than ever before (see the text boxes "CompuAdd Delivers a Low-Cost SPARCstation" and "Solbourne S4000 Outguns SPARCstation 1+"). So why is Sun Microsystems introducing its new SPARCstation 2 series, starting at roughly $20,000? As with everything, when you cut costs, you also cut corners. Graphics, performance, expandability, ease of use: One or more of these important aspects typically disappears from low-end workstations.

Sun's SPARCstation 2 series shows the company's commitment to the power user. Even at the bottom of the new line, Sun doesn't scrimp on features. Sixteen megabytes of memory is standard (a trend that we hope catches on—you can't do diddly in 8 MB anymore), as are a 40-MHz SPARC CPU, a 200-MB SCSI hard disk drive, three SBus connectors, two serial ports, audio I/O, thick-wire Ethernet, and a SCSI port. The SPARCstation 2GX system we received is the low-end model (see photo 1); nonetheless, it has accelerated color graphics.

Photo 1: The Sun SPARCstation 2GX.
This tiny case holds up to 96 MB of memory, two SCSI hard disk drives, and three SBus expansion cards. Access to the 3½-inch floppy disk drive is on the right side. The window system is Sun's OpenWindows, a mix of the X Window System and Sun's NeWS PostScript-compatible extensions.

A Look Inside

The inside of the SPARCstation 2GX is a study in effective computer design (see photo 2). The motherboard is smaller even than most "baby" AT clone types, with most of the space taken up by single in-line memory module sockets. Four 4-MB modules make up the 2GX's 16 MB of memory. The motherboard has room for 16 such modules for a total of 64 MB; an optional daughterboard can hold another 32 MB for a system total of 96 MB. The motherboard is small by necessity. It has to fit in a pizza box-size case along with up to two 3½-inch SCSI hard disk drives, one 3½-inch floppy disk drive, and a power supply.

The hard disk drives are mounted on plastic brackets that allow easy snap-out removal. The entire case comes apart by removing two screws. There wasn't even enough room in the case for a 50-pin SCSI cable between the two hard disk drives; Sun mounted dual connectors on the motherboard, so both hard disk drives have their own short cables going right to the board.

The 2GX's display controller is mounted on a daughtercard, overlapping another of the expansion slots. Sun claims there are three SBus "slots," which are really just sockets on the motherboard, but our 2GX had only one such socket free—the other two were occupied by the display controller. Outside the case are connectors for two serial devices, SCSI devices, monitor, keyboard/mouse, and audio. The audio connector is a DIN socket, which is where you plug in the microphone/speaker.

In Living Color

The 2GX's display controller accelerates wire-frame operations to what Sun calls "the fastest in the industry" (for the price, we tend to agree), but it also apparently extends its might to the windowing system. It displays 256 colors (from a palette of 16.7 million) at a resolution of 1152 by 900 pixels. Our 2GX came equipped with a 19-inch (76-Hz refresh rate) Sony Trinitron monitor. Images are sharp, corner to corner, an important consideration if you are selling workstations into the contentious advanced graphics market. The SPARCstation 2 line reaches into that very market, with a set of options geared to match the user's level of need. The 2GS offers accelerated three-dimensional solids operations, with a 24-bit main display buffer depth and a 16-bit z-buffer. (Sun claims the 2GS will calculate and display a minimum of 150K-byte 3-D vectors, and 20K-byte solid Gouraud-shaded polygons per second.)

The 2GT, Sun's top of the SPARCstation 2 line, adds hardware antialiasing, a 24-bit z-buffer, double-buffered 24-bit display (for animation), alpha transparency, 8-bit overlay, and a resolution of 1280 by 1024 pixels. Sun claims the 2GT will calculate and display 500K-byte 3-D vectors (or 100K-byte antialiased 3-D vectors) and 100 z-buffered Gouraud-shaded polygons per second, a fivefold increase over the 2GS. (For an explanation of graphics buffering, see "3-D Graphics, from Alpha to Z-Buffer," July BYTE.)

The 2GS and 2GT are targeted at the mid- to high-end graphics market dominated by the likes of Silicon Graphics and Hewlett-Packard. These two companies pack more hardware features into their workstations (e.g., hardware texture mapping and specularity), but Sun's performance numbers are impressive. For the mainstream CAD, CAM, and other design applications users, the 2GS and the 2GT speed up essential operations enough to make complex modeling a snap. In the area of "virtual reality," however, more capable workstations still make a better choice.

From an ordinary user's standpoint, the 2GX's graphics price/performance ratio is excellent. You rarely spend time waiting for windows to draw—they just appear. Moving, resizing, and other window manipulations are similarly speedy. The graphics performance makes the 2GX's operating environment a pleasure, but there's a lot more to Sun systems than just fast hardware.

Gunning for the Mac

Steve Jobs, among other luminaries, has proclaimed the X Window System everything from poorly done to outright "brain damaged." And true enough, on its own, it lacks functions needed to support modern applications.

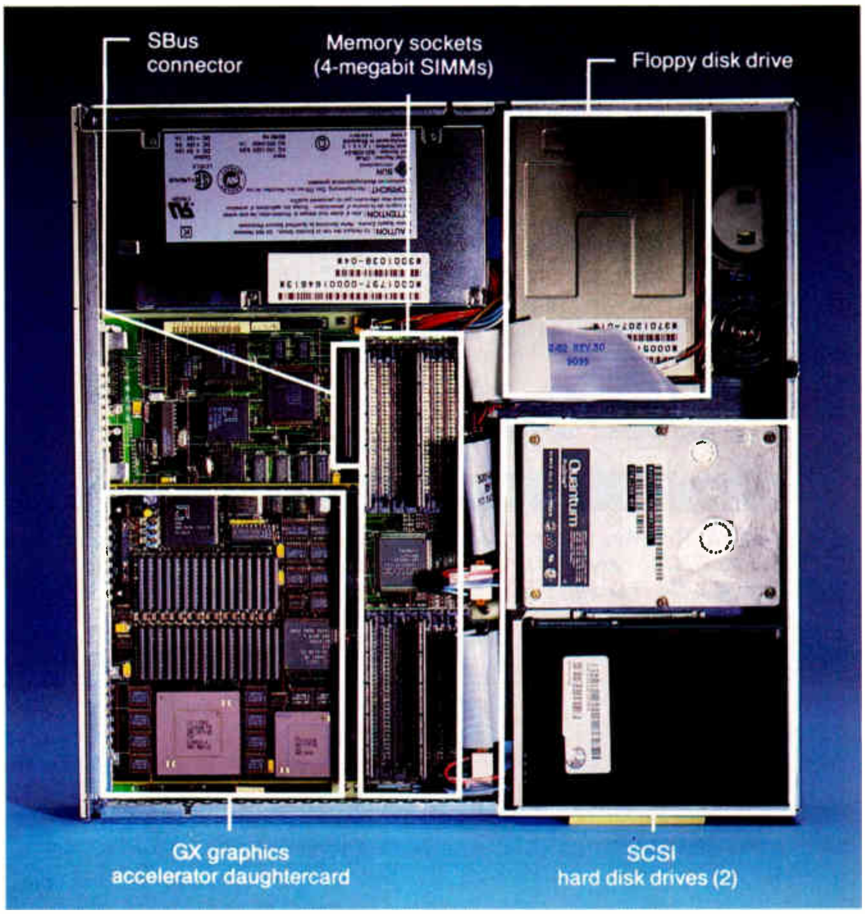
But OpenWindows 2.0 is impressive. It is an excellent demonstration of the strengths of Open Look. It is complete, well integrated, and easy to use. Months ago, we had seen beta versions of OpenWindows 2.0 on much smaller machines and were impressed with the speed with which it worked then. It sings on the SPARCstation 2 series.

OpenWindows has, as its root, Sun's X11/NeWS (Network-Extensible Windowing System). NeWS adds PostScript compatibility (Sun's own, not Adobe's) to X Window. X11/NeWS uses a single server to handle both the PostScript and the X11 requests. The compatibility is complete. In our tests, every X application we ran across the network worked perfectly, with the exception of one that tried to take control of the color map. The Open Look Window Manager (olwm) did give up the color OpenWindows' designers, because the Mac is an obvious influence. There is a marvelous File Manager, and a bundle of other applications called the DeskSet. Out of the box, OpenWindows might not be as easy to use for new users as a Macintosh, but with a bit of effort, system administrators can build a collection of menus and icons that can call out every function of the system without resorting to the shell.

The rest of the operating system is the familiar SunOS, a BSD Unix derivative with some System V libraries and utilities thrown in. SunOS is both a software developer's and a user's playground, not only because it has so much third-party support, but also because Sun provides libraries for all its added layers. As a result, there are tens of thousands of commercial applications for SunOS, a point that has not been missed by Solbourne and CompuAdd.

X Window, NeWS, and Open Look combine to make a powerful graphics application environment, and Sun even includes X Graphics Library (XGL), an X11-based immediate-mode 2-D and 3-D graphics library. This makes the

Photo 2: The inside of the 2GX.
Everything is designed to conserve space, without sacrificing expandability.



CompuAdd Delivers a Low-Cost SPARCstation

Jon Udell

The SPARCstation 1 lives in the guise of the CompuAdd SS1. CompuAdd uses a metal case, as it hopes to get an FCC class B rating. The SS1 can also accept 5¼-inch storage devices and sports a 100-watt power supply.

A SPARCstation from CompuAdd, the mail-order PC-compatible folks? Yes. CompuAdd's SS1 looks, feels, and, for all intents and purposes, is the original 12.5-million-instruction-per-second SPARCstation 1 that Sun Microsystems discontinued this summer. Differentiation was not the goal here. The SS1 has the same SPARCstation "pizza-box" case. Pop the top, and you'll find the same compact 8½- by 11-inch motherboard. With the same three SBus slots. And the same SPARC chip set: LSI Logic's 20-MHz L64801 integer unit, along with a supporting cast of LSI Logic application-specific ICs handling floating-point, caching, memory management, and DMA chores. Clearly, we've entered the era of the commodity workstation.

Don't feel sheepish if you can't tell the SS1 and the SPARCstation 1 apart. Neither can SunOS 4.1. The SS1 comes bundled with the current release of Sun's hybrid BSD/System V Unix, which boots and runs flawlessly. Any lingering doubts about the SS1's compatibility dispel when you run `sundiag`, Sun's low-level diagnostic utility. It probes every hardware nook and cranny: physical and virtual memory, disks, CPU and FPU, and Ethernet. No smoke and mirrors here; the SS1 aces all the tests.

Our prototype system came with 8 megabytes of memory, the standard connectors (SCSI, thick Ethernet, two serial, keyboard, and audio I/O), a 19-inch Moniterm monitor (monochrome, 1152 by 900 pixels), a 3½-inch floppy disk drive, a pair of internal SCSI hard disk drives (105-MB Quantums), and an external 200-MB SCSI drive. Subtract the disks, and you've got CompuAdd's entry-level system, priced at $5995. A diskless unit with a 16-inch color monitor and an 8-bit frame buffer will run $7495, or, with 200-MB of disk storage, $8695.

How does the CompuAdd stack up against the low end of Sun's SPARC product line? If you're comparing entry-level systems, the SS1 looks like a more expensive (but expandable) version of Sun's $4995 SLC (see table A). But what about real-world systems with adequate storage and color capabilities? An SS1 with a 200-MB drive and 8-bit color will cost $1300 less than Sun's comparably equipped IPC, and a whopping $5800 less than a comparably equipped SPARCstation 1+ (see table B). Of course, both the IPC and the 1+ are 25-MHz machines rated at 15.8 MIPS, so the SS1 does give away some speed. Note also that the CompuAdd prices don't include Sun's OpenWindows, which Sun now bundles with all its SPARC products.

Beyond that, Sun's seemingly anomalous pricing clouds the issue somewhat. Does the 1+'s extra RAM capacity (40 MB versus 24 MB) and third SBus slot make it $4500 better than the IPC? Sun thinks so, and, following that logic, CompuAdd's three-slot, 64-MB-maximum SS1 looks like a real deal. However, relative to the IPC—assuming you don't plan to grow out of it—CompuAdd's price advantage is less compelling. Either way, though, there's clearly a niche for the SS1.

There are a few minor differences between the SS1 and the 1+. The SS1's entry-level system comes with a larger monitor—19 inches as opposed to 17 inches. The SS1's case is metal, not plastic, and leaves room inside to re-

THE FACTS

CompuAdd SS1
$5995 and up

CompuAdd
12303 Technology Blvd.
Austin, TX 78727
(800) 531-5475
Inquiry 1067.

LOW-END PRICE/FEATURE COMPARISON

Table A: *Weighing your performance needs against your budget will determine whether the CompuAdd SS1 is a viable SPARC system choice. Sun provides superior performance, but the SS1 offers three SBus slots and up to 64 MB of RAM. The entry-level systems are diskless and have 8 MB of RAM and a 1152- by 900-pixel display.*

	Price	Color?	Monitor	Slots	MIPS	Maximum RAM	GX graphics option?
Sun SLC	$4995	No	17"	0	12.5	16 MB	No
CompuAdd SS1	$5995	No	19"	3	12.5	64 MB	Yes
Sun IPC	$8995	Yes	16"	2	15.8	24 MB	No*
Sun SPARCstation 1+	$8995	No	17"	3	15.8	40 MB	Yes
Solbourne S4000	$8995	No	19"	3	25.5	104 MB	Yes

*The IPC has two SBus slots and can theoretically support a GX accelerator. Sun "doesn't support" that configuration.

HIGH-END PRICE/FEATURE COMPARISON

Table B: *The high-end systems are configured with a 200-MB hard disk drive, a 16-inch color monitor, and a 1152- by 900-pixel by 256-color graphics display.*

	Price	SunOS?	ONC/NFS?	OpenWindows?
CompuAdd SS1	$8695	Yes	Yes	No
Sun IPC	$9995	Yes	Yes	Yes
Sun SPARCstation 1+	$14,599	Yes	Yes	Yes
Solbourne S4000	$22,495	No	Yes	No

place the 3½-inch floppy disk drive with a 5¼-inch device—for example, a CD-ROM. It has a beefier power supply (100 watts). It also comes with a mechanical mouse instead of Sun's standard optical mouse. Who cares? I do. Last year, a software vendor hauled a Sun system up to BYTE for a demonstration and then found he'd forgotten the optical mouse pad. An hour of hand-waving ensued. Since then, I've viewed optical mice with suspicion.

For demonstration purposes, CompuAdd provided a healthy assortment of applications, including Lotus 1-2-3, AutoCAD, Interleaf's TPS, FrameMaker, and Island Graphics' iWrite, iPaint, and iDraw. The arrival of 1-2-3 and AutoCAD legitimized the SPARCstation in the eyes of many people. The availability of popular PC spreadsheet and CAD software makes SPARC machines seem less exotic. Meanwhile, programs like TPS and FrameMaker—designed, built, and targeted to run on high-performance workstations—make SPARC more desirable. That's the push-pull dynamic that Sun hopes will carry its latest low-end machines beyond the technical arena and into the much larger commercial realm. CompuAdd, gambling on the success of that strategy, plans to ride along in Sun's slipstream.

A Basketful of GUIs

Unix is a real face-dancer these days, and on the CompuAdd I had a chance to try out several of its current manifestations. The SS1 will ship with SunView, the original Sun graphical user interface. It's awkward and dated, but more SPARC programs today support SunView than support any other GUI. Although CompuAdd won't be bundling OpenWindows, the X11/NeWS/Open Look amalgam that is Sun's new standard, our prototype SS1 came with OpenWindows 2.0. (OpenWindows will be available separately from CompuAdd, but the company hadn't yet decided on a price. You can get it directly from Sun for $295.) OpenWindows runs a pair of networkable window servers—X Window and NeWS—under the control of the Open Look window manager. The servers can cooperate so that, for example, X applications can use NeWS's scalable fonts. Too bad that only Sun and Silicon Graphics seem to take NeWS seriously. Its PostScript imaging model adds a lot of spice to a window system.

OpenWindows tolerates SunView applications, albeit grumpily. I was able to run Interleaf in a SunView window, alongside X11 and NeWS windows. The SunView windows kept getting stuck in the foreground, though, and things never seemed quite right. Clearly there's some distance to go yet before SPARC machines will be able to lay claim to the seamless support of a large software base that characterizes the Macintosh and, to a lesser extent, Microsoft Windows.

On the other hand, I'm more and more impressed by the ease with which Unix machines communicate—over both LANs and wide-area networks. This, more than cosmetics, will be what drives commercial acceptance of Unix. CompuAdd, a vendor of PC and Mac equipment, understands that its customers increasingly want to build heterogeneous networks, and that Unix can help glue such networks together. You want Macs in the art department and PCs everywhere else, all hooked up to a couple of SPARCstations acting as file servers and typesetting workstations? No problem. It will be one-stop shopping from CompuAdd.

Jon Udell is a BYTE senior editor at large. You can reach him on BIX as "judell."

power of the graphics hardware available to the developer, and it smooths over the differences between SPARCstation 2 models, but the developer needs to compile with different versions of the library for different graphics levels of the SPARCstation 2 series.

Over the Line

As we mentioned, Sun's selection of X Window as its graphics environment base makes connectivity across platforms almost automatic, but only in one direction. Ordinary X applications run without difficulty under OpenWindows, either locally or across network connections, but running OpenWindows applications that use NeWS, Open Look, or other extensions require those extensions on the displaying system. It is possible to write OpenWindows applications that don't require fancy software on the display server, but that would mean stripping out some of the things that make OpenWindows special. Developers should not resort to this, because Sun's low-end monochrome and color workstations also run OpenWindows.

When you can attach a fully compatible diskless node for under $5000 (the Sun SLC), the lack of ability to exploit the window system's full potential on an X terminal or PC X server becomes unimportant. Sun has even rolled its GX graphics accelerator into its SPARCstation IPC, making that (according to Sun) the lowest-cost high-speed color workstation.

Being a Sun system, the SPARCstation 2 series systems come loaded with TCP/IP, NFS, and NIS (the Network Information Service, previously known as Yellow Pages). We had no trouble at all getting the 2GX talking to all the systems in the BYTE Unix Lab. X applications like `xterm` and `ico`, which didn't use Open Look fonts or services, ran fine across the wire, and remote log-ins and NFS activities proceeded without a hitch.

The Whole Enchilada

Sun is still the top dog in workstations. Systems like the SPARCstation 2 series offer proof that the number one spot is likely to be Sun's domain for some time. The SPARCstation 2 series' design is remarkable throughout, from its downsized desktop case to Sun's imaginative approach to operating environments. It seems perfectly suited to both demanding graphics applications and typical business fare.

Sun provided demonstration versions of many applications, including FrameMaker, WingZ, and iPaint, iDraw, and

Solbourne S4000 Outguns SPARCstation 1+

Owen Linderholm

The quiet-running Solbourne S4000 offers an estimated 20 percent performance increase over the Sun SPARCstation 1+.

Solbourne Computer, one of the first companies to license and build SPARC-compatible systems, has mostly concentrated on the high end with high-powered server systems. However, the company, along with its Japanese partner, Matsushita, has had the goal of building a desktop SPARC system based around a highly integrated SPARC processor of its own design. The Solbourne S4000 is that system (see the photo).

The S4000 is based around a custom SPARC chip codeveloped by Matsushita and Solbourne. The MN10501 chip uses 64-bit data paths throughout, making it the first fully 64-bit SPARC processor. It incorporates a floating-point unit (FPU), memory management unit, cache controller, and memory, making it one of the most highly integrated SPARC processors available. The on-chip cache is 8K bytes of direct-mapped physical instruction and data cache. The memory bus used by the chip is 64 bits wide and transfers data at a rate of 60 megabytes per second. Solbourne and Matsushita have been working on this processor since Solbourne first announced its intentions to make SPARC-compatible systems.

The 33-MHz processor achieves a MIPS rating of 25.5 and a SPECmark of 12. This makes it about 20 percent faster than the SUN SPARCstation 1+. The FPU and integer units within the chip operate asynchronously, and each has separate registers. Separate instruction and data caches, 64-bit data paths to the caches, and the ability to do load and store operations in a single clock cycle make the chip operate fast.

The base system ($8995) includes 8 MB of RAM and can be expanded up to 104 MB in 8- or 32-MB increments using 1-MB single in-line memory modules. The S4000 comes with three SBus slots operating at 25 MHz. It includes an Ethernet port, two RS-423A serial ports, 8-kHz audio with an internal speaker, and various SCSI mass storage options. Supplied with the system is a 107-key PC-style keyboard, which seemed lightweight compared to Sun's keyboard, and an optical three-button mouse. During the boot process, an LED on the front of the unit changes color at each phase. Should the boot fail, the color of the LED will tell you at what point the problem occurred.

The S4000 can hold either one or two 3½-inch full-height, SCSI hard disk drives, each with 200 MB of storage space. The system can also optionally have a single 3½-inch floppy disk drive. The system box measures 17 by 17 inches and is a little over 3 inches tall.

The system board is only 9 by 11 inches, which leaves room for considerable expansion inside the system. The size was achieved by the integration of the processor and using four custom ASICs for glue logic, peripheral, and memory control. Installing the full complement of RAM, however, limits mass storage expansion options to a single 200-MB hard disk drive. The result is that users must make a trade-off between memory storage available and mass storage available, a trade-off that may be difficult to make in some cases.

The design of the system is very clean. It consists of six field replaceable modules, so that if problems occur, modules can be rapidly removed and replaced with repaired or new parts in the field. All that you need to do is unscrew seven screws to strip the machine.

The Solbourne's operating system is OS/MP 4.0D, a SunOS 4.0.3 derivative that includes NFS, ONC, TCP/IP, SunView, X Window, the Solbourne Window Manager and options for GKS graphics, PEX (Phigs Extensions to X Window), Solbourne Phigs, and a DOS emulator. The Window Manager has a "virtual desktop" feature that effectively expands your work area beyond the screen's boundaries. A box in the lower right corner shows available OpenWindows. This box is live; move the cursor into it, and you can select what you need. A "hammer and nail" feature lets you tack a window in place, so no matter where you move on the virtual desktop, that window remains in view.

There are many graphics options for accelerated two-dimensional and three-dimensional graphics. Standard graphics are monochrome on a 19-inch monitor with 1152 by 900 pixels and a 1-bit-per-pixel frame buffer.

Standard color options include a 16- or 19-inch monitor displaying 1152 by 900 pixels with an 8-bit color storage frame buffer and a 2-bit overlay frame buffer. This allows up to 256 colors from a palette of over 16 million. A high-resolution color option is also available with a 19-inch monitor and a display of 1280 by 1024 pixels with two color maps, each providing 256 colors from a palette of over 16 million.

An advanced color option includes an accelerated color frame buffer known as SBus Graphics Accelerator (SGA), which can have an optional piggyback z-buffer daughtercard to accelerate hidden pixel removal. An eight-plane version, the SGA40, uses two SBus slots.

THE FACTS

Solbourne S4000
$8995 and up

Solbourne Computer, Inc.
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continued

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Solbourne S4000 *(continued)*
Solbourne expects a 24-plane version to be available in early 1991.

Many hardware graphics accelerators for Unix systems put X Window primitives in hardware to speed them up. Solbourne goes beyond this by putting both X Window and PEX graphics primitives in microcode on these boards to dramatically improve the system's 2-D and 3-D performance in these environments. Graphics information is stored in main memory and is pageable. The SGA accelerator board has direct memory access across the SBus to this information, so there is no work for the CPU to do in supplying the graphics information to the SGA, resulting in improved performance. The SGA board also uses two digital signal processing chips to implement a graphics transform engine that runs at a peak of 50 million floating-point operations per second. One part of the board implements a fast rectangle area fill at 240,000 pixels per second.

Some of the functions handled in microcode on the SGA include 2-D and 3-D line drawing with line styles and perspective and depth cues; 2-D polygon pattern fills; 3-D polygons with strips, meshes, Bézier patches, Gouraud shading and hidden surface removal; an illumination model with eight light sources; BitBlt and dithering; and multiple color maps.

Solbourne claims that the SGA40 accelerator can draw 450,000 lines per second in 2-D operations, 200,000 lines per second in 3-D operations, and can draw 10,000 Gouraud shaded polygons per second. The SGA has direct memory access to graphics information that is stored in main memory, so that the CPU and the SGA can operate in parallel.

The S4000 with a 16-inch color monitor, 8 MB of RAM, and no disk drives costs $11,495; it costs $13,995 with the SGA40. A 19-inch color system with 16 MB of RAM, a 200-MB hard disk drive, a floppy disk drive, and the SGA40 with the z-buffer option costs $22,495. (See the tables in the text box "CompuAdd Delivers a Low-Cost SPARCstation" for price and feature comparisons.)

The basic Solbourne S4000 is an $8995 monochrome SPARCstation 1+ clone that runs faster. It can also be expanded far more than other SPARC systems in this price range. In fact, internal memory expansion can go beyond that of the SPARCstation 2 series. The operating software is not pure SunOS. It is, however, derived from SunOS and should be highly compatible with it. At the high end, the S4000 with full graphics options costs a little more than a Sun SPARCstation 1+ or IPC with GX graphics, but it also outperforms them considerably. In fact, some of its graphics features can be compared to those in the new SPARCstation 2 line.

All in all, the S4000 line is a very flexible and expandable one that makes a great deal of sense. It starts relatively cheap but with good performance. It expands easily to a very respectable level of performance, still with a good price. This level of flexibility should help Solbourne in the years ahead, where there is likely to be an explosion of SPARCstation clones.

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iWrite. These programs all take advantage of the unique environment created by OpenWindows, and the system's performance makes them fast and glamorous. Any PC user enamored of Windows 3.0 or X Window on a VGA should feel like the horse-and-buggy driver at the dawn of the automobile. There are graphics environments that just get you where you're going, and then there's the real thing. Workstations still have that sewn up, along with the Macintosh, and OpenWindows widens the gap even farther.

Although other SPARC machines like the Solbourne and CompuAdd challenge Sun for price and performance and take advantage of the abundance of Sun applications, they are attacking only the SPARCstation 1 and 1+. It is unlikely they will have a negative effect on Sun's preeminence. In fact, their presence fortifies Sun's position. Sun SPARCstations will not suffer the same fate that IBM PCs did from the clone world. Sun is not IBM; Sun is still hungry and can move fast enough to stay ahead of the spawned industries.

Working with the SPARCstation 2 series is almost an educational experience, disproving some widely held beliefs. First, those who insist that Open Look has been murdered in its sleep by OSF/Motif should feast their eyes on OpenWindows. OSF has been quicker in giving Motif more press coverage and (perhaps as a result) getting it on more machines, but more applications developers have gone with Open Look. OpenWindows 2 is X Window and Open Look taken to their best and most logical potential. Second, even though the line between PCs and workstations is getting blurrier by the day, systems like the 2GX (and the IPC, for that matter) prove that workstations still have an edge over even Unix-equipped personal computers. Third, X Window is *not* unsuitable as an environment for demanding applications. If a vendor takes the time, as Sun has, to build on the base that MIT provides, then X applications can be fast, feature-laden, and easy to use.

Some systems are trendsetters. Just as the Apollo 2500 gave the low-end workstation market reason to exist, the Sun SPARCstation 2 series redefines the midrange. And since Sun is the unquestionable leader of the workstation world, responsible for introducing workstation technology that sets standards, we hope that the SPARCstation 2 series signals a veering away from the cutting of corners. While some users may want the world's cheapest workstation on their desks, others can afford, and demand, the traditional performance, effortless networking, and software leadership that make the term *workstation* mean something. Two thumbs up for the SPARCstation 2 series and OpenWindows 2.0. ■

Tom Yager and Ben Smith are BYTE technical editors. You can contact them on BIX as "tyager" and "bensmith," respectively.

THE FACTS

SPARCstation 2GX
less than $22,000
SPARCstation 2GS
less than $27,000
SPARCstation 2GT
less than $52,000
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less than $15,000
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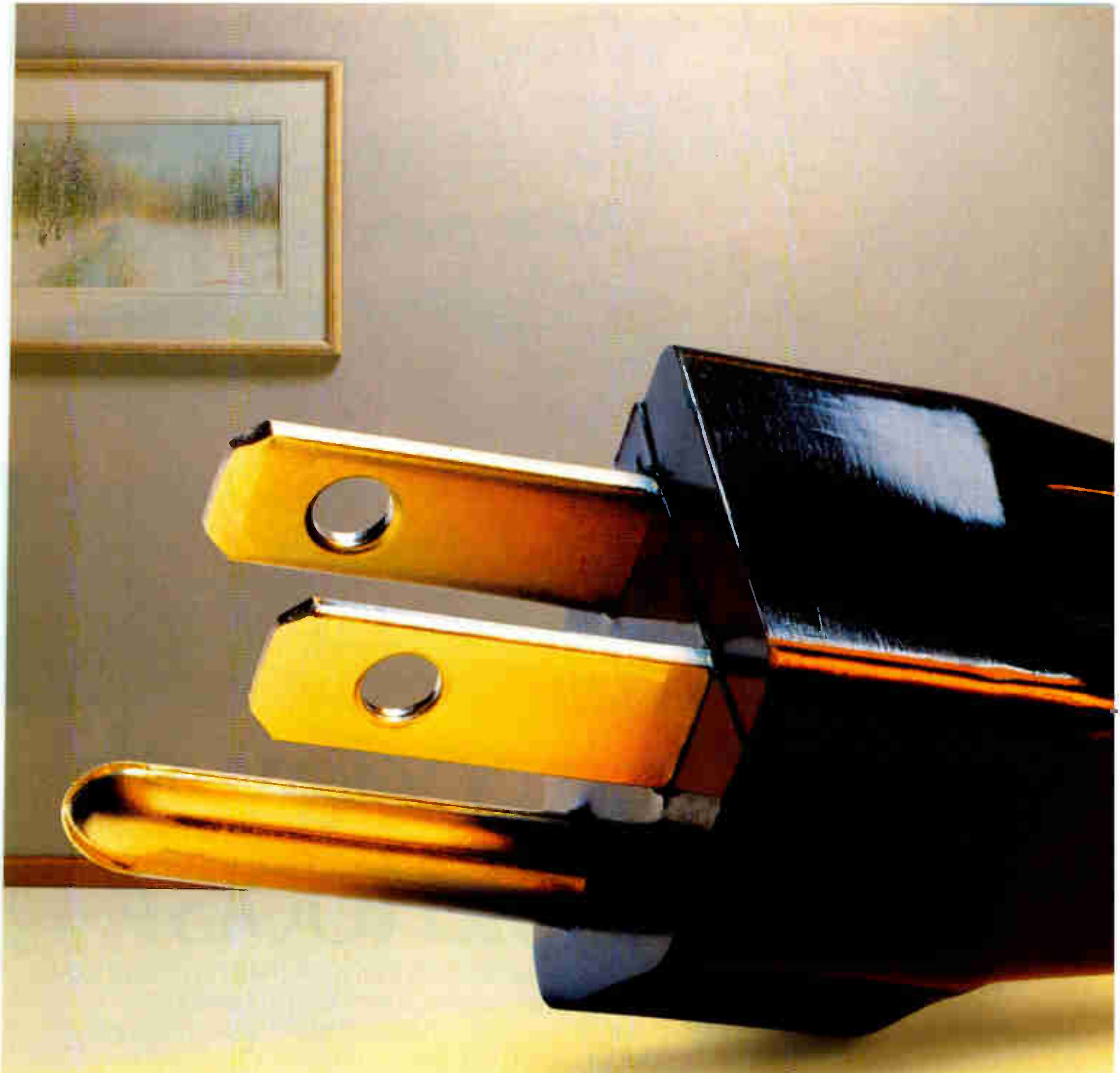

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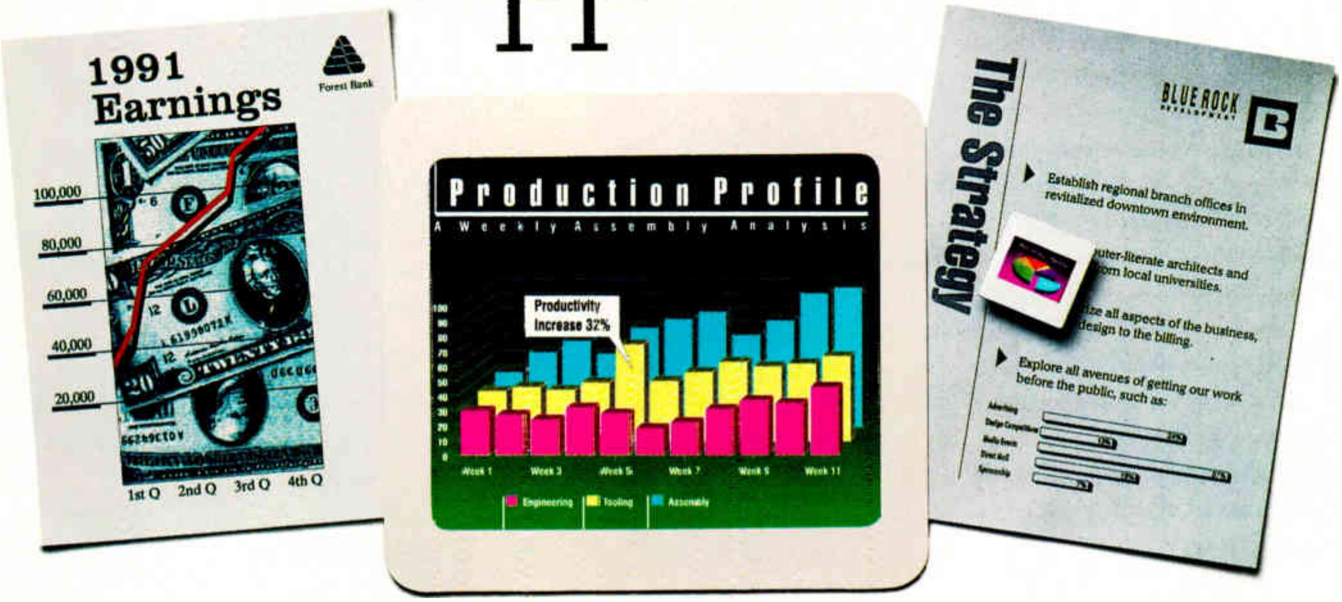

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Suddenly, Everything's Smaller in Texas

TI's new 386SX notebook weighs less than 6 pounds

Andrew Reinhardt

The Texas Instruments TravelMate 3000 packs a 20-MHz 386SX, floppy and hard disk drives, and a VGA screen into a box three-quarters the size of the Manhattan yellow pages.

In Texas, where everything is larger than life, they suddenly seem to have a knack for designing computers that are especially small. Hard on the heels of the Compaq LTE 386s/20 comes a new 386SX notebook from Texas Instruments (TI) called the TravelMate (TM) 3000. This petite powerhouse from Dallas undercuts its rival from Houston: The overall performance is somewhat lower, but the TI notebook is almost 2 pounds lighter and has a list price that's $1000 less.

The compact size and weight of the new TI notebook system are not surprising, since it follows in the wake of the company's impressive TravelMate 2000. This lightweight notebook, codeveloped with Sharp and also sold by CompuAdd, includes a 286 processor and a hard disk drive, yet it weighs under 4½ pounds.

The TM 3000, along with similar notebooks from Compaq, Epson, and Toshiba (see the text box "Toshiba and Epson Join SX Notebook Club" on page 152), is part of a new wave of computers that combine compact size with 386 performance and compatibility. The jump to the 386 has brought other improvements as well. In the LTE 386s/20, Compaq erased a drawback of its earlier 8086 and 286 LTEs, the lack of VGA graphics. TI has likewise solved the problems of the TM 2000 by adding to the TM 3000 a floppy disk drive, better screen contrast, conventional I/O ports (instead of the miniature ports used before), and 50 percent longer battery life, the company says.

The TM 3000 uses the 20-MHz version of the 386SX, boasts a VGA-resolution display, and includes both a floppy disk drive and a hard disk drive. All this power is packed into an 8½- by 11-inch case less than 2 inches high and weighing a comfortable 5¾ pounds, including the battery. To top it off, TI tosses in some snazzy software utilities and offers a

PHOTOGRAPHY: PAUL AVIS © 1990

Toshiba and Epson Join SX Notebook Club

Designers from Texas are not the only ones shrinking 386SX computers into notebooks. Toshiba, whose T1000 practically defined the early notebook, and Epson, a quiet but long-time player in the laptop market, have both announced plans to produce SX machines in svelte form factors.

Both machines were announced too late for a hands-on evaluation, but their specifications indicate that they could be contenders in the market, assuming that pricing (which was unannounced at press time) is in line with their somewhat lower performance.

The Toshiba T2000SX, scheduled to be available in January 1991, looks like a cross between the company's existing 286-based T1200XE notebook and its T3100SX laptop. Measuring 10 by 12 by 2 inches and weighing in at just under 7 pounds including battery, it is larger and heavier than the TI Travel-Mate 3000 but lighter than the Compaq LTE 386s/20.

The T2000SX uses a 16-MHz 386SX chip and comes with 1 megabyte of RAM standard, expandable to 9 MB.

The Toshiba T2000SX is a little larger than the Texas Instruments TravelMate 3000 and uses a 16-MHz 386SX. It has the same keyboard as the Toshiba T3100SX.

An 80387SX coprocessor is optional. Both a 3½-inch 1.44-MB floppy disk drive and a hard disk drive are built into the system; initially, only a 20-MB hard disk drive will be available, but Toshiba eventually plans to offer a 40-MB drive as standard.

The edge-lit supertwist nematic LCD offers VGA-resolution graphics with 16 shades of gray but measures only 8½ inches diagonally. Serial, parallel, external monitor, and numeric keypad ports are included, and there is an expansion bus for a desktop docking station. A slot for an optional modem is located under the machine.

Epson announced its machine, the NB3s, cautiously: Although it was the first SX notebook to be unveiled, Epson disclosed neither prices nor a firm delivery date. However, on paper the notebook looks impressive. It reportedly weighs just under 6 pounds and measures 8½ by 11¾ by 1¾ inches, or about a tenth of a pound and 1 cubic inch more than the TI TravelMate 3000.

The NB3s uses a 16-MHz 386SX CPU and can hold up to 5 MB of internal RAM and an optional math coprocessor. The base memory configuration has not been announced, but it will likely be 1 or 2 MB of RAM. For mass storage, both a 3½-inch floppy disk drive and a 20- or 40-MB hard disk drive are included. The backlit, black-on-white LCD offers VGA resolution with 16 levels of gray. Standard I/O ports include serial, parallel, external CRT, and numeric keypad.

One of the most distinctive aspects of the Epson notebook is its desktop docking station, which, in addition to two full-size AT-bus slots, offers bays for up to 120 MB of mass storage and support for a 101-key keyboard. The docking station itself is only 3⁷⁄₁₀ pounds, so the notebook and base combined weigh less than 10 pounds. The NB3s is slated to ship before the end of this year.

keyboard that I believe is superior to that of the LTE.

Power to Go

The TM 3000's 20-MHz 386SX CPU has enough horsepower to run demanding applications while on the road, including software written specifically for the 386 instruction set. An 80387SX math coprocessor is an option, although it was not installed in the unit I evaluated. Preliminary BYTE benchmarks rate the CPU performance at 2.75 times the speed of an IBM AT, which is a tad faster than the Compaq LTE 386s/20 and most of the deskbound 20-MHz SX machines that BYTE has reviewed so far.

The system is supplied with 2 MB of

RAM, expandable on the motherboard in 2-MB increments up to 6 MB. For mass storage, one of two 2½-inch Conner Peripherals hard disk drives is available: a 20-MB drive with a 23-millisecond average access time or a 19-ms 40-MB drive. A 3½-inch 1.44-MB floppy disk drive is located on the front of the system.

On the BYTE benchmarks, the 20-MB drive turned in a disk I/O rating of 1.60, or about 70 percent as fast as the LTE's drive. But TI supplies a disk-caching utility that boosts performance and saves battery life; with a 64K-byte cache installed in extended memory, the benchmark index rose to 1.80. It should be noted that the drives for the Compaq notebook are available in 30- and 60-MB capacities; TI plans to offer a 60-MB version in the second quarter of 1991.

The TM 3000's display is a triple supertwist nematic LCD measuring 10 inches diagonally. It is switchable between black on white or white on black via a toggle. While it is essentially the same screen used in the TM 2000, TI says that engineering refinements have produced blacker blacks and better contrast.

The screen offers 640- by 480-pixel VGA resolution with a 32-gray-shade palette (16 shades visible at a time) using the Chips & Technologies VGA chip and Quadtel VGA BIOS. It is lit from the side by a single cold-cathode fluorescent tube, yet I found it very crisp and legible in a variety of lighting conditions. The only drawback is performance: The video subsystem posted a rating of 5.31 in the BYTE benchmarks, versus 8.00 for the LTE 386s/20.

What the display and hard disk drive lack in zip, the keyboard makes up for in comfort. The TM 3000 has a 79-key keyboard with 10 function keys on the top row (F11 and F12 are accessed with an Fn key) and an embedded numeric pad superimposed on the alpha keys. Separate cursor-movement keys are arranged in an inverted T on the lower right side of the keyboard. I found typing on the TM 3000 much easier than on an LTE: the keys have a good "clicky" feel and adequate travel, and I greatly prefer the arrangement of the arrow keys to the awkward reclined-L pattern on the LTE.

To connect the TM 3000 to the outside world, TI provides standard I/O ports (i.e., parallel, serial, PS/2 mouse, and external VGA monitor), grouped behind a hinged door on the left side of the computer. Also on the left is a proprietary slot for an optional 2400-bps internal modem. On the right side is a mini-connector for an optional numeric keypad, and on the back is another miniport for connecting to a desktop base station.

The base station is the same one offered for the TM 2000 except for a different adapter to accommodate the greater height of the TM 3000. It contains 1½ AT-bus slots for add-in cards, a 3½-inch storage bay, and a power supply to drive both the notebook and the expansion chassis. The base station is scheduled to be available in December, but TI hasn't yet announced a price.

BENCHMARK RESULTS

Preliminary BYTE Lab benchmark results indicate that the new TI notebook computer has a fast CPU index compared to other 20-MHz 386SX systems, but disk and video performance are mediocre. All benchmark indexes show performance relative to an 8-MHz IBM AT; higher numbers are better.

System	CPU	Disk I/O	Video
TI TravelMate 3000	2.75	1.60	5.31
Compaq LTE 386s/20	2.58	2.32	8.00
Dell 320LX	2.19	1.86	7.10
NEC ProSpeed SX/20	2.05	1.11	5.33

A Power Boost

Notebook computers push the envelope in power management, because designers have to squeeze the maximum operating time out of the smallest possible battery. Although the TM 3000 uses about twice as much power as the TM 2000, TI has managed through improved power engineering and a variety of software utilities to boost run time by 50 percent, from 2 hours to 3. I wasn't able to verify this claim because my evaluation unit had some power glitches.

The TM 3000 uses removable, rechargeable nickel-cadmium batteries that together weigh about 1 pound. (Without the batteries, the system weighs only 4⁷⁄₁₀ pounds, or about one-third of a pound more than the NEC UltraLite.) TI says that the batteries can be recharged inside the computer in 3 to 4 hours when it is not in use. An external charger will also be available.

THE FACTS

TravelMate 3000
with 20-MB hard disk drive, $5499
with 40-MB hard disk drive, $5999

Texas Instruments, Inc.
Information Technology Group
P.O. Box 202230, ITG-065
Austin, TX 78720
(800) 527-3500
Inquiry 1076.

To prolong operating time, TI integrated many of the TM 3000's functions into low-power application-specific ICs. CPU speed drops automatically from 20 MHz to 8 MHz when the system is idle, and a software utility called BatteryPro induces processor wait cycles when the CPU is holding for keyboard entry or I/O. These techniques alone can save 20 percent to 25 percent of battery life, TI says. Other utilities included with the TM 3000 let the user specify time intervals for blanking the screen and powering down the hard disk drive. The system also includes BatteryWatch from Traveling Software.

Swimming with Sharps

TI produced the TM 2000 in conjunction with Sharp, which sells the same machine under the name PC 6220, but Sharp did most of the engineering work. With the TM 3000, that situation is reversed: TI did the design near Dallas, and the machine will likely be relabeled and sold by Sharp as well. This alone is a clear indication of TI's engineering prowess. That TI was also able to match and even beat Compaq at a game the latter has made a specialty bodes well for TI's future in notebooks.

Then there is the price. For a starting configuration with 2 MB of RAM and a 20-MB hard disk drive, the TM 3000's suggested list price is $5499. This includes DOS 4.01, LapLink, BatteryWatch, and other bundled software for controlling the display, disk cache, and power management. A configuration with a 40-MB drive will list for $5999, or $500 less than the 30-MB Compaq LTE 386s/20. This is still a lot of money, but if you need a 386 on the road or you just can't resist the latest breakthrough in portable power, the TM 3000 may be just the ticket. ■

Andrew Reinhardt is an associate news editor for BYTE in New York. He can be reached on BIX as "areinhardt."

The Okidata OK.™ It's why we had to re-invent the laser printer.

What's the Okidata OK? It's a badge of honor that every Okidata product has to earn—a symbol of our commitment to design and deliver products that offer outstanding value and performance. Products that will not only satisfy you, but impress you.

The Laserless Printhead: Warranteed for 5 Years.

The performance promise behind the Okidata OK is the reason we had to re-invent the conventional laser printer. Our engineers frankly rejected the industry-standard page printer technology of laser beams, lenses and rotating mirrors. Instead, they designed and built a proprietary, solid-state LED printhead with no moving parts. It's a printing system so trouble-free, we guarantee our LED print element for 5 full years—making it by far the longest warranty in the industry.

PC MAGAZINE EDITORS' CHOICE
June 12, 1990
Okidata OL400

But reliability isn't the only advantage our unique printhead offers. It also means a simpler design, resulting in a straight-line paper path that's far less likely to jam—even when feeding heavy stock, envelopes, or labels. And, since we build it ourselves, it means something else—a lower cost.

The OL400: The Only $999 Page Printer.

Our 4 ppm OL400, for example, has the lowest list price of any page printer on the market: only $999.* Yet that price gets you a printer that earned a PC Magazine Editor's Choice Award, with standard features—extra fonts, a full 200-sheet paper tray—that you won't find on a LaserJet® IIP selling for hundreds of dollars more. Plus a slim, low-profile design that's less bulky on a desktop.

The OL800: Twice the Output, with Room to Grow.

And the OL400 isn't the only Okidata LED page printer to offer outstanding value. For applications where greater speed is needed, the OL800 delivers 8 ppm with all the advantages of the Okidata LED printhead: straight-line paper path, 5-year printhead warranty, and a low $1499 list price.

Like all our LED page printers, the OL800 emulates HP® Series II for compatibility with most popular software; with its speed and selection of resident type fonts, it can handle the printing needs of a whole work group. What's more, as your applications change and your needs grow, a simple upgrade kit turns the OL800 into either a font-scaling OL820 or a PostScript®-compatible OL840.

The OL820: Smarter Than a LaserJet III.

The OL820 earned the Okidata OK by learning how to do font-scaling on the fly. Thanks to a special chip our engineers designed into the 820, it can solve complex type-sizing and positioning problems instantly—problems the LaserJet III needs to talk to its software to work out. That means the OL820 can deliver up to three pages of sophisticated text while the LaserJet III is still working on its first page.

And all at a price that's hundreds of dollars less than the LaserJet III.

The OL840: PostScript and Beyond.

And for applications that require full Adobe PostScript® compatibility, our OL840 delivers it in spades. It's ready to connect to any PC or Macintosh® system, or to both at the same time—then switch between systems with the push of a button.

The Okidata OK. It's a promise that makes our job—to design and manufacture a line of page printers offering both outstanding value and performance—a hard one.

But it makes your job—choosing the right brand of page printer for your application—easier than ever before.

For additional information, call us at 1-800-800-7333.

Oki OK!

OKIDATA® OK!™
an OKI AMERICA company

We don't just design it to work. We design it to work wonders.™

Pictured with optional second paper tray; available on OL800, OL820 and OL840 models.
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*Manufacturers suggested retail price. Dealer prices may vary.
OKIDATA is a registered trademark of Oki America, Inc., Marque déposée de Oki America Inc.

When Laser Printers Can't Cut It

The BYTE Lab tests 27 dot-matrix and page printers that pick up where laser printers leave off

Stanford Diehl and Howard Eglowstein

Are you planning to run out and buy a laser printer? If so, stop, take a deep breath, and consider what you are buying a printer for. You might want to consider a laser printer alternative.

Sure, laser printers are fast and getting less expensive by the day. But maybe you need to print multipart forms; laser printers can't do that. Or perhaps you will be printing long program or database listings. A large stack of cut sheets is definitely not the way to print long listings. And at 5 cents per page, they're five times the cost of dot-matrix output. A long piece of perforated pin-feed paper is much more convenient and fits easily in a special binder. If you've ever pasted together multiple letter-size spreadsheets, you're sure to appreciate the ability to print on 13-inch-wide paper.

There are alternatives to the laser printer, and this month, the BYTE Lab looks at 27 printers that might suit your needs. You be the judge.

Quality is a big consideration when buying a printer, so all the reviewed printers have 24-pin print heads (or the equivalent) and produce letter-quality output. For the dot-matrix printers, we chose wide-carriage models and further required that they all handle graphics in either IBM Proprinter or Epson LQ emulation. This narrowed the field to 21 dot-matrix and two ink-jet printers. Another alternative to a laser printer is a page printer with a nonlaser print engine. The text box "You're Being Paged" on page 158 introduces two LED, one LCS (liquid-crystal shutter), and one ink-jet page printer, each with print quality to rival the laser printers and full Hewlett-Packard PCL emulation.

If You Can't Fight 'Em, Emulate 'Em

All printers evolved from the simple typewriter. Teletypewriter machines provided feedback to the earliest hackers before CRTs became popular. Even after monitors became the preferred interface, modified teletypewriters hung around as simple hard-copy output devices. From the teletypewriter evolved the daisy wheel, whose loud and clumsy operation drove users to dot-matrix printers as soon as the machines produced acceptable quality. Now, of course, ink-jet printers and cheap laser printers threaten the dot-matrix models for mainstream applications.

Centronics marketed the first successful line of dot-matrix printers and, for a time, had the market mostly to itself. Then the Japanese printers poured in. Seiko was the first Japanese company to manufacture dot-matrix print heads. Then Seiko turned them over to its Epson subsidiary, which began selling printers of a quality and price that Centronics couldn't match.

In 1981, when IBM needed a printer for its new Personal Computer, it chose an Epson. Although the name tag said "IBM," the printer and its underlying command set were pure Epson. IBM's choice of an Epson solidified the Epson standard. Even the so-called Centronics parallel port is actually an Epson modification of the original Centronics design.

In today's dot-matrix market, most manufacturers emulate the Epson printer command set. Printer companies emulate the Epson so that their printers will be compatible with leading software packages. To communicate with a printer, every software package must include a driver that the specific printer can understand. A printer vendor must either write its own driver for every major piece of software or create a printer that can talk to the most popular drivers around. While having a wide range of emulations will increase a printer's chances of being compatible with software products, all a printer really needs these days are IBM and Epson emulations. To be successful, most software must include drivers for the Epson and the IBM Proprinter. If your printer emulates these two (see photo 1), you won't have to worry about software compatibility.

Still, emulating the commands is not enough. The command sets, after all, continue to evolve, sprouting new features and capabilities each time Epson or IBM releases a new printer. Luckily, the enhanced commands are backward-compatible. If you have a newer Epson printer, you can still use software that supports the old models; you just won't be taking full advantage of the printer. For instance, in table 1, we list two Epson emulations—Epson 1050 and Epson 2550. Any printer that emulates the 2550 will also work with a 1050 driver and, indeed, with drivers dating back to the original MX series. The printers that do not support 2550 emulation do not include the latest enhancements to the Epson printer command set. Likewise, IBM's latest printer, the Proprinter XL24E, has an enhanced command set (that's what the *E* stands for). You should always use the most recent driver that your printer will support to ensure that you're getting the most out of your investment.

Fujitsu takes an interesting approach to the emulation issue. The DL4600 uses the Fujitsu DPL24C Plus command set,

PHOTOGRAPHY: PAUL AVIS © 1990

You're Being Paged

Perhaps you want a page printer but you have specific needs that a laser printer cannot address—larger paper, say. While they're not in the same category as the dot-matrix and ink-jet character printers, the four page printers that we examined (see photo A) have specific design advantages over their laser counterparts (see table A).

The first thing we wondered when we started to test these LED, LCS (liquid-crystal shutter), and ink-jet page printers was: What's the point? They aren't really cheaper, they're not always faster (see figure A), and the LED/LCS technology uses essentially the same supplies as a laser printer.

The Epson EPI-4000 ink-jet printer is unique in that it can handle PCL or Epson graphics on 11- by 17-inch paper. It's probably not a good choice as a general-purpose printer; it's slower than the Hewlett-Packard Series II, and the water-based ink makes the paper wrinkle if you print a large black area. Still, the print quality is good, and if you need to print on large paper, the EPI-4000 is your only option.

LED and LCS technologies are similar in that they use a photosensitive drum to attract toner, much the way a laser printer does. The difference is that a laser printer uses a scanning laser beam to charge the drum. LED and LCS printers use an array of 2550 individual elements—one for each pixel on an 8½-inch line. On an LED printer, there is one LED for each pixel, and as a given line is printed, the printer activates the required LEDs.

The LCS printer uses a similar technique, but it places an array of liquid-

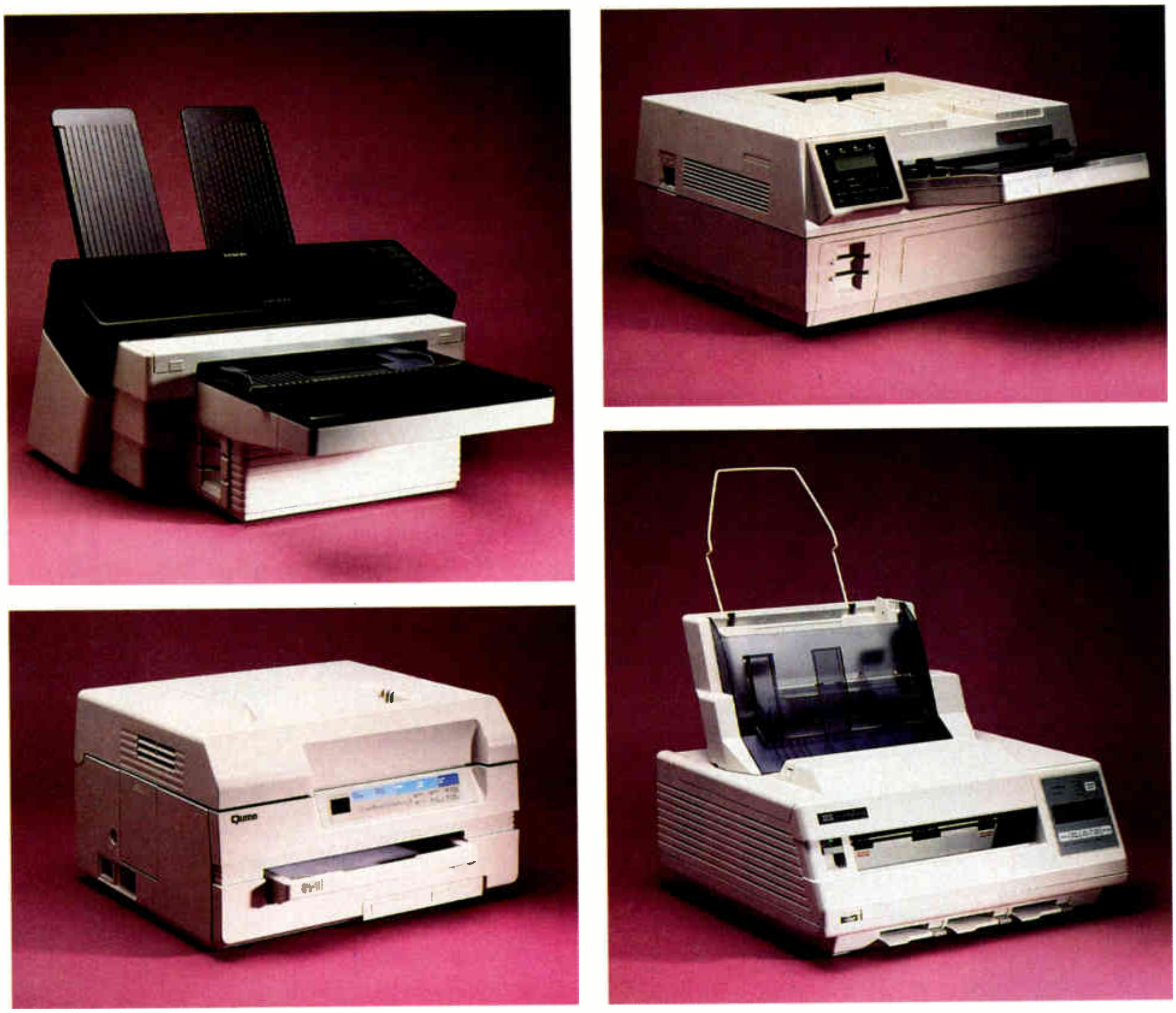


Photo A: *Laser quality without the laser: Page printers reviewed are (clockwise from top left) the Epson EPI-4000, the Okidata OkiLaser 820, the Fujitsu RX7100 S/2, and the Qume CrystalPrint Publisher II.*

crystal elements between the drum and an incandescent light source. According to Qume, this configuration allows for more even light distribution, preventing a streaky appearance in large black areas. Compared to laser printers, LED and LCS printers have fewer moving parts to break, which suggests that they may be more reliable. Without the scanning mirror, the LED/LCS technologies print a more even black without any trace of scan lines. As for performance, the Okidata OkiLaser 820 (LED) was the fastest in our long-document and text-and-graphics tests, thanks to its fast paper handling. The Fujitsu RX7100 S/2's exposed paper bin (see photo A) made it easy to load. Qume's CrystalPrint Publisher II has a fast RISC processor, which gave it an edge on the short-memo test. CrystalPrint Publisher II has both PostScript and Apple LocalTalk interfaces, making it a fine addition to any Mac network.

Overall, we couldn't detect any substantial difference in print quality between the CrystalPrint Publisher II's LCS engine and the LED printers, although all three had much blacker blacks than the Hewlett-Packard LaserJet Series II. As for reliability, the claims seem reasonable; time will tell.

COMPARING PAGE PRINTER FEATURES

Table A: *Ink-jet, LED, and LCS printers offer a range of interface and emulation choices. (○=yes; ●=no; (O)=optional.)*

Model	Epson EPI-4000	Fujitsu RX7100 S/2	Okidata OkiLaser 820	Qume CrystalPrint Publisher II
Price	$1999	$1395	$2295	$3995
Dimensions in inches (D,W,H)	19.6 x 12 x 28.2	6.7 x 16 x 15.7	8.5 x 17.7 x 17.7	9.1 x 15.7 x 13.4
Weight (pounds)	39⅝	39	37	35⅛
Memory—standard	512K	640K	512K	3 MB
Memory—expansion	2 MB	4 MB	4 MB	6 MB
Interface				
AppleTalk	○	○	○	●
Parallel	●	●	●	●
Print sharing	○	○	Optional	○
Serial	●	●	●	●
Twinax	●	○	○	○
Technology	Ink jet	LED	LED	LCS
Maximum print speed	Depends on page	5 ppm	8 ppm	6 ppm
Pages/refill	1000 LQ pages	6000 pages	2500 pages	7500 pages
Duty	5000 hours @ 25% duty	3000 pages/ month	5000 pages/ month	6000 pages/ month
Paper capacity	100 sheets	150 sheets	200 sheets	100 sheets
Maximum paper size (inches)	11 x 17	8½ x 14	8½ x 14	8½ x 14
Emulation				
Diablo 630	○	●	●	○
Epson	LQ and FX	FX	○	○
HP LaserJet II	●	●	●	●
IBM Proprinter	○	●	●	○
PostScript	○	(O)	○	●
Resident fonts	3	7	5 (HP), 13 (Scalable Oki)	8 (HP), 39 (PostScript)
Options	Push tractor	Font cards, second paper bin	Font cards	Font cards

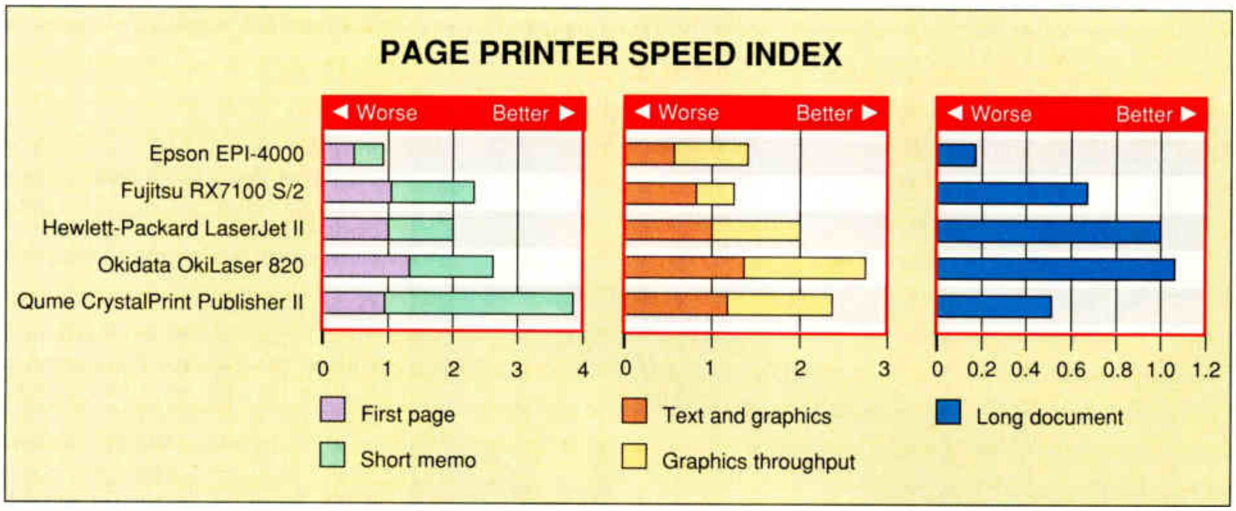


Figure A: *Since these printers work like Hewlett-Packard LaserJets, we ran the tests used for our July Product Focus, "Laser Printers Get Personal." The first-page and short-memo tests are heavily influenced by warm-up time and the speed at which fonts can be downloaded. The text-and-graphics and graphics-throughput tests reflect the speed of a lengthy binary-image transfer. Finally, the long-document test rates the printers on their ability to churn out long listings. In all cases, the tests are normalized to the Hewlett-Packard Series II (its index rating is 1).*

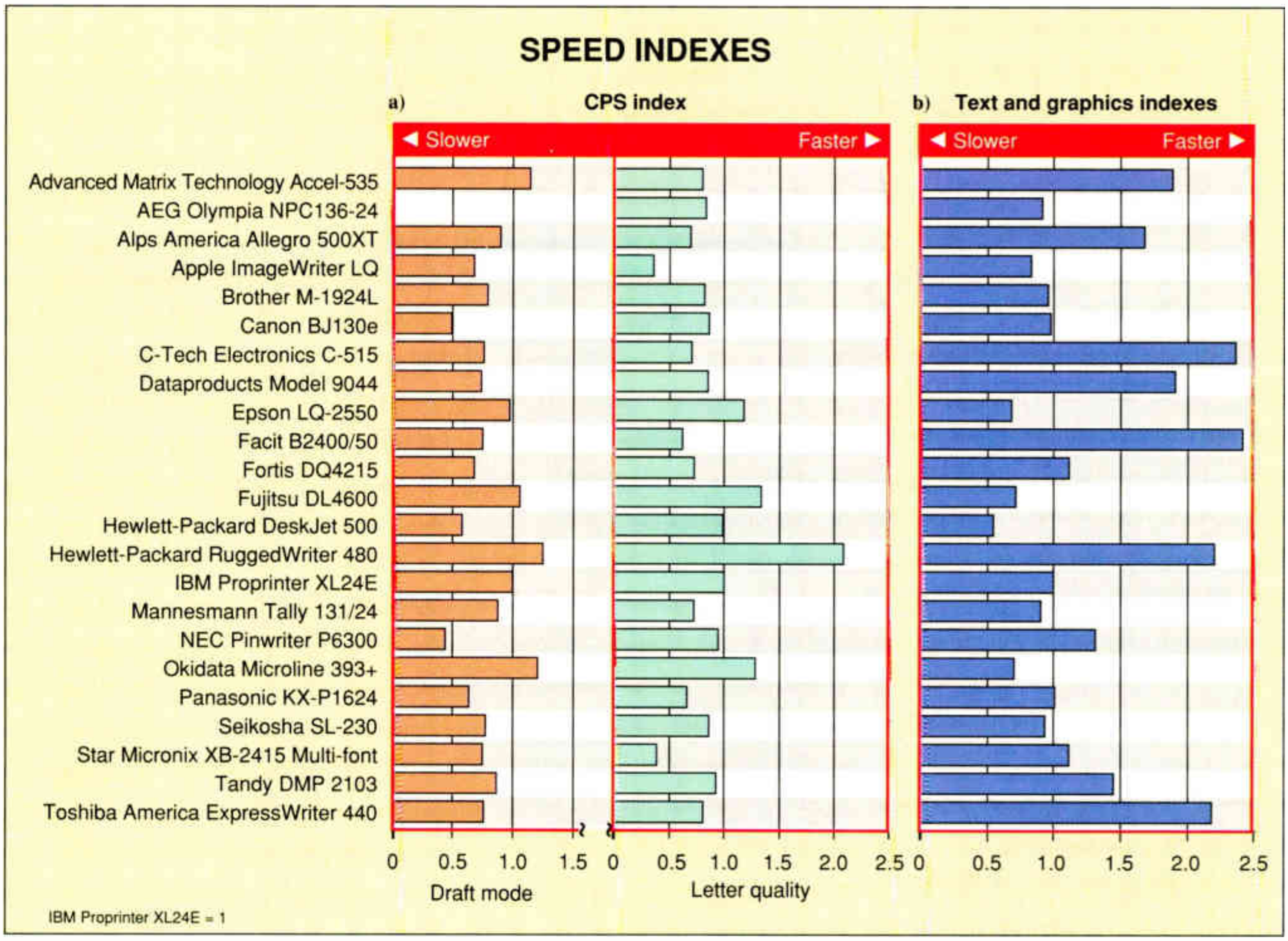


Figure 1: (a) *Vendors' cps (characters per second) ratings do not always reflect real-world results. Our tests use a typical formatted document. The results are normalized on the IBM Proprinter XL24E (its index rating is 1, so a printer with a rating of 2 runs twice as fast as the Proprinter). The Hewlett-Packard RuggedWriter 480 had far and away the fastest letter-quality printing. The RuggedWriter 480 and the Okidata Microline 393+ turned in the fastest draft performance.*
(b) *Our text-and-graphics test included text, line art, a gray-scale test pattern, and a gray-scale TIFF image scanned at 300 dots per inch. The results are normalized on the IBM Proprinter XL24E (its index rating is 1). The Facit B2400/50 and the C-Tech C-515 led the field. All printers were tested with the Windows 3.0 Proprinter driver unless only an Epson driver was supported. The Hewlett-Packard DeskJet 500 required its own driver.*

which includes most of the commands for the Proprinter and Epson LQ-2550. On top of that, the DL4600 printer accepts "emulation cards." These optional cards slide onto the memory board and deliver additional printer emulations.

Quick and Dirty

Many buyers look to dot-matrix printers without worrying too much about print quality. They just want their output fast. When you're pumping out an early draft or a preliminary listing, you usually want it right away. Speed has become a major factor in dot-matrix purchasing decisions.

Note that the results of our testing (see

Photo 1: *Setting the standards. Most dot-matrix printers emulate one or both of these two printers: the IBM Proprinter XL24E (top) and the Epson LQ-2550 (bottom).*

figure 1a) conflict with the characters-per-second (cps) ratings as listed in table 1. Don't be alarmed. We have not uncovered a conspiracy. When printer vendors publish speed ratings, they are literally referring to the time it takes to print a burst of *characters*. This time does not include movement of the print head, linefeeds, and carriage returns. Our test generates a long document with numerous elements not included in vendor tests (see the text box "Lab Tests: Connect the Dots" at right). Keep this in mind when reviewing cps ratings. You can use these ratings to compare the speed of various printers, but don't expect a printer rated at 300 cps to print a 10,000-character document in 33 seconds. The BYTE Lab tests reflect real-world results that you can expect to duplicate (see also figure 1b). Table 1 includes draft and letter-quality cps ratings at 10 cpi, the accepted standard, as supplied by the vendors.

When you opt for letter-quality printing, you will, of course, forfeit some speed. Many dot-matrix printers enhance quality by printing a second identical character on top of (or slightly offset from) the first. As you would expect, this technique will at the very least halve the print speed.

Luckily, you don't have to wait for the entire printout before getting back to work. This is where printer *buffers* come in. The bigger the buffer, the more output your computer can pass to the printer and the sooner you get control of your keyboard. On the other hand, printer memory is not as vital to a dot-matrix printer as it is to a page printer. Because a page printer must first build an image in its memory, it requires a minimum amount of RAM to do its job. Dot-matrix printers use memory only as buffer space and to download fonts. So, if you're planning to use downloadable fonts with your dot-matrix printer or if you just want a healthy buffer, make sure that you have adequate memory. Table 1 lists each printer's maximum memory configuration.

Lab Tests: Connect the Dots

We started our tests by hooking each printer (except the Apple ImageWriter LQ) to our base system, a Compaq Deskpro 386/20. We fiddled around with the printer before consulting the manual, just to see how intuitive the interface was. We loaded razor-cut fanfold paper and fed it into the printer as specified in the manual. Usually, pushing a formfeed button or pulling back on the paper bail lever caused the paper to load automatically. We then tried the tear-off function and parked the paper for single-sheet feeding. Numerous formfeeds helped test the feeding mechanism. We usually developed a strong impression of a printer before the first real test even started.

For one test (see figure 1a), we printed a fairly long (55K-byte) document from the DOS prompt. We timed the test from the first strike of the print head to the formfeed at the end of the document. This was designed to test speed in characters per second on a formatted document. We ran the full-speed test twice, once in high-speed draft quality and once in letter-quality mode. For the Apple ImageWriter LQ, we printed from Microsoft Word 4.0 on a Mac Portable. To test the Canon BJ130e for Canon mode compatibility, we connected to a Canon Cat, one of Canon's dedicated word processors (it ran fine).

As the cps test ran, we took a sound reading of each printer. A sound meter recorded the decibel reading 3 feet in front of the printer. We recorded the highest dB rating consistently registered on the meter (see figure 2). We took a second reading for those printers with special quiet modes.

We ran our text-and-graphics speed test from PageMaker 3.01 under Windows 3.0. With the Windows print spooler disabled, we started timing as soon as the printer began receiving data, and we stopped timing when the printout was complete (see figure 1b). Our graphics file included line art, a scanned TIFF image, a gray-scale test pattern, and text in various fonts. We tested both Epson and IBM Proprinter emulation for those printers supporting both; otherwise, we used whatever driver the printer could handle. Some printers, such as the NEC Pinwriter P6300 and the Fujitsu DL4600, have custom Windows 3.0 drivers. For these printers, we tested the available emulations as well as the native drivers. We timed the Hewlett-Packard DeskJet 500 using the standard DeskJet driver. We also tested the DeskJet 500–specific driver with scalable font technology. The scalable fonts looked terrific, and we had no problems running PageMaker with them. The PageMaker file ported directly to Mac PageMaker 3.02 for printing from the Mac Portable.

Next, we parked the fanfold paper and loaded a seven-part McGraw-Hill requisition form (if you can get one of those through, you can get anything through—these monsters have seven sheets of heavy paper and six separate carbons). We set the gap adjustment until the highest-quality printout was achieved. If a printer would not accept the seven-part form, we removed pages from the form one by one until the form fed properly. Although not all printers accepted the seven-part form, they all met or exceeded the vendor specification for multiple copies. Ink-jet printers will not generate multipart copies.

Please Turn That Thing *Down*

The new breed of dot-matrix printer is worlds quieter than its ancestors, although after testing over 20 of them, we still went to bed at night with that annoying hum in our ears.

Some models with special "quiet" modes dampen noise by printing more slowly and by printing one-half of the line in each of two passes. Our tests revealed that most printers produce copy at roughly half-speed when printing in quiet mode. Some of the printers were pleasantly muted even without a quiet mode. And, of course, if you really cherish your peace and quiet, the ink-jet printers barely break out of a whisper. We took sound readings for each printer and graphed the results in figure 2. We used the most common unit of sound measurement, decibels, in our testing. Doubling the volume means a 10-dB increase. A difference of 5 or 6 dB is significant, and even a 2-dB difference is noticeable.

It helps to listen to the printer before you buy it. Try to carry on a normal conversation with the printer running. We found that the dB rating of a printer was not always as important as the quality of the sound that it made. Some emit an unobtrusive sound that may register a higher dB rating, while a "quieter" model may make you cringe with its high-pitched squeal. Two of the quietest printers, the Brother M-1924L and the Seikosha SL-230, registered 65 dB in fast draft mode; in quiet mode, they both registered 62 dB. Compare that to the Panasonic KX-P1624, which prints at 77 dB in fast draft, 68 dB in quiet mode. Then

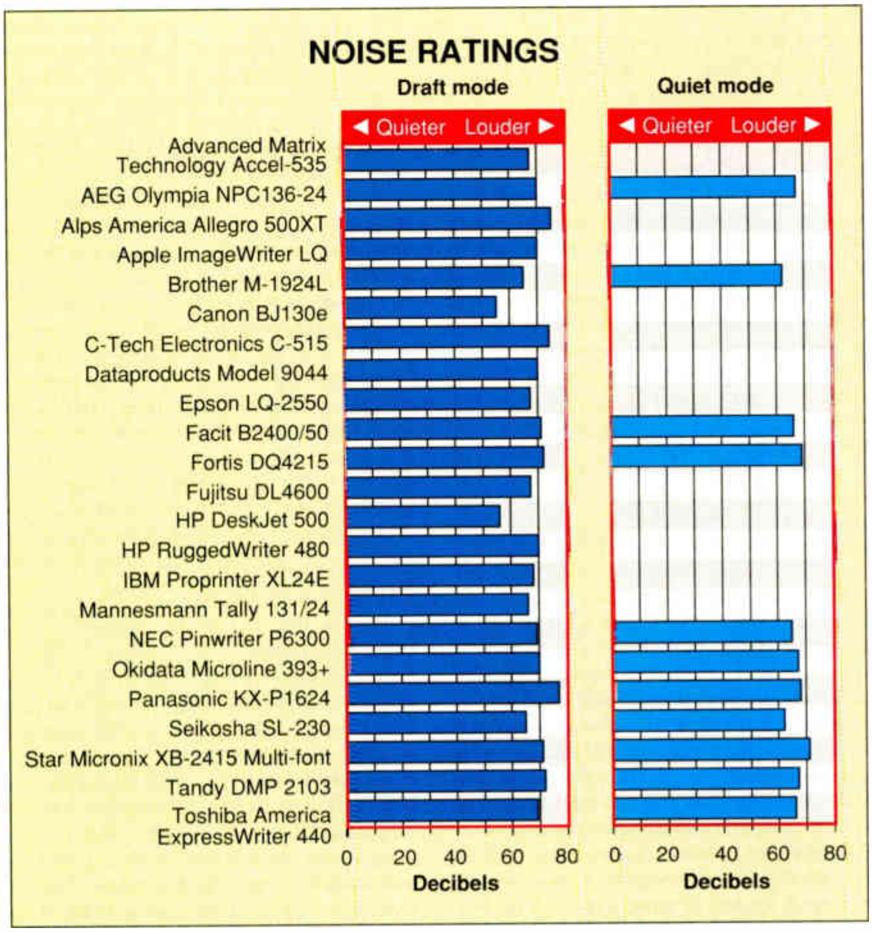
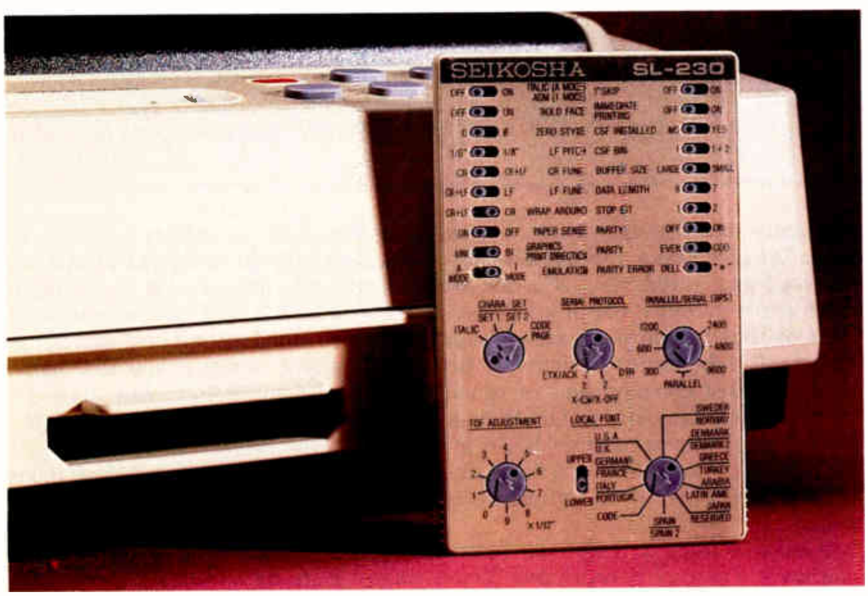


Figure 2: *Sound readings taken 3 feet away from the printer. On a dB scale, an increase of 10 equates to sound twice as loud, but even a 2-dB difference is noticeable. A typical conversation registers 60 dB, while a passing truck registers about 90 dB. It was no surprise that the two ink-jet printers (the Canon BJ130e and the Hewlett-Packard DeskJet 500) were the quietest. For those printers that include a quiet mode, we measured that separately.*



there are the Alps Allegro 500XT and the C-Tech C-515, buzzing in at 75 dB and 74 dB, respectively, without a quiet mode to tone down the chattering when the phone rings.

One solution to the noise problem is a printer muffler—a cabinet with foam insulation and cooling that you place over the printer. Depending on the size and quality of the enclosure, we found printer mufflers listed in several mail-order catalogs for between $70 and $250. Or you could hook your printer to a long serial cable and put it in your closet.

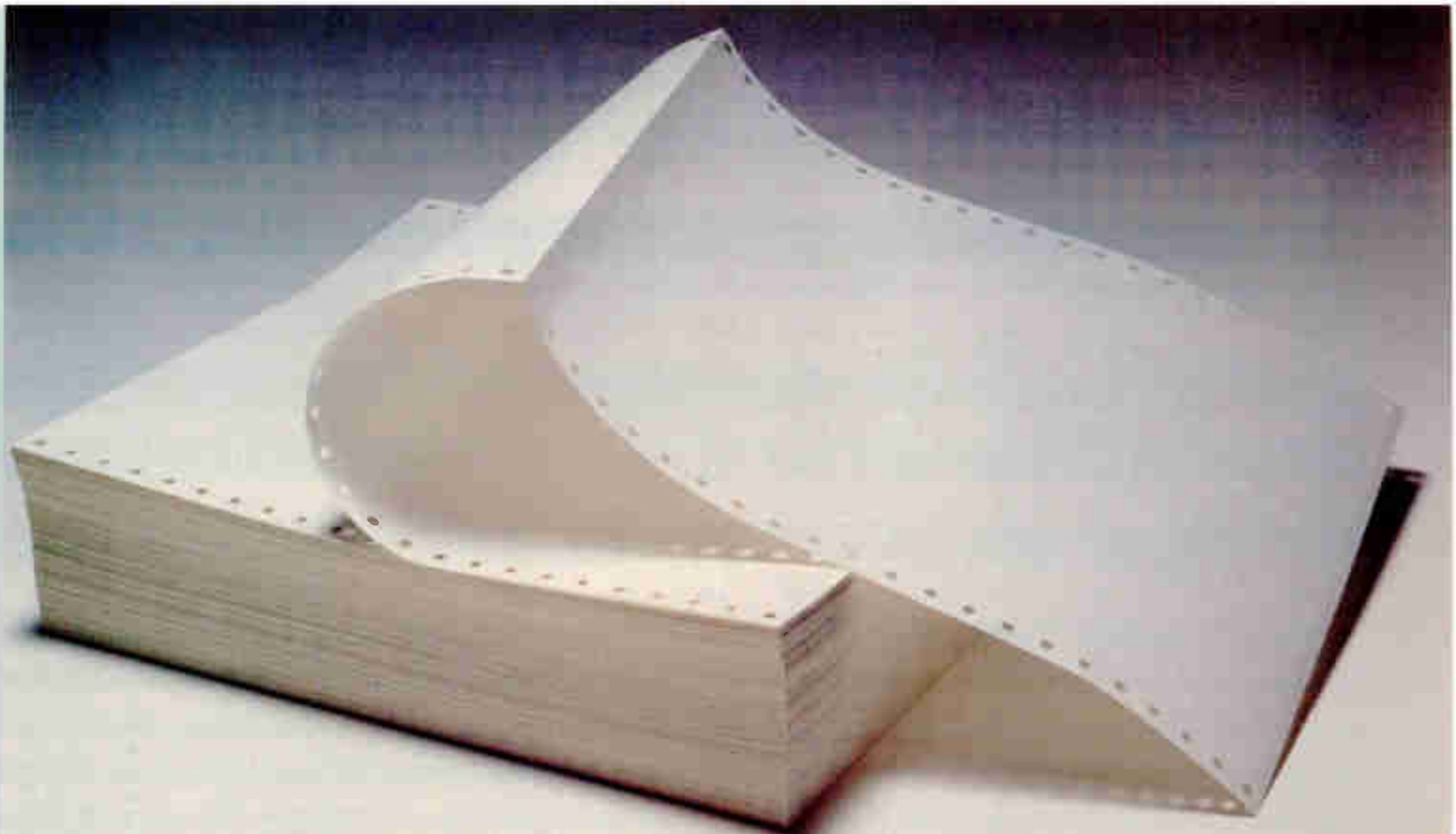
DIP Switches, R.I.P.

As simple as the technology seems at first glance, dot-matrix printers are notoriously aggravating to work with. Vendors of the latest breed have bucked this trend by improving paper-handling features and the user interface. For the most part, DIP switches—those tiny, cryptic switches used to configure printers in the past—have gone the way of the daisy wheel. Among the 24-pin printers that we looked at, only the Hewlett-Packard RuggedWriter still uses the old-time interface. In fact, the RuggedWriter uses DIP switches only for configuration settings that you won't normally deal with on a day-to-day basis. The RuggedWriter handles font and pitch changes by front-panel controls.

Some vendors still use a variation of the DIP switch theme. The Seikosha America SL-230 keeps its configuration switches on a credit-card-style function card (see photo 2). You set the switches (kind of like rotary DIP switches) and then slide the card into the front of the printer. The twist here is obvious: You can have different cards configured for each printer application. This feature is especially handy when different applications need to share one printer. Instead of fumbling through a new configuration each time a different user requires hard copy, each user simply plugs in a customized card.

Among the printers we reviewed, most offer a true menuing interface. You view menu options from an LCD or from a printed list. Either way, your current selections and possible choices are clearly displayed so you don't have to refer to a manual each time. Some of the printed menus—such as the ones from C-Tech,

Photo 2: *The Seikosha SL-230's credit-card-style function card serves the same purpose as old-fashioned DIP switches. You can keep multiple function cards, each configured for a different application.*



The argument for buying our new laser line printer is full of holes.

Consider the facts and you'll agree. The Laserfold is the logical conclusion for departmental computing environments. Particularly where high-speed printing of high-quality text is an everyday requirement.

That's because the Laserfold ends the trade-offs between high-speed line printers and high-end page printers. It simply gives you the best of both... at a lower cost than either.

It combines laser-quality character resolution, a fast 16-pages-per-minute output, extremely quiet operation and desktop size.

So when you're printing high-quality text on fanfold paper for business, technical or accounting applications, there's simply no argument against choosing the Laserfold.

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(314) 427-1919

Nimax
Livonia, MI
(313) 427-1010

Proven Solutions
Olympia, WA
(206) 352-4512
(800) 541-0183

Q/Cor
Norcross, GA
(404) 923-6666
(800) 548-3420

Chess
Denver, CO
(303) 573-5133

Circle 230 on Reader Service Card

COMPARING PRINTER FEATURES

Table 1: *Paper-handling options, speed, and noise ratings are among the most important features that distinguish 24-pin dot-matrix printers.*

Printer	Advanced Matrix Tech.	AEG Olympia	Alps America	Apple	Brother	Canon	C-Tech	Dataproducts	Epson	Facit	Fortis
Model	Accel-535	NPC 136-24	Allegro 500XT	ImageWriter LQ	M-1924L	BJ130e	C-515	9044	LQ-2550	B2400/50	DQ4215
Price	$1485	$799	$799	$1399	$849	$995	$749	$1099	$1499	$849	$899
Rated characters per second—draft (10 cpi)	400	200	250	250	225	240	200	250	333	200	200
Rated characters per second—LQ (10 cpi)	80	67	83	115	75	110	66	83	111	65	67
Standard buffer (bytes)	32K	24K	23K	5K	64K	64K	28K	2K	8K	26K	24K
Optional buffer (maximum) (bytes)	400K	56K	55K	None	32K	None	None	32K	32K	None	None
Type of tractor	Push	Push	Push	Push or pull	Push	Pull(O)	Push	Push	Push	Push	Push
Bottom feed?	●	○	●	●	○	○	○	○	○	○	●
Autoload?	●	●	●	●	●	●	●	●	●	●	●
Paper park?	●	●	●	○	●	N/A	●	●	●	●	●
Tear-off?	●	●	●	○	●	N/A	●	○	●	●	●
Autobail?	●	●	○	○	●	N/A	●	●	●	○	●
Plug-in font cartridge?	●	●	○	○	●	○	●	●	○	●	●
Quiet mode?	○	●	○	○	●	N/A	○	○	○	●	●
Number of multiple copies	6	3	4	5	4	N/A	4	3	6	4	3
Resident fonts	4	6	7	N/A	9	3	9	2	7	2	4
Ribbon life (characters)	5 million	2 million	2 million	4 million	3½ million	1 million (cartridge)	3½ million	2 million	3 million	3 million	Not available
Print-head life[1]	Not available	100 million characters	200 million dots/pin	400 million dots/pin	200 million dots/pin	Not available	200 million dots/pin	200 million dots/pin	200 million dots/pin	150 million characters	100 million characters
Mean time between failures	15,000 hours (50% duty)	6000 hours (20% duty)	6000 hours (25% duty)	6000 hours (25% duty)	6000 hours (25% duty)	Not available	6000 hours (25% duty)	5000 hours (10% duty)	6000 hours (25% duty)	>4000 hours (20% duty)	6000 hours (20% duty)
Number of stored configurations	5	2	3	1	1	1	1	1	4	1	2
Dimensions in inches (D,W,H)	24 x 7.35 x 16.9	24.4 x 5.1 x 13.8	23 x 8.4 x 13.6	23.2 x 5.12 x 15	24.6 x 15.3 x 6.1	24 x 5.4 x 14.3	22.5 x 4.6 x 12.4	23 x 5.3 x 14.3	26.6 x 7.7 x 20.4	23.25 x 5.12 x 13	25 x 6.5 x 16
Weight (pounds)	48	22	17.7	38	26.5	26.5	19.84	26.5	44	24.2	27
Tested decibel level (high-speed draft)	67	70	75	70	65	55	74	70	67	71	70
Emulations											
IBM Proprinter XL24	●	●	○	N/A	●	●	●	○	○	●	●
Epson LQ-1050	●	●	●	N/A	●	○	●	●	●	○	●
Epson LQ-2550	●	●	●	N/A	●	○	○	○	●	○	●
Others	Diablo 630, Xerox 4020				Diablo 630, Brother HR			Diablo 630		Epson LQ-850	
Graphics resolution (maximum) in dpi	240 x 480	360 x 180	360 x 360	216 x 216	360 x 360	360 x 360	360 x 180	360 x 180	360 x 360	360 x 180	360 x 180
User interface	LCD, select-dial	LCD	Printed menu	DIP switches	LCD	DIP switches	Printed menu	Printed menu	LCD	Printed menu, move print head	LCD
Auto thickness sensor	○	○	○	○	○	○	○	○	●	○	○
Heat sensor	○	○	●	○	○	○	○	○	●	○	○
Micro feed (increment)	1/120 inch	1/180 inch	1/180 inch	1/216 inch	○	○	1/216 inch	1/180 inch	1/180 inch	1/180 inch	1/180 inch
Color	●	○	○	●	(O)	○	○	(O)	●	○	(O)
Warranty (years)	1	1	1	1	1	1	1	1	1	1	1
Hardware interface	P, RS-232C	P, RS-232C	P, RS-232C(O)	RS-232C, RS-422, LocalTalk(O)	P, RS-232C	P, RS-232C(O)	P, RS-232C	P, RS-232C(O)	P, RS-232C	P, RS-232C	P, RS-232C

●=Yes. ○=No. (O)=Optional. N/A=Not applicable. LQ=Letter quality.

[1] Vendors measure print-head life in characters or in dots per pin. The number of pins fired per character depends on various factors. A draft character equals roughly two dots.

Dataproducts, Okidata, and Tandy—print a line for each option you cycle through. For instance, to change the setting for characters per inch, you cycle through each option (e.g., 15 cpi, 12 cpi, 10 cpi), and each option is printed on a line as you move through them. You then press a second button when the proper option is printed out. The method is simple and clear, but it's also slow, and it wastes paper. To save time and paper, the Facit B2400/50, the Mannesmann Tally 131/24, and the Star Micronics XB-2415 Multi-font vary the technique somewhat. These models also print out menu options, but to select those options, you press directional keys to use the print head as a cursor to make your selection.

For true clarity and ease of use, you can't beat the LCD interface. With the best ones, clear options are displayed on the panel and selected simply, without reference cards or wasted paper. So if you crave an elegant cure for the printer installation blues, take a close look at the models with LCDs: the AEG Olympia NPC 136-24, the Brother M-1924L, the

COMPARING PRINTER FEATURES

Fujitsu	Hewlett-Packard	Hewlett-Packard	IBM	Mannesmann Tally	NEC	Okidata	Panasonic	Seikosha America	Star Micronics	Tandy	Toshiba America
DL4600	DeskJet 500	RuggedWriter 480	Proprinter XL24E	131/24	Pinwriter P6300	Microline 393+	KX-P1624	SL-230	XB-2415 Multi-font	DMP 2103	ExpressWriter 440
$1199	$729	$1695	$1199	$999	$999	$1499	$650	$998	$899	$899	$699
333	240	400	240	250	250	345	160	230	200	225	200
111	120	200	80	83	125	115	53	77	67	75	66
24K	16K	2K	14K	17K	80K	23K	12K	5K	41K	16K	Not available
None	272K	16K	None	49K	None	17K	32K	64K	201K	None	Not available
Push	None	Push	Push	Push	Push	Push	Push	Push	Push	Push	Push
○	N/A	●	○	○	●	●	●	○	○	●	○
●	●	●	●	●	●	●	●	●	●	●	●
●	N/A	○	●	●	●	●	●	●	●	●	●
●	N/A	●	○	●	●	●	●	●	●	●	●
●	N/A	○	○	○	○	●	○	●	●	○	○
●	●	●	●	●	●	●	○	○	●	○	○
○	N/A	○	○	○	●	●	●	○	●	●	●
5	N/A	6	4	3	4	4	4	4	4	4	4
7	9	3	4	7	8	4	7	9	16	6	5
5 million	1000 pages (cartridges)	5 million	Not available	2.5 million	3 million	5 million	3 million	5 million	4 million	2 million	3 million
400 million dots/pin	(Part of cartridge)	Life of printer	Not available	150 million characters	200 million dots/pin	400 million dots/pin	200 million dots/pin	300 million dots/pin	200 million dots/pin	200 million characters	200 million dots/pin
8000 hours (25% duty)	20,000 hours (25% duty)	20,000 (10% duty)	Not available	7800 hours (25% duty)	6000 hours (25% duty)	4000 hours (25% duty)	5000 hours (25% duty)	5000 hours (30% duty)	4000 hours (25% duty)	5000 hours (25% duty)	Not available
2	1	1	1	2	1	1	4	1	1	1	1
22.9 x 7.5 x 15.2	17.3 x 8 x 14.8	23.6 x 8.2 x 13.7	22.7 x 4.8 x 13.5	23.5 x 6.3 x 12.5	23.6 x 8.25 x 15	16.4 x 7.1 x 22.4	23.2 x 5.6 x 15.7	23.9 x 5 x 13.8	23.3 x 5.5 x 13.4	21.7 x 4.6 x 13.6	22.5 x 5.1 x 12.4
39.7	14.3	35	27	25.7	29	37	32	26.5	23.1	22.3	19.84
68	56	70	68	66	69	70	77	65	72	72	69
●	(O)	○	●	●	○	●	●	●	●	●	●
●	○	●	○	●	●	●	●	●	●	●	●
●	○	○	○	●	●	●	●	○	○	○	○
Fujitsu DPL24C	HP PCL, Epson FX-80(O)	HP 2930, HP LaserJet		NEC Pinwriter	NEC P5200/5300						
360 x 360	300 x 300	180 x 180	Not available	360 x 360	360 x 360	360 x 360	360 x 360	360 x 360	360 x 360	360 x 360	360 x 360
LCD	DIP switches	DIP switches	Buttons, musical tones	Printed menu	Printed menu	Printed menu	LED matrix	Function card, move print head	Printed menu, move print head	Printed menu	Printed menu
●	○	○	○	○	○	○	○	○	○	○	○
○	○	○	●	○	●	○	●	●	●	●	○
1/60 inch	○	1/180 inch	1/180 inch	1/180 inch	1/180 inch	1/180 inch	1/180 inch	○	1/360 inch	1/80 inch	1/80 inch
(O)	○	○	○	(O)	(O)	(O)	○	○	(O)	○	○
1	3	1	1	1	1	1	2	1	2	1	1
P, RS-232C	P, RS-232C	P, RS-232C, HPIB(O)	P, RS-232C(O)	P, RS-232C(O)	P, RS-232C(O)	P, RS-232C	P, RS-232C(O)	P, RS-232C	P, RS-232C(O)	P	P, RS-232C

Epson LQ-2550, the Fortis DQ4215, and the Fujitsu DL4600.

Perhaps the slickest interface of all (the most fun, anyway) belongs to the Advanced Matrix Technology Accel-535. In addition to a detailed 16-character LCD, the control panel has a select dial (see photo 3). The dial serves a few purposes. With the printer off-line, the dial acts as a platen knob, properly positioning your paper. If you turn the dial while pressing the Alt button, the print head moves left or right. This provides an easy way to set margins and print forms. You just position the head where you want to print and go to it. And finally, the dial aids the user interface. You turn the dial to scroll through various menu options. Making setup changes on the Accel-535 is as easy as picking songs on a jukebox.

Another way to prevent configuration headaches is to use stored configurations. If you have two or three different applications for the printer, you can store the proper configuration for each one of them. When it comes time to change

How to Tell One Dot-Matrix Printer from Another

Armed with a good knowledge of printer basics, how do you go about selecting a 24-pin dot-matrix printer? As we pointed out in the main article, first decide if you really need one. If you're planning to spend many hours a day printing, you might be better served by an LED, LCS (liquid-crystal shutter), or laser printer. If quality is more important than multipart capability, or if noise is likely to be a problem, perhaps you'd be better off with an ink-jet printer.

On the other hand, if your applications require high-quality output, don't buy a dot-matrix printer just to save a few bucks. Down the road, you will probably regret not purchasing a page printer. Laser-quality output is quickly becoming the standard for business correspondence. Dot-matrix print, even at 24-pin resolution, just won't look professional enough. For basic correspondence needs (even simple letters and memos), you should spring for the extra cash for a low-cost page printer.

If, after you have carefully weighed all these points, you're committed to buying a dot-matrix printer, consider the following issues. Do you plan to alternate between tractor-fed and single-sheet paper on a regular basis? If so, parking and autoloading features are essential. If you're going to share the printer on a network and load it down with long print jobs, a heavy-duty print mechanism and high-speed output would be wise. If you need the multipart capability but have to work in close quarters with the printer, pay attention to the quiet mode or the machine's overall noise ratings.

Label stock has improved significantly over the years. It used to be that the labels would come off the backing paper and jam up under the print platen, causing all sorts of serious, sometimes fatal, jams. Getting adhesive labels out from under the platen can be almost impossible. Things are better now, but we suggest that you stick with straight paper paths for printing labels. A front-to-back or bottom-to-top path will serve you well.

Finally, when you start scouting out printers, don't be content to print on a preconfigured display model. That's a good way to narrow down your choices, but once you're close to a decision, ask if you can take it through the configuration process yourself. You'll learn a lot about the printer's operation and ease of use. We found out as much about these printers by setting them up and configuring them as we did testing and analyzing them.

parameters, you can do it in one easy step; just activate the custom configuration. Table 1 reports the number of stored configurations available with each printer.

Choosing the Right Path

Despite advances, most dot-matrix printers still require some babysitting. A major problem is back-feeding. Many models still feed paper from the rear and send output to the rear. All too often, the output will curl around to the feeding mechanism, wrap around the platen, and cause a crippling paper jam. You can always direct the paper over the front of the printer to avoid the problem, but there are better solutions.

Some vendors devise paper separators. A rack or tray separates the output from the ingoing paper, with varying degrees of success. A better way is to feed your paper in from one direction and out another. With bottom-feed printers, you can place the paper below the printer and never have to worry about back-feeding again. The paper flows in the bottom and out the rear, which also frees up a little desk space. Some bottom-feed printers require an optional pull tractor, and you will need a special stand with an opening on the surface to accommodate bottom feeding. The Alps Allegro 500XT and HP RuggedWriter 480 feed from the front and send printed copy out the rear. This prevents back-feeding and makes printing labels easier. With a straight paper path, the labels do not wrap around the platen where they often peel off or jam the printer. You'll need to clear some extra space in front of your printer, but that's far easier than clearing a nasty jam.

Desk Snakes

Another aggravating paper problem involves the placement of a printer's cables. The parallel cable and the AC cord join the traffic at the rear of the unit, often causing messy tangles and an obstructed paper path. Some vendors, such as Brother, put the cable port on the side of the printer. This solves one problem but may cause others. The cable and port are more exposed to possible abuse, and you will need to clear out additional space beside your printer to make room for the cable. Epson opted for a simple solution: A clear plastic cover lies over the cables, keeping them out of your way.

Tractors that pull paper from above the print head are the most efficient way to move paper, but getting the last page of

Photo 3: *The Advanced Matrix Technology Accel-535 has the slickest interface of the 27 dot-matrix and page printers we reviewed this month. By spinning the dial, you can scroll through the options in the menu display. When not setting options, the dial can move the paper or set margins.*

a printout requires the waste of a whole sheet. To avoid this, each printer that we tested has a *push tractor* below the printing mechanism. Some vendors offer pull tractors as an option, usually to accommodate thick forms and labels. We had no problem with tractor feeding from any of the printers we tested.

The only difficulty we encountered came from the paper itself. Perforated sheets come in two major forms—regular and razor-cut. The regular paper has thick, meaty perforations that require some effort to tear. Razor-cut paper has more precise perforations that tear cleanly and leave clean edges. Sometimes in our tests the sheets tore too easily, separating the paper from the pin-feed strips and causing a paper jam. Reloading the paper usually was enough to get the job printed.

A few important features have significantly improved paper handling. Most dot-matrix printers now load automatically. You just place the paper in the tractor and push a button, and the paper loads to the correct position. The print head senses the position of the paper so that it feeds consistently each time.

What a Rip-off!

The "tear-off" feature saves tractor-fed paper. After you've printed a page, you can press a button to make the paper feed enough so that you can tear it off. When you return to printing, the paper is rolled back to the top of the form. Anyone who has wasted sheets of paper just to tear off a printout should appreciate this feature. Some printers automatically advance paper to the tear-off position whenever the buffer is clear of data. When more data pours in, the printer pulls the paper back to its previous spot and begins printing again. Pretty slick. With the Alps Allegro 500XT, the paper advances to a tear-off position whenever 1 second passes without data coming into the printer. When we printed graphics from PageMaker under Windows 3.0, the data came out in spurts spaced more than 1 second apart. The Allegro would print a line of graphics, feed to the tear-off position, retreat, print another line, and feed to the tear-off position again. It's easy enough to turn off the tear-off feature, but you should be able to configure the interval, as well.

For loading single sheets, you'll really appreciate a *parking* feature. Simply push a button, and the fanfold paper retreats as far back as the tractor and stops. You can then switch to friction feed and load your single sheet. Another push of a button automatically loads the fanfold paper again. If you do a lot of switching between fanfold paper and single sheets, you really need parking.

Lift That Bail

Another clever feature is the automatic bail. While the paper is loading, the paper bail automatically retracts from the platen. Then, as the paper passes beneath it, the bail snaps into position. This feature is especially useful when you have a single sheet that does not feed quite far enough for the paper bail to trap it. If you leave the bail down and start printing, the paper will often crumple as it encounters the bail. Otherwise, you have to watch the paper as it ejects and close the bail at the right time. Automatic bails stay open when the page is loaded and snap down as soon as the paper is beneath them.

One clear application still belonging solely to the dot-matrix crowd is printed forms. To test the printers, we loaded them with a seven-part, friction-feed form and filled it out, checking each copy for legibility. Although a couple of printers were unable to print all seven copies, they all easily lived up to the vendor specifications. Table 1 reports how many copies the printer can safely handle (the number on the table includes the original). We recommend that you stay within the vendor specifications for multiple copies. You can damage your print head if you don't. The printer usually has a "paper gap" adjustment. You set the lever to reflect the number of pages being loaded. The Epson LQ-2550 and the Fujitsu DL4600 can automatically sense the paper thickness and adjust the print head accordingly, so you need not worry about manual adjustments each time.

Cut-sheet feeders hold a stack of single sheets, loading them to the printer one at a time. At least, that's the theory. Friction feed and gravity are not the most reliable loading method. If you plan on using cut sheets most of the time, an inexpensive laser printer would better serve your needs. Paper cassettes smoothly feed single sheets, and a laser printer's output is usually more suitable for a cut-sheet application.

And Another Thing...

You should always consider upgrade possibilities. Will you want color? The Advanced Matrix Technology Accel-535, Apple ImageWriter LQ, and Epson LQ-2550 can give you that right out of the box. Other models, as listed in table 1, offer a color option. This usually involves installing a small device that will raise and lower the ribbon so that the pins strike one of four color bands. To print secondary colors (such as green), the head lays down first a track of yellow and then a track of cyan. While it may form a pretty shade of green, printing a light color over any darker color will pick up stray color, ruining the ribbon. After a while, your yellows will be tinged with green, your reds with purple. Expect your color ribbons to have a much shorter life. Color-capable printers often treat an

Photo 4: *Two rugged machines: the Hewlett-Packard RuggedWriter 480 (bottom) and the Okidata Microline 393+ should stand up to hard use.*

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Model	H. Frequency	Dot	Resolution
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MF-5121	21 to 50kHz	0.31	1024 × 768
MF-5221	30 to 80kHz	0.31	1280 × 1280
MF-5321 (A.R.Panel)	30 to 80kHz	0.31	1280 × 1280
MF-5421 (A.R.Panel)	30 to 80kHz	0.26	1600 × 1280

IDEK also offers its new Model MF-5117 17" Flat Screen Color Monitor that delivers the same superior resolution and performance as the other members of the IDEK lineup.

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144 Centre Mountain View, CA 94041 U.S.A.
Phone: (1) 415-962-9410 Fax: (1) 415-962-9474

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COMPANY INFORMATION

Advanced Matrix Technology
(Accel-535)
765 Flynn Rd.
Camarillo, CA 93012
(805) 992-2264
Inquiry 1111.

AEG Olympia, Inc.
(NPC 136-24)
3140 Route 22
P.O. Box 22
Somerville, NJ 08876
(800) 999-7808
Inquiry 1112.

Alps America
(Allegro 500XT)
3553 North First St.
San Jose, CA 95134
(408) 432-6000
Inquiry 1113.

Apple Computer, Inc.
(ImageWriter LQ)
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry 1114.

Brother International Corp.
(M-1924L)
200 Cottontail Lane
Somerset, NJ 08875
(201) 981-0300
Inquiry 1115.

Canon USA, Inc.
(BJ130e)
One Canon Plaza
Lake Success, NY 11042
(800) 848-4123
Inquiry 1117.

C-Tech Electronics, Inc.
(C-515)
2515 McCabe Way
P.O. Box 19673
Irvine, CA 92713
(800) 347-4017
Inquiry 1116.

Dataproducts Corp.
(Model 9044)
6200 Canoga Ave.
Woodland Hills, CA 91367
(800) 624-8999
Inquiry 1118.

Epson America, Inc.
(LQ-2550 and EPI-4000)
20770 Madrona Ave.
Torrance, CA 90509
(800) 289-3776
Inquiry 1119.

Facit, Inc.
(B2400/50)
P.O. Box 9540
Manchester, NH 03108
(603) 647-2700
Inquiry 1120.

Fortis Direct Connect Systems
(DQ4215)
1820 West 220th St., Suite 220
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(Pinwriter P6300)
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(Microline 393+ and OkiLaser 820)
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(KX-P1624)
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(XB-2415 Multi-font)
420 Lexington Ave., Suite 2702
New York, NY 10170
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(DMP 2103)
1800 One Tandy Center
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Toshiba America Information Systems, Inc.
(ExpressWriter 440)
Computer Systems Div.
9740 Irvine Blvd.
Irvine, CA 92718
(800) 334-3445
Inquiry 1059.

all-black ribbon as a color ribbon, spreading out the printing chore over the four black "bands." A black ribbon will last at least four times as long as a color ribbon for black printing jobs. Because of the extra color bands, a color ribbon is more expensive, and printing black text will use only one-fourth of the ribbon.

You may also want a wider variety of type styles as your needs develop. Most of these printers accept some kind of font card to generate additional fonts. However, there is no standard equivalent to the HP LaserJet cartridge. In general, dot-matrix font cartridges are proprietary beasts, offered directly by the company that sold you the printer. Some have a rich selection of fonts to choose from; others have only a select few. Vendors add new ones all the time, so find out how many and which fonts are available for your model. Be aware that because the fonts are nonstandard, your software probably won't know about them. You'll have to add the font functionality to your applications or select your new fonts from the control panel.

By all means, skim through the printer's documentation. At the very least, it should include clear step-by-step installation and operation instructions, expository illustrations, a complete listing of command sequences (in ASCII, decimal, and hexadecimal notation), and—as always—a sufficient index. You may not need it all now, but it may come in handy sometime.

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PRODUCT FOCUS

important. For others, quality or the ability to handle multipart forms is the deciding factor. The text box "How to Tell One Dot-Matrix Printer from Another" on page 166 explains how you might choose between them and how we selected the five printers below.

It turns out that there's a good reason for the market leaders being market leaders. Epson may not be known for its other hardware offerings, but the people there sure know how to build a printer. The LQ-2550 ($1499) is a beautiful machine. It has a simple LCD interface and all the amenities, including an automatic bail and a thickness sensor. Color is standard, and you certainly won't have to worry about compatibility. Likewise with the IBM Proprinter. Its interface is a bit cryptic, relying in part on musical tones, but its output is beautiful and its construction solid. The Okidata Microline 393+ (see photo 4) printed well, has all the amenities, and is built like a tank. For heavy-duty use and high-quality output, you probably can't do better than the Okidata.

Like the LQ-2550, the Advanced Matrix Technology Accel-535 ($1485) is expensive, but, again, with good reason. This printer is fast and full-featured. The LCD interface is as elegant as it gets. Color is standard, as is a 32K-byte buffer (upgradable to over 400K). You'll also get four resident fonts and an excellent manual.

If speed is not a major concern but price is, the Panasonic KX-P1624 offers all the major features, seven resident fonts, and a 12K-byte buffer for $650. For $149 more, the AEG Olympia NPC 136-24 adds an automatic bail, a 24K-byte buffer, and an LCD interface.

Dot-matrix printers still have a broad market that page printers can't touch. And even if you already have your fancy page printer, you may want a dot-matrix printer to churn out your drafts and listings. That strategy will save time and money, not to mention wear and tear on your laser printer engine. Don't discount the lowly dot-matrix printer. It could be just the workhorse you need. Prices should continue to fall as laser printers put a squeeze on the low end of the market. You should be able to find some real steals out there. Dot-matrix technology may not be sexy, but it's still alive and well. "Old Man Ribbon," he just keeps printing along. ■

Stanford Diehl and Howard Eglowstein are BYTE Lab testing editor/engineers. They can be reached on BIX as "sdiehl" and "heglowstein," respectively.

BYTE

REVIEWS

SYSTEM

Tom Yager

Sony NeWS and MIPS Magnum: A Double Shot of RISC

With such a crowd of Unix workstations in the low-end market, how can you tell them apart? In a word, software. Consider, for example, the Sony NeWS 3710 and the MIPS Magnum 3000. Both machines are based on the MIPS R3000 RISC CPU chip set. Both have floating-point acceleration and fast color graphics.

Physically, these machines have much in common. They are compact, the Magnum 3000 slightly more so (see the photos). They come equipped with quarter-inch cartridge tape drives. At the rear, the machines have connections for the keyboard, serial devices, a thick-wire Ethernet port, and external SCSI devices. While both workstations use the same CPU and floating-point chips, the NeWS 3710 runs at 20 MHz, while the Magnum 3000 runs at 25 MHz.

From there, the hardware differences are almost insignificant, with a couple of exceptions. The NeWS 3710 holds a front-facing, high-density 3½-inch floppy disk drive next to the tape drive. It's a bit more expandable than the Magnum 3000, holding two 25-pin serial ports and three internal expansion slots. On the review system, two of the three slots were available; one was occupied by the color display controller. The NeWS 3710 also boasts digital stereo audio and the ability to power itself down.

The Magnum 3000 has one Industry Standard Architecture–compatible internal slot, but the color display adapter fills it (leaving it free only on the monochrome system). The machine also has two serial ports, but one of them is devoted to the mouse through an odd cable arrangement. For convenience, the mouse plugs into the keyboard (as with the Sony), but the Magnum 3000's keyboard cable splits to connect to both the keyboard and serial port number 1 sockets. A round "don't touch me" sticker bound one edge of the case, indicating that the unit is not field-expandable.

How It Feels

If you sit in front of a workstation all day, as I do, how well the system interacts with you is important. In the case of these two machines, the display is no problem—both use the gorgeous Sony Trinitron monitor. Sony shipped a 19-inch display; MIPS sent a 16-inch monitor. The colors are true, and the pixels are small and sharply defined, making the display easy on your eyes.

The Magnum 3000's keyboard is springy, and it looks very Mac-like. It sports a network activity light (which, incidentally, never came on). The key placements are just where you'd expect them to be. The feel was a little stiffer than I like. The Magnum 3000 uses the likable, old-style Logitech Mouse (the boxy one). You can rest your entire hand on it, and the buttons have a short travel and a positive click that lets you know that you've pressed them.

On the other hand, the NeWS 3710's keyboard and mouse were so unpleasant to use that they might as well have been wrapped in barbed wire. Special keys, such as a Vertical Line key, are placed so that a touch-typist has to stop dead and hunt for them. The Delete key is next to the Return key, inviting disaster from unsuspecting operators who terminate their programs when they try to get to the next line. The right-hand Shift key is adjacent to a dead key (it doesn't travel—I call it a "finger breaker"), and the Alt key appears on only one side of the keyboard. The mouse is also awkward to use. It's hard to wrap your hand around it, and the button travel is too long. My mouse squeaked, appropriately, when I pressed the buttons.

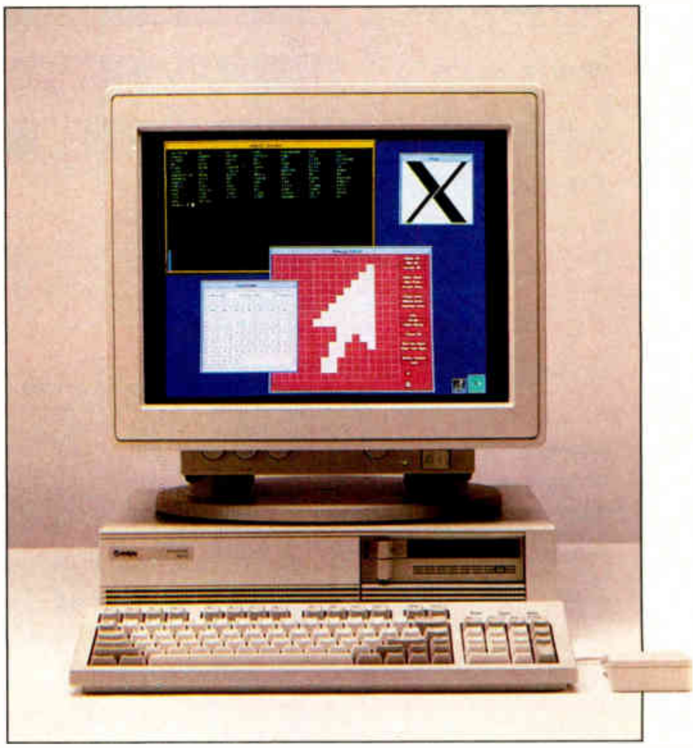
One redeeming feature of the NeWS 3710's interface is its software-operated power switch. I first encountered such a switch on the AT&T 3B2 and thought it was a great idea. If you're working at home and a nasty thunderstorm starts moving in, you can dial up your Sony workstation at your office and tell it to shut itself off. A special argument to the `shutdown` command, `-x`, does an orderly shutdown and dumps power.

The front-mounted power switch will not power down the machine (it only works to power it up), which is good, since the placement makes it a prime target for accidental contact. Remote power-down capability also adds extra teeth to any power-monitoring scheme you might set up. When your uninterruptible power supply kicks in, you can have the system automatically power off. This is such a simple, worthwhile idea and is so easy to implement that I can't understand why it isn't standard on every computer.

Software: The Real Difference

Don't let anyone fool you—the most important piece of equipment in a workstation is the software. In this regard, the systems are as different as they can be and yet still be similar; let me explain.

The NeWS 3710 that I received was running the same operating system as other Sony workstations: BSD 4.3. The Magnum 3000 runs its own RISC/OS, which is a mix of System V and BSD. The operating-system question may be moot by the time you read this; Sony is switching over to System V release 4. Much of what that operating system promises is already in RISC/OS. MIPS stacked the BSD file system, libraries, and commands atop a System V kernel. The folks at MIPS insist that the Magnum 3000 can compile and run any BSD or System V application without modification. Add to that job control, TCP/IP networking, line-printer handling, and other BSD-isms, and you have an operating system that should please even the staunchest BSD fanatic. I prefer System V as an application environment: It's easier to maintain and use, and all the benefits of System V are apparent in RISC/



The MIPS Magnum 3000 has a smaller case than the Sony NeWS 3710 and performs noticeably better. ▶

The Sony NeWS 3710. The floppy disk and tape drives are concealed behind a door on the right front of the case. ▼

Sony NeWS 3710

Company
Sony Microsystems Co.
645 River Oaks Pkwy.
San Jose, CA 65134
(408) 434-6644

Components (as reviewed)
Processor: 20-MHz MIPS R3000
Memory: 8 MB of RAM; 64K-byte instruction cache; 64K-byte data cache
Mass storage: 3½-inch 1.44-MB floppy disk drive; 640-MB hard disk drive
Display: 19-inch Sony Trinitron color monitor; 1280- by 1024-pixel 256-color display
I/O interfaces: Two serial ports; thick-wire Ethernet interface; SCSI port; three Sony expansion slots

Price
$18,200
With 16-inch monitor; $16,900

Inquiry 1110.

MIPS Magnum 3000

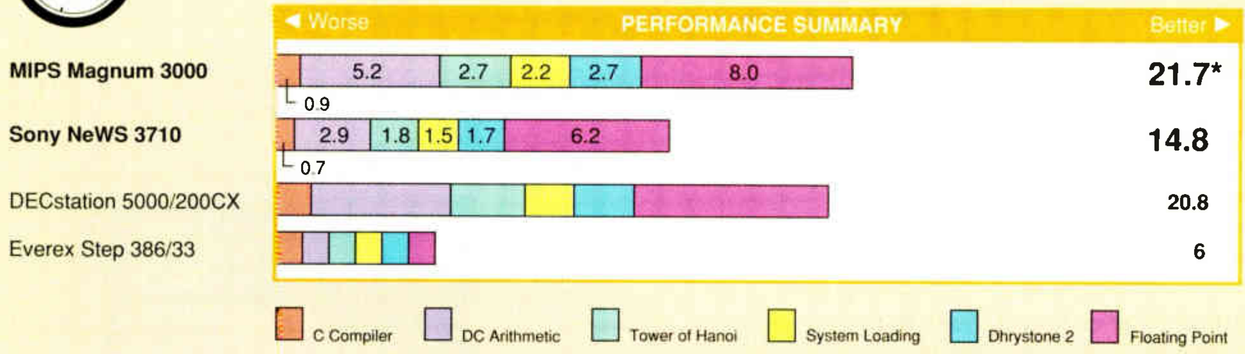
Company
MIPS Computer Systems, Inc.
950 De Guigne
Sunnyvale, CA 94086
(408) 720-1700

Components (as reviewed)
Processor: 25-MHz MIPS R3000; R3010 math coprocessor; 32K-byte instruction cache; 32K-byte data cache
Memory: 16 MB of RAM
Mass storage: Two 200-MB internal SCSI hard disk drives; 150-MB cartridge tape drive
Display: 16-inch Sony Trinitron color monitor; 1280- by 1024-pixel 256-color display
I/O interfaces: Two serial ports; thick-wire Ethernet interface; SCSI port

Price
$17,990

Inquiry 1109.

UNIX BENCHMARKS



HIGH-LEVEL PERFORMANCE

	Sony NeWS 3710 Time	Sony NeWS 3710 Index	MIPS Magnum 3000 Time	MIPS Magnum 3000 Index
* **C Compiler**	3.1	0.7	2.3	0.9
* **DC Arithmetic**	0.2	2.9	0.1	5.2
* **Tower of Hanoi** (17-disk problem)	0.3	1.8	0.2	2.7
System Loading[†]				
1 concurrent background process	3.0	1.3	2.1	1.9
2 concurrent background processes	3.9	1.5	2.8	2.1
4 concurrent background processes	6.5	1.5	4.5	2.2
* 8 concurrent background processes	11.6	1.5	7.8	2.2

* Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with 8 concurrent background processes), Dhrystone 2, and Floating Point tests.

† System loading was performed using Bourne shell scripts and Unix utilities.

Note: All times are in seconds unless otherwise specified. Figures were generated using the BYTE Unix benchmarks version 2.6. Indexes show relative performance; for all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1.
N/A = Not applicable.

LOW-LEVEL PERFORMANCE

	Sony NeWS 3710 Time	Sony NeWS 3710 Index	MIPS Magnum 3000 Time	MIPS Magnum 3000 Index
* **Dhrystone 2** (without registers; Dhry./sec.)	24000	1.7	37271	2.7
Arithmetic (10,000 iterations)				
Arithmetic overhead	0.7	1.1	1.0	0.7
Register	2.8	1.0	2.3	1.3
Short	2.7	1.3	2.4	1.5
Integer	2.8	1.1	2.3	1.3
Long	2.8	1.1	2.3	1.3
* Floating Point	1.9	6.2	1.5	8.0
Double	1.2	10.8	0.9	14.4
Throughput				
System call overhead (5 x 4000 calls)	0.5	2.1	0.5	2.2
Pipe throughput (read and write 2048- x 512-byte blocks)	0.9	1.0	0.3	3.0
Pipe-based context switching (2 x 500 switches)	0.2	3.2	0.1	4.8
Process creation (100 forks)	0.4	2.9	0.4	3.1
Execl throughput (100 execs)	0.5	6.6	0.8	4.1
Filesystem throughput (1600 1024-byte blocks in Kbytes/sec.)				
Read	988	N/A	884	N/A
Write	1458	N/A	859	N/A
Copy	185	N/A	327	N/A

OS. Soon, Sony will have them, too.

Both systems provide X Window System services, as well. Sony's X server includes the Shape (for handling nonrectangular objects) and Bézier (representing complex curves with few data points) extensions. These provide fertile ground for involved graphical applications.

The xdpyinfo program, which reports information about the configuration of the X server, told me that both displays measured 1280 by 1024 pixels, with a depth of 8 bits (256 colors). Sony's port of X Window is apparently the more complete, as it supports all the available X color models.

Managing colors in a portable way is probably the most difficult aspect of writing X applications. It's also the thing most programmers mess up. An X server that supports multiple color models helps smooth over these differences.

MIPS's X server, while fully functional, is less robust; it supports only one color model (PseudoColor) and lacks the Shape and Bézier extensions included in Sony's server.

In simple tests, X performance was almost identical, with the Magnum 3000 showing a negligible edge. Both machines do common text and window operations in a snap.

The NeWS 3710's differentiating feature is an unusual one: sound. The machine includes the circuitry and software for digitizing high-resolution stereo audio and playing it back directly from disk. A small transistor-radio-size box handles sound I/O; it holds a monophonic microphone and a tiny speaker. If you are going to experiment with the NeWS 3710's sound, don't waste time with the built-in mike and speaker. I hooked up a compact disc player and a pair of amplified speakers. The quality and clarity of the sound are excellent even at lower resolutions. At the top 37.5-kHz resolution, the NeWS 3710 had no trouble playing back crystal-clear stereo audio captured from a CD. There was no dis-

For a description of all the benchmarks, see "The BYTE Unix Benchmarks," March BYTE.

cernible noise or hum from having the machine's workstation guts churning so nearby.

Is this fluff? Today, it probably is. Someday, however, quality audio will likely become standard fare on all systems. Macintosh users have long been aware of the value of having a variety of expressive sounds under program control. Sony's X-based sound editor is primitive and has a demo feel to it, but there's great potential there.

Complex programs could benefit from vocal prompts and varied audio warnings whose tones indicate the severity of the condition. Aids for the handicapped suggest themselves, as do educational applications. It will take some time before audio capabilities like those in the NeWS 3710 are exploited to their full potential, but getting the hardware in there is a good start.

Pedal-to-the-Metal Performance

All this fancy hardware and operating-system software would be for naught if they didn't perform. Both systems do well, running more than twice as fast as the Everex Step 386/33 baseline system. This is worth considering if you're trying to choose among platforms. Something else worth considering is that not all implementations of the same hardware yield the same results. As the benchmark results show, the Magnum 3000 takes an early lead in integer performance and holds onto it right through the floating-point benchmark, outgunning both the NeWS 3710 and the MIPS R3000-based DECstation 5000/200CX. MIPS writes its own compilers, and the performance figures prove that the company *knows* RISC. The company uses this knowledge to full advantage, and it knows its audience, as well.

Network and X performance are respectable, and I had no trouble hooking either system into BYTE's Unix Lab network. Either machine would make an excellent X Window client server (a machine that runs X programs faster than you can and displays them at your workstation/X terminal).

As is typical of systems for which SCSI is integrated onto the motherboard, disk performance is marvelous on both machines, with the NeWS 3710 coming out slightly ahead. There is enough juice there to hang a bevy of external SCSI drives off either of these machines and leave them on-line as compute *and* Network File System file servers.

Shutdown

I liked both systems, but I'm afraid that there isn't much to recommend the NeWS 3710 as a general-purpose workstation. It doesn't measure up to the Magnum 3000 in performance or multi-environment compatibility. I've been told to expect more "Sonyisms," of which the digital audio is the first, and Sony may well be able to make a name for itself in multimedia and other niches.

I'm loath to call any system perfect, but the Magnum 3000 seems to have all the bases covered: price, performance, and software. I would have traded the squat case for more internal expansion, but that's a minor gripe. The MIPS machine is an excellent value—evidence that sometimes it's worth going straight to the source. ■

Tom Yager is a technical editor for the BYTE Lab. You can reach him on BIX as "tyager."

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Tom Yager and Tom Thompson

REVIEW

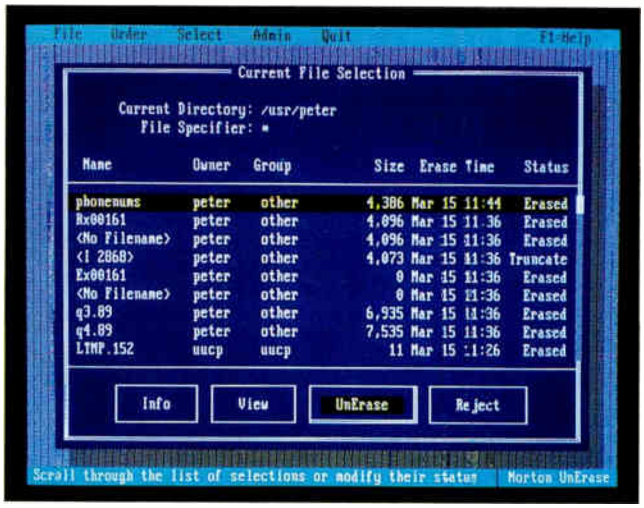
The Norton Utilities for System V

Getting involved with Unix can be like stepping into another dimension. So much of what Unix does happens quietly and invisibly, and the operating system's complexity can make it difficult to maintain. Unfortunately, with the growth of PC Unix, virtually every user must be prepared to perform some system administration.

Interactive Systems, one of the leading vendors of 386 Unix, and Segue Software have come to the rescue with a version of the Norton Utilities for 386 Unix System V. While the Norton Utilities for System V shares some utilities (e.g., UnErase, Disk Test, and Disk Explorer) with its DOS namesake, it is not a generic DOS package simply ported to Unix. Rather, it's a new package that Segue and Interactive wrote from the ground up to be Unix-specific.

I installed and tested the Norton Utilities for System V on an Advanced Logic Research PowerVEISA 486-25 running Interactive Unix System V/386 version 2.2. The first release of the software runs only on Interactive and AT&T 386 Unix. The disks are installed using AT&T's procedures, not Interactive's. That's a pity—Interactive's install programs are faster and more informative.

After the installation, a script sets up your system to run Norton. The bulk of the script is the rebuilding of the kernel to include support for the UnErase utility. Once installation is complete, you must reboot your machine to activate UnErase.



The Norton Utilities for System V's UnErase utility provides a list of erased files for restoration.

The documentation is stylish and appropriate. It assumes no prior knowledge of Unix and even provides a brief tutorial on common operations. A new Unix user should have no trouble installing and running the Norton Utilities.

Jumping Through Hoops

As DOS users of the Norton Utilities will attest, the package includes an odd assortment of utilities, ranging from the playfully benign to the genuinely dangerous. Where appropriate, each utility interacts with the user through a full-screen color interface. Even though it is text-based, the interface is attractive, sporting pull-down menus, windows, and drop shadows. Wherever it is better to use the sparser Unix command-line interface, Norton uses it.

UnErase, the single most important feature of the Norton Utilities for System V, lets you recover deleted files or directories. As with the DOS version, recovery is easier if you attempt it immediately after deletion. But because Norton builds UnErase into the Unix kernel, the Unix UnErase is a bit more flexible than the DOS version.

You can optimize UnErase for either maximum protection or most efficient use of disk space. The utility retains disk blocks normally freed by file deletion and returns them to the system according to user-defined age and disk free-space limits. This utility works entirely as advertised; I can't think of anything that I would have added.

Two other utilities, Disk Test and Disk Explorer, combine to give administrators easier access to verification and repair of both floppy and hard disk drives. Disk Test verifies the integrity of a disk and lets you remap bad sectors when possible. The Disk Test and Editor programs both understand the structure of the Unix file system. The Editor, for example, has the power to browse, randomly or sequentially, through i-nodes and free-list entries. It also has the power to modify those entries, and that's where the trouble comes in.

The drawback to the Norton Utilities for System V is that it puts in the hands of *all* users a set of utilities that paint friendly, almost harmless faces on potentially destructive operations. A single slip with the Editor, for example, could render an entire system helpless. Since Unix systems are often used by several people (many of whom likely possess the all-powerful root password), it might be appropriate to offer a "safe" (and, possibly, less expensive) version.

All Things Considered

There's much more to the Norton Utilities than I can comment on here. Worth brief note, however, is a set of commands that enhance Unix shell scripts with sound (even music), color, and boxes done in line-drawing characters.

Norton for Unix is well worth having around. System administrators should routinely install UnErase on every 386 Unix system in the house. The package is well done and deserves widespread use. In the sparse domain of shrink-wrapped Unix software, the Norton Utilities for System V is bound to be a star. ■

Tom Yager is a technical editor for the BYTE Lab. You can reach him on BIX as "tyager."

The Norton Utilities for System V

BYTE LAB

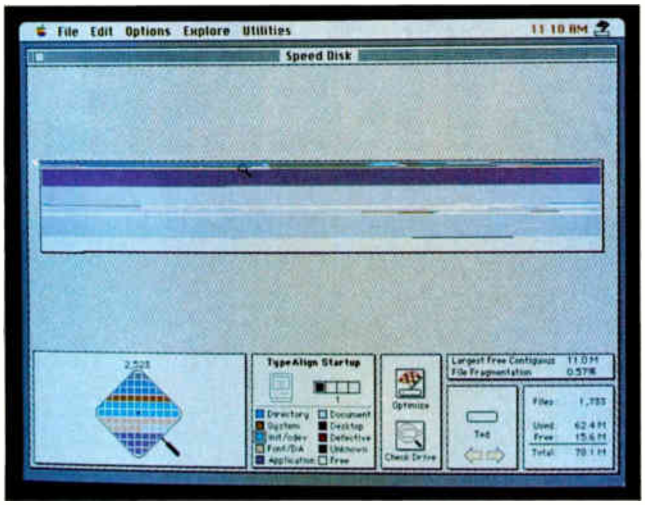
Company
Interactive Systems Corp.
2401 Colorado Ave.
Santa Monica, CA 90404
(213) 453-8649

Hardware Needed
386 or 486 PC, PS/2, or compatible and at least 2.5 MB of free hard disk space

Software Needed
Interactive or AT&T Unix System V/386 release 3.2

Price
$295

Inquiry 1055.



The disk optimizer for the Norton Utilities for the Macintosh uses colors to represent different file types and their location on the target disk drive. The magnifying glass lets you pinpoint a file by block.

The Norton Utilities for the Mac

Peter Norton Computing may be well known for its PC disk utilities, but I felt some apprehension when I learned that the company had written a version for the Mac. Mac applications written by PC software companies typically have serious interface flaws. After looking at the Norton Utilities for the Macintosh, however, I have to say that my fears were unfounded.

The $129 package includes a manual and several disks that contain a disk repair/recovery application and several helpful utilities. The disk repair application resides on a red, self-booting "crash disk" that lets you boot your Mac and start recovery procedures when your Mac's hard disk drive conks out. This application contains a disk editor, with modules that diagnose and repair problems with the disk's directories or recover an accidentally formatted disk.

Exploration

The disk editor lets you examine disk data block by block. You can inspect and change data in a file's data or resource forks, or you can examine and modify the disk's boot blocks (information that the Mac needs to boot) to, say, increase the number of files the Mac can have open at any time. You cannot, however, edit the boot blocks from within the window that describes the boot block's contents, as you can with Symantec's SUM II Tools application. Instead, you make changes from a window that displays data in hexadecimal, and that makes changes tricky.

The repair utility checks and detects problems with the disk's media and volume directory structure. It also checks for problems with files and makes repairs. For example, it can fix a file's bundle bits, which tells the Finder if the file has an icon that it must copy to the Desktop file. A bad bit usually gives you the generic document icon.

On the other two disks are useful utilities: a disk optimizer or defragger application, a file undelete cdev, a desktop layout application (used to change how the Finder displays and organizes file icons), a disk activity INIT, and help files. The disk optimizer is one of the best I've seen. It first presents a map of the hard disk's allocated and free blocks. On a color Mac, it uses different colors to flag file types such as directories, system files, applications, and data. Optimization is rapid, and the program performs integrity checks before optimization begins. You can cancel the operation at any time. The optimizer reorganizes the least-altered files (e.g., system files and applications) on one part of the disk, and it places files that change often (documents and the Desktop file) adjacent to the disk's free space. This improves performance and slows fragmentation. I optimized the hard disk drives on a Mac SE, SE/30, II, IIx, IIci, and IIfx without problems.

The FileSaver cdev functions in a way that's similar to SUM II's Shield cdev and 1st Aid Software's Complete Undelete: It creates and updates a hidden file that contains a snapshot of the volume directory and keeps a record of the most recently deleted files. FileSaver, like Complete Undelete, shows which of the deleted file's blocks have been reallocated to give you an idea of the file's recoverability. You can also search for deleted files by type from a scrolling list of document types, such as MacWrite and Word. If your file is not on this list, however (say you're looking for a Photoshop file), there's no way to specify a different file creator or type.

Best Choice for Beginners

The Norton Utilities for the Mac clears the design hurdle of providing an easy-to-use interface while letting you probe volume directories, boot blocks, and data and resource forks on a Mac disk drive. The program has some minor rough edges, such as the FileSaver problem I mentioned, but overall, it's a good first showing in the Mac market.

Symantec, which offers the competing SUM II product, now owns Peter Norton Computing. Symantec says it will continue to sell both the Norton Utilities for the Mac and SUM II.

If you are familiar with the Mac's workings, SUM II Tools or Central Point Software's Mac Tools lets you get to your system's innards in more detail than does the Norton Utilities. But the Norton Utilities gives you easy-to-use tools and a bootable crash disk, while with SUM II you have to make this disk yourself—something you don't want to do in a panic situation. Mac novices should pick the Norton Utilities as their first line of defense against disk disaster. ■

The Norton Utilities for the Macintosh

Company
Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(408) 253-9600

Hardware Needed
Mac Plus or higher

Software Needed
System 6.0.4 or higher

Price
$129

Inquiry 1056.

Tom Thompson is a BYTE senior editor at large with a B.S.E.E. degree from Memphis State University. You can reach him on BIX as "tom_thompson."

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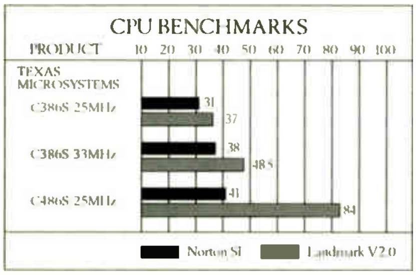

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Jon Udell

REVIEW

CAD and NetWare 386 Join Forces

It used to be that people complained they couldn't get at mainframe data. Now the data they can't get at lives on a PC. Networks abound, and the pendulum is swinging in the direction of central storage again. But few PC programs share data effectively on LANs. True, most databases can support concurrent users. But other categories of software—CAD, for example, as well as spreadsheets and word processors—typically cannot. All too often the network ends up as a speedy file transfer link, not as a foundation for collaborative work. CADvance 4.0 from IsiCAD aims to change that.

The latest release of this popular architecture, engineering, and construction (AEC) package makes good on the promise of multiuser CAD. On a NetWare 386 LAN, CADvance 4.0 goes further: NetWare loadable modules (NLMs) running on the server handle some of the database and rendering chores.

To install the program, you'll need some of the latest weapons in the arsenal of DOS computing. CADvance now requires over 500K bytes of conventional memory after you've loaded your network driver and shell. This means that, under NetWare, it requires one of the new high-loading (EMS or XMS) NetWare shells. Unfortunately, it also requires at least one 64K-byte bank of expanded memory. So, on a 386 machine with extended memory, you can't get away with just the XMS shell. You will also require QEMM, EMM386, or an equivalent "limulator" to turn some of the extended memory into expanded memory.

CADvance also requires a security device—a parallel-port "dongle." Thankfully, you only need one. The dongled workstation acts as a license server. In addition to CADvance, it runs a TSR program that monitors the number of active CADvance users. You can install this program on more machines than you have licensed it for, because the license applies to concurrent users, not to machines.

The Sociology of CAD

IsiCAD has always used CADvance to target the AEC realm, where CAD drawings coordinate the efforts of a variety of trades. For example, an architect's floor plan typically governs the design and specification of electrical, communications, plumbing, heating, and ventilation systems. With single-user CAD software, even on a network, the designers of these various systems can't refer to a live copy of the floor plan.

Under DOS, single-user (or non-network-aware) software can only offer the limited protection that is afforded by the file system's read-only attribute. If you don't turn the attribute on, anyone can overwrite the floor plan. If you do set the read-only bit (by means of the ATTRIB command), no one can write to the file—not even its author, the architect. Even worse, there's no advance warning of an unauthorized attempt to write to a protected document. There is nothing to prevent you from reading the document and modifying it in memory; only when you try to store the file does DOS complain.

What's the answer? Everyone should be able to view the floor plan, even as the architect modifies it (see the figure). The networking extensions introduced with DOS 3.0—and implemented in all DOS and non-DOS PC network operating systems—lay the foundation for this sort of sharing. The architect's program opens the floor-plan document in deny-write mode, thereby asserting an exclusive right to modify the document. Another program can then open the document in deny-none (or shared) mode and view it. Should the second program also try to open the document in deny-write mode—that is, for write access—it will fail. In that case, the program can deliver a timely warning, and the user won't waste any time trying to edit the file.

In CADvance 4.0, the architect opens the floor plan by means of the `File/Load` command, which (if successful) confers the exclusive write privilege. Other draftsfolk on the network can then open the same document by means of the `File/Ref` command, which opens it for read access as a *reference file*. Reference files work like underlays. If you're designing the plumbing, for example, you can use a live copy of the floor plan as a guide. You can see, and even snap to, the outlines of the offices, but you can't select or modify them. There can be reciprocity as well. For example, it might be useful to cross-reference the electrical and plumbing diagrams while each of them also refers to the floor plan. That way, subsystem designers can monitor how the evolution of other subsystems affects their own.

Network Consciousness-Raising

Unlike CADvance 4.0, which is actively network-aware, most PC CAD programs are passively network-tolerant. Still, file sharing isn't that tough to implement, and I expect that the competition will soon follow suit. But there is more to the story.

Although the reference-file scheme relies only on properties of the networked file system (and therefore will work on any PC LAN), CADvance 4.0 puts the NetWare application programming interface to good use. Generally, with any NetBIOS LAN or NetWare, a program that fails to open a file in deny-write mode can report only that it failed, not why. In other words, it can report "file in use," but not "Joe's using the file." Of course, the latter message is the one that you really want, and when you are running CADvance under NetWare that's

CADvance 4.0

Company
IsiCAD, Inc.
1920 West Corporate Way
Anaheim, CA 92803
(714) 533-8910

Hardware Needed
Server: Sufficient hardware to run NetWare 286 or 386 or another PC LAN operating system; math coprocessor recommended for hidden-line-removal NLM
Client: AT or compatible with 640K bytes of RAM, at least 500K bytes of conventional RAM available after loading network drivers, and at least 64K bytes of expanded memory; math coprocessor recommended for 3-D work

Software Needed
Server: NetWare 286 or 386 3.1 (recommended) or other PC LAN operating system
Client: MS-DOS 3.1 or higher; network shell

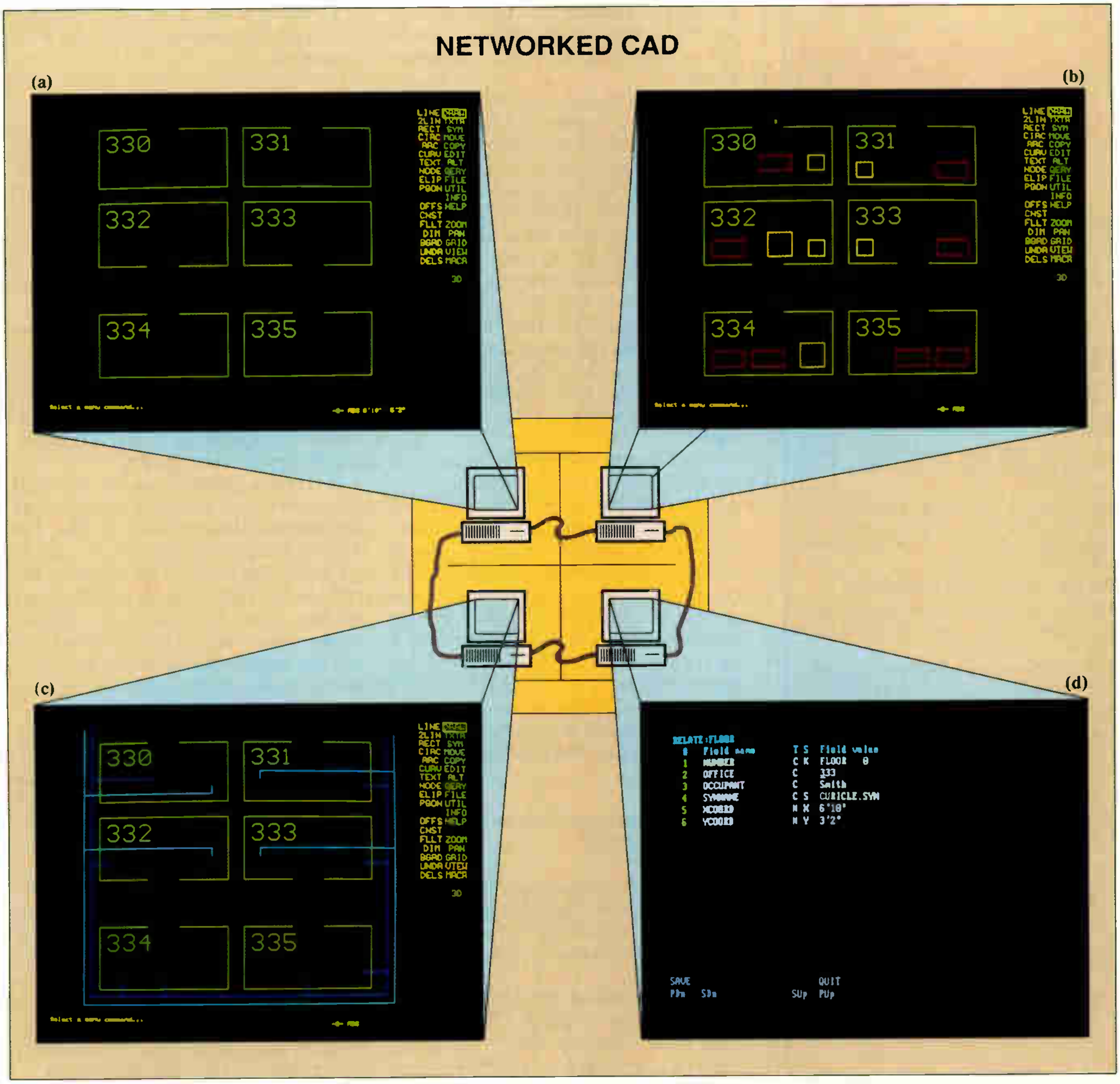
Price
Single-user configuration: $3495
Five-user license (as reviewed): $12,000
10-user license: $20,000

Inquiry 1061.

the one you get. Once you know that Joe's holding up the show, you don't have to start yelling or charge over to his cubicle. With the built-in message utility, you can contact Joe directly or broadcast a message to all CADvance users on the network.

Anyone who's tried to print graphics on a networked printer or plotter knows the attendant frustrations. Although you can redirect LPT or COM ports across the network, the results aren't always what you'd expect. With CADvance 4.0, you can send plot jobs straight into NetWare queues, bypassing the troublesome middleman. You can attach a descriptive name to the plot job and queue each job on automatic hold. That way, a queue operator can identify each job's priority and paper requirements and manage the queue accordingly.

continued



(a) *CADvance 4.0 lets architects create and revise floor plans while* **(b)** *computer-systems designers note the location of PCs in an overlay above the "live" floor plan in read-only mode;* **(c)** *communications engineers add a second overlay of network cabling drawings on the live floor plan, and* **(d)** *a Facilities Manager links objects in the plan to an external database.*

The Visual Database

Networking aside, what sets CADvance apart from most PC CAD programs is its ability to link objects in a CAD drawing with an external .DBF (dBASE-style) database. According to IsiCAD, a number of CADvance users describe themselves as facilities managers—that is, people who must track equipment inventories by location. For these users, CAD drawings are both pictures and databases. Of course, you can't use standard database tools to query the specialized graphical databases that underlie CAD programs. But with CADvance, you can link a graphical database to a conventional one.

Since I'm responsible for managing part of BYTE's editorial LAN, I tested CADvance's database connection by relating a database of workstations, cabling, and network hardware to an office floor plan. With dBASE IV (CADvance requires .NDX index files, so I couldn't use my favorite dBASE work-alike, FoxPro), I defined four databases indexed on a common field—the name, or number, of a CAD object. The first, the Relation database, links objects in CAD drawings to .DBF files. The remaining three Instance databases store information about offices, workstations, and network hardware.

Next I began hooking database records to objects in my floor-plan drawing. You can also use the database to search for, and graphically select, objects in a drawing. Under NetWare 286, that's easier said than done. You have to supply the typically machine-generated object number as a search key. Under NetWare 386, however, CADvance provides a server-based NLM that can perform Structured Query Language (SQL) queries against the .DBF database. So, for example, I was able to select all the symbols representing Macintoshes with this query:

```
select from workstn where workstn
.vendor = "apple"
```

What about concurrent access to the database? No sweat. The CADvance record editor, like the dBASE browser, will either lock the active record or tell you that it can't.

While I applaud IsiCAD's database support, I have to admit I found these tools a tad unwieldy. That's partly because it's awkward to switch between CADvance and dBASE. You can shell to DOS, and CADvance 4.0 relinquishes all but a 10K-byte stub of itself when you do, but effective use of dBASE with CADvance really demands 386 DOS multitasking à la Desqview or Windows. Even then, keeping the drawings and databases in sync takes perseverance. And the SQL dialect is fairly weak: no LIKE clauses, no joins, and no subselects that return more than one value.

On the other hand, although the CAD/database interaction may not be pretty, it does work. If you need to mix the two disciplines, CADvance may be the only game in town. And the SQL NLM represents a genuine innovation for PC CAD. It's exciting to see client/server technology begin to stretch the horizons of DOS computing.

Other Dimensions

The core CAD program in CADvance remains essentially what it was in previous versions: a solid two-dimensional drafting tool with limited, though useful, 3-D extensions. You won't be designing next year's Ferrari coupe with CADvance—complex surfaces aren't its forte. But it has all the tools you need to design and document a commercial office building, and they're geared for efficient production drafting. Almost all the commands "nest," so you can always interrupt what you're doing to zoom, pan, place a symbol, or run a macro program. Mouse buttons do the right thing in most situations. And things get done quickly.

To boost a 2-D drawing into the third dimension, you assign elevations and heights and then extrude it. The 3-D module sports interlocking x,y, x,z, and y,z grids. You can lock the cursor to any of these and slide the grids relative to one another. To reorient the model, you can choose from a set of standard views, rotate the model relative to any axis, or—what's most intuitive—set the location and height of a "camera" and a "target." You can easily look around and through a 3-D model, capturing views for a presentation. Under NetWare 386, you can even queue up a series of snapshots on which the server will perform hidden-line removal.

A number of PC CAD programs outstrip CADvance's 3-D modeling prowess. But in the final analysis, the spinning teapots that shimmer on screens at computer graphics trade shows don't matter much to people who design office buildings for a living. CADvance has always been a practical tool for the AEC professional, and now version 4.0 makes workgroup CAD equally practical. ■

Jon Udell is a BYTE senior editor at large. You can contact him on BIX as "judell."

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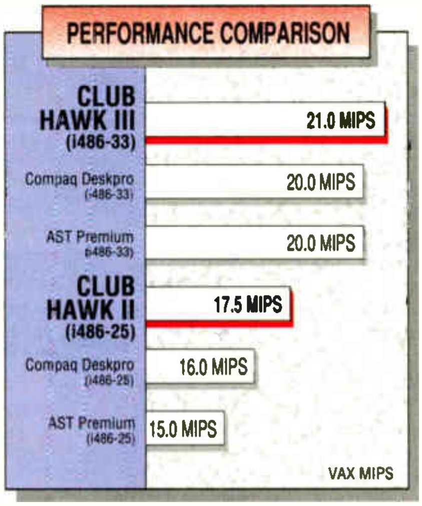

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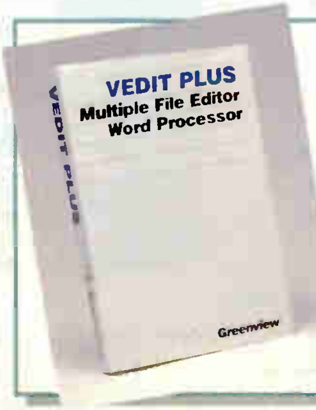

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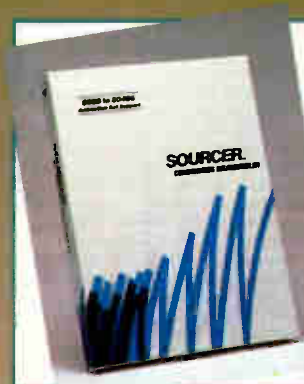

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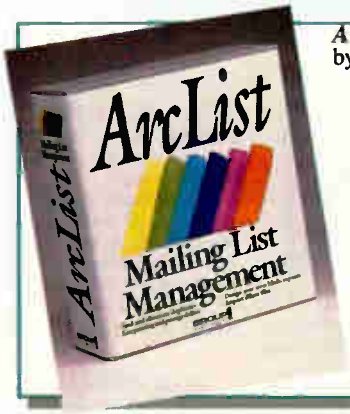
LIST: $359 **PS** Price: $329
FastFaxts 55-007



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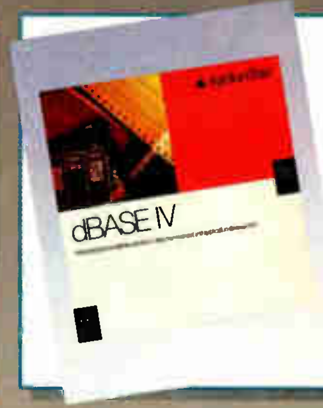

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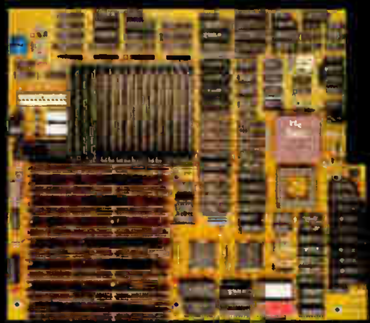

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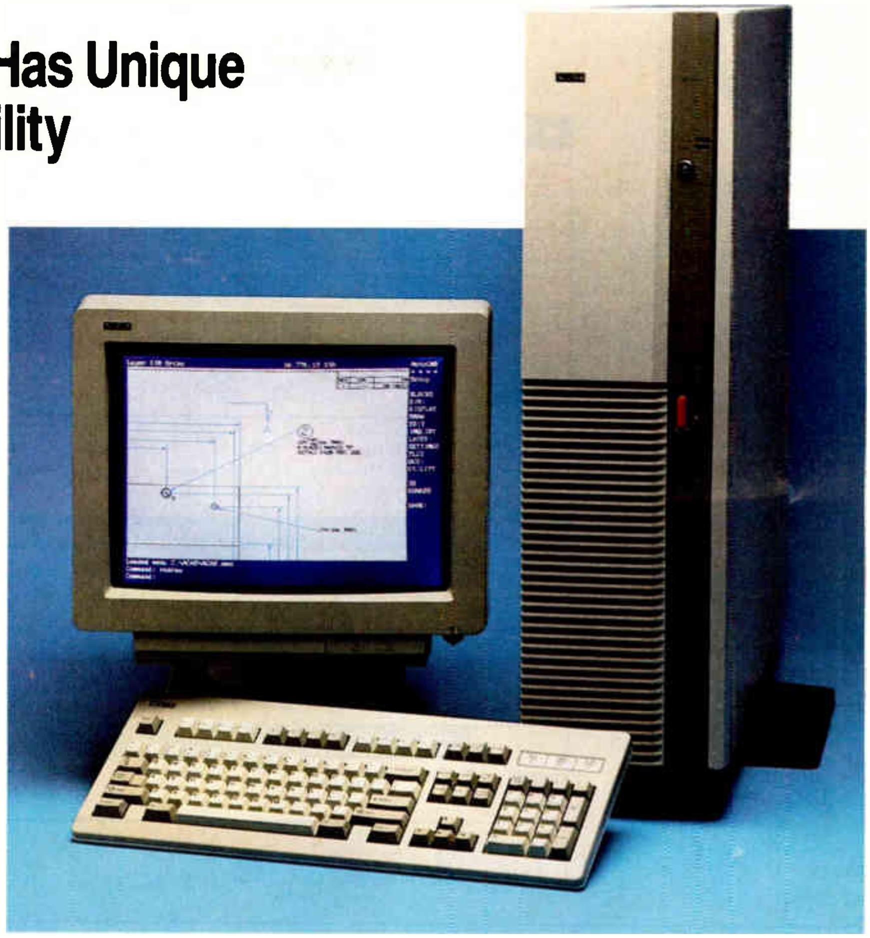
REVIEW

NCR's S486/MC33 Has Unique Approach to Reliability



As the size of its case suggests, the NCR S486/MC33 has plenty of room for expansion. It is also one of the fastest 33-MHz 486 systems BYTE has tested.

The new 33-MHz i486-based systems are increasingly taking over tasks that were previously dedicated to minicomputers and RISC-based workstations. The latest entry from NCR's Workstation Products Division, the S486/MC33, is no exception. This system has been designed from the ground up for high performance, maximum expandability, and unmatched reliability. It is also one of a handful of 33-MHz i486-based systems with the Micro Channel bus architecture.

All this performance, expandability, and reliability come at a price. The base price for the S486/MC33 is $13,995, which includes only the base unit and a single 3½-inch 1.44-megabyte floppy disk drive. The BYTE evaluation unit included 16 MB of error-correcting DRAM ($8400), an NCR SCSI host adapter board ($500), a 670-MB Maxtor SCSI hard disk drive ($6500), a 16-inch Super VGA monitor ($1995), a keyboard ($100), and MS-DOS 4.01 ($150), for a total system cost of $31,640.

While this price will keep away most home computer users, it is in the price range traditionally accepted for minicomputers and high-performance workstations, where increased productivity can quickly pay back such investments. The system also incorporates reliability features not found on any other 486 system, and it is backed by the quality and service that NCR has become known for—second not even to Big Blue.

The size of the S486/MC33's tower case is substantial: At 29 by 29½ by 7½ inches and a weight of 83 pounds with a hard disk drive, it seems to be trying hard to match the system's hefty price tag (see the photo). Nevertheless, the well-designed chassis is tailored for easy access and uncompromised expandability. It includes nine drive bays, four memory-board slots, one slot for the SCSI controller, one 16-bit Micro Channel expansion slot with video extension, and six 32-bit Micro Channel expansion slots.

Once unlocked, the system cover glides easily along guide rails to provide ready access to the system internals. You can remove it completely for accessing the drive bays. Rollers at the front and rear bottom of the cabinet let you easily tip and roll the system.

Bulletproof Design

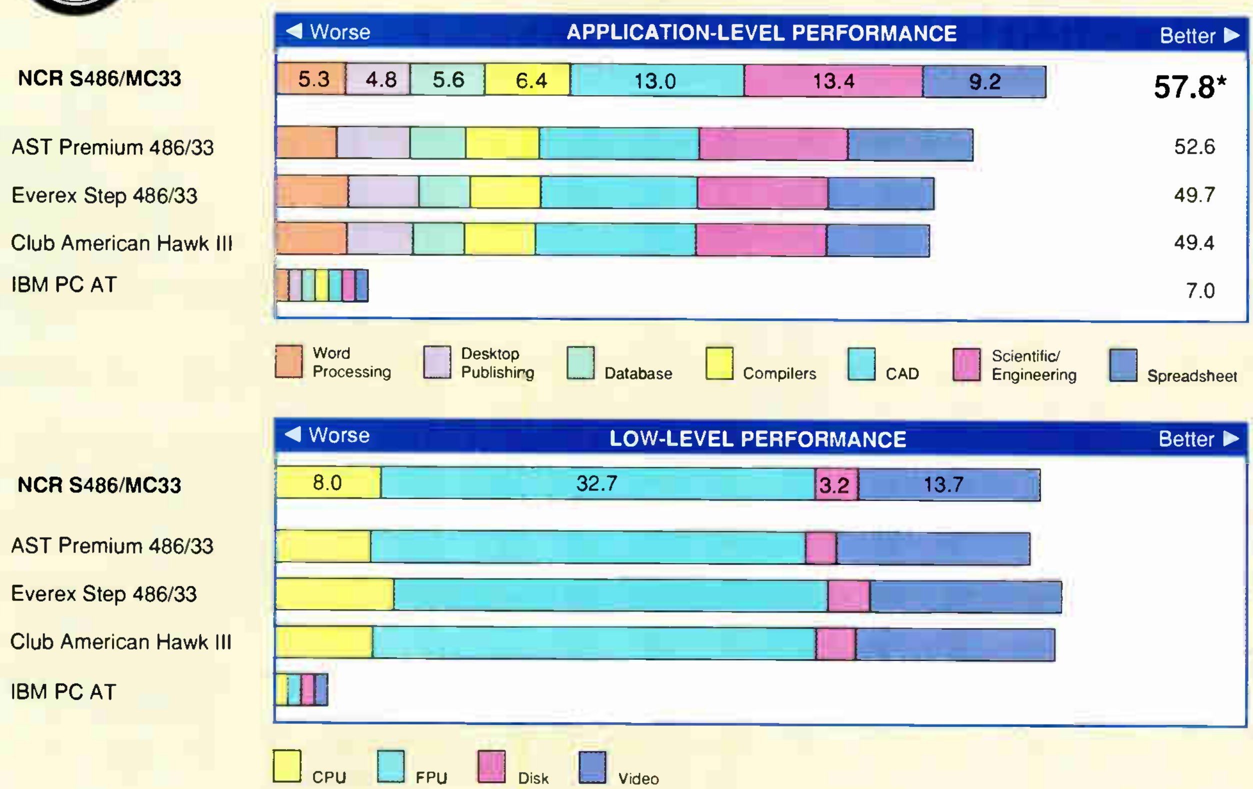
The main processor board is impressive. Built almost entirely with surface-mount technology for reduced size and greater reliability, the large board includes an i486 processor, a Weitek WTL4167 math coprocessor socket, a 600- by 800-pixel Super VGA video controller with 1 MB of RAM, a floppy disk drive controller, two serial ports, one parallel port, a PS/2-style mouse port, and 12 expansion slots. Oddly, the two serial ports are brought out to a single 25-pin connector. The first port, COM1, uses the IBM RS-232C pin-out. To use both ports, however, you must connect the included Y cable to the system's serial connector, which then provides you with separate connectors for COM1 and COM2.

Because DRAM chips require periodic refreshing of on-chip capacitors to maintain stored bit values, they are prone to occasional bit loss from such things as alpha particle hits (naturally occurring background radiation). As the amount of memory in a system increases, so does the likelihood of bit losses, with single-bit losses being the most common.

High-end computers such as the S486/MC33 typically incorporate a lot of memory—often 16 MB or more—so NCR decided to design the memory subsystem for greater reliability. Instead of the simple parity-detection circuit found in most PCs, the NCR memory boards incorporate error detection and correction circuitry, which is capable of correcting any single-bit errors that occur on the fly and can also detect and notify the processor of any double-bit errors. So if you're wondering why the 16-MB memory board costs more than your entire PC, it's because NCR designed it for reliability with a capital *R*.

NCR offers 4-MB and 16-MB memory boards for the S486/MC33. With four available memory slots, the system supports 64 MB of memory. The memory board slots are uniquely designed, with connections to both the processor's

DOS BENCHMARKS



CONVENTIONAL BENCHMARKS

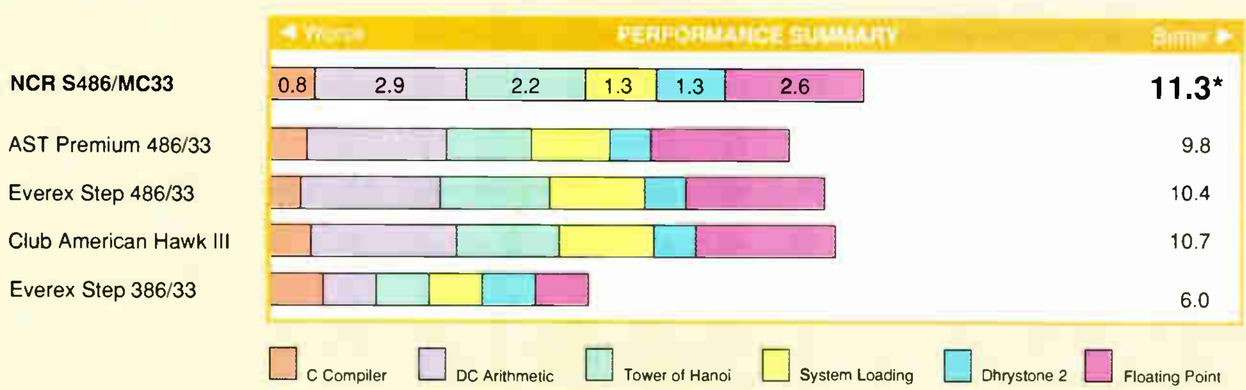
	LINPACK (single) (MFLOPS)	Dhrystones (Dhry./sec.)
NCR S486/MC33	0.8822	26929.4
Everex Step 486/33	0.8959	26912.9
Club Hawk III 486/33	0.9263	27472.3
AST Premium 486/33	0.8947	25849.4

* For application and low-level benchmarks, results are indexed and show relative performance; for each individual index, an 8-MHz IBM AT running MS-DOS 3.30 = 1. For all benchmarks, higher numbers indicate better performance.

The BYTE low-level benchmark suite identifies performance differences between machines at the hardware level; the application benchmarks evaluate real-world performance by running a standard test suite using commercially available applications. Application indexes include tests using the following programs: Word processing: WordPerfect 5.0; Desktop Publishing: Aldus PageMaker 3.0; Database: Borland Paradox 3.0 and Ashton-Tate dBASE IV; Compilers: Microsoft C 5.1 and Turbo Pascal 5.5; CAD: AutoCAD release 10 and Generic CADD level 3 1.1.5; Scientific/Engineering: Stata release 2, MathCAD 2.5, and PC-Matlab 3.5f; and Spreadsheet: Lotus 1-2-3 release 3.0 and Microsoft Excel 2.1.

The BYTE Lab introduced version 2.0 of the DOS benchmarks in the August issue (see "BYTE's New Benchmarks: New Looks, New Numbers"). Benchmark results for machines reviewed under previous versions aren't directly comparable. To obtain a copy of the benchmarks, join the listings area of the byte.bmarks conference on BIX or contact BYTE directly.

UNIX BENCHMARKS



* The graph above summarizes the results of the Unix benchmarks (version 2.6). All results are indexed to show relative performance; for each test, an Everex Step 386/33 running Xenix 2.3.1 = 1. The cumulative index is formed by summing the indexed performance results for the tests. Comprehensive results are available by contacting BYTE.

NCR Model S486/MC33

Company
NCR Corp.
Workstation Products Division
1700 South Patterson Blvd.
Dayton, OH 45479
(513) 445-5000

Components (as reviewed)
Processor: 33-MHz Intel i486; socket for 33-MHz Weitek WTL4167
Memory: 16 MB of error-correcting DRAM, expandable to 64 MB; reprogrammable BIOS in Flash EPROM
Mass storage: 670-MB 12-ms Maxtor SCSI hard disk drive; Teac 3½-inch 1.44-MB floppy disk drive
Display: 16-bit Super VGA controller on motherboard; 16-inch Super VGA color monitor
Keyboard: IBM Enhanced 101-key
I/O interfaces: Dual serial port; parallel port; PS/2 mouse port; video port; keyboard connector; SCSI port; one 16-bit and six 32-bit Micro Channel expansion slots

Price
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local bus and the Micro Channel bus. This dual-ported design permits Micro Channel bus masters to access the memory, in addition to the i486 itself. The memory subsystem is designed for interleave operation for improved performance, typically averaging less than one wait state. There is no secondary cache in the system; instead, the system relies on the i486's own 8K-byte four-way set-associative cache.

Like its main memory subsystem, the S486/MC33's ROM BIOS is unique. As with most computers in this performance range, the BIOS is placed into shadow RAM for faster operation after boot. Unlike other systems, however, the S486/MC33 uses a flash EPROM to store its BIOS. Unlike conventional EPROMs, flash EPROMs can be electrically erased and reprogrammed in the system. This allows NCR to change or upgrade the system BIOS simply by inserting a disk with the new BIOS and running a utility to program the flash memory. No more replacing BIOS EPROMs.

A vertical backplane runs almost the full height of the case along the back of the drive bays. A "drive carrier" is mounted to each drive, which then slides into a drive bay and connects the drive to the backplane. The backplane is cabled to the SCSI host adapter board and the floppy disk drive interface connector on the main processor board. The top two half-height drive bays are reserved for 3½-inch floppy disk drives or a tape drive. The remaining four half-height bays and three full-height bays are available for SCSI devices, including hard disk drives, optical disk drives, and tape drives. The SCSI host adapter board can support up to seven devices simultaneously, and it includes an external connector for connecting to SCSI devices outside the S486/MC33 cabinet, such as scanners and laser printers.

NCR offers several SCSI hard disk drives, optical drives, and tape drives for its S486/MC33 system, including a 327-MB hard disk drive, a 670-MB hard disk drive, a 600-MB CD-ROM drive, a 200-MB tape drive, and a 320-/525-MB tape drive. On the flexible side, only the 3½-inch 1.44-MB floppy disk drives are offered. NCR also offers a non-SCSI 80-/120-MB tape drive that installs in the lower floppy disk drive bay.

A World-Class System

The S486/MC33 is clearly designed for the world market. Its 385-watt power supply, for example, is an auto-switching unit that works properly at a nominal 115 volts or 230 V and at 50 or 60 Hz. NCR also offers keyboards for nine different languages, and the installation manual is presented in five languages. The system documentation consists of several manuals, and, as expected from a company like NCR, all of them are complete, well organized, and heavily illustrated.

The keyboard, with its PS/2-style connector, has a very nice feel but no key click. The 16-inch monitor included with the evaluation unit also provides a good-quality display, with sharp images and good color renditions.

The system comes with a set of utility and driver disks. These include complete system diagnostics, setup utilities, and device drivers. There are device drivers that support the enhanced video modes, as well as SCSI drivers for OS/2 and Unix. I ran the system using the MS-DOS 4.01 operating system that came with the evaluation unit. I saw no evidence of any compatibility problems after running numerous DOS applications on the system—it just ran very fast.

How Fast Is It?

The S486/MC33 proved to be one of the fastest systems ever tested by the BYTE Lab. With a CPU index of 8.0, the system is faster than both the AST Premium 486/33 (at 7.2) and the Club Hawk III 486/33 (at 7.4). The Everex Step 486/33, however, showed a higher performance level, probably because of its secondary cache, with a CPU index of 9.0.

NCR is one of the largest manufacturers of SCSI controller chips, so it isn't surprising to find that the S486/MC33's SCSI disk subsystem outperforms those of all the other systems in its class. In contrast, the S486/MC33's VGA video circuitry, while still fast, lags slightly behind all its competition.

In addition to admirable performance in the low-level benchmarks, the S486/MC33 also outperformed the other 33-MHz 486 systems in most of the application-level benchmarks. It was slightly lower only in the desktop publishing and word processing benchmarks.

The S486/MC33 also performed well on the BYTE Unix benchmarks. Its 11.3 cumulative index was almost twice that of the baseline Everex Step 386/33.

A Step Ahead of IBM

The S486/MC33's design has been well thought out and well implemented. Traditional IBM customers will feel right at home with the high-quality construction, reliable design, complete documentation, and Micro Channel architecture. In addition to high performance and multiple-master support, Micro Channel offers the ability to configure plug-in boards via software, without having to use jumpers and DIP switches.

Until recently, IBM offered little to compete with the S486/MC33. IBM's PS/2 Model 70 486-B21 is merely the company's Model 80 386 design with an i486 processor card replacing the 386 card. It has no system optimization to take advantage of the i486's features.

Its good points notwithstanding, the S486/MC33's price must be reckoned with. To justify that price tag, its performance and reliability must result in savings for the user. Based on the performance results, this should be the case for many users. For example, the S486/MC33 is well positioned as a high-end network server, where its high processing speed and fast disk accesses will keep even large networks running with minimal downtime. The S486/MC33 will also shine as an engineering workstation, where complex calculations can tax the CPU. ■

Roger C. Alford is the president of Programmable Designs, a Michigan-based consulting firm. He is the author of Programmable Logic Designer's Guide *(Howard W. Sams & Co., 1989). You can reach him on BIX c/o "editors."*

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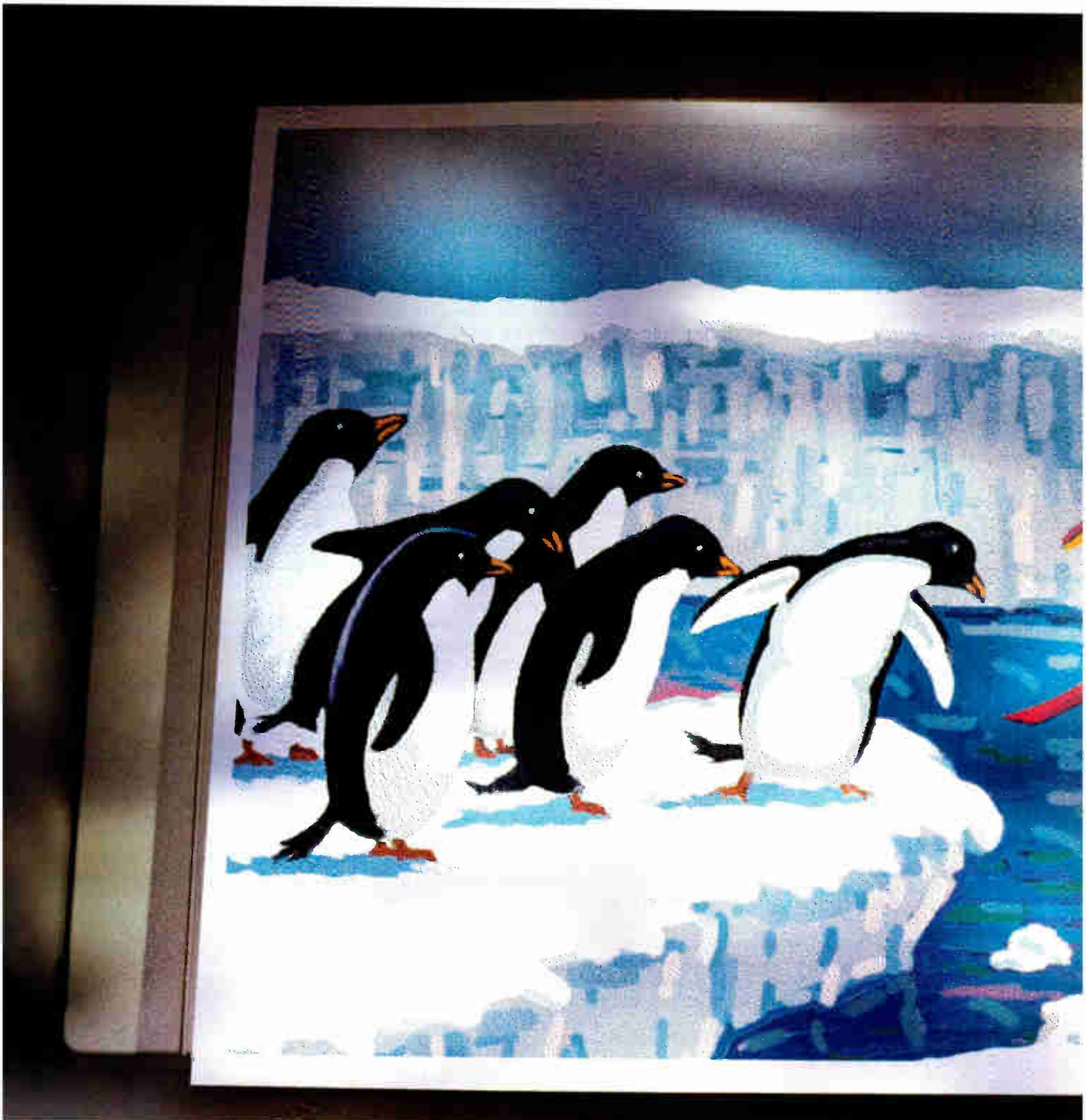

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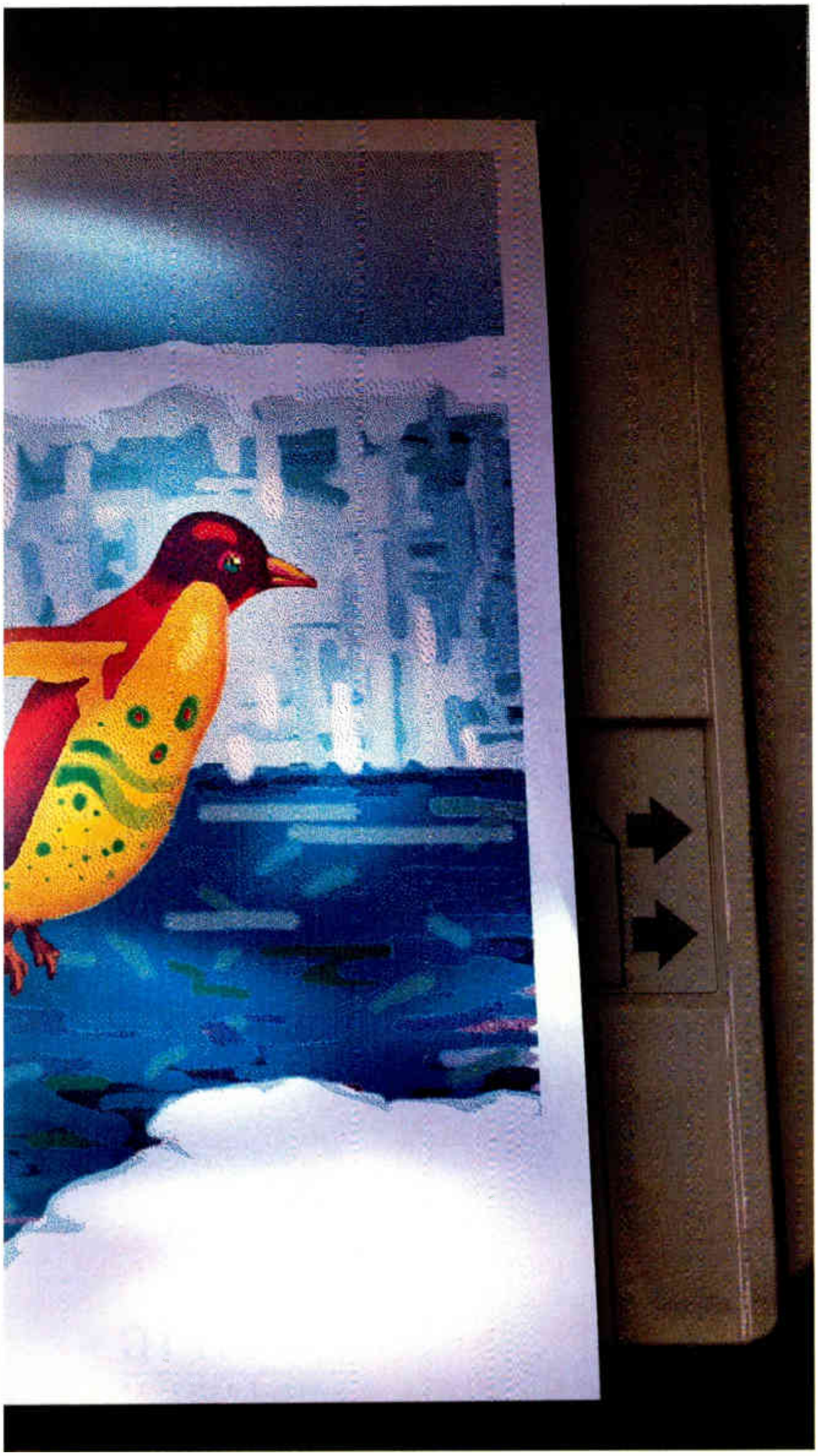

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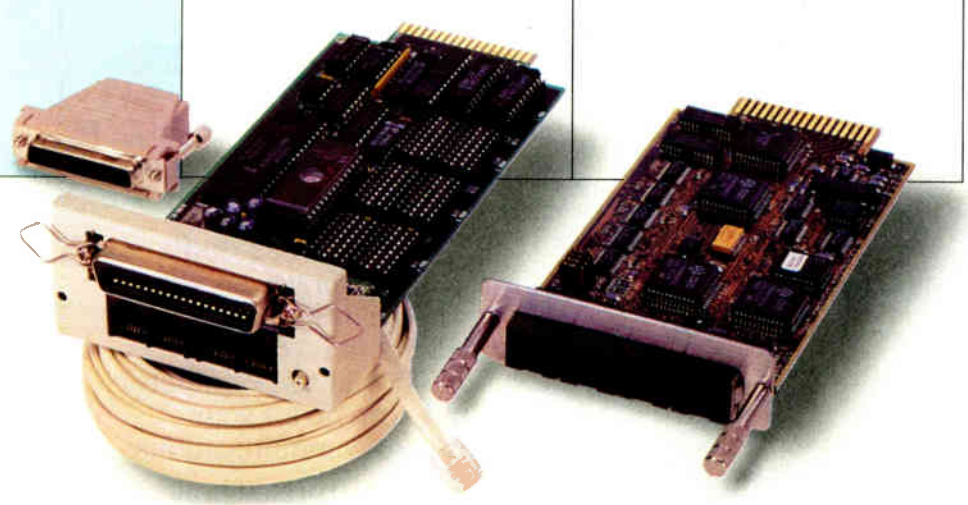
Warranty	**Lifetime**	**Two Years**



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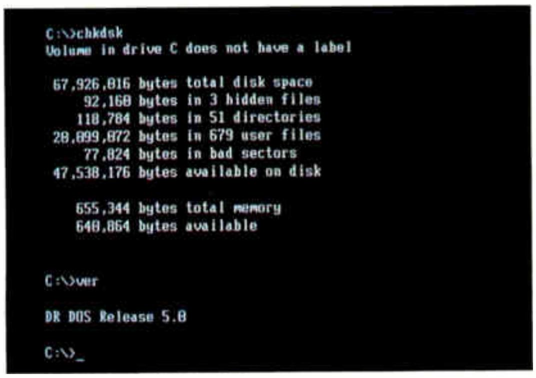
Lamont Wood

REVIEW

DR DOS Offers Hope for the RAM-Crammed



DR DOS can reclaim upper memory and locates the DOS kernel in high memory to give you more work-space memory than you get with MS-DOS.

While you can use various expedients to break the 640K-byte straitjacket that MS-DOS imposes on RAM, the most straightforward way is to switch to a new operating system. But then you would have to abandon your MS-DOS applications and learn new ones—and that's not a very popular course.

But there is a middle ground, and Digital Research, Inc. (DRI), the firm that was behind the CP/M operating system in the 1970s, has provided it with DR DOS 5.0. This $199 operating system for PCs and compatibles is a precise emulation of MS-DOS—no small feat—with embellishments that will interest users who need to load an application, a hardware driver (e.g., a network interface), and a TSR program all at once, but need more than 640K bytes to do it.

I tested DR DOS on a 16-MHz Club American 386 with Hercules graphics, a 40-megabyte 28-millisecond hard disk drive, and 4 MB of RAM.

I installed DR DOS with a setup command that demands little of the user, and it ran immediately. No disk reformatting was necessary. DR DOS automatically loaded its own version of all the MS-DOS command and utility files (using the same names that DOS uses), plus a few extras. The only incompatibility with my existing MS-DOS CONFIG.SYS file was that DR DOS wanted all text in the file to be in uppercase letters. Aside from slight differences in some of the screen messages (and the ECHO command's producing a carriage return, disrupting any carefully positioned AUTOEXEC .BAT screen menus you have written), you'd need the VER command to reassure yourself that you're in a new operating system.

But there are differences—potentially big ones—in the way the two operating systems handle RAM.

Down Memory Lane

To illustrate what DR DOS does, I'll define some terms and map out the tortured world of PC memory. *Conventional memory* is the first 640K bytes (655,360 bytes) of RAM. You generally can't use all of it for applications, since DOS and various device drivers must consume some of it. (With MS-DOS 3.3, I usually end up with 542,848 bytes available; this is called the *transient program area.*) The amount of available memory is important, because PC software can normally run only when it's in conventional memory.

Meanwhile, the 384K bytes between 640K bytes and 1 MB (1024K bytes) is called *upper memory*. RAM above 1 MB is called *extended memory* (unless you're talking about *expanded memory*, which swaps pages of RAM in and out of conventional memory). The first (or lowest) 64K bytes of extended memory is called *high memory* and should not be confused with upper memory.

DR DOS takes advantage of the fact that while upper memory is reserved for video RAM and the ROM BIOS, much of it remains unused. The amount that is unused varies with the configuration of the machine and the kind of video you're using, but it's probably more than 100K bytes between the VRAM and the ROM BIOS. Some of the VRAM immediately above 640K bytes may also be unused. Both blocks could be reclaimed for an application, except that MS-DOS can't raise its eyes above the 640K-byte mark.

What DR DOS does is supply a memory manager, EMM386.SYS, that opens up available RAM in upper memory. It also handles expanded and extended memory support. After installing the memory manager, you can use the DR DOS HILOAD command to load and run an application in upper memory. To see what RAM you have available in upper memory, DR DOS supplies a function called MEM, which not only lists the names and locations of all applications and drivers currently in RAM, but also graphically maps the state of your RAM.

With DR DOS loaded and EMM386 .SYS installed, I found I had 720,880 (704K) bytes of conventional memory (640K bytes plus 64K bytes that EMM-386.SYS can reclaim from VRAM if you are using a Hercules, CGA, or MDA display), of which 689,040 bytes was unused. Plus, there was another 148,096 bytes of free upper memory above the VRAM. As compared to the 542,848 bytes that I had previously, DR DOS had given me almost 300,000 bytes—memory that had been there all along, overlooked by MS-DOS.

Thus, using the HILOAD command can be astonishing—like pitching a cinder block into a puddle and seeing it disappear without a splash. For instance, I was able to HILOAD GWBASIC into upper memory, where it took up about 80K bytes, and I still had about 60K bytes of upper memory free—about all GWBASIC can use for programs and data. Thus, I was able to run a full GWBASIC installation without affecting the amount of conventional memory available. (Well, almost—DOS's environment data for each application is still loaded in conventional memory, and in this case, it took up about 500 bytes.) I could even use the SHELL command to

DR DOS 5.0

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leave GWBASIC and load another program, Xerox Ventura, in conventional memory, run it, leave it, and then return to GWBASIC using the EXIT command from DOS. While they were coresident, the two programs were not running at the same time—this is still DOS, not Unix or OS/2.

I could load a TSR program (in this case, SideKick), and as far as the conventional memory count from CHKDSK was concerned, it had disappeared with hardly a trace. It was in there, however, and it popped up and ran on demand.

DR DOS also has a HIDEVICE command that you can use within the CONFIG.SYS file to load device drivers into upper memory. Obviously, it replaces the MS-DOS DEVICE command.

And DR DOS exploits high memory, whose 64K bytes generally goes unused. Using the HIDOS.SYS driver, DR DOS will load the 37K-byte DOS kernel into high memory. The result is less dramatic than with EMM386.SYS, but equally magical; DOS still runs, but for all intents and purposes, it takes up no space.

DR DOS also has its own CACHE command, which sets up a disk cache in user-defined amounts of extended or expanded memory. It caches only disk reads, so a power glitch won't wipe out any data that was waiting to be written to the disk from the cache. While CACHE doesn't need EMM386.SYS or HIDOS .SYS, once it's invoked it's still part of the operating system, and applications use it automatically.

No Free Lunch

There is, of course, no free lunch—even if DR DOS does seem to be serving up multi-K-byte servings of RAM gravy. As you probably guessed from the name, the EMM386.SYS memory driver that accomplishes most of these wonders requires a 386 (or i486) processor. HIDOS.SYS will work with a 286 and will also function much the same as EMM-386.SYS if you're using Leap or Neat 286 processors from Chips & Technologies.

Also, if you're already using a memory manager (such as HIMEM.SYS in Microsoft Windows or QEMM.SYS in Desqview), you cannot use EMM386 .SYS, and the advantages of reclaiming upper memory are lost. However, you can still use HIDOS.SYS to get that extra 37K bytes by relocating DOS to high memory. If you are already using such a third-party memory manager, you're probably already using large amounts of extended memory, and a few score K bytes of upper memory may not seem important.

You may also be using applications or drivers that, for whatever reason, won't run in upper memory, or already use high memory. DRI doesn't think there are many software packages with this problem, but DR DOS's devices come with options and switches that let you disable any feature that causes trouble.

EMM386.SYS can also set up shadow ROM, where it remaps the video-control portion of the ROM BIOS to a sector of extended memory, on the theory that RAM is faster than ROM. Therefore, this should make your screen display faster. Many clones nowadays come with shadow ROM already built in; mine did not, but invoking the feature produced no noticeable speedup in the screen display. A technician at Club American said I could expect only about a 10 percent improvement, although a faster machine,

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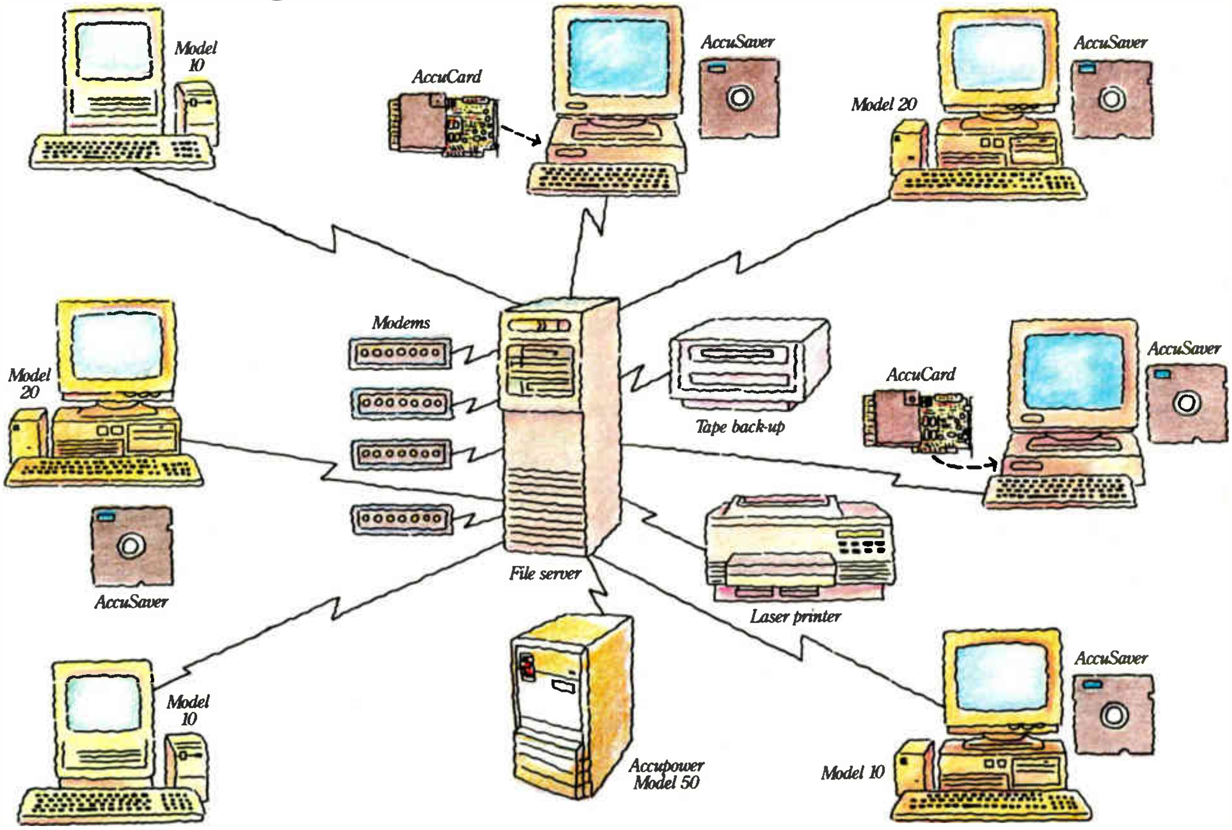

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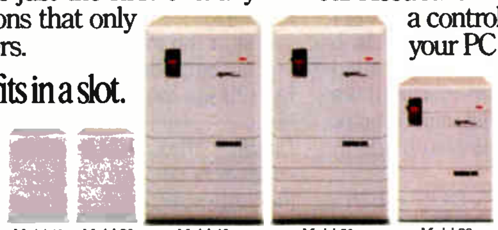

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such as a 33-MHz 386, might show a 30 percent improvement.

My applications ran at about the same speed under DR DOS as they did under MS-DOS. However, loading EMM386 .SYS slowed disk-based activities down by about 10 percent. If the extra memory EMM386.SYS makes available means that an application needs to perform dramatically fewer disk accesses, the slowdown might be negated, but I encountered no such situations. On the other hand, using CACHE does speed things up noticeably, especially for programs that normally swap code to and from RAM. After being invoked the first time, a function would often run without producing any disk activity, since the necessary code was in the RAM cache. The difference was less evident when reading through data files, and it did not make up for EMM386.SYS.

There was no particular difference between the print speeds of DR DOS and MS-DOS. However, an odd problem—and the only real bug I encountered—surfaced when I was copying files in binary format to the printer port (using COPY /B PRN) to load emulation software into a laser printer. The initial version of DR DOS that I had couldn't do this at all. A second version—which DRI said is the version of DR DOS that is now being shipped—did work, but it took 55 seconds to transmit a file that MS-DOS transmitted in just 4 seconds.

DOS Embellishments

Beyond memory management features, there are a number of small but interesting differences between MS-DOS and DR DOS. The most obvious difference is that DR DOS inserts commas into byte counts, so you get "655,360" instead of "655360." Beyond this boost to legibility, usability also gets a boost, thanks to a new help-screen option for most DOS commands. If, for instance, you can't remember how to do a backup, you can just type BACKUP /H and a help screen will appear.

And you don't have to type anything at all to use DR DOS if you don't want to, because it comes with a point-and-click graphical shell called ViewMax. It is strongly reminiscent of the GEM interface, right down to the pop-up calculator and digital clock. And that should be no surprise, because GEM is also made by DRI.

DR DOS replaces MS-DOS's EDIT line-at-a-time text editor with a handy full-screen editor that uses WordStar control keystrokes. Unsurprisingly, it's named EDITOR.

You can assign varying levels of password protection to files and subdirectories. The TREE command can produce a graphical diagram of your disk directories. FORMAT only works with floppy disks. To wipe out a hard disk, you have to use the FDISK command. Since the program is menu-driven, you'll be less likely to absentmindedly vaporize your data with it. And if you do use FDISK, you'll find that DR DOS supports disk partitions of up to 512 MB. For examining file contents, there's an extended version of DIR called XDIR, which shows more information than DIR.

For laptop users, DR DOS has a utility called FileLink for file transfers over serial cables. Functionally, it's comparable to Traveling Software's Desk-Link. Also for laptops is a CURSOR function for changing the shape and blink rate of the cursor to make it easier to find on an LCD screen. DRI says that power management techniques to extend battery life for portable computers are also built into DR DOS, but those features must be integrated by hardware manufacturers.

The Ultimate Answer?

If you have a 386 and need extra RAM (perhaps because of a need to pile on device drivers), DR DOS may be your salvation. It frees up more than enough RAM to hold the average network driver, which is usually 64K bytes to 128K bytes in size. And it does it without affecting your applications in any way—you don't have to convert to OS/2 or some other environment to escape the RAM cram.

Otherwise, the $199 you'd have to pay for DR DOS may or may not be worth it. Many considerations are involved. FileLink may make it a good value if you're a laptop user. The password function and the 512-MB disk partition may be interesting for certain applications. The help screens, screen editor, and ViewMax generally make it an easier DOS to use. One consideration that you should not overlook is that Microsoft can be expected to hatch an answer to DR DOS with its own further enhancements to MS-DOS.

But in the meantime, DRI has added a viable competitor to the DOS world. That in itself is a long-overdue development. ■

Lamont Wood has evaluated personal computers and software for 13 years, authoring more than 200 articles on the subject. He currently writes a computer column for the San Antonio Business Journal. *You can contact him on BIX as "lwood."*

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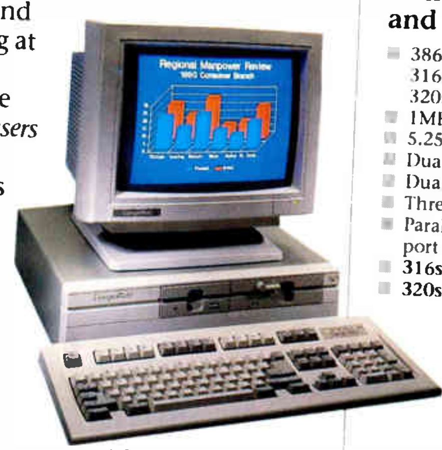

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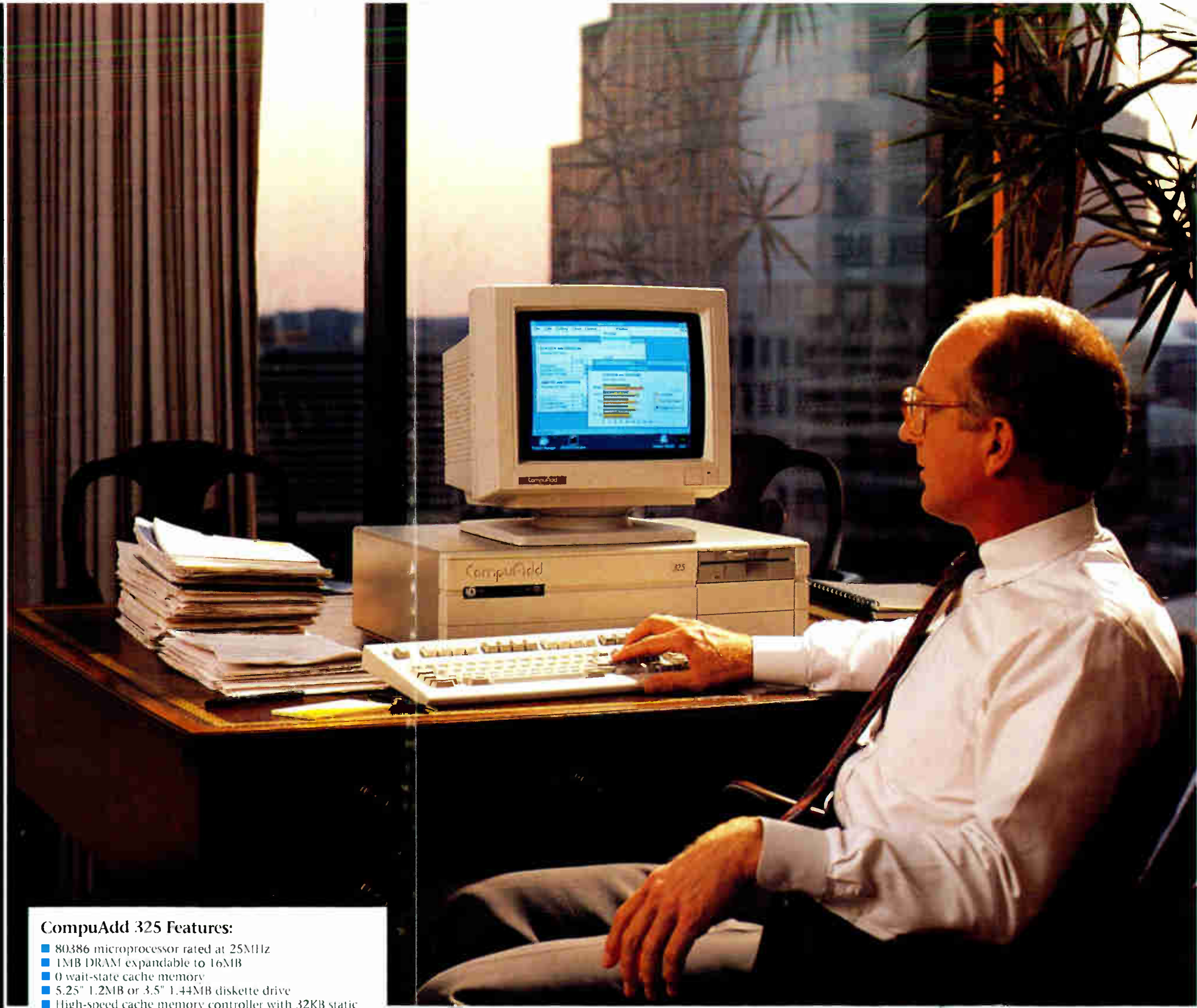

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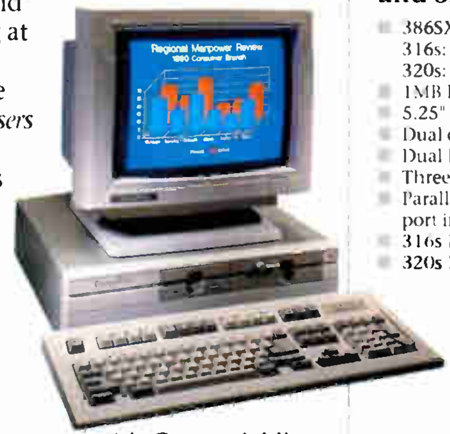

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Tom Yager

REVIEW

On Becoming a ClockWise Scheduler

ClockWise provides a wide, readable view of your workgroup's calendar.

It's been a bad day. Your meeting had to be postponed because someone else was using the conference room. The boss is peeved because his favorite project is behind schedule, and all because someone whom you gave responsibility to dropped the ball.

Well, buck up, because Phase II Software has an answer: ClockWise. This application taps Unix's multiuser power to bring you a distributed scheduling database. Users can create their own schedules, reserve conference rooms and other resources, and plan meetings based on the availability of other users. Management can delegate tasks to subordinates and check on their progress. And for those moments when the boss isn't looking, ClockWise even gives you the current phase of the moon, tides, and a daily trivia question or pithy quote.

I installed ClockWise 1.1 on an ALR PowerVEISA 486/25 with 13 megabytes of memory, Interactive Unix 2.2, and the X Window System running on a Matrox MG Series 8514/A card.

Did It Have to Be Unix?

Until ClockWise, there was no widely available tool for bringing users of dissimilar systems together. Since Clockwise runs under Unix, users can connect to it through either a network link or a serial cable. ClockWise's interface is strictly text-based, so you can tap in with a dumb terminal, a DOS system, a laptop, or a Unix workstation. All that's required is a terminal or emulator that is supported by the flavor of Unix that you select to run ClockWise.

The database is best kept on a single system. Running ClockWise from a serial port or via remote network log-in ensures this, but it is also possible to share the database while running a local copy of ClockWise on your desktop system. Using Remote File System or Network File System (or whatever file-sharing scheme your system supports), you can mount the remote database directory where ClockWise expects to find it.

In addition, the program's variety of connection types makes it possible to use ClockWise from a dial-up terminal. Fast, error-correcting modems are becoming quite common, and running full-screen applications like ClockWise through them works nicely. Field personnel can dial in and update their schedules, and branch offices can exchange selected databases with the main office via modem.

ClockWise 1.1

Company
Phase II Software Corp.
238 Broadway
Cambridge, MA 02139
(617) 354-8771

Hardware Needed
286- (Xenix only), 386-, or i486-based PC with 2 MB of memory and 1 MB of free hard disk space

Software Needed
Interactive Unix 2.0 or higher; AT&T and SCO Unix, ESIX, and AT&T 3B2 also supported

Price
$995 (unlimited users; other license terms available)

Inquiry 1060.

Individual Scheduling

Even as a single-user application, ClockWise has a good deal to recommend it. It opens with a large, readable view of the month's calendar. Dates for which an activity has been scheduled are highlighted. There is an array of function keys across the bottom of the screen. You can access most of the important features of the program from here, but the oft-used slash key will bring up a Lotus-style menu.

The ClockWise database is really a collection of files, each with a specific purpose. Each user has his or her own protected group of files, which hold information on schedules, notes, names and phone numbers, access permissions, and groups of users.

ClockWise distinguishes between two types of schedule items: *events* and *tasks*. An event is something that is tied to a particular date or range of dates. It stands alone and is forgotten once the date passes. A task is a part of a to-do list, a milestone in a project time line that *must* be done. The user is reminded about tasks at appropriate times and can see at a glance when something has slipped behind schedule.

ClockWise is not a massive project management system, and it lacks many of the features of commercial project management programs. Its strength is in its ability to make individual scheduling easy enough that people will actually do it, and to make the information accessible to those who make financial or planning decisions based on progress.

The database can also hold information about *resources*, those pesky things that nobody can get to when they are needed. Conference rooms, overhead projectors, VCRs, and other presentation-related items are all good candidates for ClockWise scheduling.

It's Better in a Group

When you've defined a group in ClockWise, you can schedule events and tasks for that group simply by specifying the name of the group. New items will be distributed to the individual databases of the group members. So, for instance, if you schedule a meeting at 3:00 and attach a reminder to the database entry, all the members of your group will get a mail message informing them of the meeting. Users will see the entry in their schedules, with the scheduling authority identified.

If you attempt to schedule an event for someone who already has another commitment, ClockWise will inform you of the conflict. You can bring up a summary graph that displays a schedule time line for each group member for the date you're dealing with. Of course, you can override conflict warnings and schedule those individuals anyway. If they decide not to attend, all they have to do is delete the item from their schedule. You (or whoever called the meeting) will be notified of the deletion by E-mail, and a box will pop up on your screen the next time you view the event.

ClockWise has a mild integration with the mail system. You can attach reminders to any event, and they will use the Unix at command to spool a mail message for delivery at a certain date and time. This makes it possible for you to be reminded of an event even if you're not running ClockWise. If you're running a windowing environment, you might have the luxury of running ClockWise constantly in the background. In that case, reminders can pop up on the bottom line of the ClockWise display window. Either way works about as well, since ClockWise also notifies you when new mail has come in.

Interfacing 'Round the Clock

The ClockWise user interface is, without a doubt, this program's best feature. Even though I take points away from companies whose programs blandly follow the slash menu scheme (a slash is *not* an intuitive way to pop up a menu), the rest of ClockWise's interface makes perfect sense.

Entering dates, for example, is more easily done here than in most applications I've seen. Enter a date in just about any format you can think of, and ClockWise will take it in. In a few places, ClockWise will try to guess the proper date for a field. If the guess is close but not quite there, you can use simple expressions, such as "+10," which adds 10 days to the date. There aren't as many ways to format time expressions, but ClockWise is forgiving.

In virtually any place where a field requires an entry that conforms to a list (e.g., user or group names), you can press a function key to pop up a window with the list. The name database (which holds names, telephone numbers, and related information) is always a function-key press away, making it easier to fill in fields that require contact names or phone numbers.

You can attach a variable-length note (e.g., a database memo field) to most ClockWise entries. Pressing a function key will expand the memo into a pop-up window.

Scheduling Some Fun

ClockWise's designers must have known how dry and boring most scheduling applications are to use, because they built in some simple features that help prevent you from taking it all too seriously.

As mentioned earlier, ClockWise has a screen that displays the current phase of the moon, sketched out in text characters. The moon screen also shows the tides and has a space reserved for a witticism. You can select a daily quote, a fortune (usually just an unattributed witty saying), or a trivia question. ClockWise comes loaded with a database that will supply a different saying or question for each day. The trivia question answers appear only on the *next* day, and you can't cheat.

What place is there for features like this in serious business software? I won't debate the topic, except to say that it's about time someone worked a little fun into what is otherwise a rather tedious affair. As nice as ClockWise is to work with, entering every worthwhile happening into it would get to be a bit of a drag after a while.

All this furious data entry would be for naught if you couldn't print it out, and can you ever. Phase II Software took the time to make custom layouts for daily, weekly, monthly, project, and other print formats. If you have a PostScript printer, ClockWise's output is very functional, and it looks good enough to hang on a wall. If you only have access to a text printer, you can still get a usable printout, but the PostScript output is simply eye-popping.

ClockWise is now right up there on my list of useful Unix tools. If you're not an organized person, it can help, but you still need to get into the habit of writing everything down. ClockWise isn't the full realization of the potential of workgroup computing, but it still won me over. ■

Tom Yager is a technical editor and Unix expert for the BYTE Lab. You can contact him on BIX as "tyager."

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Ben Smith and Tom Yager

REVIEW

Battle for the Best Unix V/386

For many users, an operating system is an invisible layer. But some of us prefer to keep in step with the latest developments. The BYTE Unix Lab has been working with new releases from Interactive Systems Corp. (ISC) and The Santa Cruz Operation (SCO), and we've found both companies have made some small but important changes for the better in their products.

Interactive Unix 2.2

In almost every noticeable way, the upgrade from ISC is actually a new product. With release 2.2, even the name changes: 386/ix has become Interactive Unix.

The 386/ix 2.0.2 operating system had a flurry of demerits: an inept installation procedure; incomplete, poor-quality manuals; and a lack of on-line manual pages. With Interactive Unix 2.2, all these concerns have been addressed, but ISC didn't stop there.

With regard to the installation procedure, Interactive Unix has one of the best that we've seen. The entire installation process is managed by a full-screen color program that walks new users through every step with concise help text. Context-sensitive help is only an F1-key press away.

Our only complaint is that this interface was not carried through to other parts of the operating system. It would have made a wonderfully friendly front end for `sysadm`, for example.

ISC's addition of both paper and electronic documentation eliminates one of SCO's longtime advantages in this area. ISC always had a quality operating system, but the lack of decent documentation cast a black shadow over it. Prior to release 2.2, the documentation was sparse and perfect-bound (the kind of book that never stays open). Now, the manual set is complete, and it comes in stiff cardboard binders with clearly marked index tabs. On-line manual (`man`) pages for commands and library functions are standard now. Unfortunately, pages are not added when you install the X Window System and OSF/Motif. That's an oversight that needs attention.

In addition to answering age-old complaints with release 2.2, ISC has rolled in some new ingredients of its own. Interactive Unix now complies with the POSIX 1003.1 operating-system specification; developers select System V or POSIX program behavior at compile time. POSIX compliance also brings an important feature, *job control*, to Interactive Unix. With this, it is possible to suspend a process and resume it later.

ISC provides a new C shell that activates and manages this job control. Here is how it works: While a program is running, you can press a special "switch" character to suspend the program and place it in the background. A shell prompt then appears. The C-shell command `bg` sets a job running again in the background (control returns to the shell), and `fg` makes the suspended session the active one. For example, you can suspend a `vi` editor session to do a compile and easily resume the `vi` editor session afterward.

Also taken from POSIX are the portable archiver, `pax`, and the ability to assign membership in multiple groups to a single user. The `pax` archiver is compatible with both `tar` and `cpio`, but it also has an enhanced data-storage format and an interface of its own. Multiple groups allow system administrators to fine-tune file access.

Also included in Interactive Unix 2.2 are a number of useful features, such as additional and enhanced device drivers (with floppy disk and SCSI tape foremost among them); new versions of `sendmail` and `smail`; multiple EGA and VGA fonts; a `setcolor` command for modifying the console character colors; and extended (secondary) DOS partition support.

ISC has also upgraded its TCP/IP, VP/ix, Software Development System, and X products significantly. The company claims to have sold more 386 3.2 Unix packages than any other vendor, and with Interactive Unix 2.2 and these other upgrades, that trend should continue.

SCO Unix 3.2 Version 2.0

Version 2.0 of SCO's Unix 3.2 contains much more than just a few patches and fixes. It is SCO's statement about the new AT&T Unix System V release 4, a release that is slowly starting to come out of the porting labs and into the real world. We would verbalize SCO's statement as "take the most sought-after (and easiest to implement) features of V.4 and implement them under V.3.2." The most obvious of these features is the Korn shell with full job control, and SCO's new release has it.

The Korn shell has all the features of the Berkeley C shell, including command-line history, aliases, and internal handling of `test` and arithmetic operations from scripts. What the Korn shell has that the C shell lacks is an internal editor (emulating either `vi` or `emacs`) for editing commands in the history list before reissuing them. (This is even better than the command history in VMS, Digital Equipment's operating system for VAX computers.)

Having the Korn shell with job control makes complex Unix sessions almost as

---

SCO Unix 3.2 version 2.0

Company
The Santa Cruz Operation
400 Encinal St.
Santa Cruz, CA 95061
(408) 425-7222

Hardware Needed
386- or i486-based PC with at least 2 MB of memory (3 MB or more recommended) and 40 MB of free hard disk space

Price
Single-user: $595
Multiuser: $895
Update: $95-$150

Inquiry 1062.

Interactive Unix 2.2

Company
Interactive Systems Corp.
2401 Colorado Ave.
Santa Monica, CA 90404
(213) 453-8649

Hardware Needed
386- or i486-based PC with at least 4 MB of memory and 40 MB of free hard disk space

Price
Single-user: $495
Multiuser: $795
Update: $100

Inquiry 1063.

Interactive Unix has one of the best installation procedures we've seen. The process is managed by a full-screen color program that walks new users through every step.

easy as running in an X environment, though not quite as scenic. Job control is not supported for the C shell in SCO Unix, even though it is in Unix V.4 and ISC Unix 2.2.

Other significant elements of SCO Unix 3.2 version 2.0 include a way to make shared library operations of non-SCO Unix systems work with SCO Unix, as well as support for High-Sierra and ISO9660 CD-ROM drives. There are numerous enhancements to SCO's already serious "trusted system" implementation. The `vi`, `sh`, and `mail` utilities have been "internationalized," and they now handle 8-bit characters. (The 2-byte-character internationalization of strings is still not a standard part of any Unix system.) This new version also includes more POSIX 1003.1 features, including pax.

SCO and Microsoft (the trademark holder of Xenix) have influenced what is included in AT&T's V.4. And, despite its effort to *be* Unix, SCO tends to put more energy into adding value to Unix than into following the standard path. The company has publicly stated that it has not made plans to adopt AT&T's V.4, but this doesn't mean that SCO isn't going to continue to implement what it thinks are the operating system's best features. ■

Ben Smith and Tom Yager are technical editors who run the BYTE Unix Lab. You can contact them on BIX as "bensmith" and "tyager," respectively.

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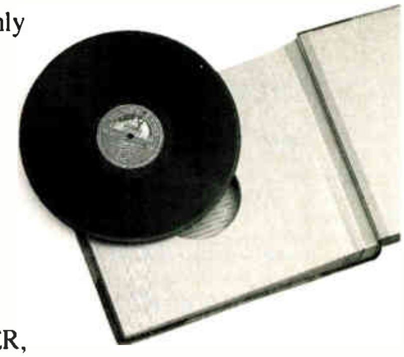

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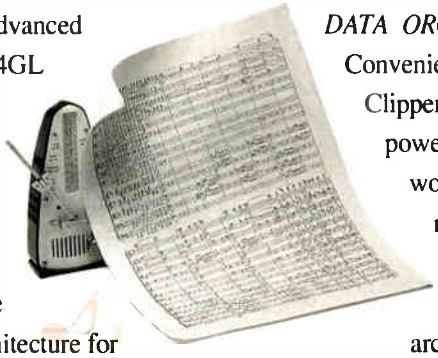

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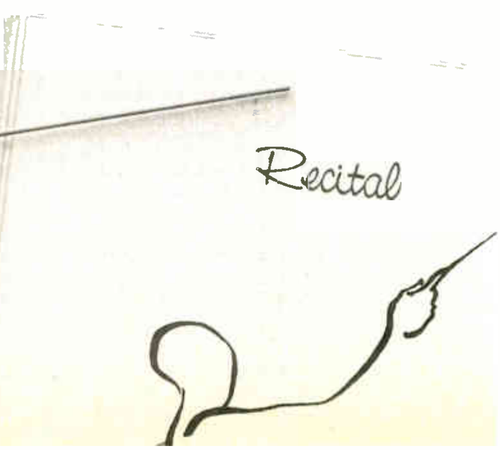

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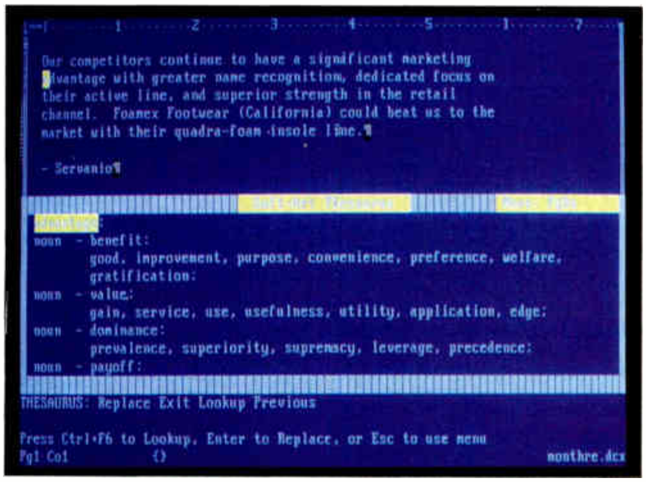
Ben Smith

REVIEW

Microsoft Word Brings PC-Style Word Processing to Unix



Microsoft Word for Unix looks and acts just like Word for DOS.

If you are a seasoned Unix user, you might wince at the thought of a PC program cluttering up your "serious" Unix computer. The Unix `vi` or `emacs` editor (with a little `nroff` or `troff` formatting code) is all you think you will ever need (or want). If this is your attitude, classify yourself a bigot. Open your eyes, and widen your view. Microsoft Word is a word processing (and nearly a desktop publishing) program, not a text editor. There's a world of difference.

I'm not saying that there aren't some tried-and-true Unix word processing programs around, but I assure you that you wouldn't want to compare them to Microsoft Word, arguably the most popular multiplatform word processing program. On the other hand, there are some real gotchas in having a personal computer program on Unix—a multiuser, multitasking operating system with a rich history and set of traditions.

Microsoft Word 5.0 for Unix

BYTE LAB

Company
The Santa Cruz Operation, Inc.
400 Encinal St.
P.O. Box 1900
Santa Cruz, CA 95061
(408) 425-7222

Hardware Needed
Computer running AT&T Unix 386 release 3.2 or higher (including SCO, Interactive, and other AT&T derivatives) and 3.8 MB of disk space, assuming one printer, 1.5 MB of memory for first user, and 500K bytes for each additional user. Versions also available for many AT&T computers.

Price
Unlimited number of users: $995

Inquiry 1005.

Full-Featured Word Processing

Shrink-wrapped Unix applications are a goal of The Santa Cruz Operation. It is its packaging of Microsoft Word 5.0 that makes this a reality. As with any SCO-supported package, installation requires little more expertise than being able to find the floppy disk drive and knowing which way to insert the four disks. You do need to know what kind of printer you have.

Microsoft Word's massive functionality is delivered in an easy-to-use style. Users at all levels will find it appropriate for writing the most complex as well as the simplest text files, memos, and even programs. If you wish, you can save your files as plain text files without any embedded formatting information. You can read and write to PC Microsoft Word files, allowing seamless interchange of files among the Unix, Macintosh, Windows, and DOS versions.

Word provides you with on-line help, multicolumn page layout, style sheets, graphics importing, printer-font loading, mail merge, redlining, optional postponement of editing changes, hidden text, and sorting. (Take a breath here. . . .) There's also index generation, outline generation and expansion, spreadsheet links, an interactive spelling checker and thesaurus, a built-in calculator that you can apply to columns of numbers in your text, a macro-language processor that you can prime with captured keystrokes, document management across multiple directories, and multiple windows on the same file or across separate files.

Simple Escape-key sequences invoke most commands, but all are mapped to function keys and Alt keys for people who like to let their fingers jump all around the keyboard. But any Microsoft Word user is used to all these features.

What is different is that this is a Unix application. Unix is very different from the MS-DOS, Microsoft Windows, and Macintosh environments. First, Unix is a multiuser operating system, meaning that there has to be a way to prevent more than one person from editing the same file at the same time; Word has file locking. Each user must be able to have his or her own Word options environment; there is an `mw.ini` configuration file in each user's home directory, and a master file in Word's library directory.

Unix application programs can make no assumptions about the user's display and keyboard. Unlike MS-DOS, the display isn't limited to one of a predictable set. With Unix, there are as many different displays as there are different printers.

SCO has this problem pegged. If you are working at the console, the fit is flawless. Every function key, cursor motion, and Alt-key combination is identical to what you find on the PC version of Microsoft Word. Where there is a conflict (e.g., SCO Unix uses an Alt/function-key combination to switch between virtual terminals), standard Word key combinations are given precedence, but an alternate is given to the conflicting combination (in this case Control-Alt-function key).

More amazingly, Word works as well on terminals as on the console; even the function keys and Alt keys are consistent. Word's method of selecting text (without a mouse) is Shift-arrow key. Although far from a common combination on character terminals, even this is implemented.

With SCO's Microsoft Word for Unix you also get manuals, installation notes, and other goodies (e.g., keyboard templates) that are as good as what you get with the MS-DOS version of Word. You also have excellent (though not always timely) support from SCO where the technicians not only know Word, but are also experienced with Unix.

What You Don't Get

DOS users may be disappointed to find that the Learning Word program is missing. Similarly, the preview function, which lets you see your page layout before printing, isn't there. You also don't get mouse support or on-screen fonts.

On the Unix side, there isn't much integration with the Unix shell and utilities (a feature of emacs-type editors). Word doesn't follow many of the Unix traditions, such as naming the initialization file something like `.mswrc` so it doesn't clutter up your home directory listing. You can get around this by changing an environment variable.

You may also need to edit the `termcap` file (a description of terminals' attributes) to get Word to use color and different text modes (e.g., italic, bold, and underline). All these deficiencies are really minor when you put them up against what you *do* get. What is surprising is that this is not implemented as an Open Desktop application. Open Desktop is SCO's shrink-wrap Unix workstation software. It is basically an X Window System/Motif environment with bundled applications: networking, virtual MS-DOS machine, and DBMS.

What is lacking in Open Desktop is the rest of the office-automation software, primarily a word processor. What is lacking in Microsoft Word for Unix is a way to use the mouse and to display fonts, features that Open Desktop offers through Motif and X Window.

Who Is It For?

Microsoft Word for Unix is for those 386 Unix users who want an easy-to-learn and feature-loaded word processor.

I should add "easy to use" to the list. For instance, to save a file and quit with WordPerfect, you need to press F7 (better have your keyboard template or a good memory) and then a *Y* (for yes) to save the document. If the document already exists, you need to confirm that you want to replace the existing file: another yes. This has only gotten you to the point of saving and closing that file. You still have to tell WordPerfect to go away: *another* yes.

But with Microsoft Word, you press Escape (for the command menu) and Q (for quit). If you have unsaved changes, Word will ask if you want to save them (*Y* for yes), but that is the only step that may come between you and returning to the Unix shell. Much simpler, and there is no magic key to remember.

Now, compare Microsoft Word with the Unix `vi` editor. To cut and paste a block of text with `vi`, you must move to the top of the block and place a mark with a command like `mt`. You then move to the bottom of the block and yank the block to the unnamed buffer; the command is `y't`. Now move to the new position and "put" the buffer in with the command `p`. This amounts to six key presses for `vi` (not counting moving the cursor to the new point and problems with working with blocks that are only lines).

With Microsoft Word, you position yourself at the beginning of the block and then hold the Shift key while you move to the end of the block. Having marked the block, you press either Escape and then C (for the command menu method for Copy—a two-key-press operation) or the Alt-F3 combination (1½ keystrokes). Now you move to the new location and press the Insert key (one keystroke). Microsoft Word wins with 3½ keystrokes; plus, you can see the block as you mark it.

I prefer an emacs-style editor for my work at BYTE (I won't go into the rigamarole for copying blocks with emacs). My book publisher's editors, however, do all their editing with (you guessed it) Microsoft Word. So, for the sake of convenience, I now use Word when I am writing for them. I don't have any complaints. In fact, I found Word much easier to learn and use than WordPerfect (Word's biggest competitor).

If you are already well established using Unix editors and formatting programs, you probably won't be drawn to Word until it has better support for the Unix and/or X environment. But if you are running Unix on a 386 or 486 computer and want a real word processor, Microsoft Word is an excellent choice. ■

Ben Smith is a BYTE technical editor and author of Unix Step By Step *(Howard Sams, 1990). He can be reached on BIX as "bensmith."*

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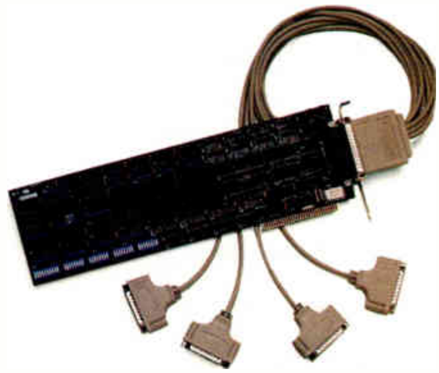

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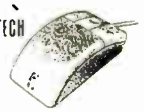

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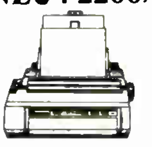

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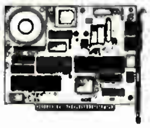

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REVIEW

Plug-and-Play Unix Machine

The Dell Station 425E turnkey system smooths the road for new Unix users. Bundled software includes X.Desktop and the Uniplex II Plus Advanced Office System software.

The Dell Station 425E is a turnkey Unix system that Dell hopes will snare PC system users who are migrating to Unix. Built around the company's 486/25E Extended Industry Standard Architecture (EISA) system, the Dell Station bundle includes Unix and applications software that together form a powerful integrated system. Dell clearly designed the 425E with first-time Unix users in mind, and the success of this design distinguishes the 425E from its competition.

The Dell Station's $9687 base price looks steep until you consider what it buys. On the hardware end, the workstation is a 25-MHz 486 EISA computer with 8 megabytes of RAM, a 5¼-inch 1.2-MB or 3½-inch 1.4-MB floppy disk drive, a 15-millisecond, 100-MB Intelligent Drive Electronics (IDE) hard disk drive, and a 150-MB quarter-inch cartridge tape drive. The system also includes a Dell Super VGA color graphics adapter and an 800- by 600-pixel color monitor, a serial mouse, and an IBM Enhanced 101-key keyboard.

For software, the 425E includes a Dell-licensed version of Interactive Systems' Unix System V 3.2, the X Window System, an easy-to-use X.Desktop iconic file manager environment, MS-DOS emulation, and a full suite of Uniplex Advanced Office System applications running in the X.Desktop environment. TCP/IP and Network File System software are optional.

Dell installs the operating system and applications software on the hard disk drive, so all you have to do is connect the system components and turn on the power. An easy-to-follow installation routine then takes you through the steps of setting the date and time, initializing user accounts, and making passwords for the administrative accounts.

Inside the Station

The Dell Station fits in a full-size IBM AT-type case. The components are laid out with three half-height bays on the right side, with two half-height bays beside them. My review system had high-density 5¼-inch and 3½-inch floppy disk drives in the top two right-hand bays and the tape drive in the bottom right-hand bay. Instead of the standard 100-MB IDE hard disk drive, the review system had an optional Micropolis 330-MB ESDI hard disk drive. The unit also included an extra floppy disk drive, which brought the total price to $10,725.

The computer has six EISA slots and two 16-bit ISA slots. The ESDI hard disk drive controller card and VGA color graphics adapter occupied the two 16-bit slots in my test machine, and two of the 32-bit slots held 16-bit Ethernet and tape controller cards. The motherboard accepts up to eight 1- or 2-MB single in-line memory modules, for a maximum of 16 MB of 80-nanosecond RAM.

The Super VGA graphics adapter and color monitor provide adequate detail for the icons and graphics on the X.Desktop interface, but Dell should have included a higher-resolution graphics option. The Interactive X port that Dell used as the basis for the operating system includes drivers for 8514 graphics as well as for hardware graphics accelerators.

The motherboard integrates two serial ports and one parallel port. The Dell mouse (which is made by Logitech) plugs into one of the serial ports. For multiuser configurations, Dell furnishes serial port expansion boards to support up to 32 remote terminals over asynchronous lines.

The Dell Station's cooling fan is one of the noisiest that I have come across in years. I had the system set up about 6 inches from a wall, which may have enhanced the sound, but you could tell when the computer was turned on from anywhere in the house.

Big Software Bundle

Dell Unix System V release 1.1 is a licensed version of Interactive Systems' 386/ix release 2.0.2, which is an implementation of AT&T Unix System V 3.2. Dell has enhanced it to include new X drivers, an on-line manual, and several other features. The company has taken great pains to relieve the average user of ever having to deal with the nitty-gritty of Unix.

The Dell Station 425E is designed to make it easy for non-Unix users to get started. You never have to learn the intricacies of `grep`, `awk`, or `sed`. The menu-driven `sysadm` program makes mundane system management relatively effortless.

continued

Dell Station 425E

Company
Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(800) 274-3355

Components (as reviewed)
Processor: 25-MHz Intel i486; socket for Weitek 4167 math coprocessor
Memory: 8 MB of SIMM RAM
Mass storage: High-density 5¼-inch and 3½-inch floppy disk drives; 330-MB ESDI hard disk drive; 150-MB internal cartridge tape drive
Display: 14-inch Dell VGA color monitor; 800- by 600-pixel Dell Super VGA adapter
Keyboard: 101-key IBM Enhanced layout
I/O interfaces: Two serial ports; one parallel port; one thin Ethernet port

Software
Dell Unix System V 3.2 with the X Window System, X.Desktop interface, OSF/Motif window manager, VP/ix, Uniplex II Plus Advanced Office System version 7, Uniplex Advanced Graphics System, and Uniplex Windows

Price
$10,725

Inquiry 1108.

Another difficulty of making Unix a viable operating system for naive or inexperienced users has been the absence of application programs that have a uniform interface. The Uniplex suite of business applications goes a long way toward overcoming this difficulty. Uniplex's software tools include a word processor, a spreadsheet, a database (Informix), presentation graphics, an appointment calendar, an E-mail system, and several other utility programs. All these programs present you with the same general interface so that you have to learn only one basic set of keyboard and mouse actions.

GUI and Text Interfaces

The Dell Station offers two graphical user interfaces and a text-oriented user interface. When setting up a new user account, the system administrator has the option of making that user's interface either a standard X GUI running an `xterm` window and `xclock`, or a special X environment with the OSF/Motif window manager running X.Desktop and Uniplex. The latter is totally window- and icon-based and lets you perform normal operations such as changing directories, opening applications, viewing text files, and deleting files using the mouse. When you need to get into a Unix shell, you need only click on the desktop area to open a shell window. You can access three text-oriented, full-size Unix screens for use as standard log-in sessions. One of these screens is the logical Unix console that displays system messages.

The MS-DOS Connection

Dell uses Interactive's VP/ix to support MS-DOS applications. You can run DOS applications in two environments. While you're in the X.Desktop environment, you can open a monochrome, text-only DOS window, or switch to a different terminal session (by simultaneously holding down the Control, Alt, and Sysrq keys and pressing either F1, F2, or F8) to use a full-screen window. After you log in, you can type `run VP/ix` to start a full-screen DOS window with complete enhanced VGA support for graphics or text. You can switch back to the original X screen any time you like by simply holding down Control, Alt, and Sysrq and then pressing F3.

Running an MS-DOS session in a full-size VGA window offers excellent software compatibility. I ran Flight Simulator (to stress-test graphics compatibility), WordPerfect 5.0, and Procomm, and I didn't experience any problems. You can run as many as three separate full-screen MS-DOS sessions and switch among them.

The first DOS session that you start or DOS window that you open has control of the floppy disk drive (or drives). If you want to access the drive from another window or terminal, the original DOS session must release the device.

MS-DOS can access and use Unix files, but DOS users must have at least Unix read access to those files. Unix filenames that are illegal under DOS are parsed to unique DOS filenames when listed with the DOS `dir` command. Also, the DOS copy command has switches to convert between Unix and DOS ASCII text files. (MS-DOS gives each line both carriage-return and linefeed characters; Unix, on the other hand, uses only a linefeed.)

But Does It Perform?

If you're accustomed to working on a computer with a windows-based interface, you'll be impressed with the Dell Station's performance. When you click on a window that's partially covered by other windows, it snaps to the top of the

Is Windows 3.0 the end of DESQview™?

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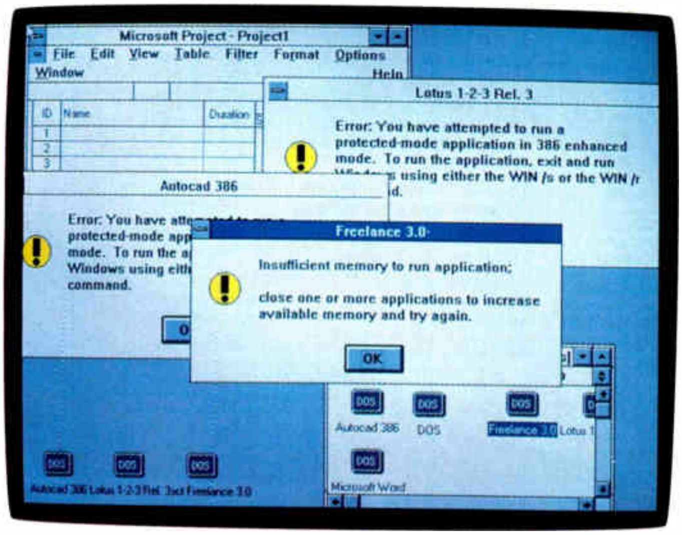
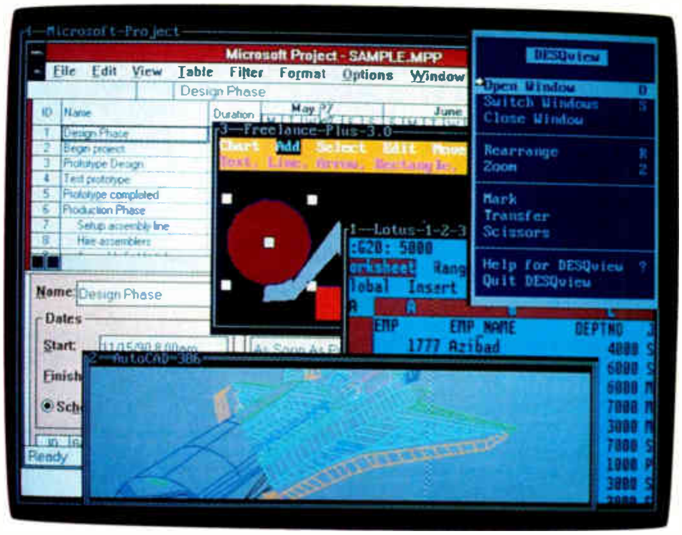


Windows 3.0. The multitasking, windowing environment.



DESQview 386 2.3. The multitasking, windowing environment.

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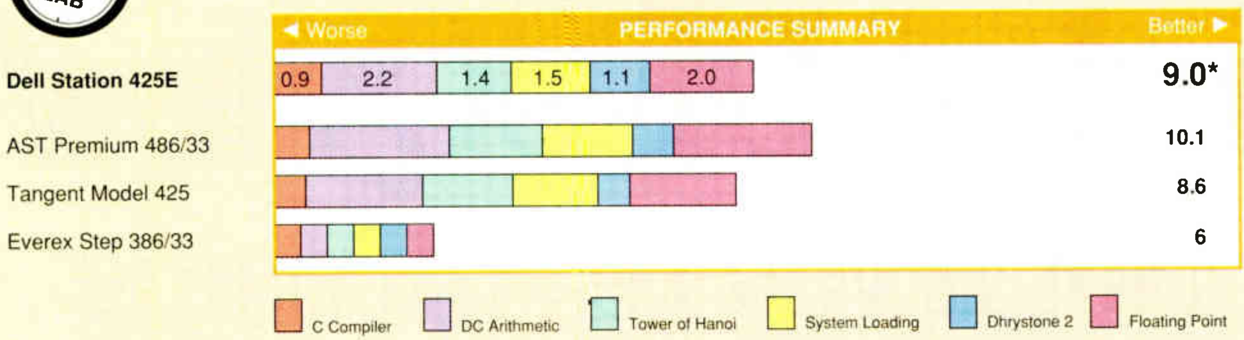
This comparison was made using a system like the one you might run: Both shots show an ALR FlexCache 33/386 running DOS 3.3 with VGA display adaptor, Novell NetWare v3.01 Rev. A, with IPX/SPX v3.01 Rev A, Microsoft Mouse 7.00, and Microsoft SMARTDrive v3.03 disk cache. Buffers were set to 20. For the Windows screen, we ran Microsoft Windows 3 HIMEM.SYS and EMM386.SYS. For the DESQview screen, we ran QEMM 386 v5.1.

UNIX BENCHMARKS



HIGH-LEVEL PERFORMANCE

	Time	Index
* **C Compiler**	2.3	0.9
* **DC Arithmetic**	0.3	2.2
* **Tower of Hanoi** (17-disk problem)	0.4	1.4
System Loading[1]		
1 concurrent background process	3.2	1.3
2 concurrent background processes	4.2	1.4
4 concurrent background processes	6.8	1.4
* 8 concurrent background processes	11.6	1.5

LOW-LEVEL PERFORMANCE

	Time	Index
* **Dhrystone 2** (without registers; Dhry./sec.)	15625	1.1
Arithmetic (10,000 iterations)		
Arithmetic overhead	0.2	3.6
Register	3.1	0.9
Short	3.8	0.9
Integer	3.1	1.0
Long	3.1	1.0
* Floating Point	6.1	2.0
Double	6.3	2.1

	Time	Index
Throughput		
System call overhead (5 x 4000 calls)	0.8	1.4
Pipe throughput (read and write 2048- × (512-byte blocks)	0.8	1.2
Pipe-based context switching (2 × 500 switches)	0.6	1.0
Process creation (100 forks)	0.5	2.3
Excel throughput (100 execs)	1.2	2.8
Filesystem throughput (1600 1024-byte blocks in Kbytes/sec.)		
Read	648	N/A
Write	364	N/A
Copy	236	N/A

* Cumulative index is formed by summing the indexed performance results for C Compiler, DC Arithmetic, Tower of Hanoi, System Loading (with 8 concurrent background processes), Dhrystone 2, and Floating Point tests.

[1] System loading performed using Bourne shell scripts and Unix utilities.

Note: All times are in seconds unless otherwise specified. Figures were generated using the BYTE Unix benchmarks version 2.6. Indexes show relative performance; for all indexes, an Everex Step 386/33 running Xenix 2.3.1 = 1. N/A = Not applicable. For a description of all the benchmarks, see "The BYTE Unix Benchmarks," March BYTE.

stack instantly. When you drag or resize a window, it pops into its new size or location without hesitation. This instant visual feedback adds greatly to the qualitative feeling of working with a high-performance computer. However, the speed is at least partially due to the fact that the Dell Station has to manage only a 4-bit color plane with 800- by 600-pixel resolution.

Overall, the Dell Station scored well against other i486-based machines that the BYTE Lab has tested. The Dell outperformed the Tangent Model 425 and Compaq Deskpro 486/25, and it ranked just behind the 33-MHz AST Research Premium 486/33 overall (for more on the comparison systems, see "486 EISA Machines: A Slow Start in the Fast Lane," October BYTE, and "High-Performance 486 ATs," November BYTE). The Dell Station's one weak point was its floating-point test scores, but it outperformed all three of its competitors on the Dhrystone 2 tests. And none of the comparison machines can compete in terms of price when you consider the Dell Station's bundled software.

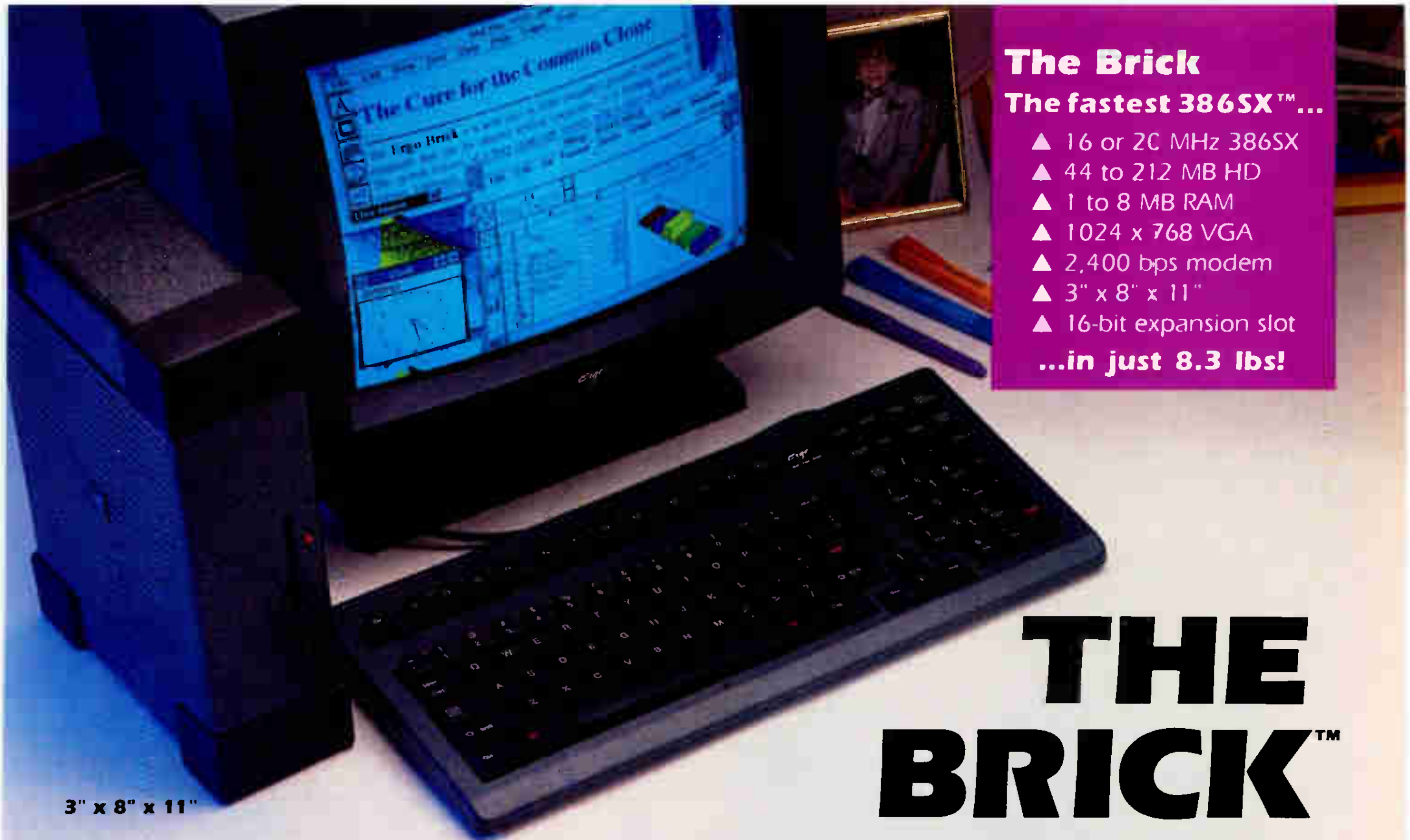
A PC in a Unix World

In a world of RISC workstations, the Dell Station bucks the trend by combining a state-of-the-art CISC-based hardware platform with its Unix. Dell has used this platform to run an X-based version of Unix that makes the system as user-friendly as possible. To that extent, Dell has succeeded, although some users may be disappointed with the graphics subsystem.

Considering the wealth of software that the Dell Station includes, the price isn't bad. The new Sun SPARCstation IPC, which retails at just under $10,000, is a similar hardware package, but it lacks an OSF/Motif-type interface—at least until the next release of SunOS Unix—and it includes no applications software (BYTE will review the SPARCstation IPC in an upcoming issue). With the addition of the optional Dell Station Partner Kit ($399), you can use MS-DOS PCs as X terminals networked to the Dell Station, and the cost per user for this system drops rapidly.

The Dell Station isn't going to convert any engineering workstation users, but if you're new to Unix or you're recommending a Unix system for the people in your office, the Dell Station requires a lot less hand-holding than other Unix alternatives. And that should make everyone happy. ■

John Unger is a scientist working for the U.S. government in the Washington, D.C., area. He does most of his work on a Sun-3. You can reach him on BIX as "junger."



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— PC MAGAZINE, Sept. 1990

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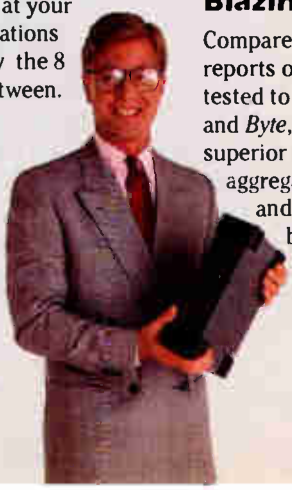

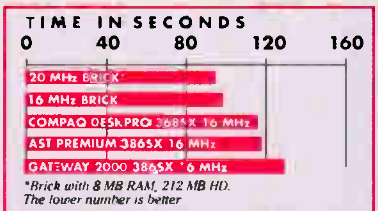

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Circle 352 on Reader Service Card

Jon Udell

REVIEW

LAN Manager 2.0: A Force to Be Reckoned With

Everybody loves a good horse race. In the realm of PC networking, that's just how industry watchers like to portray the contest between Novell and Microsoft. Novell's NetWare, eight lengths ahead, suddenly finds Microsoft's LAN Manager thundering in hot pursuit.

The battle for mind- and market-share won't end in a photo finish under the wire. But it will increasingly clarify an evolving vision of advanced network computing. Here are the essential ingredients of that vision: A network operating system should be easy to use and administer, work smoothly with other kinds of networks, support distributed (client/server) applications, run with blazing speed, exploit advanced hardware, protect its resources with a rock-solid security system, and scale up gracefully from small to very large installations.

LAN Manager's latest version, 2.0, scores well on all these fronts. Some of its new features, notably local security at the server and disk fault tolerance, match long-standing NetWare capabilities. Other features, such as limited multiprocessor support and domainwide user accounts, break new ground.

Read the Books First

Five well-written manuals document the system. The installation process, while dead simple, requires choices that you can't intelligently make until you read the books and know the big picture. And make no mistake, it is a *big* picture. You will likely be working with both OS/2 and DOS machines. On the OS/2 side, you've got to consider which file system to use: the DOS-style file allocation table (FAT) or OS/2's High Performance File System.

Any OS/2 system benefits from the standard features of HPFS: banded allocation, caching, B-tree directory lookup, and long filenames. But a LAN Manager server gets extra mileage out of HPFS; drive mirroring and duplexing require it. On a 386 machine, an alternate installable file system called HPFS386 runs in native 32-bit mode. (A dual-processor version that runs HPFS386 and the network I/O subsystem on a dedicated processor should be available by the time you read this.) HPFS386 can distribute permissions for files throughout the file system, storing them in HPFS *extended attributes* rather than in a separate database file. That is the basis of *local security*, which enables you to protect the server's entire file system, not just the resources it shares with the network. As with a Unix machine, you log on for local access.

Although it is possible to run a LAN Manager server on a FAT partition, I can't think of any good reason for doing so. For OS/2 workstations, it's another matter. If you're going to dual-boot DOS and OS/2, you'll need a FAT partition. Even so, savvy users will dedicate most of the disk to the superior HPFS.

Next you've got to choose whether to make an OS/2 machine a workstation, a peer server, or a full-blown server. As you'd expect, memory requirements increase as you move up the ladder, from 3 to 3.5 to 6 megabytes, respectively. I knew I wanted to make a 12-MB Compaq Systempro a server, but I erred in installing my second OS/2 system, a Dell 386/25, as a workstation. The extra half-megabyte required for a peer server buys you more than a limited ability to share disk, printer, and other resources. A peer server can also be a backup *domain controller*. That means it keeps an automatically updated copy of the primary server's user accounts database. When I learned that, I promoted the Dell 386/25 to a peer server, which meant removing and reinstalling the workstation software. Like I said, read the books first.

The DOS Connection

Since DOS is a much less complex beast than OS/2, it recovers more easily from a wrong choice. LAN Manager comes in two flavors for DOS: basic (big) and enhanced (bigger). The basic version, a minimal MS-Network work-alike, can use the high-memory area (HMA—the first 64K bytes of extended memory) to shrink its memory footprint. With HIMEM.DOS, the version of the HIMEM.SYS driver that comes with LAN Manager, the basic workstation software used 69K bytes on a Gateway 386SX running DOS 4.01.

The enhanced version adds all the beef: resource browsing, messaging, the named-pipes protocol (required to access, for example, SQL Server), and queue manipulation. It can also use the HMA (and, in certain circumstances, EMS as well); with HIMEM.DOS in place, the enhanced version ate up 120K bytes on an Arche Legacy 386/33.

The enhanced workstation offers to install a Windows 3.0 driver. Presumably, you could run the basic version under Windows, but without the network support for browsing available servers and queues and for receiving messages, it wouldn't buy you much. The enhanced version, on the other hand, dovetails nicely with Windows. You can use the File Manager to browse network drives, the Control Panel to locate and connect to network printers, and the Print Manager to monitor and control print queues. A utility called WinPopup receives and displays messages. You can also send out messages from within Windows; that's a convenience that the NetWare driver for Windows doesn't currently offer.

Plumbing the Physical Layer

LAN Manager 2.0 and NetWare 386 handle network infrastructure—adapter drivers and protocols—in a similar way. LAN Manager's NDIS (the Microsoft/3Com network driver interface specification) and NetWare 386's ODI (for open data-link interface) both do the same job: They separate hardware drivers from transport protocols. Network drivers used to be "monolithic": Adapter manufacturers had to incorporate transport protocols in their driver software. With NDIS or ODI, driver writers need only conform to a generic transport-protocol interface—a simpler (though hardly trivial) task. Moreover, both interfaces support two kinds of multiplexing. Different protocols can share an adapter so that, for example, LAN Manager's NetBEUI (the NetBIOS extended user interface) and TCP/IP can coexist on the same physical network.

It works the other way, too—multiple adapters can share a protocol. In that case, the protocol spans two physical networks. Just for fun, I converted my test LAN Manager network from a single Ethernet segment to two, joined at the Systempro server. With only four machines, there was no reason to divide the cabling. However, it's a strategy that comes into play when managing large, congested networks. It took me 10 minutes to add a second network adapter to the Systempro and to rearrange the cables, and another 5 minutes to tell LAN Manager to "bind" the NetBEUI protocol to the second adapter.

In the two-segment configuration, all

LAN Manager 2.0

Company
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080

Hardware Needed
Server: 286, 386, or 486 system with 6 MB of RAM
OS/2 workstation: 286, 386, or 486 system with 3 MB of RAM and OS/2 1.1 or higher
OS/2 workstation with peer service: 286, 386, or 486 system with 3.5 MB of RAM
DOS basic workstation: 8086 or higher system with 640K bytes of RAM
DOS enhanced workstation: 8086 or higher system with 640K bytes of RAM; extended or expanded memory recommended

Software Needed
Server and workstation with peer service: OS/2 1.2 Standard Edition (CSD XR04053) or higher
DOS workstation: DOS 3.1 or higher

Price
Five-user license: $995
Additional 10-user license: $995

Inquiry 1065.

workstations communicated with the common server and vice versa. But they couldn't all talk to each other. LAN Manager 2.0 doesn't permit a machine on one physical network to communicate directly with a machine on the other. That's something that third parties will have to provide.

More interesting than multiple adapters, though, is the notion of multiple protocols. Users increasingly want Macs, PCs, Unix workstations, and Digital Equipment and IBM hosts to be plug-and-play. Each of these cultures relies on deeply entrenched network protocols. Microsoft's NDIS, like Novell's ODI, is an architecture that enables a network to participate in several cultures at once. However, the core LAN Manager 2.0 doesn't capitalize on that opportunity. Just as NetWare 386 ships only with its native IPX protocol, LAN Manager 2.0 ships only with its native NetBEUI. For now you'll have to look elsewhere—most likely to 3Com—for the extra pieces you need to connect a LAN Manager network to a Macintosh or Unix network.

LAN Manager workstations, like servers, bind one or more protocols to one or more adapters at run time. That means a LAN Manager OS/2 or DOS (enhanced) client can fit cleanly into a heterogeneous environment. (Although NetWare 286 clients are monolithic, NetWare 386 clients can also multiplex protocols by means of ODI.)

In general, it's a snap to install and rearrange NDIS drivers. My only gripe is that there's no sanity-check utility like Unix's `ping` or NetWare's `comcheck`. I always like to test out basic connections before layering on a lot of network software. But when I encountered a faulty adapter configuration, I didn't discover the problem until the domainwide security system failed to initialize.

Locking the Gate

Under LAN Manager 1.x, you could walk up to a server, toggle from the LAN Manager session to an OS/2 command window, and proceed to snoop around in the server's file system. People rightly complained about that, and version 2.0 solves the problem—with a vengeance.

When you install a 2.0 server on a 386 system, you can opt for local security. I did that, and when the server booted, it prompted me for the administrator's name and password. I typed "admin" and "password" per the manual's directions but failed to gain administrative privileges.

As I later discovered, the first batch of LAN Manager 2.0 disks were shipped with a password expiration date (a policy that has since changed), and mine had expired. The result was a convincing demonstration of local security—I was simply locked out of the file system. I couldn't even edit CONFIG.SYS to prevent the server software from starting. Not that that would have helped, since local security is intrinsic to the file system and doesn't depend on the network software. It looked as though I'd have to wipe the disk and start over. Although there was a workaround—one that Microsoft supplied and would probably prefer I keep to myself—it's clear that the new LAN Manager has really battened down the hatches.

Local security applies only to the server's console. From the network perspective, server security comes in two flavors: share-level and user-level. Share-level security mimics MS-Network and PC-LAN networks, which can password-protect shared resources but can't specify levels of access by user. User-level security enables much more precise control. You can specify how each user (or group) can access each shared file, directory, print or serial device queue, or named pipe. (While NetWare 386 also supports file-level permissions, NetWare 286 does not.) When a server runs user-level security, it can also audit who does what with its shared resources. While it's more powerful and generally more desirable than share-level security, user-level security demands more administrative effort. In most cases it'll be worth the trouble, but it's handy to have the simpler, more open share-oriented method available as an option.

Domains and Log-on Security

A domain can weld a group of servers and workstations into a single administrative unit. It sounds simple, and in a way it is, but you've got to work with the domainwide log-on security system for a while to sort through all its implications. Domain-based security is optional. Nothing prevents you from setting up a network with one or more stand-alone servers, each (as with NetWare) responsible for its own user accounts. In that case, however, each server accessible to a workstation has to maintain privileges for that user. Conversely, the user must supply a password each time he or she tries to attach to a shared resource.

To activate domain security, you first name a primary domain controller and one or more backup domain controllers, join the controllers to a special group (called "servers"), and then start the `netlogon` service on each participating server. This makes sense even on a single-server network. Once the server validates your log-on request, you're in. For the rest of that session, you can use any resource your permissions entitle you to use, no questions asked.

The real purpose of domainwide security, of course, is to simplify multiserver administration. Within a domain, all servers running the `netlogon` service share identical copies of the user accounts database. The primary domain controller owns the master copy, which replicates automatically to the backups. Any domain controller can validate a log-on request, and, in fact, Microsoft recommends that you configure workstations to prefer different domain controllers to spread out the burden of log-on processing.

This arrangement simplifies the network administrator's life, because a single accounts database governs all access to a pool of servers. Conversely, for users it means that a single log-on request will grant access to the pool of servers. If the primary controller should ever fail, you can promote a backup controller to

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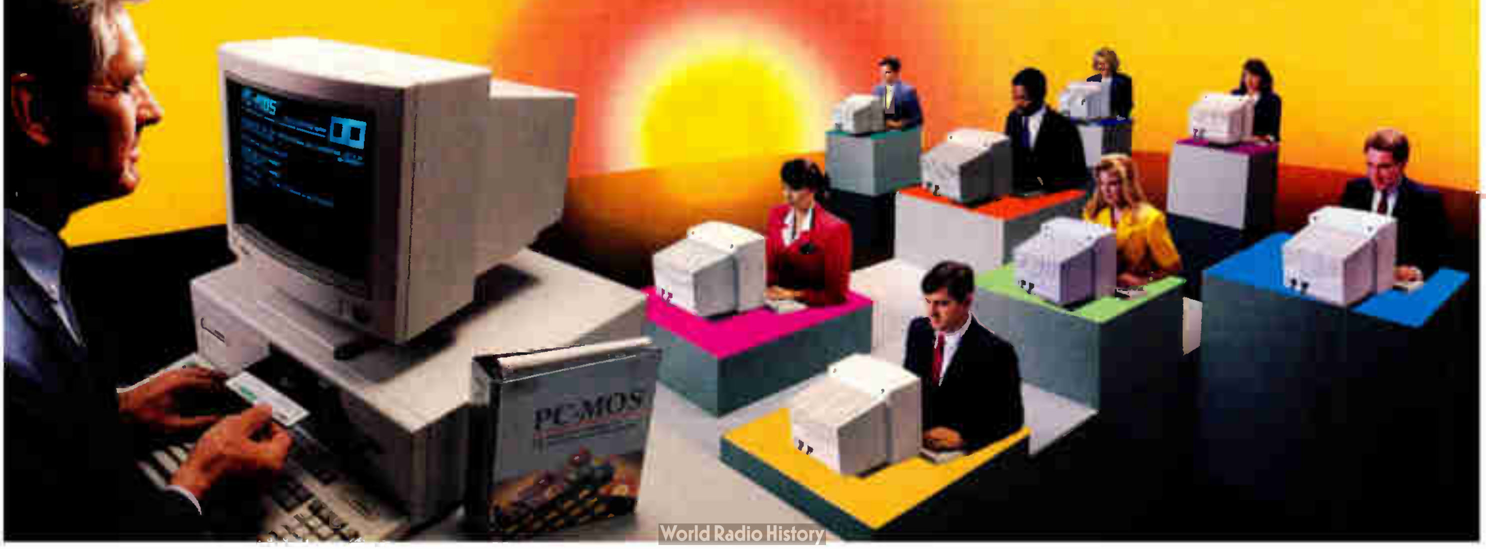


take its place.

What confused me at first was the distinction between domains and log-on security. Domains exist whether or not you run log-on security. When you start a workstation, it comes up in a "workstation domain" and can see only the servers in that domain. You might want to partition a large multiserver network into several such domains.

Within each domain there can be stand-alone servers and/or domain controllers. Moreover, a single server can be both a stand-alone controller *and* a domain controller at the same time. That's what happened when I set up the Dell 386/25 (a peer server) as a backup controller. I kept thinking that the permissions I assigned in the domainwide accounts database would apply to resources that the Dell shared. But they didn't; I couldn't access the Dell system from other workstations. Eventually it dawned on me that the Dell wasn't running the `netlogon` service. Peer servers can't run `netlogon`; only full servers can. Despite the fact that it was acting as a backup domain controller, the Dell needed its own accounts database to support its role as a peer server. Unix LAN administrators routinely deal with these kinds of subtleties. But if you are used to simpler PC networks, the full implications of LAN Manager 2.0's distributed security may take a while to sink in.

Printer and Communication Queues

One of NetWare 286's more annoying peculiarities is that you have to define all your printer queues during installation. But with LAN Manager 2.0, as with its predecessors, that's not the case. It treats disk, printer, and serial-device resources in pretty much the same manner. You pick a share-name, specify its resource type, and assign the necessary permissions. Of course, before you can share a printer with the network, the printer first has to be installed locally—that is, its driver must be registered with the OS/2 Print Manager.

Printer queues integrate well with the messaging service. LAN Manager keeps you posted when a print job holds, resumes, or finishes, and when the printer goes off-line (which is most helpful). However, DOS workstations running the basic client service can't receive these helpful messages. They must monitor queues manually by means of the `net print` command.

Communication queues enable OS/2 workstations to share modems, scanners, and fax machines. For example, I installed a modem in the Systempro and shared it as NETMODEM. Using Hilgraeve's HyperAccess/5 for OS/2 on the Dell, I connected to the remote modem and logged onto BIX. You can also pool modems. For example, the protocol to share a pair of modems would be

```
net share netmodem=com1:,com2:
```

at the server, and then, at the workstation,

```
net use com1 \\server\netmodem
```

LAN Manager searches the list of modems and connects the client to the first available one.

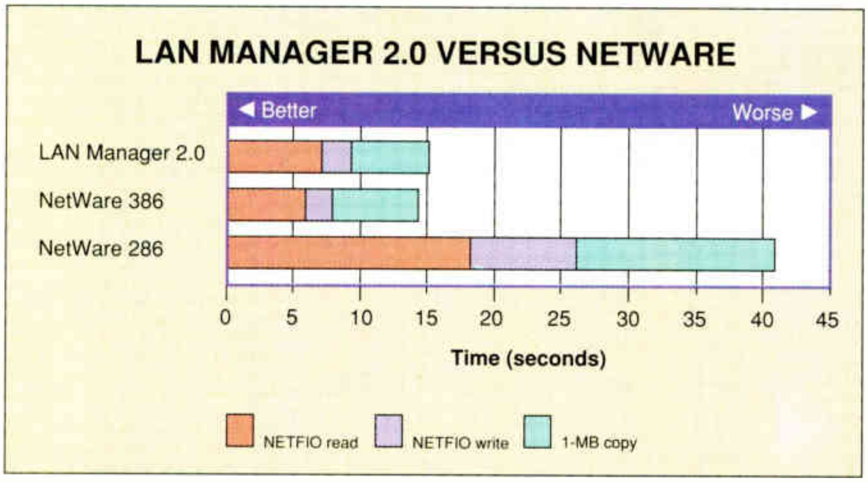
Distributed Computing

Two LAN Manager features—remote administration and the `netrun` facility—hint at the remote processing capabilities that underlie LAN Manager. To remotely administer a server, you run `net admin` and set the focus to the remote target. For example, once I granted administrative privileges on the Systempro to the Dell's account, I was able to run `net admin` on the Dell, switch to the Systempro, and remotely add to its list of shared resources.

Behind the scenes, the two machines establish an RPC (remote procedure call) session. In fact, many of the LAN Manager application programming interface calls take a server-name parameter that governs whether the function executes locally or remotely. While remote administration is a nice touch, what this really means is that any developer of LAN Manager–aware distributed software has a huge head start. Tools for building client/server applications are part of the basic fabric of the network operating system.

The `netrun` service executes entire programs on the server. A named pipe connects the client's standard input and output handles to a proxy that executes on the server. It's a tad awkward to set up. On the server side, you've got to specify a *runpath* that lists directories containing programs that the client can run. The client has to use a directory on the server and then make that its current directory.

continued



NetWare 386 holds a slight edge over LAN Manager 2.0, which more than doubles the performance of NetWare 286. The NETFIO test opens multiple files and performs seeks, reads, and writes in a pattern designed to simulate a typical database application. LAN Manager and NetWare 386 were tested on a Compaq Systempro running 32-bit NE3200 Ethernet; NetWare 286 was tested on an 8-MHz NEC PowerMate 286 running 16-bit InterLAN Ethernet. A Gateway 20-MHz 386SX running DOS 4.01 was used as the client machine.

Even then, with only standard input and output to work with, you're limited to TTY-style batch processing. The `netrun` service is a stone ax in comparison to Unix's elegant X Window System. What is it good for? You might want to index piles of text at the server without clogging the wire with packets. More generally, it's another reminder that OS/2—and, thus, LAN Manager—has the basic interprocess communications mechanisms needed to support distributed computing.

Days of Reckoning

Network consultants around the world are now subjecting LAN Manager to close scrutiny. No one I've spoken to doubts that version 2.0 deserves to play in the major leagues. It has the requisite performance (see the figure), security, and scalable architecture, along with strong support for heterogeneous networking and distributed computing.

The question is not whether LAN Manager 2.0 will succeed, but to what extent. The answer depends on a host of variables, including price, third-party support, and the relative fortunes of DOS, Windows, OS/2, and NetWare. Although price may not be the major concern of large-scale network purchasers, NetWare 386's $7995 price tag has caused considerable sticker shock among smaller fry. A 25-node LAN Manager 2.0 installation costs less than $3000 yet delivers many comparable features.

To date, more database servers support LAN Manager than NetWare. But although LAN Manager 2.0 and NetWare 386 servers are roughly comparable, their strengths differ on the client side. LAN Manager favors the OS/2 workstation; NetWare favors DOS. Since OS/2 has yet to displace DOS on many desktops, chalk up a serious advantage for NetWare. I'm perversely optimistic about OS/2's future—version 2.0 is tantalizingly close to displacing Windows on my everyday machine—but you can't ignore basic 640K-byte DOS machines. While we're waiting for client/server software to materialize, we have to keep doing our jobs.

Still, the events of the last year or so have proved, once again, that you should never say never. DOS was never going to bust out of 640K bytes. Windows was never going succeed. NetWare would never be easy to install. Unix could never look good. Macs would never be cheap. I think I'll wait and see what next year holds for OS/2 and LAN Manager. ■

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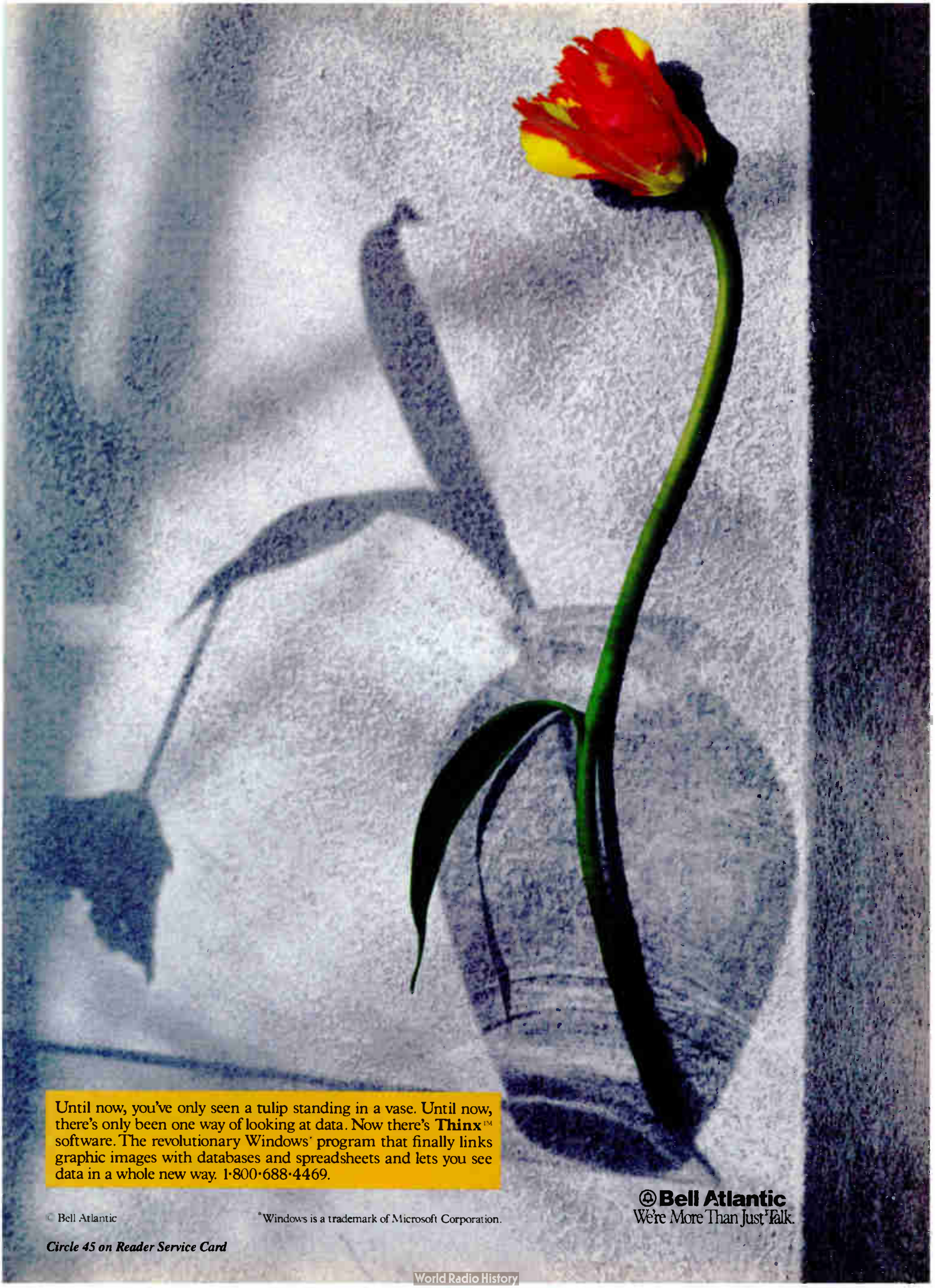
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Tom Thompson

REVIEW

A Digital "Quill" for Mac Video Displays

VideoQuill operating on a Mac IIfx using a ColorCapture 2.0 display board. Note the heavy lines in the title bars for the Tools, Palette, and document window. These lines are 2 pixels wide to reduce flicker on an interlaced display.

Working with live composite video on a Mac II-class computer has never been easier. Many new NuBus boards now display live video in a Mac window and copy a freeze-frame digital video image to a disk file. Unfortunately, video-oriented software has been slow in coming. One of the first to arrive is Data Translation's VideoQuill, a $495 program that lets you combine text, graphics, and video for impressive presentations.

VideoQuill uses outline fonts and a variety of special effects to render high-quality text painted with 16- or 24-bit colors. The software's real strengths, however, lie in working with live or captured video. You can display high-quality text over live video (video titling), or you can merge text and graphics with video (live or captured) for multimedia presentations. (To use VideoQuill with live video, you'll need a videographics board, such as Data Translation's ColorCapture 2.0, and an extra monitor.)

VideoQuill 1.0

Company
Data Translation, Inc.
100 Locke Dr.
Marlborough, MA 01752
(508) 481-3700

Hardware Needed
Mac II family or SE/30 computer; 2 MB of RAM; color display (16- or 24-bit color preferred); hard disk drive; for work with video, a videographics board and interlaced monitor are required

Software Needed
System 6.0.3 or higher with 32-Bit QuickDraw

Price
$495

Inquiry 1224.

Full-Spectrum Text and Color

You'll get your best results from VideoQuill on 16- and 24-bit color displays. While VideoQuill functions in 8 bits, it's difficult to gauge how your work will look without using deeper displays. When you first create a VideoQuill document, a dialog box prompts you for the document's pixel depth (either 16 or 24 bits, which can be independent of the display's depth that you're working on), window size (using either the current display's size or values that you type in), and the window's position on the display. Inside the document window you design a layout composed of rectangles or text; VideoQuill doesn't provide tools to let you draw arcs or circles. The package's text quality and fine color control partially compensate for this shortcoming.

The software's own set of outline fonts draws high-resolution text in type sizes of from 5 to 2000 points. Eighteen default sizes (ranging from 12 to 800 points) reside in the Text menu; in this menu, an Other selection lets you enter values outside of these sizes. You can rotate text either by clicking on a rotate tool and dragging the text string or by typing a degree value for the rotation angle in a dialog box. The latter is handy for precision work. You can modify the text's kerning, leading, and word spacing. Using other tools, you can color and position drop shadows along the text. VideoQuill uses its own antialiasing algorithm to prevent ragged text by blending the character's colors with the background colors.

VideoQuill works with outlines supplied by URW, a German type foundry, not Adobe Type 1 fonts. These outlines exist as separate files that you copy into a `VideoQuill Fonts` folder. Nine typefaces arrive in the standard package; 47 additional typefaces cost $495.

You can select color ranges for the current object (either text or a rectangle), and the background from the Palette menu's color palette. An object can have a single (flat) color, or if you use a range, a smooth blend from the starting to the ending hue. You can adjust the object's color transparency, and instead of a color, you can import an image into the object. For example, you might type the text string "sunset," select Picture from the Color menu, and choose a file that contains a scanned sunset image. The sunset appears within the text's outline.

You can paste the Clipboard's contents in front of or behind the current object, move the current object a layer forward or backward, or bring the current object to the front or the rear. Unfortunately, VideoQuill lacks a grouping operation that would let you combine and treat a collection of objects as a whole.

VideoQuill imports graphics and images in TIFF, PICT, or MacPaint formats. You use the Picture Box tool to select a point in the window and drag out a box outline with the mouse. Next, a Standard File dialog box prompts you for the image's filename. The software pastes a full-size image into the newly drawn box. You can also use the Clipboard to import images, but the other method offers more precise control over where and how much of an imported image shows in the window. You can import all of an image (by not drawing the box) or use a Hand tool to move the image until the desired portion appears in the box. You can also scale the image to fit the box and adjust its transparency.

continued

Trial Run

For my evaluation, I used two systems: a Mac IIci with 4 megabytes of RAM, a SuperMac Spectrum/24 Series III board, and a 19-inch display; and a Mac IIfx with 8 MB of RAM, an Apple 8•24 display board, and an AppleColor 13-inch monitor. Both of these systems ran System 6.0.5 software and had 80-MB hard disk drives. I used a Data Translation ColorCapture 2.0 videographics board to provide live video and capture 16-bit images. A RasterOps 364 video board captured 24-bit video images and previewed the video output from the ColorCapture board. I installed these boards in the Mac IIfx. My video source was a Pioneer VP-1000 laser disk player.

The application operates in a 3-MB MultiFinder partition. This leaves little room for running anything other than VideoQuill on the IIci, but applications that handle 16- and 24-bit data routinely require lots of memory. I managed to shoehorn MindWrite in with VideoQuill to see how well the latter coped with low-memory situations (and to write this review). VideoQuill did quite well operating in a less-than-optimal partition size, and it popped up alerts warning of low memory without crashing. The application worked without a hitch on the IIfx.

VideoQuill helps you produce impressive documents and snazzy slides suitable for presentations. However, the software's real purpose is to work with video. The video capabilities of the application worked flawlessly. For example, video is one of the "colors" you can pick for objects. When you use VideoQuill with a videographics board, the software substitutes live video for this object's color. VideoQuill accomplishes this by modifying bits in the object's alpha channel. The alpha channel modifies or describes an object's characteristics; in this case, it handles video control. The channel is a bit in size for 16-bit color and a whole byte for 24-bit color.

This feature provides some unique effects. Since the background is an object, you can let it pass video except where text is present. This makes VideoQuill useful for video titling, but its capabilities don't end there. For example, you could type "TV" and select video for the text's color. A videographics board driving an interlaced monitor would show a colored background, with live video filling the *T* and *V* characters on the screen. Or you could make a business chart and draw a box in the corner that would pass the video. You retain this alpha channel information when you save the window as a VideoQuill document. VideoQuill can also export documents as either TIFF or PICT files.

On the interlaced monitor I connected to the ColorCapture 2.0 board, text looked fine at every point size, and color blending was superb. VideoQuill readily accepted images that were captured by the RasterOps 364. Trying to let video bleed through areas of a scanned image proved to be a bit tricky using VideoQuill itself. First, using an image-manipulation application, such as PhotoMac or Photoshop, I selected a color in the image to pass video and had the application strip out regions with that color. Then, after selecting the transparent background color option, I pasted the image into the VideoQuill document. Finally, I set the background to the video color.

I found it easier to use Data Translation's ColorCapture application bundled with the ColorCapture board to select a range of colors in the image and set the alpha channel bit. ColorCapture saves the image as a PICT file, and VideoQuill recognizes the alpha channel information once you import the file. For example, using a scanned autumn scene with blue sky and red-orange trees, it was easy to use ColorCapture's color controls to set the alpha channel bit to pass video for the sky tones. When I pasted the image into VideoQuill, the trees appeared superimposed over live video.

You can print VideoQuill documents, but only at screen resolution (i.e., 72 dots per inch). When I printed from VideoQuill to a 300-dpi Tektronix Phaser color printer using the 6.0 LaserWriter driver, the output looked dark and muddy. I got better results by saving the document as a TIFF file, importing it into Photoshop, and printing.

More Tools

VideoQuill has some shortcomings. Circle and arc tools would make for better layouts, and the lack of a grouping tool makes complicated designs difficult. It would also be nice to incorporate some of ColorCapture's color controls that operate on the alpha channel into VideoQuill.

Despite these flaws, VideoQuill does work, and the results with video can be quite spectacular. It provides features not found in some presentation packages, and it breaks new ground working with the video medium. For those who have to work with video now, VideoQuill can help you pen a solution. ■

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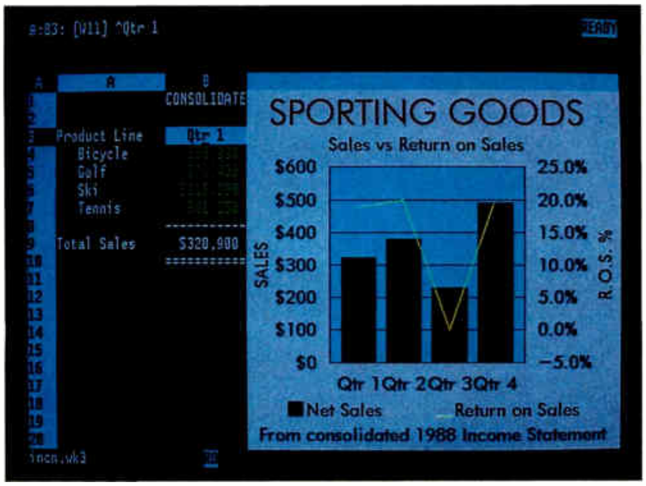
Rick Farris

REVIEW

Unix and 1-2-3



Lotus 1-2-3 for Unix System V sports multiple views and graphics support.

Spreadsheets are no longer the domain of single-user personal computers. As personal computers approach the throughput of workstations, many users are abandoning DOS for more powerful multiuser operating systems. Lotus Development has noted this, and Lotus 1-2-3 for Unix System V is its solution.

Lotus 1-2-3 for Unix System V is essentially a port of Lotus 1-2-3 release 3.0, dressed up to take advantage of the multitasking, multiuser environment of Unix System V/386.

The package consists of a user's guide, a reference manual, and six 1.2-megabyte floppy disks. The documentation has the qualities normally associated with Lotus: clear and to the point.

Installation under SCO Unix System V took only 20 minutes. Lotus took advantage of SCO's `custom` installation program, which handles all the file extraction, copying, and permission setting necessary to build the Lotus directory hierarchy in the location of your choice.

Will You Recognize It?

Running 1-2-3 on the console of a computer running Unix System V/386 is much like running 1-2-3 release 3.0 under DOS. VGA and EGA are supported, with a choice of text resolutions ranging from 25 rows by 80 columns to 60 by 80. Graphs are displayed on supported adapters.

One enhancement added for Unix System V is the ability to simultaneously display up to 26 worksheets in *perspective* mode. The number of worksheets to be displayed must be selected on the command line, though, so if you have already started work and decide that you need to display more than the three default worksheets, you must save your work, exit the program, and restart 1-2-3 to use this feature.

The familiar 1-2-3 command keys, such as "/" to bring up the menu bar and arrow keys to select items, are used, but combinations that would normally use the Alt or Control keys are implemented in a more portable way. For instance, moving from one sheet to the one above it is invoked with Control-PageUp in DOS and Control-A PageUp in Unix. Likewise, the Alt-function keys are invoked by typing Control-F and then pressing the function key. This lets the same keystrokes work from a variety of input devices.

I didn't run any exhaustive performance tests, but a macro that took 13 seconds to run under DOS (on a 25-MHz 386, with no 80387) executed in 29 seconds on an identical Unix machine under a fairly heavy multiuser load.

Running 1-2-3 from a remote computer is more of an adventure. Except in special circumstances (as with the Sun-River Fiber Optic Station), graphics are not supported; therefore, you cannot display graphs. In addition, since terminal keyboards rarely match PC keyboards, an adjustment is necessary in the command keys. For instance, the command to move to cell A1 on the first spreadsheet is normally Control-Home; on a Wyse WY-50 terminal, the command sequence is Control-A PF2 7 (7 is the PC numeric keypad key for Home).

Working Together

Lotus 1-2-3 for System V can retrieve any file on your Unix network that you normally have permission to access. Since worksheets can be saved in both .WK3 and .WK1 formats, it is possible to have a central repository of worksheets for all the users on the network, both DOS and Unix.

An important point, however, is that file locking is available only for files on the machine 1-2-3 is running on. File locking across the network is not supported from within 1-2-3. It is a good idea to store worksheets on the 1-2-3 server to avoid the loss of information caused by two users updating the same worksheet at the same time.

Lotus 1-2-3 for System V is licensed for one CPU: This means that to access 1-2-3, you must log onto the licensed computer. Note that this is distinctly different from a file-server license, where the executable code is actually running on your local machine.

Lotus 1-2-3 for Unix System V provides the industry-standard spreadsheet to users of Unix System V for the PC. It extends the base 1-2-3 release 3.0 product with features suited to Unix-style networking, and it can even be run from ASCII terminals. It tries hard to preserve the look and feel of the DOS version of 1-2-3, and it largely succeeds. ■

BYTE LAB

Lotus 1-2-3 for Unix System V

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

Hardware Needed
Compaq, IBM, or compatible 386 PC with 4 MB of RAM and 5 MB of free disk space

Software Needed
System V 3.2 from SCO, AT&T, or Interactive, or SCO Xenix 2.3

Price
Single-user: $695
10 users: $1295
Four additional users: $495

Inquiry 1148.

Rick Farris is a principal at RF Engineering, a custom software house. He can be reached on BIX c/o "editors."

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The ideal solution for numerically or I/O intensive applications is Microway's new Number Smasher-486/33T workstation. Two configurations are available, each incorporating state-of-the-art power and cooling with 300 to 600 megabyte drives.

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Stan Miastkowski

REVIEW

A "More Filling" Generation of Tape Backup

Coretape Light (left) and the Jumbo 250 up the ante of tape capacity for today's mega-megabyte hard disk drives.

You've heard it all before: If you want to avoid despair, back up the data on your hard disk drive. However, as standard hard disk drive capacities break the 100-megabyte barrier, the backup process becomes more and more of a chore. Backup is especially painful if you're using floppy disks; soon you begin to feel like a high-tech short-order cook, flipping disks like so many thin black pancakes.

A tape backup unit is the obvious answer. No disk flipping, no piles of ill-marked floppy disks. You can start the backup and partake of another cup of coffee, or schedule the backup to start automatically at a predetermined time. TBUs aren't exactly new, but in keeping with hard disk trends, the latest generation of QIC-80 (quarter-inch cartridge) TBUs offer higher capacities. I tested two of the new incarnation: the Jumbo 250 from Colorado Memory Systems and Coretape Light from Core International.

Both units use varying forms of data compression to pack lots of bits on a tiny tape. As its name implies, the Jumbo 250 fits up to 250 MB of data on a DC-2120 tape; Coretape Light fits up to 300 MB on the same cartridge size. (Without compression, DC-2120 tapes hold a maximum of 120 MB.)

QIC Developer

Colorado Memory Systems isn't new to the backup game; nearly a decade ago, it was instrumental in developing the QIC standard that nearly all TBUs use. The Jumbo 250 ($499), like its predecessors, is a well-built unit that stands up to hard daily use. In its basic configuration, it mounts in a half-height drive bay and hooks up to your system's floppy disk drive controller as the second drive. But that limits you to the maximum 500,000-bps data transfer rate of an AT floppy disk (250,000 bps with a PC).

An optional $129.95 add-in board boosts the data transfer rate to 1 megabit per second (500,000 bps on a PC). The controller also lets you use a second floppy disk drive or mount the Jumbo 250 in an external enclosure that you can easily transport from system to system.

More interesting is the top-of-the-line "jumperless" board that I tested with the Jumbo 250 (this board isn't available for XTs—only ATs, PS/2s, and compatibles). In addition to the high-speed controller, it includes hardware data compression using the proprietary STAC chip. At $299.95 ($399.95 for the Micro Channel version), it's not exactly a low-cost option, but it's a boon for the truly hurried. Without the add-in board, the Jumbo 250 still offers data compression, albeit in a software version, whose speed is highly dependent on the speed of your system's processor.

The Jumbo 250 is easy to install. I just slid it into a free drive bay, plugged in the 16-bit add-in compression board, connected power to both using an included Y-adapter, and hooked a cable between them.

The automatic software installation is a revelation, especially when you're installing one of the add-in boards. The utility checks your system and sets the jumperless board for interrupt, DMA channels (two are needed with the compression board), and I/O base address. It saves lots of hair-tearing, but it's not foolproof, nor did I expect it to be.

After I installed the Jumbo 250 and attempted to start a backup, the software kept telling me that I didn't have a tape unit installed. I finally figured out that the culprit was my Microsoft Bus Mouse, which was using the same interrupt as the tape board. (Since the mouse wasn't moving, the automatic installation utility didn't "see" it.) I moved a jumper on the mouse board, and everything was fine.

Trendy TBU

I cringed slightly when I found that Core planted the Coretape *Light* moniker on its $545 TBU; it sounds just a tad too trendy for me. Coretape Light accommodates a slide-in mount in a free drive bay. Core

BYTE LAB

Jumbo 250

Company
Colorado Memory Systems, Inc.
800 South Taft Ave.
Loveland, CO 80537
(303) 669-8000

Hardware Needed
IBM AT, PS/2, or compatible

Price
$499; controller, $129.95; controller with hardware compression, $299.95; controller with hardware compression for Micro Channel systems, $399.95

Inquiry 1105.

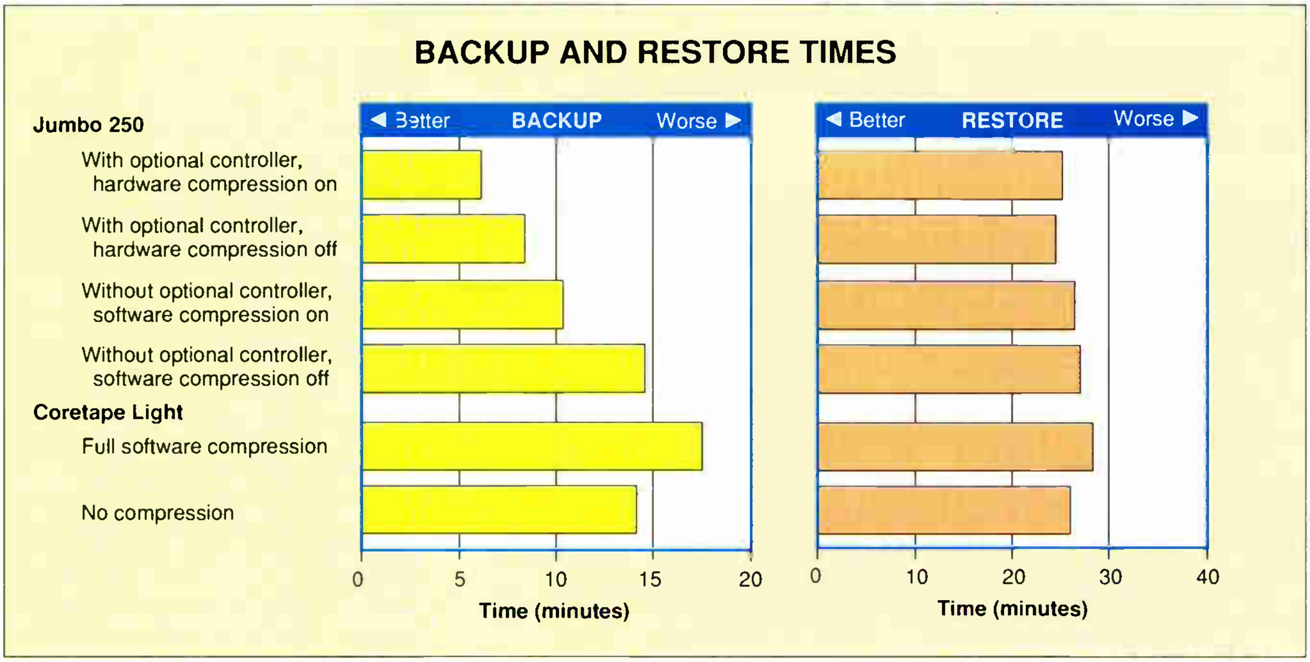
Coretape Light

Company
Core International
7171 North Federal Hwy.
Boca Raton, FL 33487
(407) 997-6055

Hardware Needed
IBM AT, PS/2, or compatible

Price
$545

Inquiry 1106.



The compression scheme used by the Jumbo 250 sped up most processes. All tests were run on a 20-MHz 386-based AT clone using a Quantum 170S SCSI hard disk drive hooked up to a DPT 4-Mbps SmartConnex controller. Logical drive D (containing 31.3 MB of data) was used in all cases.

also offers an $89 controller (not reviewed) that lets you run a second floppy disk drive or mount Coretape Light as an external drive. Even with the optional controller, Coretape Light is limited to the slower data transfer speed of the AT floppy disk drive controller. Coretape Light is even more of a snap than the Jumbo 250 to install. You slide it in, plug in power and the second floppy disk drive connector, and install the software.

Both the Jumbo 250 and Coretape Light offer extensive software options. There are the usual options for formatting blank tape (since it takes about an hour, most tapes come preformatted), verifying tape usability, and choosing full or partial backups. Coretape Light's software offers a few more choices, including an exhaustive test of a blank tape and a "Retension" procedure that readjusts the tension of a new cartridge or one that's been in storage for a long time.

Both TBUs also have unattended backup options—TSR programs that will perform backups at the time you determine. It's a handy option that lets your computer (instead of you) work overtime to do the backup. I set my system to back up my new data daily at 2 a.m., with a full backup once a week. Unattended backups are a great way to make sure the job gets done (of course, you have to remember to put the tape in the drive).

I've always thought that comparing backup operation speeds isn't a valuable exercise since you "set and forget" it while you're away from your computer. A couple of minutes one way or the other really isn't a big deal. But for comparison, I timed the backup and restore operations of both drives with and without their various options (see the figure). As the results show, the Jumbo 250 with the hardware compression board (and compression on) actually speeds up the backup process. Software compression is much slower, simply because it has to steal cycles from your system's processor. But the Jumbo 250's software compression is still quite fast.

No matter how you set things up, a restore operation takes considerably longer than the backup. Coretape Light has a large edge in locating an individual file on a tape, using something called Rapid Random Restore. With the Jumbo 250, I restored a single file from the middle of a backup in 2 minutes, 25 seconds; Coretape Light restored the same file in only 24 seconds, or about five times faster.

QIC Pick

Both of the basic drive units are well constructed, and the slightly higher price of Coretape Light reflects its ability to fit more bits on a tape. It also has a glass-ferrite record/read head that should hold up longer than the conventional head used in the Jumbo 250. For versatility, the Jumbo 250 is a better choice, especially if you have a free slot that you can use to take advantage of the higher throughput and/or hardware compression.

In this world of gee-whiz computer technology, TBUs are often-neglected, albeit necessary, peripherals. To me, the ability to pack up to 300 MB on a tape that's smaller than a pack of playing cards is wondrous indeed.

It's 2 a.m. Do you know where *your* data is? ■

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

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Color monitor shown available as option

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> ***PC Magazine** says:**
> **". . . Northgate stops at nothing to please its customers."**

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PC MAGAZINE
EDITORS' CHOICE
October 31, 1989

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1989 TOP 100

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Elegance 386's high performance motherboard is designed and manufactured by Northgate. With a 16Mb 32-bit DRAM capacity, it's consistently rated in the top 1% of performance — at 25 and 33MHz, Elegance 386 is the fastest in its class!

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***PC Magazine* then called for 486 ISA systems** for review. Result: there was no question about it. "Only one machine stands out," they said, "you could pay less for a 486 system, but not get the bonuses that are offered with the Elegance."*

Along the way, we added another Editors' Choice of our *OmniKey*® keyboard. There you have it ...

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About the same time, the tough testers at *InfoWorld* were thoroughly and methodically examining Elegance 486i. They reported you could buy the next highest ranked system (scoring 8.2 vs. our 9.1) **but you'd also pay three times as much!†**

***InfoWorld's* editors concluded** that Northgate's 486i "leads the pack by a comfortable margin. It offers impressive performance, exceptional expandability and it is tops in support and value."†

InfoWorld showed Elegance 486i leading the pack again as a network file server and stand-alone system as well.

And, as if we had planned it, *PC Magazine* came along with its Service and Reliability issue in which Northgate's dedication to customer support was well evidenced. "As we learned more about its service policies, it became clear that Northgate stops at nothing to please its customers." No wonder "Northgate was the hands-down winner when it came to customer loyalty."**

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Elegance 486i SVGA Color System Features

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- 4Mb of 32-bit RAM (expandable to 8Mb on motherboard; total system RAM of 16Mb with optional 32-bit memory card)
- U.S.-made motherboard
- 100Mb IDE hard drive; 16-bit controller with 1:1 interleave; 32K disk read-look-ahead cache buffer
- 64K SRAM memory cache; read/write-back caching
- High density 1.2Mb 5.25" and 1.44Mb 3.5" floppy drives; also read/write low density disks
- Eight expansion slots; one 32-bit slot; six 16-bit and one 8-bit slot
- Weitek math coprocessor support
- One parallel and two serial ports
- 14" SVGA color monitor with 1024 x 768 resolution
- 16-bit SVGA adapter with 512 K video memory
- Clock/calendar chip rated at 5 years
- 200 watt power supply (220 watt power supply in tower case)
- Desktop case with room for 3 exposed and 2 internal half-height devices
- Front mounted reset and high/low speed controls
- Exclusive Northgate *OmniKey* keyboard
- MS-DOS 4.01 and GW-BASIC software installed
- On-line User's Guide to the system and MS-DOS 4.01
- QA Plus Diagnostic and Utility software
- Microsoft Windows 3.0 and mouse
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7075 Flying Cloud Drive, Eden Prairie, MN 55344

**PC Magazine*, September 11, 1990 ***PC Magazine*, September 25, 1990
†*InfoWorld*, July 30, 1990 ††*Computer Currents*, August, 1990

Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products previously reviewed in BYTE.

A Colorful Luggable

Although the Dolch C-P.A.C. 486-25 can produce only eight colors, the screen is bright and clear, and the colors are adequate for many CAD applications.

High-powered portables are nothing new; luggable 386s have been around almost as long as their desktop-bound cousins. But while desktop 386 and 486 systems have supported high-end color graphics from the start, portables have generally been limited to low-contrast, 1-bit LCDs or gas-plasma displays.

Dolch's new C-P.A.C. color portable brings color to the high-end portable, and it does it brilliantly. I looked at the color display option on a P.A.C. 486-25 (see "World's Fastest Lunchbox," May BYTE). Unfortunately, the price of the display is too high to make this—or any machine that uses the current generation of color LCDs—much more than a novelty.

A Hitachi thin-film transistor LCD array forms the foundation for the Dolch display. The backlit TFT, or active-matrix, display, generates a bright, uniformly high-contrast image at VGA resolutions.

Each pixel is made up of three LCD elements that are sandwiched between two polarizing filters. Each element in the pixel group looks out through a different color filter—one red, one blue, and one green. A fluorescent backlight shines white light through the pixel groups.

When in the off state, the LCD elements twist light that is polarized by the rear filter so that the light cannot pass through the forward filter. When you apply a current to the LCD elements, they straighten out, and the light can pass through unimpeded. By turning different combinations of the red, green, and blue elements on and off, you can get eight colors.

Active-matrix technology uses a transistor for each element to switch current on and off and to maintain current while the LCD controller is addressing other elements. The result is a high-contrast, high-speed display: Dolch claims that the screen updates in 40 milliseconds, compared to 300 ms for passive-matrix designs.

Although the C-P.A.C. provides only eight colors, it supports all the VGA modes except mode 19, which is 320 by 200 pixels by 256 colors. The 16-color modes simply lose eight colors. The video circuitry "thresholds"—in other words, it decides whether, for example, the shade of green that the software wants to display is closer to bright green or to black, and then outputs the appropriate color.

This leads to weird effects in Windows, which uses a lot of grays in the default palette. The C-P.A.C. sees most of Windows' grays as white, so grayed-out menu choices and icons can disappear into the background.

Dolch is working on a driver that will limit Windows to the eight available colors. Meanwhile, the company suggests that current users simply modify the default palette.

However, the Dolch C-P.A.C. will probably find its biggest market among CAD users, and for this application there should be no problems. AutoCAD ran fine, and the display is easily fast enough to display pointer movements without blurring. In addition, since most CAD drawings use only a few bold colors, the eight-color limitation is not a major drawback.

At just under $4000, the portable color display is definitely only for applications for which color is essential. However, if LCD production yields improve, as many are predicting, the era of the personal, portable color computer may not be so very far off. The Dolch C-P.A.C. provides a glimpse of a bright future for portables.

—Steve Apiki

Dolch C-P.A.C. 486-25

BYTE LAB

Company
Dolch Computer Systems
2029 O'Toole Ave.
San Jose, CA 95131
(408) 435-8260

Components (as tested)
Processor: 25-MHz i486 CPU
Memory: 8 MB of RAM
Mass storage: 200-MB Intelligent Drive Electronics hard disk drive; 3½-inch 1.44-MB floppy disk drive
Display: TFT color
Keyboard: 84-key IBM AT-style with 12 function keys
I/O interfaces: One serial port; one parallel port

Price
Monochrome system: $12,995
TFT color screen option: $3995

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☐ INDIVIDUAL CREDIT complete only individual section.
☐ INDIVIDUAL CREDIT but rely on income of another. Complete entire application.
*If you are a married Wisconsin applicant, you must provide your spouse's information as indicated, even though your spouse may not be signing the contract.

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NAME ______ HOME PHONE (___) ______
SOCIAL SECURITY NUMBER ______ DATE OF BIRTH ___/___/___
PRESENT ADDRESS ______ CITY ______ ST ______ ZIP ______
DATE OF RESIDENCE MO. ______ YR. ______ BUY ☐ RENT ☐ OTHER ☐ ______
PREVIOUS ADDRESS ______
EMPLOYER ______ DATE OF EMPLOYMENT MO. ______ YR. ______
MONTHLY GROSS SALARY $ ______ BUSINESS PHONE (___) ______
PREVIOUS EMPLOYER ______ DATES OF EMPLOYMENT ______ TO ______
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ADDITIONAL MONTHLY INCOME $ ______ SOURCE ______

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BANK LOAN (Y/N) ______ HOW MANY? ______ VISA (Y/N) ______ HOW MANY? ______
MASTERCARD (Y/N) ______ HOW MANY? ______ FINANCE COMPANY LOAN (Y/N) ______ HOW MANY? ______
DEPT. STORE CHARGE CARD (Y/N) ______ HOW MANY? ______ CREDIT UNION ACCOUNT (Y/N) ______ HOW MANY? ______
OTHER MAJOR CHARGE CARDS (Y/N) ______ HOW MANY? ______

c. Joint Applicant's Personal Information

JOINT APPLICANT'S NAME ______ HOME PHONE (___) ______
SOCIAL SECURITY NUMBER ______ DATE OF BIRTH ___/___/___
ADDRESS ______ CITY ______ ST ______ ZIP ______
DATE OF RESIDENCE MO. ______ YR. ______
JOINT APPLICANT'S EMPLOYER ______ DATE OF EMPLOYMENT MO. ______ YR. ______
MONTHLY GROSS SALARY $ ______ BUSINESS PHONE (___) ______
NAME AND ADDRESS OF NEAREST RELATIVE NOT LIVING WITH YOU ______
______ RELATIONSHIP ______

d. Self-Employment Information

BUSINESS NAME ______ BUSINESS PHONE (___) ______
TYPE OF BUSINESS ☐ Proprietorship ☐ Partnership ☐ Corporation IN BUSINESS SINCE ______
YOUR ANNUAL INCOME FROM BUSINESS Gross $ ______ Net $ ______
PERSONAL BANKER'S NAME ______ BANKER'S PHONE (___) ______

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I authorize Northgate Computer Systems or its assignees to investigate credit records and to report my performance hereunder to credit agencies. I hereby certify that the following information is furnished to you for the purpose of obtaining credit and is true and correct of the best of my knowledge and belief. There are costs associated with the use of this credit card. To obtain more information about these costs, call us at 1-800-548-1993 or write to P.O. Box 59080, Minneapolis, MN 55459-0080.

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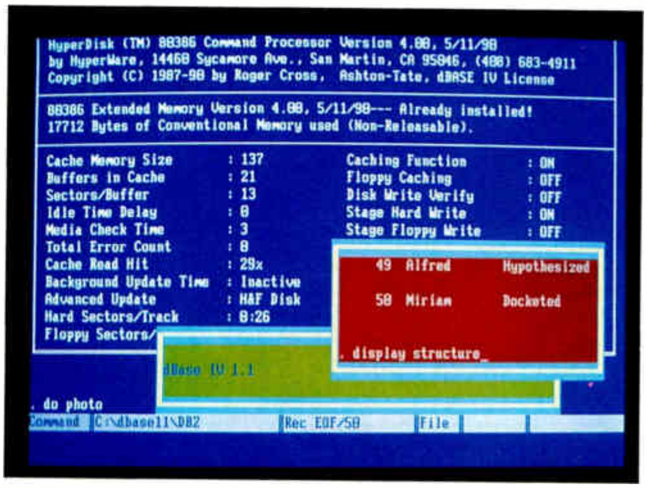
dBASE IV 1.1: Ashton-Tate Answers the Critics



dBASE IV 1.1's new DBCACHE dramatically improves the disk performance of dBASE applications.

It should have been a minor update, one of those software releases sent out to registered users without much fanfare. But given Ashton-Tate's problems with the initial release of its bread-and-butter product, I awaited dBASE IV 1.1 with anticipation and skepticism. Would the new release fix the problems, and would it allow Ashton-Tate to rebound from its current slide?

Certainly, dBASE IV 1.1 boasts some important improvements. The biggest of these is the revamped memory system. dBASE IV 1.0 ate up so much RAM that it often required extra hardware to run over a network. In some situations, each of the workstations running dBASE required an additional memory card. Version 1.1 has slimmed down, requiring a maximum of 450K bytes at run time (versus 516K bytes for version 1.0). Ashton-Tate claims that the new dynamic Memory Management System (dMMS) can swap program code overlays more efficiently.

dBASE IV 1.1 also includes a DOS environment variable (DBHEAP) that allows you to specify the amount of memory allocated for application space. For large applications, you can set DBHEAP to a higher value, freeing up additional memory for the application. For basic dBASE Control Center operations and for programs with extensive menus or windows, a lower DBHEAP value delivers additional memory for overlay swapping.

The new swapping scheme should translate into improved performance. I ran BYTE's dBASE benchmark suite under both versions of dBASE. Version 1.1 negotiated the delete/pack benchmark and the sort benchmark significantly faster than version 1.0 did. The increased speed should be even more noticeable with large, menu-intensive applications.

When I enabled DBCACHE, the new disk cache bundled with each copy of version 1.1, performance improved dramatically. Version 1.1 with DBCACHE halved the indexing time and the delete/pack time, and the sort benchmark ran almost four times faster than under version 1.0.

Ashton-Tate has also made some enhancements to the dBASE language. The most significant of these is the SET DBTRAP command. When you have DBTRAP turned on, it prevents critical errors from occurring when a routine is interrupted. For instance, it will not allow you to start a second Edit session from within a current Edit session.

The SET DBTRAP command can enhance the utility of user-defined functions. The UDF or other interrupt routine can change the dBASE environment, thus confusing the original interrupted program; DBTRAP can resolve such conflicts. And with DBTRAP off, advanced programmers have virtually unlimited control over UDFs.

The INDEX command now supports a FOR clause. The FOR clause limits the index to records meeting certain criteria. Searches are faster, and less disk space is consumed, because the index tracks only those records meeting the defined criteria. And you can now create or modify an index directly from a Browse or Edit screen.

It looks like Ashton-Tate has resolved some of dBASE 1.0's most glaring faults. The decreased RAM demand enhances network support and improves performance. More efficient overlay swapping translates into snappier operation, especially with larger applications. And Ashton-Tate has apparently fixed the bug that caused incorrect results from certain Structured Query Language queries. It looks like a strong product—but will it rebuild Ashton-Tate's reputation as the premier manufacturer of PC databases? Only time and an extensive user community can tell. ■

—Stan Diehl

BYTE LAB

dBASE IV 1.1

Company
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90509
(213) 329-8000

Hardware Needed
IBM PC, XT, AT, PS/2, or compatible with 640K bytes of memory (450K bytes available) and 4 MB of disk space

Software Needed
MS-DOS 2.10 or higher

Price
dBASE IV 1.1: $795
Developer's Edition: $1295
LAN Pack: $995
(Free to registered owners of dBASE IV 1.0)

Inquiry 1077.

STATE OF THE ART

Advanced Graphics

Time was, the words *computer graphics* implied line graphs and bar charts. Now, graphics and photography seem to have merged—at least, that's what you'd think looking at the results. Today, advanced computer graphics can create and manipulate color images in three dimensions with photographic precision and photo-realism.

When you want graphics to convey three dimensions instead of two, there's a lot more involved than just adding a coordinate. The world of three-dimensional images brings with it the added expectation of realism: The images need to resemble real-world objects. In "Graphics Go 3-D," Steve Upstill discusses the challenges involved in creating photo-realistic 3-D images.

One such challenge is ray tracing. Different companies have different methods for handling the effects of light on a scene: shading, light reflection, and color modification. But for a scene or an object to approach the appearance of realism, you must deal, in one way or another, with ray tracing. In "Ray Tracing for Realism," Andrew S. Glassner discusses the concepts and techniques necessary to imitate the effects of various types of light rays on color in a 3-D image.

Color in advanced graphics is another area where significant progress is being made. Putting great colors and a great many colors on the screen has been viable for some time now. In fact, some companies offer more colors than I can even imagine trying to choose from. The chances of being able to match a specific color on the screen are extremely high. But what happens when you print it out? In "Color WYSIWYG Comes of Age," Frank Vaughn shows how to calibrate your display device so that the colors you see on your screen are exactly the same as the colors you get on your printer.

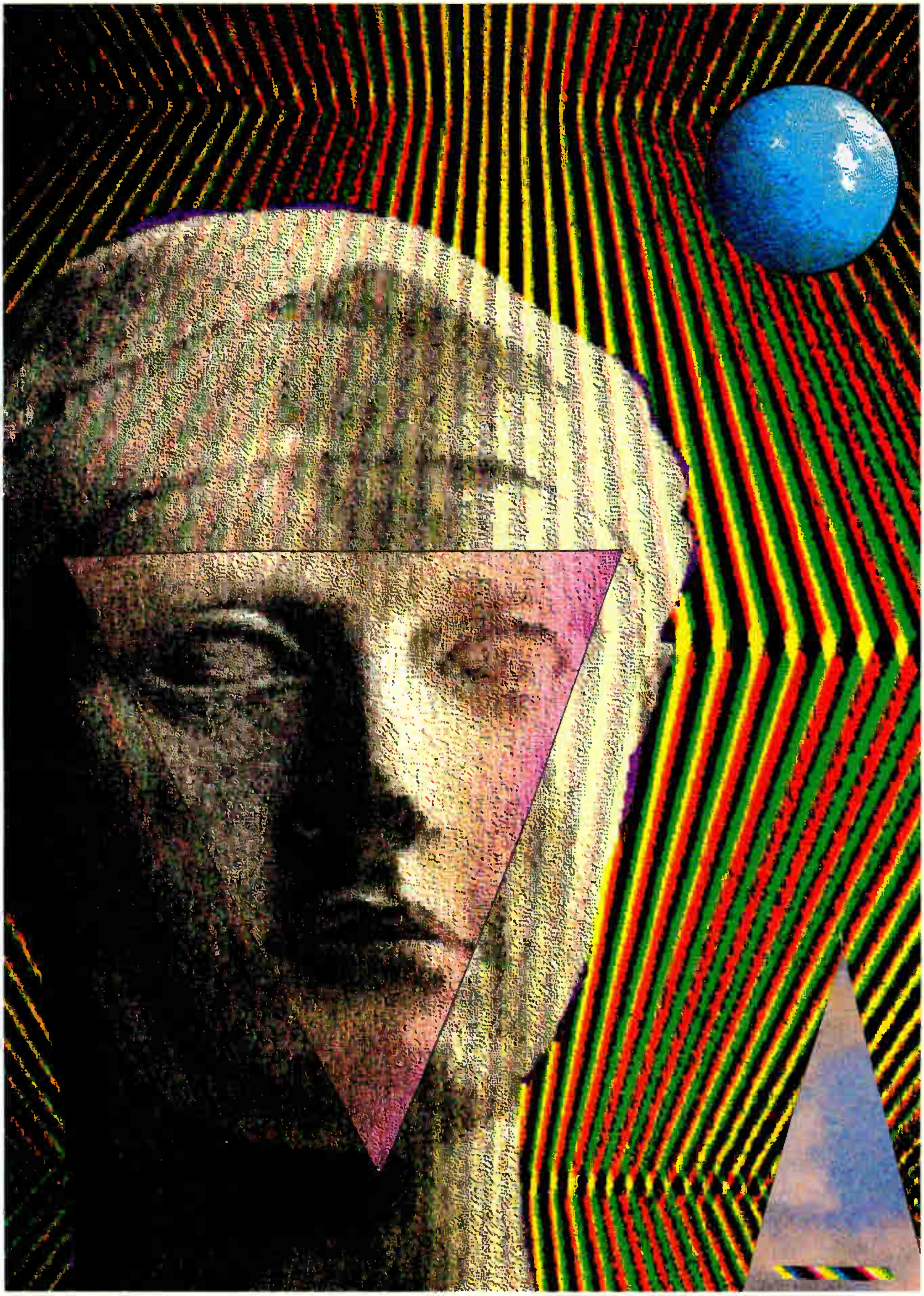
All this wonderful color talk may seem like a moot point if you use a PC-compatible machine. Workstation-quality graphics have moved to the Macintosh, but until recently, they hadn't made the trek into DOS land. Well, times have changed. Windows 3.0 provides the capability for 24-bit graphics to migrate to PCs. In "True Color for Windows," Adam Bellin and Pier Del Frate show how you can obtain high-quality images in true color on a DOS machine.

And what do you need when you have workstation-quality color graphics? You need tons of storage to hold an image—all that color and high resolution to boot can take literally megabytes for a single image—or some form of image compression. In "Putting the Squeeze on Graphics," Nick Baran investigates the new compression standards that are taking hold for full-color graphics and full-motion video.

Where do graphics go from here? Predictions are hinting loudly at TV, and the bridge between computers and TV is under construction. Have you noticed the number of new TVs touting digital capabilities? And only high-definition TV will meet the needs of high-end computer graphics. In "HDTV Sparks a Digital Revolution," Andrew Lippman describes HDTV and its impact on computer graphics and on the future.

From bar charts to wire-frame models to photo-realism, from low-resolution monochrome monitors to high-resolution color monitors to HDTV—when you're speaking of the graphics world, one line says it all: You've come a long way, baby.

—Jane Morrill Tazelaar
Senior Editor, State of the Art



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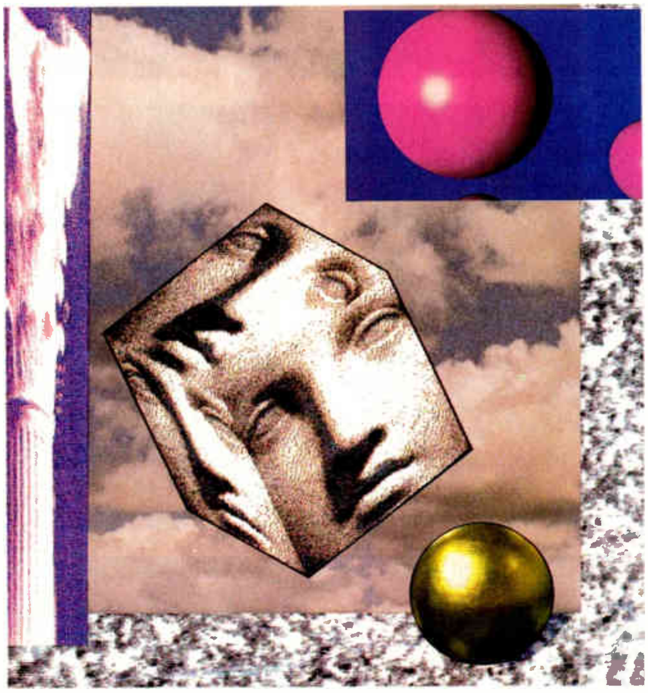
Graphics Go 3-D

Photo-realism demands that 3-D figures look exactly like real-world objects; that's the challenge

Steve Upstill



What's the big deal? 3-D isn't new. Maybe not, but three-dimensional computer-generated photo-realism is. And the tools and techniques to bring this realism to the microcomputer on your desk definitely are.

Going to three dimensions isn't just a matter of incrementing the dimension count by 1. There are fundamental expectations that 3-D graphics must fulfill, because the world that we live in is a 3-D world. For 3-D images to appear real, you must deal with all sorts of challenges that are entirely different from those faced in two dimensions.

The Challenges of 3-D

In the most formal terms, 3-D graphics programs manipulate and create images of entities that are described geometrically, as coordinates in 3-D space. This process becomes more difficult because the 3-D images must be represented on a two-dimensional surface. Any number of programs can put 2-D circles, squares, lines, curves, patterns, and other entities on a 2-D screen or page.

In some sense, a 2-D graphic is complete by itself. You don't expect a business bar chart to resemble anything you would see on the street in real life. A rich graphical language for entities in the 2-D world exists (type is one), most business people know how to interpret them, and you don't expect them to be more than they are. On the other hand, 3-D figures only make sense to the extent that they resemble actual things in the real world.

The corollary to this forms the second difference between two and three dimensions: The expectation of realism means that the surfaces of 3-D entities need correct optical properties to be properly interpreted. In addition, the problem of creating shapes in three dimensions is much more difficult than that of creating 2-D shapes in two dimensions (see photo 1).

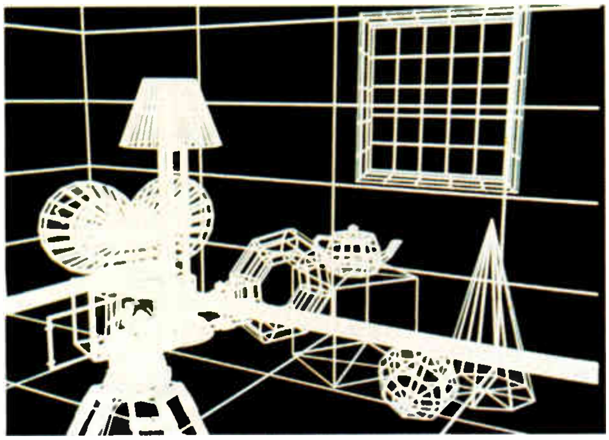
While normally you don't need to represent the interiors of 3-D figures, describing the undulations of the surface itself is by definition much harder than creating curves and regions in two dimensions. You're not just putting a curve into a higher dimension, you're also squaring the amount of information involved.

Furthermore, in three dimensions, topology becomes a problem. While curves on a page can be connected arbitrarily, the connection of surfaces without erroneous discontinuities in three dimensions is at best difficult.

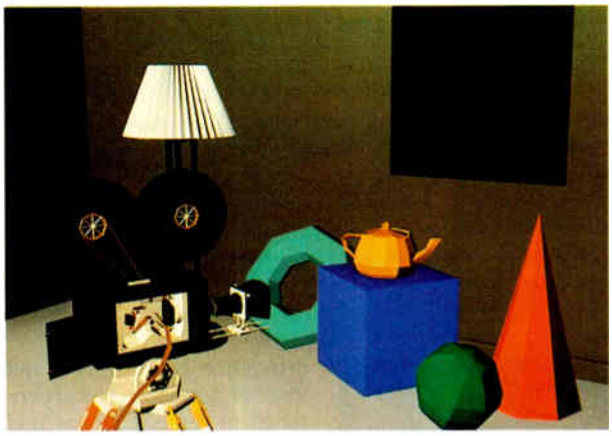
Finally, working in three dimensions is tougher than working in two dimensions because you face the problem of manipulating a 3-D world on a 2-D surface. This is more than 50 percent more difficult than manipulating a 2-D entity

ILLUSTRATION: SANDRA FILIPPUCCI © 1990

Photo 1: *A series of steps involved in modeling and rendering a photo-realistic 3-D image:* **(a)** *The wire-frame stage;* **(b)** *the polygon-fitting stage;* **(c)** *the polygon-smoothing result;*



(a)



(b) (c)

(d) (e)

(d), **(e)**, *and* **(f)** *show increasing realism due to advanced shading techniques. All these images were created with Pixar's PhotoRealistic RenderMan software and designed by Thomas Williams and H. B. Siegel. (Used by permission from Pixar.)*

(f)

on its home 2-D surface.

I am enumerating these problems to suggest why 3-D graphics have lingered so long in the background, seemingly poised to move in but never quite able to. The problems are very difficult, and until they are solved (whether or not they are recognized explicitly), the technology will languish regardless of how much hardware support it gets.

Creating 3-D Graphics

Currently, 3-D computer graphics use a mathematical description of objects in space to create an image suitable for viewing on a CRT or in a photograph. (Perhaps someday, interactive holography will allow these surfaces to be viewed more directly, but for now, the problem of converting 3-D graphics to 2-D graphics must be handled.) In the case of 2-D WYSIWYG, graphical manipulation is the same as image creation, but in three dimensions, objects and their images require a two-step process:

- *Modeling*: Creating objects, moving them around to arrange a scene, defining camera and lights, and determining how each object will look (see photo 1a).
- *Rendering*: Making a realistic image out of the resulting geometric description by applying surface characteristics (see photos 1b through 1f).

The Difficulties of Modeling

There are many reasons why 3-D modeling is more difficult than the 2-D analog, but two stand out. Fundamentally, if you're trying to design a 3-D object, you must do it in a fashion similar to a worker who handles highly radioactive material by looking through a window and manipulating a robotic arm. The 3-D designer actually has a harder task, however.

- The uranium handler looks through a window but has the benefit of depth perception and perspective—both eyes work together to provide a sense of depth, and the person's head can be easily moved to provide a different view.
- The uranium handler can see the object itself, not a wire-frame approximation of it; the 3-D graphics modeler must manipulate through a mouse (at best).
- The uranium handler isn't trying to build anything, only to move things around. The most complex task to be faced is opening a container.

Several developments have made it easier to approach interactive modeling. The increasing speed of general-purpose processors has made it easier to provide appropriate interactivity. When you can make mistakes much faster, you can correct them much faster, too. Just a few years ago, many reasonably priced 3-D displays required a bright yellow flash to reinitialize the screen before redraw.

Still, the compute-intensive nature of even sketching a scene with line segments (projecting a constantly changing set of points from a 3-D scene into a 2-D screen space) means that you must interact with only the crudest representation of your work. It is now the primary responsibility of software and interactive systems design to improve the state of the art. For example, Symbolics has merged 3-D and 2-D graphics into a single unified graphics system, the XL1200.

When you can make mistakes much faster, you can correct them much faster, too.

It sounds like a slogan from Orwell's *1984*—Weakness is Power—but a tool can often be made more usable by making it less general. In that sense, the generality of 3-D work is a limitation. The trick is to find the right places to bound the problem.

Paring Down the Problem

Many modern modelers work on a subset of the full 3-D problem. Frequently, the first functions you encounter in a modeler are *lathing* and *extrusion*. Lathing takes a 2-D curve and rotates it about an axis to create a surface of revolution. Extrusion takes a 2-D shape and moves it along a path (sometimes simply a straight line) to sweep out a surface. These capabilities make good boxes, walls, and goblets, but creating convincing trees, telephones, and dinnerware is somewhat more complicated.

Another simplifying approach concerns the basic task of moving objects around. It can be frustrating and tiring to rotate objects into a particular orientation using a mouse, or to set an object onto a surface. It can help to realize that, flying logos aside, most people live in a geocentric world. That is, horizontal and vertical are very important directions, and a lot of surfaces are flat: floors and tables, for example. A modeling system with a geocentric bias will be seen as useful, not restrictive.

Therefore, setting the default so that an object, when "born" into the world, is oriented vertically and placed on some default reference plane will make life a lot easier. Perhaps you have to slide it around on the surface of the reference plane or turn it about its vertical axis, but these tasks are relatively simple.

Many 3-D systems let you place objects and the camera anywhere in space, yet the *viewing volume* of the screen (the portion of space over which objects are visible) is only a small portion of that larger space. In trying to navigate under these conditions, it is easy to get lost, winding up with a blank screen as the camera points off into space in what has been called the "black-hole effect." In this situation, simple commands can help tremendously to reorient you, even if they don't provide the ultimate placement of the camera.

For instance, a "turn to" command might cause the camera to rotate in the direction of a particular object, the scene as a whole, or the reference plane. If the current viewing direction is more important than the camera's location, a similar command can move the camera without changing its orientation. The command moves the camera so that the viewing volume comes to include the appropriate objects and they become visible.

Another navigational aid is possible if the camera is defined in terms of both its location and a "look-at" point that determines the direction of the view from any location. If the look-at point changes, the camera turns. If the location changes, both the camera's viewpoint and its direction change (unless the movement is directly toward or away from its look-at point). Locking the look-at point at an object's center lets the camera orbit about the object without losing sight of it.

Perhaps the most dramatic and simplifying realization is that designing 3-D models from scratch is inherently difficult and much harder than designing in two dimensions. No matter how powerful a 3-D modeler is, it is likely to require significant effort both to learn how to use it and, once mastered, to maintain fluency with it. This is really the final problem for perhaps 90 percent of everyday users, who would use 3-D graphics if they could use them easily.

The most radical step, therefore, is to make it possible to create 3-D pictures

Photo 2: *An example of the creativity and photo-realism possible on computers today with 3-D tools and techniques. The Pixar Shrink-wrapped Magic poster was produced on computers by Mitch Prater using Pixar's Developer's RenderMan. (Used by permission from Pixar.)*

But for true realism, you need a more flexible model, one that allows interaction to occur dynamically while the image is being rendered. This model must be flexible enough to deal with the incredible variety of the material world.

Procedural Shading

In rendering, a procedural model leaves a "hook" in the renderer for calculating the appearance of a surface on the fly, taking into account all relevant scene elements, including lights. A new surface material would be defined as a procedure that, when called, would have access to the lights hitting the surface, plus any relevant texture maps, bump maps, shadowing information, and so on.

The RenderMan Interface, developed by Pixar (Richmond, CA), supports a rendering system that uses the procedural model. It defines entities called *shaders*, written in the RenderMan Shading Language, for just this purpose. When invoked, a shader's job is to determine the color of a surface as seen from a particular point of view, as illuminated by all defined light sources.

The shader has ultimate freedom in calculating the color. It can use any number of texture maps, bump maps, shadow maps, environment maps, and light sources. It can use an elaborate materials simulation (the pseudopod sequence in the motion picture *The Abyss*, for example, used a ray-tracing surface shader) or no color model at all. (For further discussion on RenderMan and other rendering systems that use procedural shading, see "The RenderMan Interface" by Tony Apodaca, Graphics Supplement, April 1989 BYTE.)

Procedural shading is the next logical step beyond texture and bump mapping. In many cases, a procedural approach can solve the problem of mapping 2-D surfaces onto 3-D objects. Certain naturally occurring materials such as wood and stone have a structure that can be procedurally simulated. A point on a surface can be colored as though it were a point in a solid material, resulting in an object that looks like it was carved out of the material in question.

A second capability, provided by a procedural approach, addresses the "fine structure" issues. While it is impractical to duplicate the appearance of these surfaces empirically by simulating geometric optics, it is possible to mimic their behavior procedurally.

For example, paper has a special kind of diffuseness that can be procedurally imitated, not at the microscopic level, but at the level of its larger appearance on the screen. Of course, the higher the definition of your display, the more obvious these fine-structure issues will become. (For a discussion of the overlap between high-definition TV and computers, see "HDTV Sparks a Digital Revolution" on page 297.)

Procedural shading can work together with texture maps for other novel effects. For example, a shader might use a piece of line art to change the material it simulates in different parts of the surface, to produce a net effect like inlay. Texture maps, in fact, can describe any relevant attribute and be interpreted in any way by a shader.

A texture map could be used to vary the color of a surface depending on the angle of incoming light (real metals have this kind of behavior). Of course, a shader can use a texture map exactly as intended, which illustrates that the procedural approach subsumes the mapping-only method as well.

Creating Curves

A final, qualitative concern crosses the boundary between modeling and rendering: the availability of curved surfaces to represent objects in a scene. Traditionally, flat polygons have been used because they're computationally easier to handle.

However, not many objects in the world can be accurately represented entirely with flat surfaces. While there are tricks for making the best of their limitations, polygons can only provide a reasonable approximation of curved surfaces, and that at the cost of substantially larger data storage.

A Tall Order

Creating photo-realistic 3-D graphics is a tall order. It involves powerful computer hardware, user-interface design, and complex simulations of geometric optics.

However, just about all the foreseeable obstacles to this brave new 3-D world have yielded or are dissolving. Current products contain the information required to properly render a surface, including several different types of shading and many different kinds of maps (see photo 2). ■

Steve Upstill is a product manager for Pixar (Richmond, CA). He has a Ph.D. in computer science from the University of California at Berkeley. You can reach him on BIX c/o "editors."

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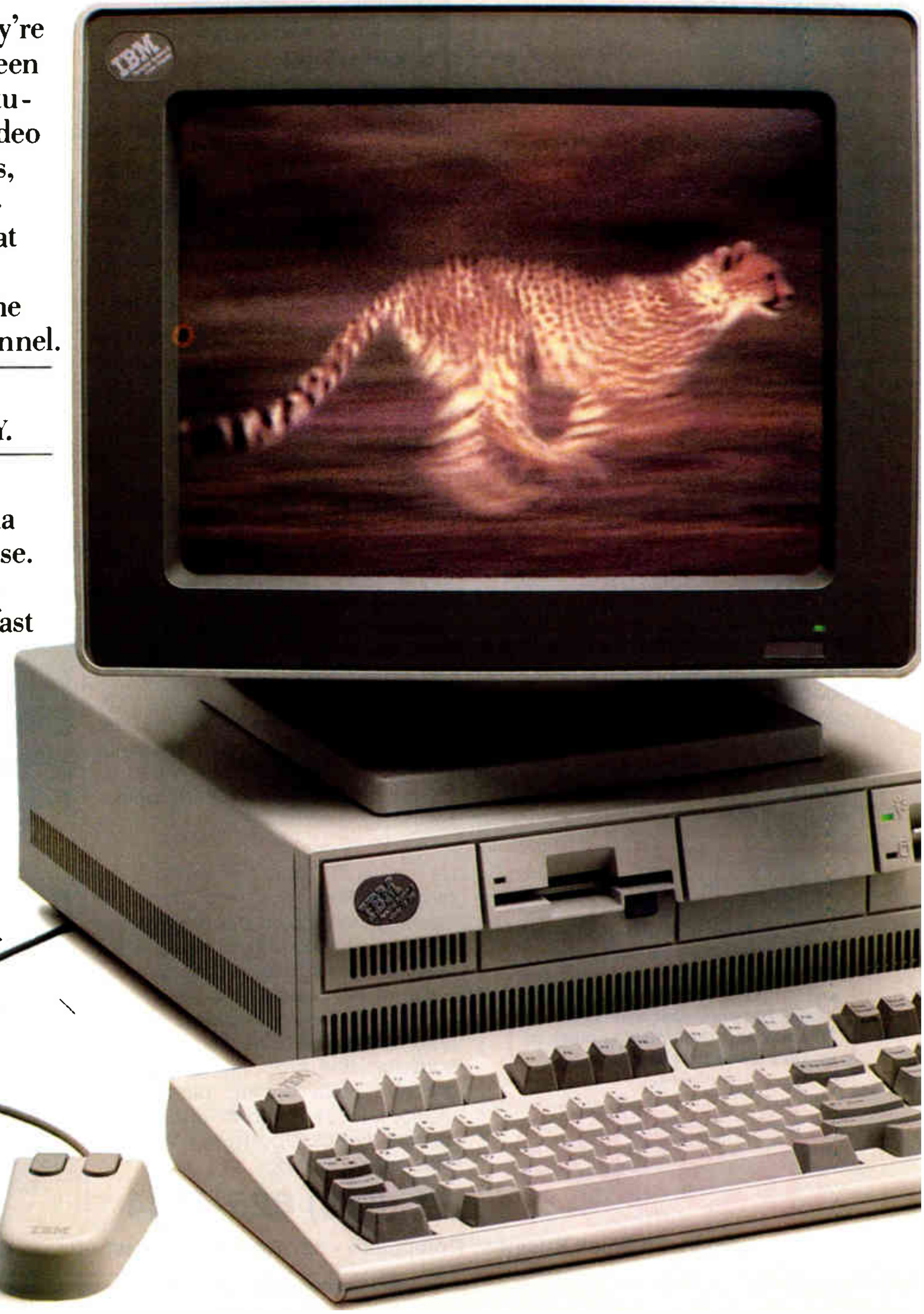

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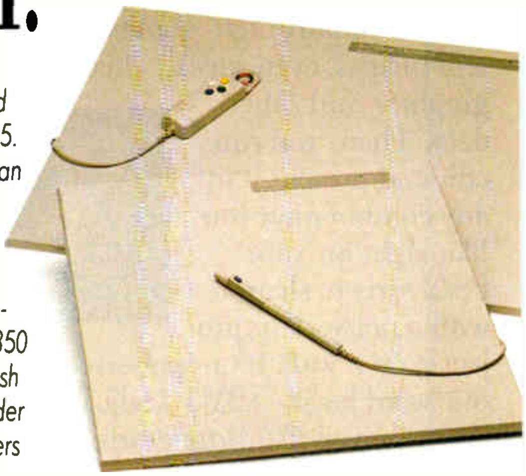

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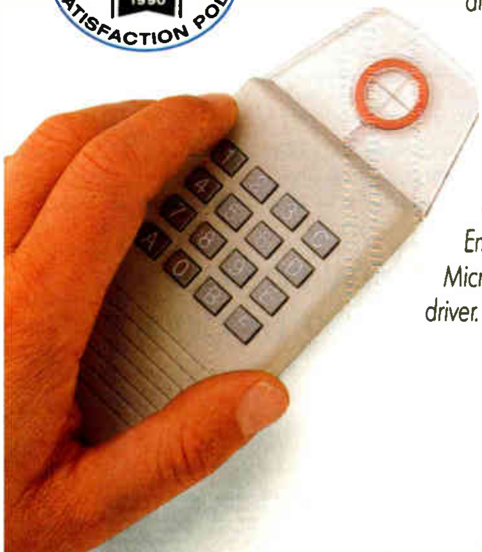

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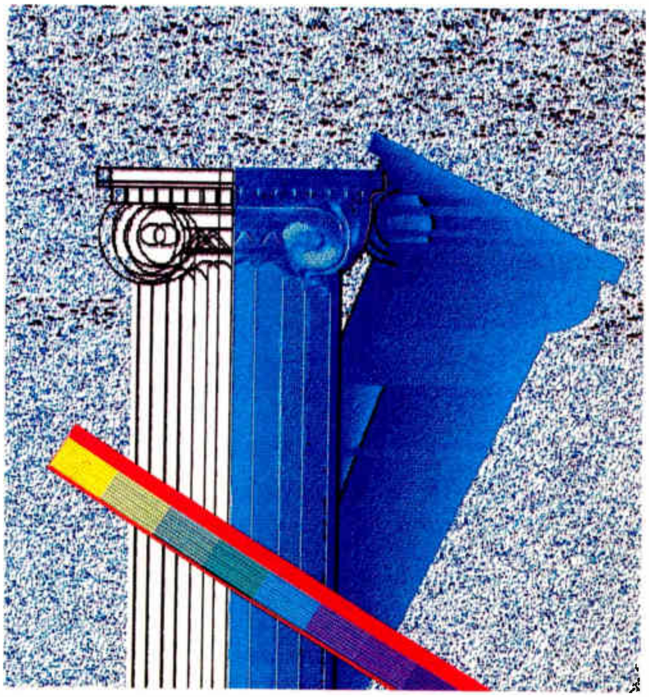
Ray Tracing for Realism

Photo-realism is within your grasp. Follow the light.

Andrew S. Glassner

Photo-realism is an elusive goal; the real world is a web of subtle and complex phenomena that scientists don't fully understand, and computer-generated pictures can only reflect current levels of understanding. You can create images that come close, though, using a variety of photo-realistic techniques. One of the most popular is called *ray tracing*.



What Is Ray Tracing?

The ray-tracing approach attempts to simulate light rays within a three-dimensional scene. You begin creating an image by describing a scene as a collection of objects and light sources. The objects are 3-D shapes in space—for example, spheres, polygons, and boxes. A light source is often nothing more than a single point that radiates light uniformly in all directions.

By convention, objects never radiate light, and light sources are never directly visible (this separation of light emitters from other surfaces is a computational convenience, which can be relaxed if you're willing to write more complex programs). You view a scene from a point in space called the *eye*, through a rectangular window in space called the *viewplane*.

The image on the viewplane in the 3-D world is the image that you will eventually show on your monitor screen. There is a direct correspondence between each point on the screen and each point on the viewplane. Figure 1 shows a typical environment.

Probably the most straightforward way to create an image is to follow light particles (called *photons*) from the light sources to the objects; this is called *forward ray tracing*. But forward ray tracing is not always practical. For example, suppose a light ray left a light source, reflected off a shiny telephone, and then passed through the viewplane into the eye. In this example, you would see the telephone at that point on the viewplane. In general, what you see through each point on the viewplane is the object that's visible along the line passing through both the eye and that point on the viewplane.

If you actually followed light away from the light sources, you would find that your image was created very slowly; many rays would never come anywhere near going through the viewplane and into your eye, so they wouldn't contribute much (if anything) to the image. It would be sheer luck if any given ray made it all the way to the eye.

A more efficient way of creating a photo-realistic image is to reverse the process. For example, if you select a point on the viewplane, you know that any object visible at that point lies on the line connecting your eye and that point

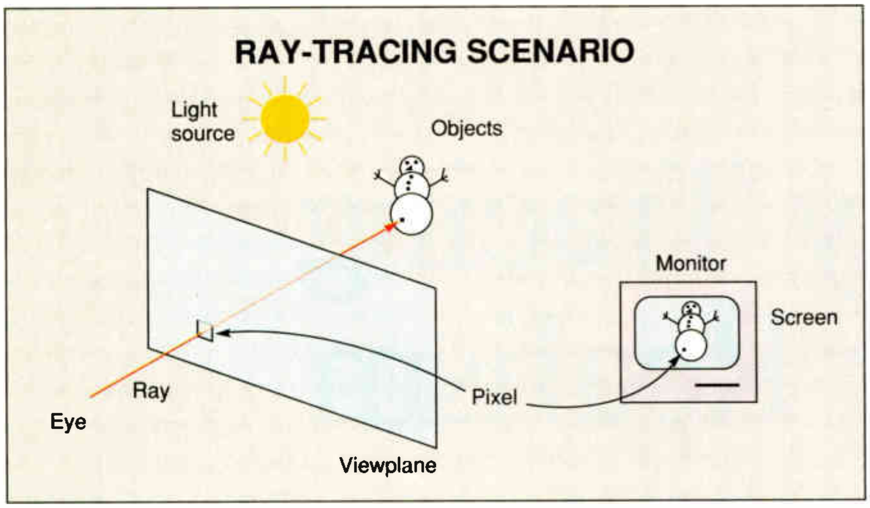


Figure 1: *A typical ray-tracing environment. Each pixel in the viewplane has a corresponding pixel on the screen. Light sources are represented by points, and objects are collections of simple shapes. The world is viewed from a point called the eye.*

on the viewplane. So you create a ray (called the *eye ray*) that begins at the eye and passes through that viewplane point and on into the world. The first object along that ray is the object that will be visible from that point on the viewplane and thus displayed on the corresponding point on the screen. This is called *reverse ray tracing*, because you're following rays from the eye back into the scene.

Typically, the screen is made up of a rectangular grid of squares called pixels, and your goal is to find the right color for each pixel on the screen. Figure 1 shows a ray starting at the eye, continuing through one pixel on the screen, and on into the world, where it strikes a sphere.

Incident Light

Now that you know the object visible at each point, you need to know its color. Suppose the first object struck by an eye ray is a white sphere; I'll call the point of intersection P. You want to know the color of the light leaving P and traveling back to the eye; the path back to the eye is found by following the eye ray backward.

The color of the light leaving P is completely due to the light arriving at P, called the *incident light* (remember that no objects emit light of their own). You can separate incident light into two categories: the light ultimately reflected off the surface and the light transmitted by the surface (transmitted light is the light that passes through a transparent or translucent surface).

Each type of incident light is passed on by the surface in two ways: *specular propagation* and *diffuse propagation*. Specular propagation is the result of a perfect reflection or transmission, just like a basketball bounced off a smooth floor. The angle at which the ball leaves the floor is completely determined by the angle at which it arrives.

Diffuse propagation is like bouncing a basketball off a very rough surface; you're never sure what direction it will go in, and if you try bouncing many basketballs into one little area, you'll find that they go off in all directions. Diffuse propagation is the theoretical limit of this type of action; diffusely reflected or transmitted light arrives at a surface and then leaves with equal intensity in all directions (this reflected intensity is less than that of the incoming light). For this reason, diffuse propagation is sometimes also called *diffuse scattering*, since the light is scattered in all directions.

Light can be propagated from a surface in four ways: reflection and transmission, both specular and diffuse. But where does this incident light come from? Basically, you have two choices: directly from light sources or propagated by other surfaces. Each of these two possible contributors of incoming light can be propagated in any of the four ways, for a total of eight possible ways for light to be propagated from a surface (this is a simplified model, but it works surprisingly well).

A ray-tracing program should look at each of these possibilities when it computes the color leaving a point—this process is called *shading*. Not all eight effects are going to be appropriate at all times, and two of them are very expensive to compute.

Direct Light

I'll begin with light arriving directly from the light sources. First, you must determine on a source-by-source basis if light from each source is arriving at point

Vector Shorthand

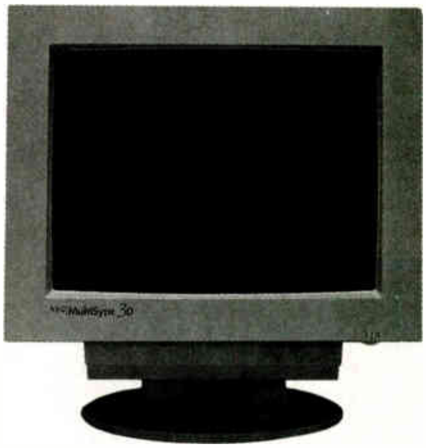
Vector equations are just a handy way to represent several different equations in one place. Each vector is formed of three components, named x, y, and z. Each component is just a single number. You can think of a vector as an arrow, starting at the origin. The components of the vector give the location of the tip of the arrow. You write the x value of a vector **V** as V_x, the y value as V_y, and the z value as V_z. Vectors are used to make notation more compact.

To make a vector longer or shorter, you can scale it. To scale a vector, you write $\mathbf{A} = s\mathbf{B}$, where s is just a single number. The length of a vector **A** is written $|\mathbf{A}|$ and is computed as the square root of the sum of the squares of its components. To scale a vector so that it has length 1.0, divide each component by the vector's length. Thus, for any vector **A** (except $\mathbf{A}=(0,0,0)$), `vectorLength(unitVector(A))` is 1.0.

The last two vector operations are the dot product and the cross product. These are extremely useful operations in computer graphics.

The dot product of two vectors **A** and **B** is a single number. Symbolically, you write $d = \mathbf{A}\cdot\mathbf{B}$, where d is the result. The value of the dot product is the cosine of the angle between the two vectors, multiplied by their lengths: $\mathbf{A}\cdot\mathbf{B} = |\mathbf{A}||\mathbf{B}| \cos(\theta)$, where θ is the angle between **A** and **B**. If both vectors have length 1.0, you can compute the cosine of the angle as the sum of the pairwise products of the components.

The cross product of two vectors **A** and **B** is a new vector perpendicular to both. Symbolically, you write $\mathbf{C} = \mathbf{A}\times\mathbf{B}$, where **C** is the new vector. The order of the arguments matters; $\mathbf{A}\times\mathbf{B} \neq \mathbf{B}\times\mathbf{A}$.



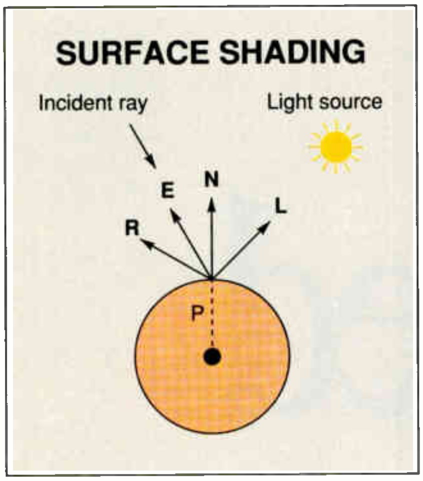


Figure 2: *Computing the shading on a sphere.* **L** *points toward a light source; this light is reflected into vector* **R**. **N** *is the normal to the sphere at point P.*

P. To see if P is illuminated by source S, you should notice a simple fact: If light S can see point P (and thus illuminate it), then point P can see source S. To determine if P can actually see S, create a new ray (called an *illumination* or *shadow ray*) starting at point P, directed toward source S.

If this ray reaches S without striking any object along the way, P is illuminated by S, and you can proceed to find out how much of the light from S is propagated back to the eye. If the ray from P to S is blocked (i.e., if the ray intersects any object at all), P is in shadow with respect to S; simply ignore source S for this point.

In the following discussion, I'll use vector notation. Points will continue to be represented by uppercase letters, such as A, and vectors will be in boldface, **A**. If you're not familiar with vector notation and operations, see the text box "Vector Shorthand" on page 264 for a quick summary. I will assume that all vectors are normalized; that is, they have length 1.0. When I build new vectors, I will assume that they are immediately scaled to length 1.0 before using them in any computations.

Shading

I will present a simple shading model that ignores many important details but is a good first approximation. Suppose that P is illuminated by source S. Every point on the surface of most objects (including spheres) has an associated surface normal; this is a vector that points away from the surface, normal to the tangent plane at that point. For a sphere, the normal is along the line from the center to that point, as in figure 2. I'll call the normal vector **N** and create a new vector, **L**, which also begins at P and points back to light source S.

Bending Light

The equations for finding the direction of reflected and refracted (or transmitted) rays come directly from the field of geometrical optics. I have given the equations in terms of some arbitrary vectors; you'll need to match the appropriate vectors to the appropriate arguments when you use the procedures.

Also make sure that your input vectors are pointing in the correct directions. The direction of each vector is important, and some of the vectors in this text box might point in the opposite direction to the vectors that you have on hand. To reverse a vector, you scale it by −1.0.

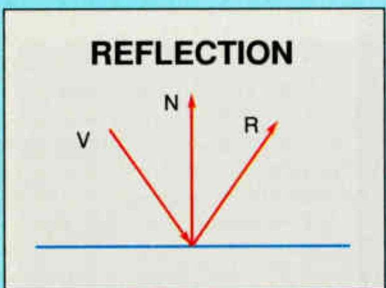


Figure A: *Specular reflection takes as input an incident vector* **V** *and a surface normal* **N**; *the output is a reflected vector* **R**: **R**=**V**−2**N**(**N•V**). *The vectors must all be pointing as indicated with respect to the point of reflection.*

Specular reflection takes as input an incident vector **V** and a surface normal **N**; the output is a reflected vector **R**:

$$\mathbf{R} = \mathbf{V} + 2\mathbf{N}d, \text{ where } d = -(\mathbf{V} \cdot \mathbf{N})$$

The vectors must all be pointing with respect to the point of reflection, as shown in figure A, where the incident vector is pointing toward the surface, and the normal is pointing away.

Specular transmission isn't quite so easy. The difference is that a light ray changes direction when it passes between two materials with different densities; this is because the speed of light is different in the two materials.

The ratio of the speed of light in a vacuum with respect to the speed of light in some material is known as that material's index of refraction, usually written with the symbol η. When light passes between two materials, the amount by which it bends is dependent on the indexes of refraction of both the material it is coming from (the incident material) and the material it is passing into (the transmitted material) and the wavelength (which I am ignoring here). The indexes of refraction of these two materials are written η_i and η_t; you will want their ratio $\eta_{it} = \eta_i/\eta_t$. The formula below is based on rays with an orientation relative to the point of transmission, as shown in figure B.

The formula to compute a transmitted vector, **T**, is

$$\mathbf{T} = \eta_{it}\mathbf{V} + \left(\eta_{it} C_i - \sqrt{1 + \eta_{it}^2 (C_i^2 - 1)}\right) \mathbf{N}$$

where $C_i = -\mathbf{V} \cdot \mathbf{N}$. Note that the value $(1 + \eta_{it}^2(C_i^2 - 1))$ might be less than 0; in that case you can't take the square root. This indicates total internal reflection. In general, **T** computed this way will not have length 1.0.

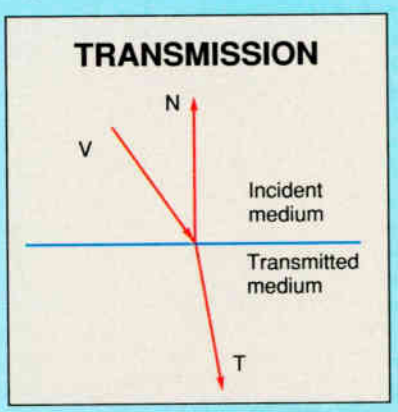


Figure B: *When light passes between two materials, the amount by which it bends is dependent on the indexes of refraction of both the material it is coming from (the incident material) and the material it is passing into (the transmitted material).*

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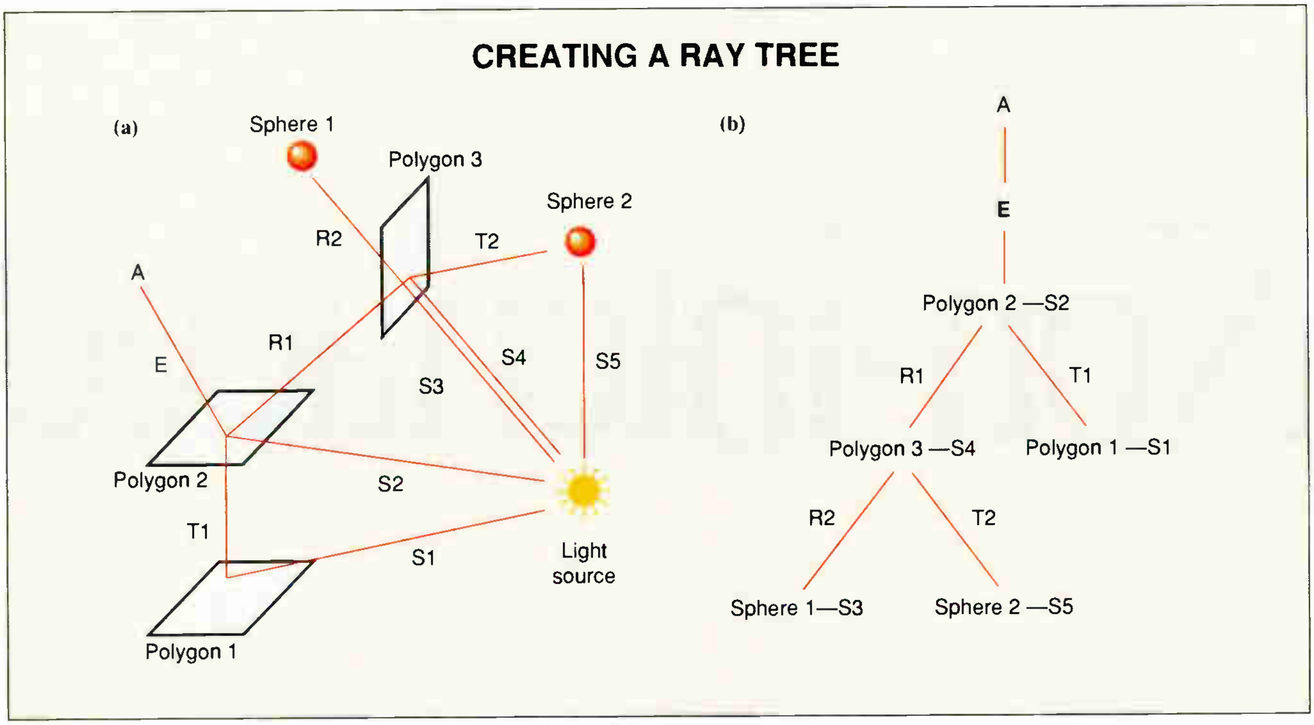

Figure 3: (a) *Each time a ray intersects an object, the color of the light leaving that object back along the ray must be computed. This color is found by creating shadow rays that point back to the light source, and reflected and transmitted rays that find the color of the light reflected and transmitted by the surface. This collection of rays can be represented abstractly with a ray tree* **(b)**. *Shading is accomplished by passing colors of objects from the bottom up to the top.*

Suppose source S has intensity I. If S is on the inside of a sphere, its light is transmitted through the surface; otherwise its light is reflected off the surface. You can find which situation holds by computing the dot product of N and L; if **N•L**<0, then S is behind the surface, and if **N•L**>0, then S is in front. If **N•L**=0, then S is on the plane tangent to the surface and sheds no light on it. Assume **N•L**>0, so the light source is reflected.

The amount of light reflected diffusely is the same in all directions and is given by DR=I (**N•L**); that is, the intensity of the diffusely reflected light, DR, is given by the intensity of the light source itself, I, scaled by **N•L**. This equation comes directly from a law of physics known as Lambert's law.

The amount of light specularly reflected back to the eye will form a highlight, which is the reflection of the light source off the surface. This depends on where the eye is. Construct a new vector, **E**, which begins at P and points back to the eye, as in figure 2. If **L** points to the light source, the law of specular reflection tells you that **R**=2**N***d*−**L**, where *d*=**N•L** and the direction of **R** is the direction of the reflected light. You can find how much of this light goes into the eye by finding how much **R** and **E** line up; this is given by **R•E**. Commonly, you raise this dot product to some power; the larger the exponent, the sharper the highlight becomes (this achieves a crude approximation of surface roughness). Thus, SR=I [(**E•R**)^k] where SR is the intensity of the specularly reflected light, and *k* controls the surface roughness.

Similar arguments hold for the transmission of light from the sources. The only difference is a correction factor that accounts for the bending of the light when it passes between media (the reason why a spoon appears bent in a glass of water). This is not hard to derive. The result is presented in the text box "Bending Light" on page 266. For more explanation, see reference 1.

The screen is made of a rectangular grid of pixels, and your goal is to find the right color for each pixel on the screen.

Your next goal is to find the incident light coming from other objects. Suppose again that you struck a white sphere at point P with an eye ray. What light is specularly reflected back along the eye ray? Above, I provided the relation between a reflected ray and its incoming direction; if you want to find the ray that reflects into **E** (the vector pointing back along the eye ray), it must be coming from **R**′=2**N**(**E•N**)−**E** (this is just a rewrite of the law of specular reflection). I've written the result as **R**′ instead of **R** to remind you that this computed reflection vector is backward from the direction from which the light arrives. Thus, any light that is specularly reflected back along **E** must be coming in along **R**′. What is the light that is arriving along direction **R**′?

The answer to that question is the big trick to recursive, backward ray tracing. To find the light coming into P along **R**′, pretend that **R**′ is an eye ray and ask what object it hits first. When you find the color of the light leaving that object in the direction of the eye ray that hit it (really **R**′), you know the color of the light arriving at P along **R**′.

The whole process, then, is recursive: To find the color of the reflected light, you find the first object that it hit and then find the color of the light leaving that object. Its color is a combination of the light arriving directly from the light sources and the light it's reflecting and transmitting, which it finds by the same techniques I just used. The light specularly transmitted along ray **T′** is found the same way (**T′** is to **T** what **R′** is to **R**): You build **T**′ (as in the text box "Bending Light") and treat it as the eye ray.

The result is a ray tree, as shown in figure 3b. The eye ray first hits an object and spawns illumination rays back to the light sources to determine direct illumination and a reflected and transmitted ray to find the light specularly reflected and transmitted by that object (see figure 3a). Each of those latter two rays then hits an object, and the process recurs. A common technique in simple ray-tracing programs is to stop the recursion at some predetermined depth (this produces artifacts in the image, but if things are not too shiny or transparent and your cutoff depth is large, it will serve as a first step).

Now that you've built the tree, you can begin to fill in the colors from the bottom up. The colors of the bottommost objects are simply due to the light sources; those colors are passed up to the next object as its reflected and transmitted colors, and so on up the tree until you've computed the color of **E**.

You may have noticed that I've ignored light that is diffusely reflected and transmitted off other objects. Handling this effect efficiently is still a research issue, and many systems just add in a small amount of constant light (called *ambient light*) at every intersection to "fake" this light.

Another point that I left dangling is the phenomenon of *total internal reflection*. Notice that the computation of ray **T′** involves a square root. If the value under the radical sign is negative, the whole expression for **T′** becomes imaginary. The physical significance of this result is that the light does not pass through the surface at all; instead, it is reflected off the surface.

At all angles less than the *critical angle*, where the value under the square root is less than or equal to 0, the light is transmitted; at angles greater than this value, the light is specularly reflected off the inside of the surface. This is the principle behind optic fibers: They are translucent so that they can transmit light, but they are designed so that whenever the light strikes the inside of the tube, it is reflected back into the shaft rather than transmitted out.

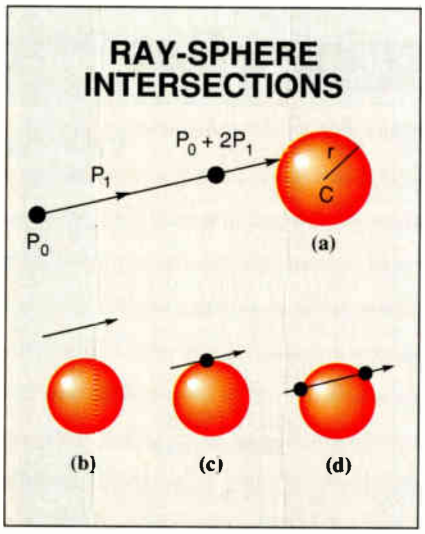

Figure 4: *A ray-sphere intersection* **(a)**. *The value of* d *in the ray-sphere intersection equation tells you whether there are 0, 1, or 2 intersections between a ray and a sphere* **(b, c, d)**. *If the intersections are behind the origin of the ray, their* t *values will be negative; ignore such intersections.*

You can see this effect if you put a spoon into a glass of water. Look very closely right beneath the surface of the water and you'll see that the spoon seems to disappear. The light right near the surface is striking the bottom of the air-water boundary at a very shallow angle and is reflected back into the water rather than transmitted into the air.

Computing Intersections

Finding ray-object intersections is one of the most important issues in ray tracing. Finding which object is first intersected by a ray is probably the most time-consuming part of any ray tracer. The most straightforward approach is to find the intersections (if any) of each ray with every object and then find the object with the nearest intersection. This method is tedious, but it works well.

Suppose you want to find the intersection of a ray and a sphere. Things will be easiest with vector notation. Suppose the ray begins at point P_0 and travels in direction $\mathbf{P_1}$. Any point P on this ray is given by $P=P_0+\mathbf{P_1}t$, for an appropriate value of t. Since you want only points in front of the ray, you're only interested in intersections along the ray with $t>0$ (t is often called the ray parameter). Figure 4a shows a sample ray hitting a sphere. The sphere has center C and radius r. It turns out that every point Q on the sphere satisfies $(Q-C)\bullet(Q-C)-r^2=0$; expand this out in coordinates and you'll find a familiar formula from geometry (try using $C=0$, so the sphere is centered at the origin; then $Q\bullet Q=r^2$, so the distance of every point Q from the origin is a constant, which is one definition of a sphere).

If the ray intersects the sphere, there must be some point, Q, that is on both the ray and the sphere at the same time. If point Q is on the ray, then $Q=P_0+\mathbf{P_1}t$. And if point Q is on the sphere, then $(Q-C)\bullet(Q-C)-r^2=0$. You can find points that satisfy both by plugging the ray equation into the sphere equation. Substitute the first into the second to get $(P_0+\mathbf{P_1}t)\bullet(P_0+\mathbf{P_1}t)-r^2=0$.

If you multiply this all out and then solve for t, you'll have a quadratic equation: $at^2+bt+c=0$, where $a=\mathbf{P_1}\bullet\mathbf{P_1}$, $b=2\mathbf{P_1}\bullet\mathbf{G}$, and $c=\mathbf{G}\bullet\mathbf{G}-r^2$, where $\mathbf{G}=P_0-C$. You are interested in the values of t that satisfy this equation. Recall that any quadratic equation has two solutions: $t_1=(-b+d)/2a$, and $t_2=(-b-d)/2a$, where $d=b^2-4ac$.

The value of d is very important. Remember that you can't take the square root of a negative number, so if d is negative, you can't evaluate the square root. The physical interpretation of this is that the ray misses the sphere completely—there is no intersection at all. Figure 4b shows this case. If d is 0, the ray grazes the sphere at just one point, as shown in figure 4c.

If d is positive, the ray intersects the sphere in two places, as in figure 4d. If there are any intersections, each intersection point is given by $P=P_0+\mathbf{P_1}t$, using the appropriate value of t. If there are two intersections, you want the nearer one; this is the one given by the smaller value of t (as long as that value is positive; if either or both values of t are negative, they give intersection points behind the origin of the ray).

Coping with Complexities

The simplest form of ray tracer builds a single ray for each pixel on the screen and fills in the pixel with the color of that ray. This can result in a picture with aliasing (or "jaggies"), which comes from using just that single color value for the whole pixel. A pixel can display only a single color, so how can you possibly do better? One answer is to take several samples distributed within each pixel and average their colors together—it's the averaged color that you use as the pixel's color value. To build a complete ray tracer, see the text box "Writing a

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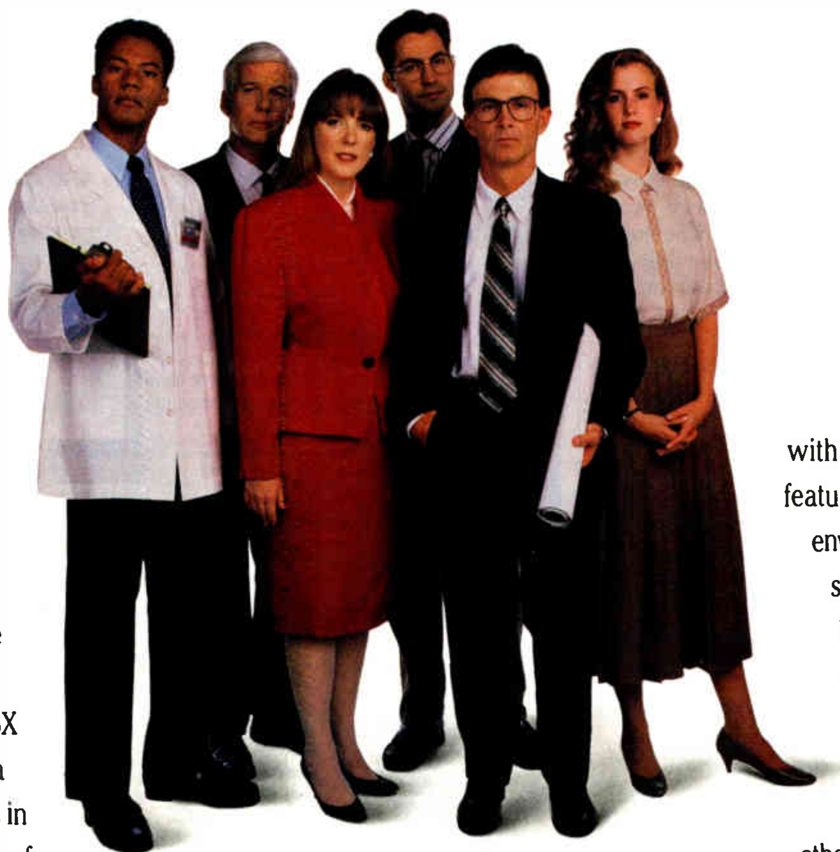

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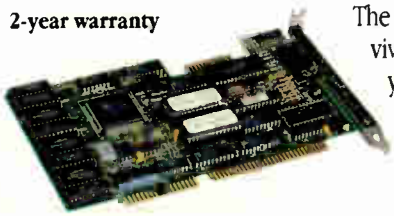

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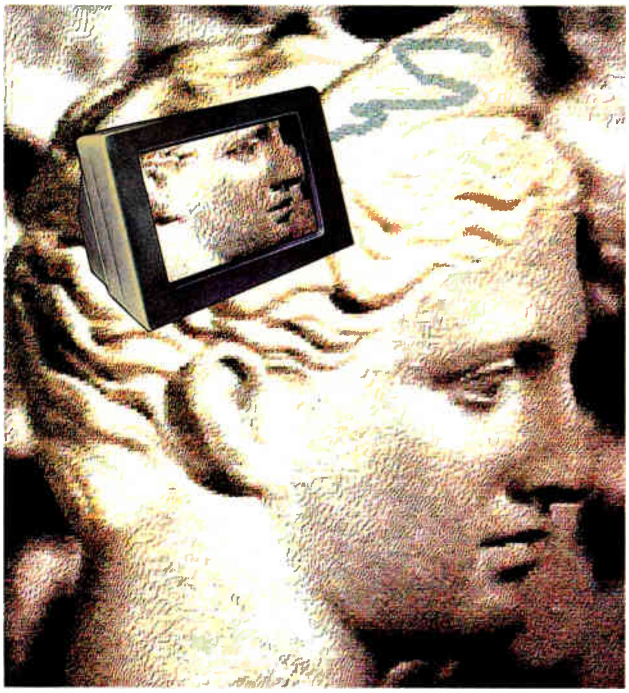
Color WYSIWYG Comes of Age

Finally! What you see in color on your screen is what you get in color on your printer!

Frank Vaughn



Truly graphical computers, such as the Mac, and sophisticated laser printers have brought WYSIWYG capabilities to word processing and black-and-white desktop publishing. With the proper hardware and software, you can be assured that your hardcopy output will match what you see on your computer display. Until recently, the same was not true of color desktop publishing. You have had no assurance that the colors on your display would match those of the final printed output.

The advent of many enabling technologies has recently advanced the state of color WYSIWYG to where it is an affordable desktop technology. Display systems with "true-color" capabilities and graphics acceleration are available and affordable for desktop computers running the more popular operating systems.

Apple Computer, for example, has established a color standard for the Macintosh called 32-Bit QuickDraw, while Microsoft has defined a 24-bit color standard for Windows 3.0. Both companies are enjoying increasing hardware and software support for these standards. On the peripherals side, color scanners with the capabilities required by serious designers are available to input true-color images, and cost-effective color hardcopy output devices are also available. None of these systems, however, ensures that the color you see on your display will be the color you get in print.

To be useful as a color-proofing system as well as a layout tool, a color desktop publishing system must ensure that the colors you see on your display are similar or identical to the colors on the final printed output. All the colors also need to be consistent from one display to another so that different designers in the same company can work with the same colors. Such color consistency may seem straightforward to the casual observer, but it is actually quite a difficult problem to solve. To see how you can achieve color consistency, you need some facts about how different technologies handle color.

What You See

Your perception of color is a function of the sensitivity of your retina to a range of wavelengths in the visible light spectrum. The human retina contains three types of cone cells, each of which responds to different wavelengths of visible light. The color you perceive depends on the relative response of each type of cone to the light striking it. The wavelengths you can detect vary from 3900 to 7000 angstroms, where an angstrom is a hundred-millionth of a centimeter.

You perceive the shortest wavelengths as blues and violets and the longest as oranges and reds. Black is the absence of any wavelengths in the visible spectrum. An even mix of the spectrum of wavelengths is perceived as white, although different light sources have their own particular mixtures for white. Each particular white has a color temperature associated with it. You can measure the color temperature of an illuminant (also known as its *white point*) by heating a blackbody radiator (a heated cavity with an exit aperture) to a temperature measured on the Kelvin scale. A cool-white fluorescent lamp has a white point of 4300 K, and an incandescent bulb has a white point of 2900 K. The table at left lists some common sources of light and their color temperatures.

COLOR TEMPERATURES OF LIGHT SOURCES

The color temperatures for some common light sources. The different color temperatures affect how you perceive color illuminated by different sources.

Source	Temperature (kelvins)
North-facing skylight	7500
Average daylight	6500
Xenon camera flash	6000
Cool-white fluorescent	4300
Tungsten-halogen lamps	3300
Warm-white fluorescent	3000
100-watt tungsten	2900
Sunset	2000
Candle flame	1900

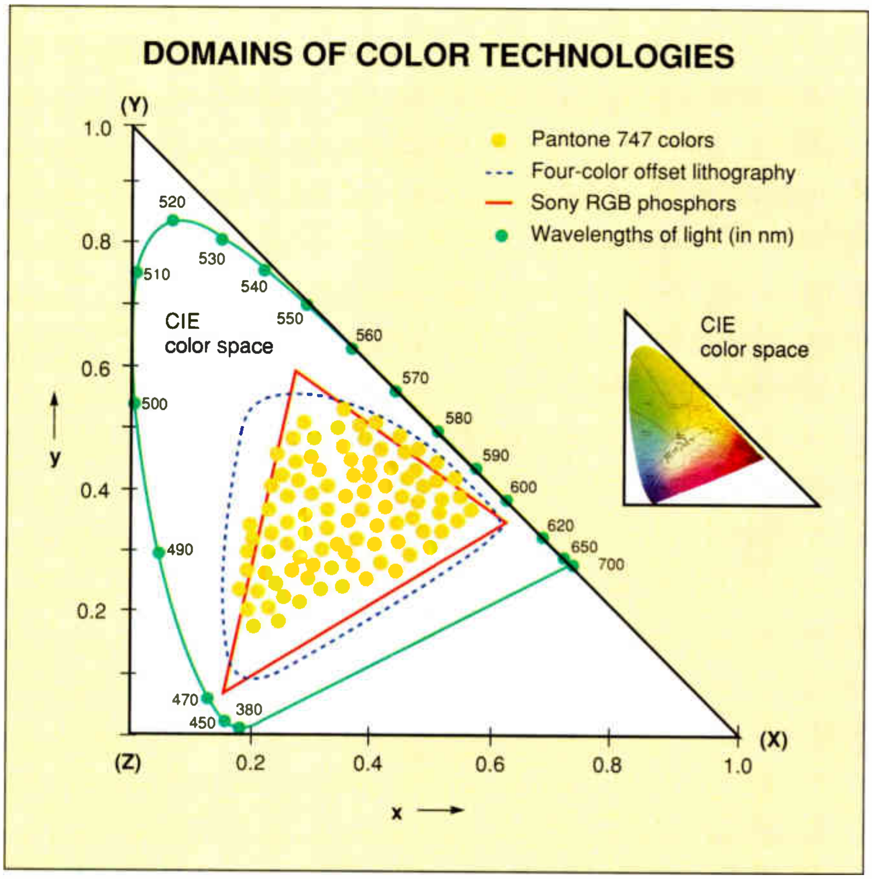


Figure 1: *The CIE color space projected into two dimensions. This is really a three-dimensional space that contains all the colors visible to the human eye. The triangular area outlined by the coordinates of the Sony RGB phosphors is a projection of its color gamut onto the color space. Pantone colors are discrete points within the space, while four-color offset lithography projects a gamut similar to the RGB gamut.*

An object's perceived color varies when you view it under illuminants with different white points. This is known as *color shift*. A red car appears to be gray when illuminated by a yellow sodium street lamp, because the red color shifts when mixed with the yellow lamp. More subtle differences are evident if the car is viewed in daylight or in a dealer showroom under fluorescent lighting.

Quantifying What You See

In an effort to organize the range of possible colors in a predictable and useful manner, the concept of the color space (also known as a color model) has been developed. Color display systems use the RGB color space, and color printing systems typically use the CMYK (cyan, magenta, yellow, black) model. These color spaces use component colors as the parameters for the model. Other color spaces may use other parameters, such as brightness. For the most sophisticated color spaces, these parameters are based on psychophysical metrics that have been experimentally determined.

The goal of a color space is to allow any color sample to fit in that space and be quantified from the combination of the component parameters at that point. Color spaces are therefore good for selecting and specifying colors and communicating color information.

Nearly all defined color spaces are based on three parameters. They are most useful for experimentally determining differences between perceived colors. The international standard for specifying color is the xyY color space, defined in 1931 by the Commission Internationale L'Eclairage (CIE). The three primary coordinates (x, y, and Y) are combined, with positive weights, and can define all colors in the human color-perception range. Any color can be specified with these weights. The same cannot be said for the RGB and CMYK color spaces.

The RGB space refers to colors known as the additive primaries: red, green, and blue. They are primary in the sense that they are the only three colors required to create white light. This is done by combining the light of each one in a process known as *additive mixing*.

The CMYK space uses the color complements of the primaries: cyan, magenta, and yellow (the K refers to black, which is used for better print quality). These complements are the colors that result when a primary color is subtracted from white light. Cyan is the complement of red (white light − red light = cyan light), magenta is the complement of green, and yellow is the complement of blue.

In the CMY space, colors mix in a process known as *subtractive mixing*. That is, the complements mix to form black. This is a theoretical ideal; because of pigment limitations, it is necessary to add the black parameter to achieve true black in hard-copy reproduction. CMYK is the color space used to define colors for most four-color printing.

The RGB and CMYK spaces can only produce a portion of the human color-perception range. By plotting each component color of the RGB or CMYK space (ignoring black) for all brightness levels (the Y in xyY), you define a subarea within the xyY space. This range of possible colors is known as the *color gamut*. Figure 1 shows the color gamuts for a few color display and hard-copy systems.

What You Get

Color display systems achieve unique colors by "adding" different intensities of red, green, and blue for each pixel on the display. The combination of full intensities of red, green, and blue phosphors for a particular pixel generates a "white" pixel. The number of intensities for each red, green, and blue component is dependent on the format used.

The 32-Bit QuickDraw format is actually a 24-bit format with 8 bits, or 256 levels, of coding for the red, green, and blue phosphors making up a pixel. The other 8 bits are undefined and reserved for future use by the standard. Given this format, the number of color combinations is 256 by 256 by 256, or around 16 million. In a display with a resolution of 1152 by 882 pixels, you have roughly 1 million pixels. Software can assign a different color to each pixel from the 16 million possible combinations.

The color gamut for displays from different manufacturers varies because they each use different types of phosphors. Thus, identical combinations of RGB intensities do not produce identical color on different RGB monitors because of the phosphor differences. Even the characteristics of a monitor change as it gets older and the phosphors wear out, which they do at different rates (blue phosphors typically degrade faster than red).

Besides phosphor differences, there is another problem in relating the intensity level of each of the red, green, and blue components to the actual luminance viewed at the screen surface. For a black pixel, the intensity level of all three components is 0—practically no light is emitted for that pixel. For a maximum "white," all the intensity levels are at 256, resulting in maximum illumination.

For each intensity level from 0 to 255, however, the displayed luminance is not linear. In other words, an intensity of 128 isn't double the luminance of an intensity of 64. The relationship of the intensity level to the luminance can be plotted to form the *gamma curve* for the display.

To find the gamma curve of a display, the logarithm of the input voltage is plotted against the logarithm of the luminance. The slope of the central portion of the resulting curve is the gamma curve. TV sets and other video displays have a gamma curve of about 2.8. Scanners typically have a gamma curve of 1.0. Figure 2 shows three common gamma curves plotted in linear space.

The gamma curves for different displays of the same type or model are typically not consistent. To achieve accurate and consistent colors on a display, you must be able to read accurately the luminance of the display that corresponds to a given intensity level. To do this, a device measures the actual intensity of light received at the display surface for each of the 256 levels of red, green, and blue.

With this information, the loop is closed around the display system. The luminance for each intensity can now be accurately set and stored in a *gamma correction* table. This table contains an output level for each of the 256 input levels, which makes it possible to control the perceived gamma curve with software.

To control the perceived gamma curve, the viewed luminance at each input level must be set to match a particular gamma curve setting. With a gamma correction table and accurate luminance data, any gamma curve that the applications software requires can be set.

Anyone with a calibrated display, whether in the same office or across the country, will see consistent colors when viewing the same image at a particular

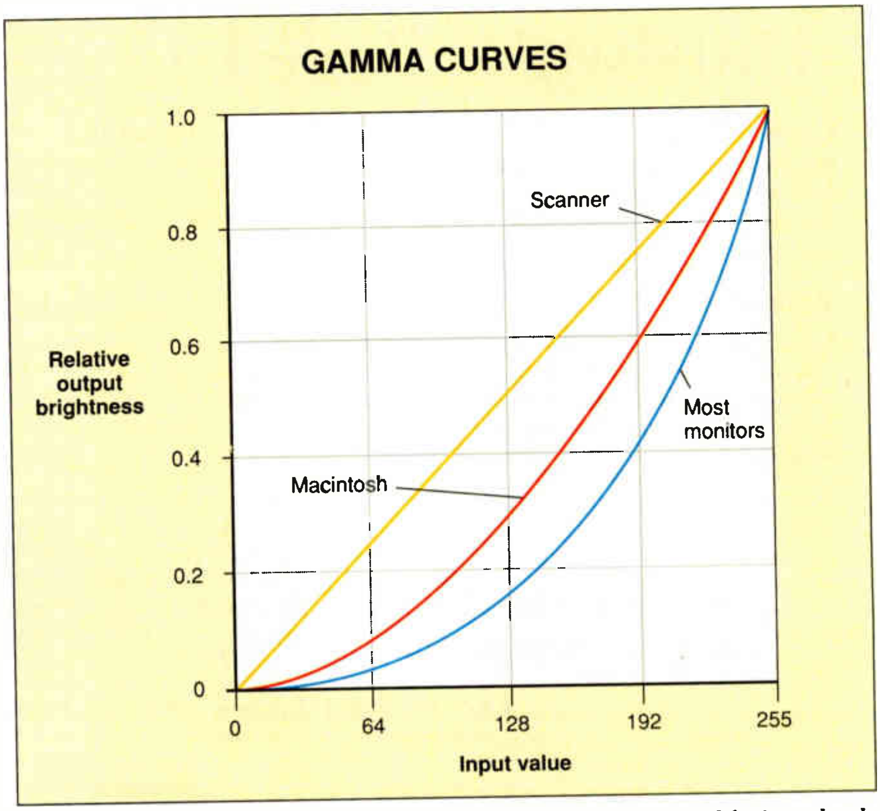


Figure 2: *The gamma curve is calculated by plotting the logarithm of the input level of a display against the logarithm of the luminance. It describes how luminance at the surface of the display changes as the intensity setting of the monitor changes. Shown are gamma values for scanners, the Macintosh, and other personal computers and workstations.*

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gamma setting. As a display ages, you can recalculate the intensity information to restore a consistent calibration of the gamma curve and color temperature.

Refining What You Get

Color calibration is done by calibration hardware that measures the outputs of pixel phosphors and either adjusts the levels of the electron beams in the monitor or changes the entries in the display system's gamma correction table. The first approach usually relies on internal sensors and requires that each color workstation have its own calibration hardware, which makes this the more expensive solution. The second approach normally requires an external sensor that can be used with multiple displays, so this is the more cost-effective solution. In a schematic overview, the external calibrator is a relatively simple device. It consists of three principal components:

1. The sensor, or luminance-measurement device, which inputs a light level and outputs a current;
2. the amplifier, which converts the current into a voltage; and
3. the A/D converter, which samples the voltage and turns it into a number—a digital representation of the luminance. This number can then be compared with other values stored, for example, in the gamma correction table of the Mac.

The combination of a calibrator and knowledge about the display being calibrated (i.e., the xyY values for the representative phosphors) enables you to calibrate the display. Measuring all the intensities for each color gun separately generates enough information to calibrate the display.

Radius has designed a solution—the PrecisionColor Calibrator—that enables you to quickly calibrate a display, correcting individual display biases and display variations that occur over time. It measures light output from the display and realigns the red, green, and blue color-gun values.

Calibrating different displays is important, but it doesn't ensure that what you see in print will match what shows up on the displays. To span the display-output gap, Radius has obtained an exclusive license from Pantone to calibrate and display Pantone Color Simulations on-screen. The Pantone Matching System is a standard method used to define spot colors in the printing industry.

When a display is calibrated accurately and you know the CIE coordinates of each phosphor, sufficient information exists to display Pantone colors accurately. Pantone has measured the CIE coordinates for the colors of the Pantone Matching System for each of two light sources: D50, the standard graphic-arts illuminant, and D65, a popular daylight illuminant. If you select a particular Pantone color, a software package called the Pantone Color Toolkit performs a CIE-to-RGB calculation. This toolkit is packaged with the PrecisionColor Calibrator.

The white point of the calibrated monitor can be adjusted to match either of Pantone's color temperatures. If the white point is set to D50, the white screen of the monitor looks more like a press sheet illuminated in a printing plant. Identifying the monitor's characteristics and then controlling or adjusting for any variations from a preset standard allows Pantone colors or any CIE coordinate color to be simulated and displayed on RGB devices. This means that the design and page-layout process also produces an accurate color preview of the finished piece.

The calibrated display acts as a preview device for Pantone spot colors. The CIE information on Pantone colors enables the Color Toolkit to simulate these colors on four-color process printers. The Toolkit can also be set to directly simulate Pantone colors for printing systems using Pantone inks. The colors for these two output processes can differ slightly because of differences in the color gamut for RGB displays, CMYK printers, and Pantone inks. The Color Toolkit can adjust for these variations within the limits of the color gamut of the RGB display. This enables the graphics artist to preview work for either output process.

Clearing the Way

There are many complexities associated with the use of color in WYSIWYG desktop publishing. The ability to accurately match the colors viewed on the display to the colors that will be output to film or hard copy is critical to making true WYSIWYG color production a reality.

Display calibration is a significant step toward using the personal computer for color design, providing a consistent measure with which to preview and match final output in the color layout and design process. This technology clears the way for more widespread use of color on the personal computer. ■

Frank Vaughn is director of engineering operations at Radius, Inc. You can reach him on BIX c/o "editors."

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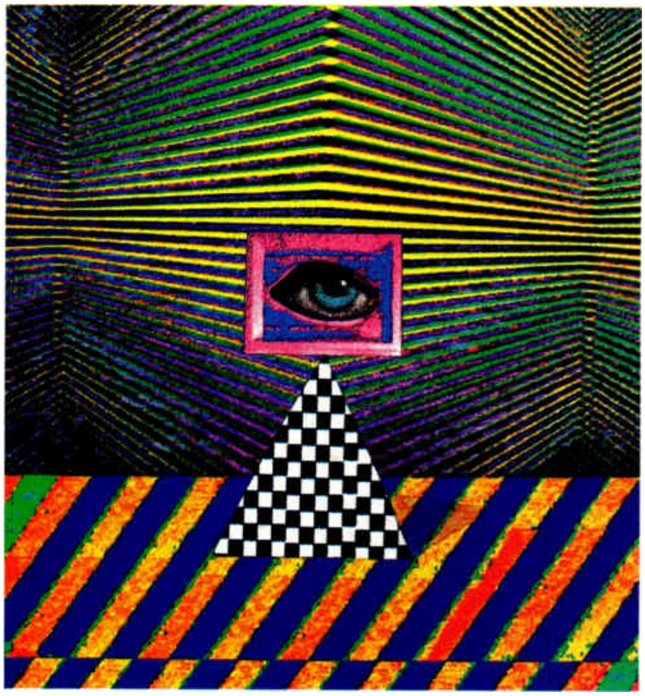

For the past few years, the Macintosh has led the way in bringing 24-bit, workstation-quality graphics to personal computers. Applications written to the 32-Bit QuickDraw standard can easily use photo-realistic images, providing you with a level of creativity never before available on personal computers.

Until recently, IBM PCs and compatibles have not offered the same ability to work in true color. Most MS-DOS software is written to take advantage of the standard display adapters—CGA, EGA, and VGA—which are limited in the number of colors they can display. Applications that work with true color images must be written for a specific display board, such as a Targa board. The advent of Windows 3.0, however, is changing all that.

The Windows Advantage

Besides providing a graphical user interface that is well suited to graphics applications, Windows 3.0 provides a graphics device interface (GDI) that frees applications developers from having to support every display adapter ever made. Developers need to write code to support the GDI only; graphics-board manufacturers then provide a single driver that translates instructions to the GDI device into commands that the graphics hardware can understand.

Perhaps the most significant feature of the Windows 3.0 GDI is its support for 24-bit graphics. It lets an application use up to 24 bits of information to define the color of a single pixel on the screen. Now, using Windows 3.0, you can see images on the screen as they will appear when printed, and you can develop quality presentations that incorporate photo-realistic images.

When running under Windows 3.0, applications can work with 24-bit images without regard to the display device you have in your system. The driver for the display device takes care of converting colors and images to its format, operating transparently to the applications.

If a Windows display device, such as the RasterOps ColorBoard 1024MC, supports 24 bits per pixel, then applications will be able to work with and display any of 16.7 million (2^{24}) colors. The ability to work with 24-bit images on-screen provides for a photo-realistic graphical environment that can support sophisticated desktop-publishing, multimedia, business-presentation, color-illustration, and image-processing applications. A computer that is running Windows 3.0 and equipped with a 24-bit video display becomes a powerful graphics workstation, able to run major graphics applications simultaneously with standard DOS applications.

continued

The 24-bit Advantage

A few applications, such as Power Point from Microsoft and Corel Draw from Corel Systems, have already been written to the Windows 3.0 24-bit standard, although display boards that support the standard are only now becoming available. Such applications not only let you view scanned or frame-grabbed images that have the same quality as the original, but, with the ability to simultaneously display 16.7 million colors, they let you create smooth-shaded objects or show a color gradient (or "fountain fill") with enough colors to eliminate all banding effects.

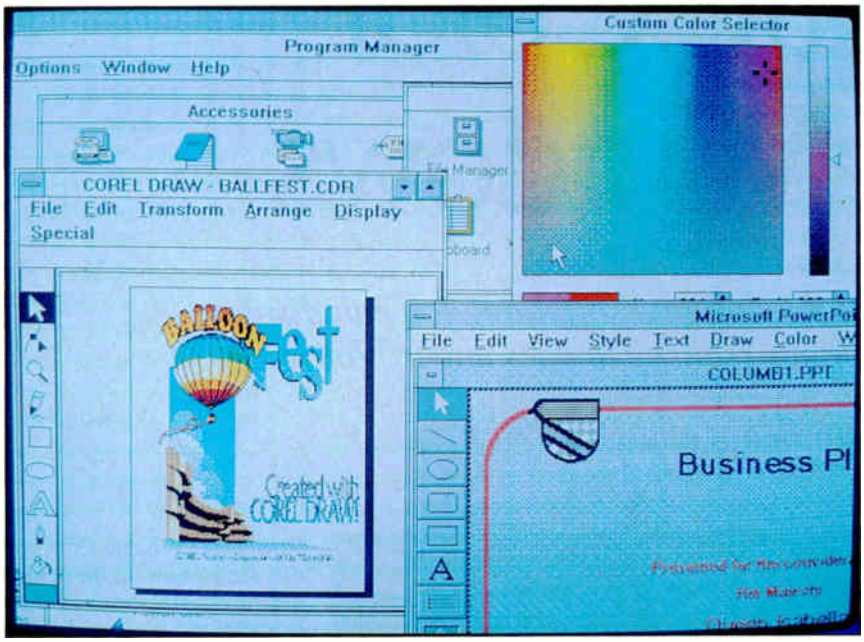

Photo 1: *Standard VGA display. Under Windows 3.0, you must use dithering when a program attempts to display more colors than the display adapter supports.*

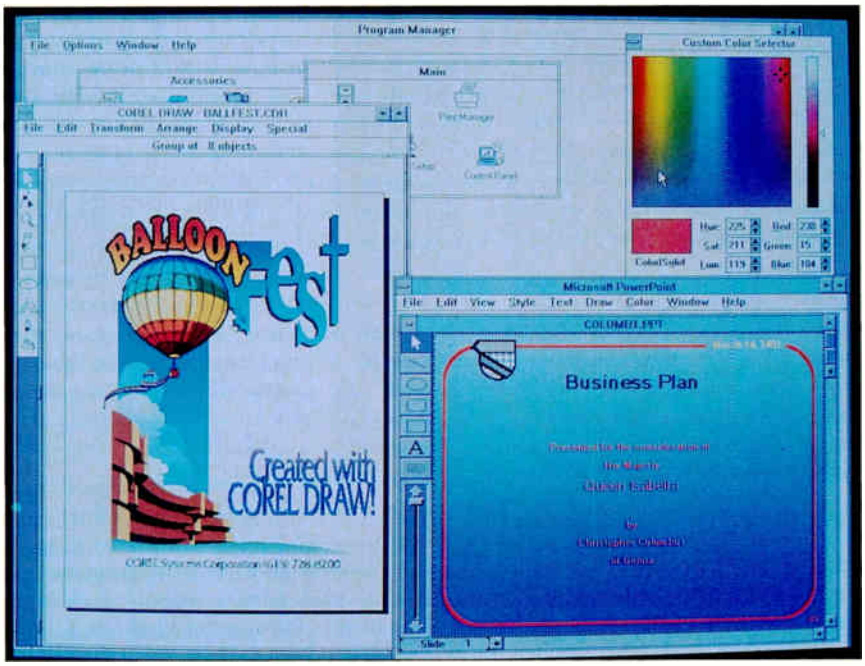

Photo 2: *A 24-bit display. With a 24-bit graphics board such as the RasterOps 1024MC, Windows 3.0 doesn't have to resort to dithering or approximations; it outputs the true colors called for by the application.*

The VGA provided on the motherboard of PS/2s produces a display with a resolution of 640 by 480 pixels by 4 bits per pixel (16 colors). Other display devices, such as Super VGA and 8514/A, let you display as many as 256 colors in higher resolutions. Although these are adequate for preliminary work in layouts and presentations, they are inadequate if you want to see the screen as it will appear in its final, hard-copy format.

Photo 1 shows a screen rendered in standard VGA, while photo 2 shows a similar display rendered in 24 bits. The displays were created on the same machine by switching between the VGA Windows 3.0 driver and the 1024MC Windows 3.0 driver. Note the difference in quality between the two. With both Corel Draw and Power Point, the fountain fills used for shading are greatly enhanced by providing 16.7 million true colors that don't rely on a dithered pattern to approximate the desired colors.

Drive That Display

The display driver links the video display hardware to the Windows environment. It provides the low-level functions required by Windows to do everything from drawing a single pixel on the screen to displaying images and drawing geometric shapes such as lines and curves.

Most of the drawing functions must also support many raster operations (ROPs) at drawing time. A ROP defines the logical operation or pattern that the BitBlt (bit block transfer) function uses when it combines the source and destination bits during a drawing operation. A ROP is applied to each pixel involved in the drawing operation. Windows 3.0 supports 256 different ROPs for the BitBlt routines, and the display driver must support all of these. (Actually, there are 128 ROPs; the second set of 128 ROPs is the same as the first with a negate operation appended.)

If the display hardware has acceleration or drawing support on-board, it can greatly increase the speed of some of the ROPs that are supported in hardware. Some display devices can support BitBlt operations without performing pixel processing; in these cases, the display driver must be able to differentiate between the operations supported in hardware and those supported by the driver.

Upping the Hardware Ante

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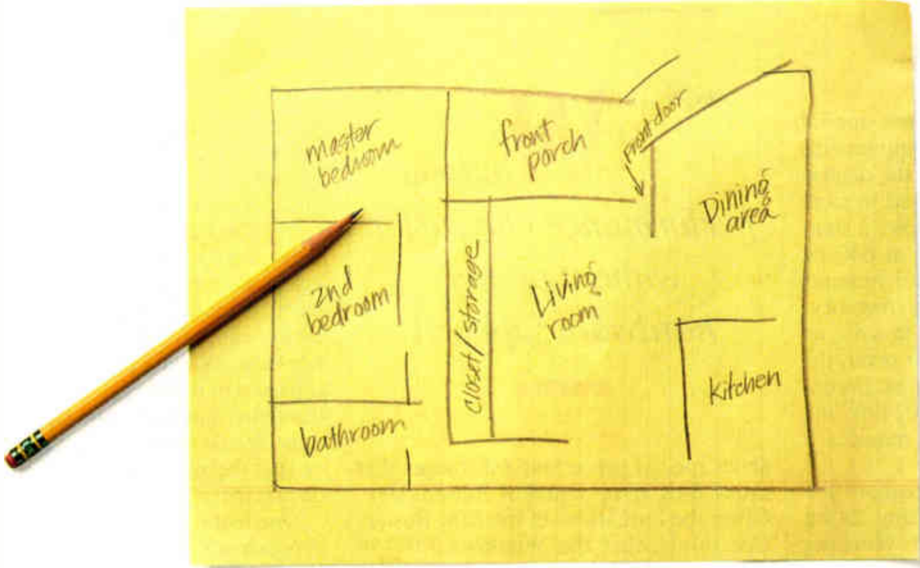

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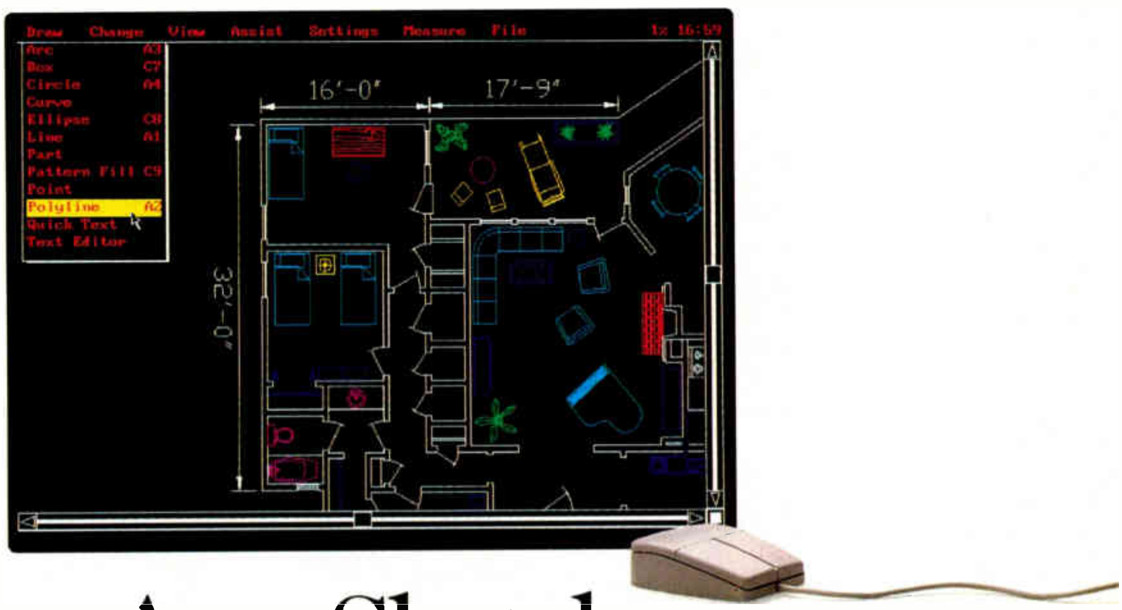

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large pixel depths—and larger spatial resolutions—your memory requirements go up dramatically, both for the display and for temporary buffers used to store images off-screen. For example, a standard VGA screen, operating at 640 by 480 pixels by 4 bits per pixel requires about 154K bytes of display memory, with a like amount required to store an image off-screen. At 8 bits per pixel, the same screen requires 307K bytes. In contrast, a screen operating at 1024 by 768 pixels by 24 bits per pixel requires 3 megabytes.

Given the large amount of memory you have to manipulate when using 24-bit images, the performance of Windows can suffer without proper hardware support. This is why the 1024MC comes with a 386-only display driver. Drivers running on the 386 can move 32 bits of data at a time, whereas the 286 can only move 16 bits at a time.

Also, the segmented-memory architecture of the 286 slows down processing when an image is larger than 64K bytes, as is the case with just about all 24-bit images. Using 4-gigabyte memory segments, 386 drivers don't need to worry about special processing for images that cross 64K-byte segment boundaries. Given the limitations of the 286, RasterOps thinks that the Windows 3.0 386 enhanced mode is vital if you want to limit the performance penalty you incur when using true color. The 286 simply does not have the horsepower to manipulate 24-bit images fast enough to satisfy most people.

Windows' performance can suffer without proper hardware support.

Windows Without 24-bit Hardware

Under Windows 3.0, colors in the palettes kept by applications and by the system are defined as 24-bit values (8 each for red, green, and blue). When these values are output to a device that can't display 24 bits, the display driver converts them to a value the display can produce. Some of these conversions are done on the fly, but a well-behaved application will usually request that logical 24-bit colors be translated into physical colors early on in the program so that the application can save the physical colors for later use. When a particular 24-bit color is passed to the display driver, the driver, through translation and approximation, must decide on the closest matching color that the physical device is capable of displaying.

One feature that helps a display device approximate colors it can't produce is the ability of Windows applications to paint and draw with brush objects. A brush is normally an 8- by 8-pixel pattern used to paint the screen. Windows or an application can request that the display driver create a brush that has a foreground and/or a background color. If the display device cannot output the colors requested in the brush, the driver generates an 8- by 8-pixel dithered pattern that most closely represents the colors requested.

The advantage of using a brush over a

Putting the Squeeze on Graphics

Image-compression technology promises to make graphics and video data as easy to manipulate as text and numbers

Nick Baran

Full-color, 32-bit images are indeed a wonder to behold on today's large, high-resolution monitors. Computer companies love to impress the media and potential customers with demonstrations featuring dazzling bouquets of flowers and Ferrari sports cars looking so vivid and real that you're ready to climb in and go for a test drive. Marketing managers wax poetic about the revolutionary potential of multimedia and scientific visualization, all for just $6995.

But beneath all the dazzle lies a big problem: 32-bit color images require enormous amounts of storage space. That full-color machine for just $6995 probably comes with an 80-megabyte hard disk drive, which, after you load the operating system and a few applications, has barely enough free space for a handful of single 32-bit color screen images. That's because the definition of a single full-color 32-bit screen image on a typical high-resolution display requires about 3 MB of data. If you intend to display animated graphics, your storage requirements go through the roof, and you also have to deal with the problem of moving all that image data from disk to your display adapter.

The technology of image compression can solve these problems. Dedicated image-compression processors have begun to appear that can compress a 25-MB color image down to 1 MB in less than a second. These processors are finding their way to the system boards of some computer manufacturers. Within the next several years, you'll see image-compression processors in all sorts of video recording and display devices, as well as on the system boards of low-cost personal computers. I'll discuss some of the emerging standards for image compression and some of the dedicated processors currently on the market.

The Graphics Bottleneck

A high-resolution monitor displays about 1 million pixels (1024 by 768, 1120 by 832, and 1280 by 1024 are typical resolutions). A black-and-white image requires 1 bit per pixel (on or off) or about 1 million bits (125K bytes) per screen image. Gray-scale images with 8 bits per pixel (selecting from a possible 2^8 or 256 shades of gray) require about 1 MB per image.

Full-color images (16.7 million possible colors) require the definition of 24 bits per pixel (8 bits each for red, green, and blue) and may require an additional 8 bits to define the degree of transparency (the *alpha channel* in Macintosh terminology), or about 4 MB per screen image. So, that bargain for $6995 turns out to cost a few thousand dollars more after you have purchased a big 300-MB or 600-MB hard disk drive for

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—Ronald W. Evans
Publisher

Storage and communications limitations are only part of the story.

storing high-resolution color images.

And then there's the problem of printing and transmitting these images. While color looks great on the screen, the ultimate goal is often color output on slides or paper. But because color laser printers still cost $10,000 or more, you usually find them on a network or in a service bureau that can receive your files electronically for printing. Sending a 3-MB file over the phone is a slow and error-prone process. Using a 9600-bps modem, it takes about 45 minutes to transmit a 3-MB file.

Storage requirements become astronomical when you digitize full-color photographs from a scanner or video camera. An 8½- by 11-inch color photograph at 300 dots per inch requires 25 MB of data (93½ square inches with 90,000 dots per square inch and 24 bits per dot). Similarly, color output devices must process 25 MB to print the same image. Transmitting such an image over a 9600-bps modem would take about 6 hours.

Storage and communications limitations are only part of the story. The other is performance, particularly with regard to animation applications requiring the storage and display of hundreds of screen images in sequence. Full-motion video requires the display of 30 frames per second. NTSC video with a resolution of 640 by 480 pixels and 24 bits per pixel translates into 1 MB of data per frame or 30 MB per second. Today's desktop computers cannot deliver 30 MBps to the screen. In addition, 1 minute of full-motion video requires a storage capacity of almost 2 gigabytes.

Hard disk drives typically have data transfer rates of 1 to 2 MBps, far from adequate for full-motion video applications. Even if the drives were faster, most microcomputer buses transfer data at rates under 20 MBps (NuBus transfers data at 10 MBps; the AT bus runs at about 6 MBps). CD-ROM drives, which can store hundreds of megabytes of data on removable cartridges and so are ideal for storing graphics images, are several times slower than hard disk drives.

The size of graphics images is also a crucial issue in the consumer electronics and communications markets. Digital video cameras, video games, color fax, and subscription over-the-phone-line movies and videos are all hampered by the size of graphics images.

The Solution: Image Compression

The solution to this problem is clearly the use of data compression to reduce the size of the files representing graphics images. Data compression is already widely used for archiving and transmitting binary and text files, and there are various standard data-compression algorithms for this purpose (see "Saving Space," March BYTE). Standards for image compression, however, are just beginning to emerge.

For both text and image compression, the principle is the same: Reduce the data to an abbreviated or shorthand form that still retains the basic information contained in the file. For either text or image compression, the technique involves finding redundant or unnecessary information and substituting an abbreviation or shorthand symbol for that information. In the case of image compression, it is sometimes possible to discard parts of the information altogether, since some of the pixel attributes may not be visible to the human eye and thus contribute little to the quality of the image.

While text-compression schemes deal with character strings and the ASCII table, image compression deals with pixels and the visual attributes (color and transparency) attached to each pixel. Because images generally have regions of uniform color or patterns, particularly in the background (e.g., a blue sky or a white wall), it is possible to represent these regions of uniformity by a much smaller entity than the definition of each individual pixel in that region. For example, you can define a group of pixels rather than individual pixels.

Two standard algorithms for image compression are emerging: the Joint Photographics Experts Group algorithm for still images, and the Motion Picture Experts Group algorithm for motion picture images (full-motion video). Both JPEG and MPEG are sponsored by the CCITT and the International Standards Organization.

An obvious question is why different algorithms are needed for still images and for motion video images. While motion video images are time-dependent and related to other frames in a sequence, still images are independent entities. Motion video generally includes

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(a) *The original image is a full 32-bit color image requiring 3.2 MB of storage.*

(b) *The second image was compressed by 14 to 1, yielding a file of 228K bytes, and then decompressed and displayed.*

sound, so audio compression must also be included in a compression scheme. It is possible to use still-image compression for motion video, but you lose the performance gains that can be achieved by correlating related frames in a motion video sequence, and, of course, you lose the audio compression.

Compression of a still image is focused on one major task: the reduction of the data describing that single image. Compression of full-motion video also performs this type of data reduction, but it can gain further reduction of each frame's data size by retaining objects in the frame from previous frames.

For example, if the video shows a man walking across a street with a blue sky background, there is no need to redraw the sky or the street in each frame. It is also unnecessary to redefine the man, pixel by pixel. Instead, it is more efficient to define a vector that moves the pixels representing the man from one location to another. By taking advantage of the redundant data in each frame of the sequence, you can greatly reduce the amount of data needed for each frame.

The JPEG Algorithm

The JPEG algorithm is emerging as the standard for still-image compression. While only in a draft version at the time of this writing, the JPEG algorithm is expected to be finalized by the end of this year. Several commercial software and hardware implementations of JPEG are already available in the marketplace and will presumably be compatible with or upgraded to the final version of the algorithm.

The JPEG algorithm is termed symmetrical because it compresses and decompresses the image in the same number of operations and therefore in the same amount of time. It is also called a "lossy" compression technique, because it discards or "loses" data in the compression process. The algorithm discards data selectively so that the human eye barely perceives any degradation in the quality of the image.

Of course, the greater the compression ratio, the more noticeable the degradation in image quality. However, the JPEG algorithm can compress printed images (starting with 300 dpi) in ratios of up to 25 to 1 with a hardly noticeable loss of image quality. Screen images (starting with 70 or 80 dpi) can be compressed up to about 15 to 1 without a major loss in image quality. The photos show a full-color screen image in its original form (a) and compressed to 14 to 1 (b).

The JPEG algorithm is an open standard, and JPEG software packages that include source code are available from C-Cube Microsystems and Kodak. The first step in the execution of the JPEG algorithm is to reduce the data redundancy in the image's pixel values. This is done by using the discrete cosine transform (DCT), which is similar to the Fourier transform but includes only the cosine part of the function.

The DCT technique involves breaking up the image into arrays of 8 by 8 pixels. These arrays are approximated as a region of varying color and intensity represented by light-frequency values assigned to each pixel. The DCT is applied to the array to concentrate the energy represented in that region into a few coefficients representing the frequencies. The higher frequencies outside the range of visible light are discarded, and the lower frequencies are preserved. This process accounts for most of the data reduction.

Although the JPEG algorithm is independent of color, implementations of the algorithm for compressing RGB images first convert the color components to YUV before executing the DCT. (Y represents luminance; U and V represent chrominance components.) The chrominance portion of the color definition can be reduced by half without affecting the human eye's perception of the image. (The chrominance value in every other pixel is discarded.)

The resulting DCT coefficients are then "quantized" to reduce their magnitude and to increase the number of zero-value coefficients. Finally, run-length and Huffman encoding are applied to represent runs of consecutive 0s and to further compress the data symbols representing the image. The figure shows a schematic of the JPEG scheme.

Note that the decompression process is exactly the inverse of the compression steps (hence the "symmetry" of the JPEG algorithm). Although the decompression process reproduces the original image, the data defining that image has been greatly reduced. Ratios of up to 25 to 1 for print images and up to 15 to 1 for screen images reproduce the original image with minimal loss in image quality.

JPEG in Hardware

The JPEG algorithm can be implemented in either hardware or software. It performs slowly in software, however. The JPEG algorithm running on a standard 25-MHz 68030 machine takes about 15 minutes to compress a 25-MB image by 25 to 1. Using a C-Cube Microsystems (San Jose, CA) image-compression processor, the same compression process takes 1 second.

C-Cube Microsystems' CL550 image-compression processor exemplifies the future direction of image-compression technology. The CL550 is a single-chip processor with built-in units for executing the DCT, quantization, and Huffman encoding operations. According to the company's specifications, the chip has 400,000 transistors and over 300 stages of pipeline, allowing it to perform over 300 steps of the JPEG algorithm concurrently.

The processor comes in 10-MHz and 30-MHz versions. The 10-MHz version can compress 5 million pixels per second and is designed strictly for still-image compression. The 30-MHz version can compress 14.7 million pixels per second, which provides adequate performance for displaying 30 frames per second of NTSC video (each frame is compressed to between 50K and 100K bytes). Up to four CL550 processors can be operated in parallel, allowing high-definition TV images to be compressed in real time, according to C-Cube Microsystems.

JPEG and CD-ROM

The 30-MHz CL550 is an example of how the JPEG algorithm can be used for full-motion video. However, there are some significant limitations. First, the JPEG algorithm has no audio-compression capability. Second, even the blazing speed of the 30-MHz CL550 is only adequate for real-time video compression using hard disk drives with transfer rates of 1 MBps or more. The process is not fast enough to allow the use of CD-ROM drives as the storage medium for full-motion video. According to C-Cube's marketing manager, Mauro Bonomi, the compression algorithm has to be "about three times faster" to work with CD-ROM drives. The way to achieve this increase in speed is to take advantage of the correlation between frames in motion video sequences.

The ability to support CD-ROM drives is crucial for the commercial application of real-time video compression. Obviously, it's not practical to send movies on hard disks. Nevertheless, the JPEG algorithm has tremendous potential for still-image compression and for some applications of real-time video. (See the text box "Video Keying" on page 294 for a description of how you can mix graphics and video images.)

According to Bonomi, computer manufacturers have shown tremendous interest in the CL550. NeXT has built the CL550 into its Nextdimension color board (see "Fast New Systems from NeXT," November BYTE). And C-Cube recently announced add-in CL550 compression boards for PCs and Macs. These add-in boards include image-compression software, allowing you to compress TIFF, PIC, and TIGA files. C-Cube also offers the Image Compression Interface, allowing third-party developers to compress files directly from their applications. The 10-MHz and 30-MHz chips are priced at $95 and $155, respectively, in quantities of 10,000, making them affordable even on high-end consumer electronics products, such as digital cameras and VCRs.

While C-Cube may be one of the first hardware manufacturers to produce a single chip running the JPEG algorithm, the competition is sure to heat up in the next few years. Intel (Santa Clara, CA) has announced plans to incorporate JPEG support into its i750 processor. Other members of the JPEG committee, such as IBM and NEC, are also probably developing compression processors.

Full-Motion Video Compression

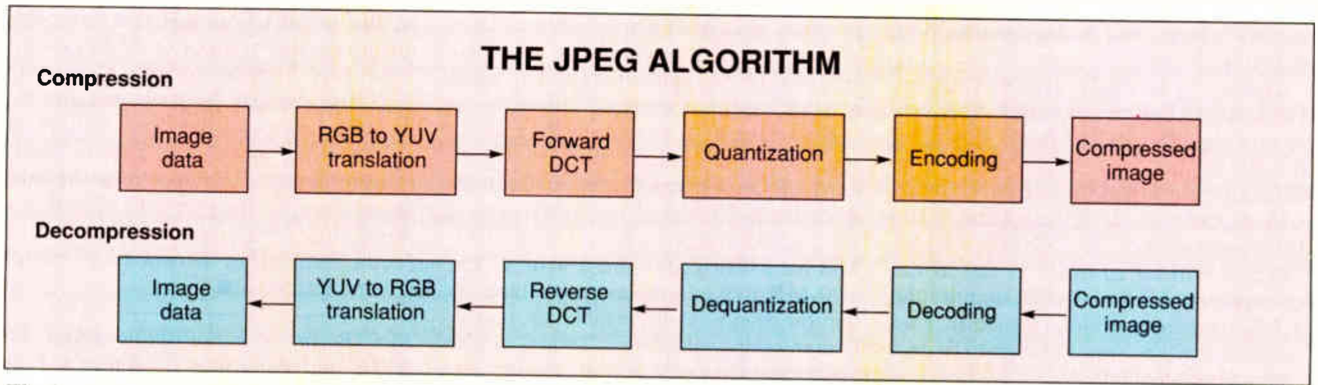
Work on the MPEG algorithm for full-motion video is in an earlier stage of development than JPEG's, and no technical details have been released as of this writing. According to a speech by Intel's Art Kaiman, delivered at the International Multimedia Conference in New York in September, the goal of MPEG is "to define a standard that can reproduce VCR/TV-quality video and CD-quality audio after it has been compressed to a data rate in the 1- to 1½-megabit-per-second range, typical of a CD-ROM or PC hard disk. This requires data compression well in excess of 100 to 1."

The MPEG algorithm will also use the DCT. Several subcommittees are working on video-compression, audio-compression, and system-integration issues, according to Kaiman. However, some 17 algorithms proposed by over 20 companies are being considered by MPEG. The challenge is to merge the best features of the various proposals into a single algorithm acceptable to the MPEG members.

Intel's involvement in MPEG is noteworthy because Intel now owns the Digital Video Interactive technology for compressing real-time video images on CD-ROM (see "Multimedia: DVI Arrives" in BYTE's *IBM Special Edition*, Fall 1990). DVI has been around since 1986 but has had limited success in the marketplace. Until recently, DVI development hardware required several add-in boards that cost about $20,000, and the video image quality was considerably lower than on a VHS VCR. Developers were reluctant to get involved.

Since Intel has taken over, DVI seems to be gaining momentum. Intel claims to have over 100 software developers in the DVI camp, and it recently announced a joint project agreement with IBM.

The current DVI development platform is based on the i750 processor, which was designed before Intel took over DVI. A complete image capture and compression system requires two boards, each of which costs about $2000. The development software costs an additional $4500. DVI currently uses two proprietary video-compression algorithms called Real Time Video and Production Level Video. The RTV algorithm can



The image compression scheme used in the JPEG algorithm. Note that the compression and decompression processes are the inverse of each other, making the algorithm symmetrical. (Courtesy C-Cube Microsystems)

Video Keying

Carl Calabria

In the language of video engineers, *keying* refers neither to telegraphy nor to data entry; rather, it's a synonym for the mixing of images. Until the dawn of the digital computer era, keyers were confined to the video production studio because of their cost and size. Today, however, digital keyers have migrated to the desktop, where they let you dynamically mix two signal sources—typically, video and computer graphics—and create a professional-quality product.

Binary keying is the simplest but least versatile technique. Like a stencil, a binary key cuts a hole in live video and replaces it with a computer-generated graphic. If a binary keyer is used to overlay text on a video background, unsightly jagged edges can result.

Linear keying, a feature traditionally found on \$50,000 to \$100,000 video production switchers, can smooth or soften those edges, yielding a more attractive foreground-to-background transition. More important, linear keying also allows the mixing or blending of specific portions of two sources. Although the technique can be effected in the analog domain with T-bar actuators, digital implementations usually produce more consistently reliable and accurate results, and at lower cost.

In a 32-bit-per-pixel digital color system, three 8-bit bytes define the relative intensities of the red, green, and blue components of the computer-generated image. The fourth byte, often referred to as the *alpha channel*, can be used to define the extent to which the computer-generated RGB image is mixed with a live video signal.

For a given pixel, an alpha of 0 will produce an output that is totally computer-generated. If alpha = 255, the pixel will be wholly live video. If alpha = 32, the pixel will be composed of 33 of 256 parts computer-generated image and 223 parts live video; the overall appearance will be that of a highly translucent graphic superimposed on live video.

With up to 256 levels of mixing available for each pixel on the screen, you can create beautiful superimpositions of text and graphics over live video. This is done by selective mixing at the edges of the computer graphic to create a smooth, blended edge. A digital linear keyer can also be operated globally on all pixels to produce professional-looking transitions, such as fading live video to or from a specific color, or cross-fading between live video and computer graphics or between two computer-generated images.

In a linear keyer, the information that dictates the level of mixing is provided by a computer. By contrast, a chroma keyer uses the information in the live video signal to determine where, and to what extent, to mix that video with a computer-generated graphic.

Everyone has seen a meteorologist standing in front of a weather map on the evening news. Actually, the meteorologist is standing in front of a plain blue or green screen. The computer continually analyzes the video signal and replaces all occurrences of that blue (or green), within a narrow range of chrominance, with the computer-generated weather map. Of course, it is essential that the meteorologist not wear anything within that specific color range. (The screen is actually a special color not likely to be found in a standard wardrobe.) Sophisticated chroma keyers can also preserve shadows and eliminate fringing effects at boundaries.

Advances in miniaturization are largely responsible for the spread of keying techniques outside the video production studio and onto the desktop. For example, on Truevision's Targa+ and NuVista+ videographics boards for PC compatibles, PS/2s, and Macintoshes, an entire digital linear and chroma keyer has been integrated onto a single 10,000-gate application-specific IC. Also resident on the boards are a 32-bit-per-pixel frame buffer, three 8-bit A/D converters, three 8-bit D/A converters, and a video encoder/decoder, providing all the essential ingredients for a desktop video production system.

Carl Calabria is executive vice president of engineering and cofounder of Truevision (Indianapolis, IN). You can reach him on BIX c/o "editors."

display 30 frames per second in real time, but it yields a low-quality image. The PLV algorithm produces higher-quality images, but it does not support real-time display.

According to Intel's Karen Andring, Intel will introduce an entirely new version of the i750, called the B series, by the end of this year. The i750B will be about twice as fast as the current i750 and will support the JPEG algorithm. The third generation of the i750 is planned for 1992. It will be 10 times as fast as the current processor and will support the MPEG full-motion-video standard. That processor will be small enough to fit on a computer system board.

The Next Hurdle

If you look at the evolution of the personal computer, there have been milestones all along the way that have signaled major improvements in computing power or price/performance curve. Usually these milestones could be anticipated a year or two before they actually had a major impact on the marketplace.

For example, articles about hard disks started appearing about two years before hard disks became really affordable. Back then, 20 MB of hard disk storage was considered a luxury. Today, 600-MB hard disk drives are a luxury, and 100-MB drives are commonplace. A similar trend is discernible in image-compression technology. Today, you're seeing the first products hit the market. In a couple of years, image-compression processors may be as commonplace as hard disk drives.

When image compression really takes hold, it could have a revolutionary impact on the way you use computers. You will be able to work with and share graphics images the way you work with text today. True color high-resolution systems will drop dramatically in price, because far less memory and disk storage will be required. And you will be able to easily transmit graphics images over the telephone lines, opening up all kinds of new possibilities for home video, satellite feeds, and other forms of graphics communications. ■

Nick Baran is a consulting editor for BYTE and the editor of Baran's Tech Letter, *a newsletter covering the NeXT computer. He can be reached on BIX as "nickbaran."*

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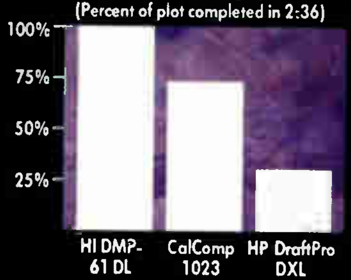

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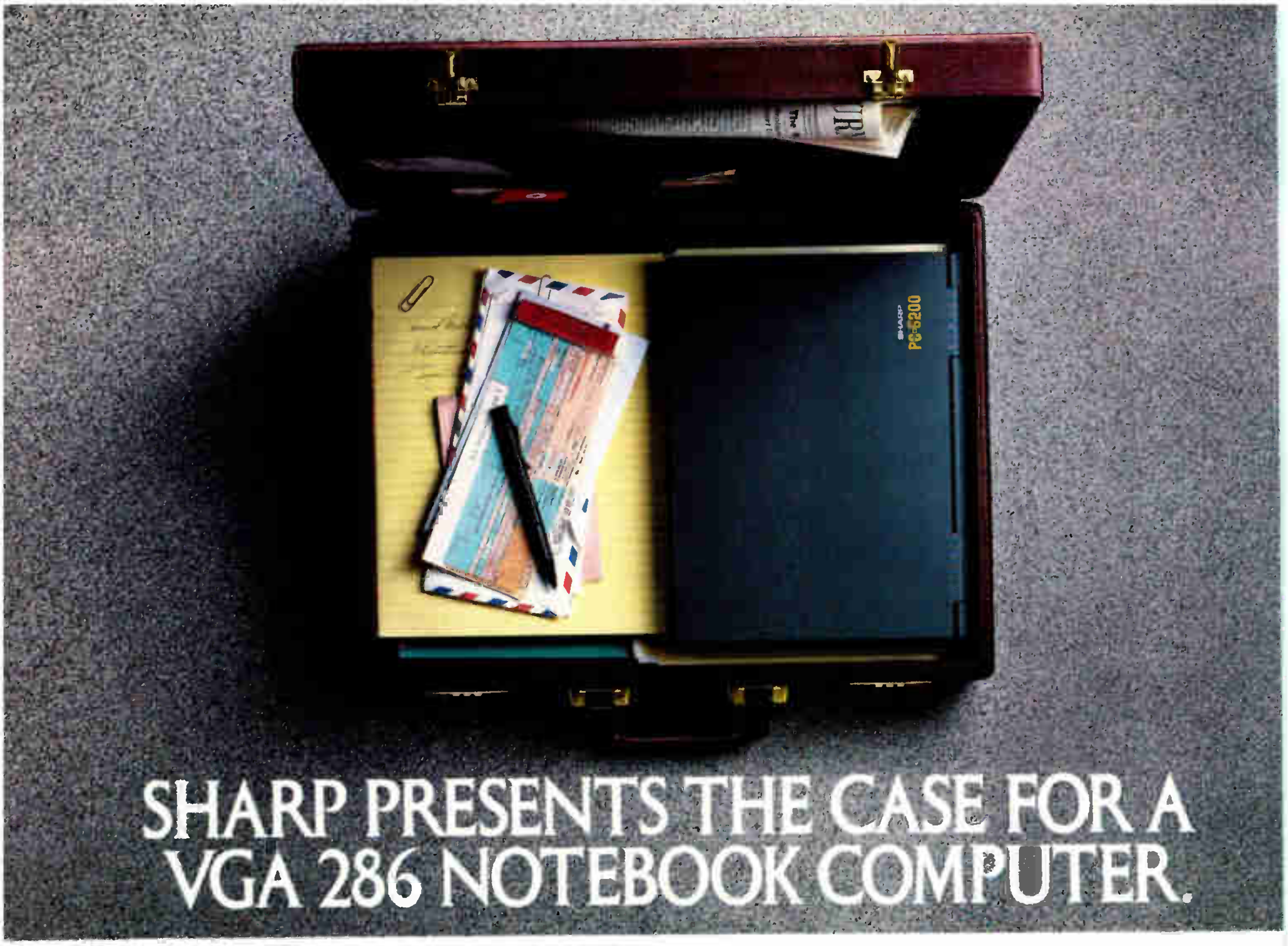
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HDTV Sparks a Digital Revolution

You can expect high-end computer graphics to integrate HDTV into normal use as the price drops

Andrew Lippman

For almost 20 years, people have been predicting a merger of computer graphics and broadcast TV, and slowly it has been happening. Early raster-scan computer graphics systems that used TV-resolution monitors and memory arrays were developed in the 1970s. Videotape became part of the graphics lab, and graphics intruded into TV broadcasts.

However, while computer graphics gradually moved to higher resolution, TV remained at 525 lines. Only video games and special-purpose, home, or personal computers interfaced directly with standard TV systems; professional workstations left TV in the dust.

Research to develop high-definition TV (HDTV) now promises to complete the merger (see the text box "High-Definition History" on page 300). New TV systems are being developed that contain sufficient resolution for "serious" use, and new ways to record, distribute, process, and display the video signal are appearing.

Perhaps the most important aspect of this new evolution of TV is the recent emergence of all-digital approaches, where the image chain avoids any analog steps and is even broadcast as a digital signal. This is manifest both in proposals for high-definition broadcasting and in new ways to compress current NTSC programs to multiplex many of them in a single channel. TV is literally learning the language of the computer.

The development of consumer TV technology is retarded by problems of international standards and the huge installed base of NTSC 525-line receivers (there are more TV receivers than bathrooms in America). But so much energy has been directed at improving video displays that the personal computer community can no longer leave TV in the living room.

TV will reenter the lab and work environment as a full-quality, wide-screen partner on computers ranging from high-end workstations to hand-held video games; and it will bring new thresholds of pictorial realism and unprecedented opportunities. In the 1990s, the shift will be to high-definition and digital pictures, and the face of the industry will change. Even if you don't watch movies on HDTV in your home, you will witness the fruits of its development on your computer.

The by-products of HDTV contain the real gold. Our imaging systems are at the threshold of a transformation from simple analog devices to high-speed digital image processors. The impact of research in TV systems has effects that range from new ways to process high-rate image data to techniques for scaling, representing, compressing, and display-

REPRESENTATIVE HDTV SYSTEMS

Current HDTV and EDTV research systems. All numbers are approximate and subject to change as proposals change. Some resolution figures are computed from available literature. The Sarnoff Labs and Philips systems are shown as examples of EDTV systems. A unified Philips/Thomson/Sarnoff all-digital system is expected by the end of this year.

Organization	Name	Type	Raster, Image resolution	Color resolution	Modulation	Notes
MIT	Channel compatible	Simulcast	787.5 progressive, 720 by 1280 pixels	360 by 640 pixels	Hybrid, 10-MBps digital image, data and audio, with analog detail	Sub-band coding; broadcast system is part of Open Architecture Concept.
Zenith	Spectrum compatible	Simulcast	787.5 progressive, 720 by 1280 pixels	Not applicable	Hybrid, 1.5-MBps digital image, data and audio, with analog detail	Sub-band analysis with block-coded detail.
General Instrument	Digicipher	Simulcast HDTV and direct broadcast satellite	1050 interlace, 960 by 1408 pixels	480 by 352 pixels	Digital, 16-QAM, 19.43-Mbps	Motion-compensated block coder (discrete cosine transform).
NHK	MUSE	Simulcast Narrow MUSE	1125 interlace, 568 by 946 pixels (1035 by 1920 pixels active raster)	Approximately 284 by 473 pixels	Explicit, time-interleaved analog samples	Subsampled image with motion-compensated detail added.
Sarnoff Labs	ACTV-I	EDTV-1	1050 interlace, 512 by 480 pixels	Same as NTSC	NTSC with additional subcarriers	Image composed of central and peripheral regions; wider and more detailed than NTSC.
Philips	HD-60	EDTV-2	1050 interlace, 480 by 490 pixels	Approximately NTSC	Augmentation channel (digital)	Second, linked channel contains augmentation data; base channel is NTSC.

ing moving-image data. This knowledge is useful at any resolution and in any system.

New TV Systems

To understand new TV systems, you need to realize the vast changes that have been made in electronics since the last TV systems were designed—in the 1950s in the U.S. and the 1960s in Europe. In those days, video storage did not exist (videotape recording was invented in 1955), and all processing was done on the analog signal, usually on a point-by-point basis.

Since this processing was expensive, the design goal was a consumer receiver that cost as little as possible. Even so, the first color TVs introduced in 1954 cost the equivalent of $3000 today.

This design approach has caused the TV industry to evolve only slowly, with cost reductions as the major technical landmarks. While it's hard to envision a new personal computer whose main feature is a 25-cent lower manufacturing cost, that has been the rule with TV; real technical advances have been few and far between.

All new systems exploit the fact that the ground rules of consumer electronics are changing. Today's HDTV systems require at least one frame of video storage in each receiver. At least one manufacturer, ITT (which makes most of the digital circuitry in the modern set), envisions 100-million-floating-point-operation-per-second processing as commonplace by the middle of the decade.

General Instrument, the inventor of VideoCipher, a direct broadcast satellite encoding system, has recently proposed an end-to-end digital system that includes digital broadcasting. In the U.S., even the cellular telephone network is not all digital.

Four divisions are commonly made among TV distribution systems.

• IDTV: Improved-definition TV is the domain of normal improvements that could come about through receiver (and potentially transmitter) development. No new standard is necessary, and the signal is compatible with normal TV. An example of IDTV that is available in existing sets (although imperfectly done) is scan conversion in the receiver to a noninterlaced display.

Yves Faroudja has shown NTSC encoders that eliminate cross-talk components, and companion decoders that are optimized for processing such a prefiltered signal. Some of these improvements are the result of inexpensive digital processing and are outside the domain of HDTV. But such equipment is already improving broadcast TV.

• EDTV-1: Extended-definition TV involves modifying the signal to include special components that an advanced receiver will use to provide a better picture. NTSC color was an EDTV-like modification to the then-existing black-and-white standard: It added the color information to the signal so that a new receiver would display color but existing monochrome receivers would not be severely impaired.

Examples of modern EDTV suggestions include adding new signals that enable a special receiver to add width to the picture or obtain additional resolution. If you own an EDTV set, you get a better picture; if not, you still get something.

• EDTV-2: A second version of EDTV that can be productively distinguished from the first uses two broadcast channels. One contains the standard NTSC signal and is available to existing receivers. The second channel, which may contain more or less bandwidth than a normal TV channel, contains augmentation information that a special receiver can use to provide a better picture. "Side curtains" for extra width and additional detail information are usually suggested for the second channel.

Two-channel image-coding systems were first proposed by Schreiber (see reference 1) and have recently been adapted and modified for HDTV. Basically, the difference between the normal NTSC image and the HDTV one is encoded into the second channel.

• HDTV: The term *HDTV* is usually reserved for incompatible systems that require a new receiver and a new, presumably higher, bandwidth channel, such as NHK's MUSE. But recently, there has been renewed interest in 6-MHz systems that provide for improved quality within the bandwidth of existing channels by avoiding any link with the design of NTSC. These systems fit into existing broadcast channels but avoid existing TV-signal formats.

The FCC has declared that all new TV systems for use in the U.S. will be restricted to the bandwidth of existing TV channels. In the U.S., most HDTV systems envision simulcasting, where a program is broadcast on a normal channel at the same time that it is broadcast on its HDTV counterpart. (For a list of current HDTV research systems, see the table.)

Among these four common divisions, there are some implicit assumptions about available channels and the means of distribution. All these enhancements assume the primacy of over-the-air broadcasting; this is a supposition that is not carved in stone but is certainly the most difficult aspect of video communications to change.

Two-channel systems, for example, require additional bandwidth and demand that the receiver equitably tune in both channels. Many viewers have problems getting even one channel with reasonable quality. Clearly, systems that hypothesize a new, incompatible channel must also suggest where the bandwidth and programming for that channel will originate.

Any new channel allocation, whether for enhancements or for an independent HDTV broadcast, will trade potential diversity for quality. Also, cable systems, direct-broadcast satellite, VCRs, and disks all lack broadcast's bandwidth constraints and legal obstacles and can therefore easily provide a better picture than the local affiliate.

Another option is a set of systems collectively called MAC, for multiplexed analog components (see references 2 and 3). These avoid NTSC artifacts (for details on artifacts, see the text box "High-Definition History") by compressing the luminance and color components in time and sequentially transmitting them. MAC is the outgrowth of new computer technology: Accurate clocks are now easier to construct than accurate filters, so separating the components temporally is potentially better than interleaving them in the frequency domain, as NTSC does.

European satellite-broadcasting systems are extensions of MAC. S-VHS, an improvement to home VCRs, is related to

The term HDTV is usually reserved for incompatible systems that require a new receiver and a new, presumably higher, bandwidth channel.

MAC in that the signal on the tape need never have been cast into broadcast NTSC form.

Most of the standard scenarios for evolution from IDTV to HDTV are staged. The tacit assumption is that people will begin to trade in their TV sets for successive improvements that will take place over a number of years. In some instances, this has not quite been the case: For example, NHK is already broadcasting 6 hours a day of 1125-line HDTV via its satellite service, yet manufacturers are introducing EDTV receivers that extend the definition of terrestrially distributed signals.

Extensible TV

There is a scenario for the evolution of TV that bypasses the jump to double the number of lines and entails a new architecture for image distribution. This approach has been championed by a dedicated few, starting at MIT, but it is gaining currency among computer manufacturers and those who are already committed to digital imaging.

The technical feature of note is that images no longer need to be defined by the number of lines or the frame rate.

continued

High-Definition History

It is reasonable to date the genesis of high-definition TV (HDTV) from the late 1960s. In those years, NHK, the Japanese broadcaster, began an effort to investigate the parameters of a new broadcasting system of far higher quality than the existing NTSC standard that has been in place since 1953.

The work was directed by Dr. Takashi Fujio at NHK Labs and was coordinated with a plethora of Japanese equipment manufacturers who attacked the various component technologies. Sony addressed cameras and recorders; Ikegami developed cameras as well; and NEC, Mitsubishi, and others developed display devices, including projectors, tubes, and processing electronics.

The main effort at NHK was directed at a new system that could become a world standard for TV broadcasting. It was designed for direct-broadcast satellite distribution and required a 30-MHz channel. Fujio's lab concentrated on the psychophysics of image viewing and coordinated the new standard.

The results of this work surfaced in the late 1970s. The first HDTV system that was shown was a scaled-up version of NTSC, based on analog processing and featuring 1125 lines displayed with a 5-to-3 aspect ratio.

To avoid the artifacts that are present in NTSC TV, the system incorporated new signal-modulation methods. The artifacts of NTSC are familiar, if not especially objectionable, in normal viewing. The two main ones are cross-color, where high-frequency edges generate spurious colors on the display, and cross-luminance, where color transitions result in crawling dots adjacent to or under the transition itself. The artifacts are particularly troublesome in computer-generated graphics, because computers do not have to obey any of the normal physical limitations on image sharpness and resolution that most real-image systems suffer from.

The NTSC frame rate and interlaced scanning pattern weren't changed in the NHK system. In fact, you could characterize the system as roughly doubling NTSC's ability to display still images.

Perhaps the most immediately evident change was the apparent picture width. A 5-to-3 aspect ratio is close to most movie-exhibition standards and is wide enough to contain two 8½- by 11-inch sheets of paper displayed side by side. The extra width is obvious even before the set is turned on—this is a distinctly different TV system.

In 1979, the NHK system was demonstrated worldwide, and efforts to initiate a universal broadcasting standard were begun shortly thereafter. The rest of the world was scooped.

One result of this work was that the rest of the world woke up and began HDTV efforts of its own. Recognizing that TV was an important technology for consumers, defense, and industrial applications, America and Europe started new research. Nations that had been using 50-Hz TV systems were particularly troubled by the Japanese initiative, since the NHK system operates at 60 Hz and there is no known way to perfectly translate (transcode) from one frame rate to another.

In 1981, a compressed format for the 30-MHz NHK studio standard, called MUSE, was shown. The concept of a production standard as distinct from a distribution standard arose, and NHK efforts centered on getting agreement on a worldwide production standard.

This was a major change in the notion of how you process TV, and its import should not be neglected. Previously, all work at NHK had concentrated on analog technology: better tubes, cameras, recorders, and systems. The notion that TV is synchronously viewed remained: The same scanning standard was used in the camera, the channel, and the receiver; they all operated together.

By 1981, it became evident that digital processing of the TV signal in real time was reasonable within the lifetime of the system and was mandatory for achieving the compression necessary to broadcast the signal; 30 MHz is just too much bandwidth for normal broadcasting, cable TV, and satellites. The popularity of home recording equipment contributed to the initiation of MUSE: A whole generation of disks and VCRs could then process the HDTV signal.

In 1985, NHK applied for certification as an international production standard at the plenary session of the CCIR, the international standards-setting body sanctioned by the United Nations International Telecommunications Union (ITU). This effort failed, however, largely through the energies of the Europeans, who noted technical flaws in the NHK system, such as artifact-prone transcoding to 50-Hz systems.

Although NHK demonstrated high-quality standards-conversion equipment, it was expensive and imperfect. The Europeans were also concerned about accepting any totally foreign system; they wanted European TV to remain the province of European industry. Nevertheless, the sleeping giants of the world had been awakened, and once in motion were hard to stop. Also, the stakes were high.

The Europeans began a coordinated multinational effort called Eureka-95 that premiered an all-European HDTV system in 1988, and the FCC opened a notice of inquiry in 1987 requesting proposals for an American broadcast standard for any new TV system that could increase quality and justify the continued (albeit sparse) use of the much-fought-over UHF band. As of this writing, there are at least seven proposals before the FCC, each vying for the American imprimatur. Selection could be as early as 1993.

One impediment to HDTV is the consumer's demonstrated lack of interest in the quality of the TV image. There is no grass-roots demand for a new system, and few consumers when faced with the question of what is wrong with today's TV will answer "artifacts." In fact, one recent test of stereophonic sound elicited the response that the image on the stereo receiver was better.

Further, a shadow-mask CRT display becomes dimmer as its resolution increases. High-resolution workstations are not nearly as bright as home TV sets and are usually used in controlled-lighting situations not at all like a modern living room. The tubes are bulky and deep. Thus, unless you are willing to dim the lights, share the room with a major piece of furniture, and reinforce the floor, the full quality of higher definition may well not be available until new flat panels are perfected.

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Instead, you specify the precision or resolution of the image in terms of clarity and frame rate. The underlying bandwidth (or storage requirement) of an image is proportional to the volume it occupies in a three-dimensional space where the axes are its resolution vertically, horizontally, and temporally.

For example, imagine a cube that is as wide as the image is clear, as tall as it is sharp, and as deep as the frame rate. The theme of extensible TV is that the bandwidth is proportional to the volume of the cube but the actual system can allow many different shapes.

You would use this notion to build a TV system in which each component in the image chain processes its image data to the best of its ability, independently. Movies, for example, have extremely high spatial resolution but a relatively low frame rate; TV systems generally have higher frame rates but significantly lower clarity. To some extent, the bandwidth requirements of movies and TV are similar. The choice between line rates and frame rates could literally be made on a moment-to-moment basis.

Such an approach to TV is extensible as the technology of cameras, processors, channels (or storage media), and displays evolve. A 5-inch TV receiver that fits under the kitchen counter need not have 1000 lines to produce a high-quality image. It need not process the complete signal or display all the detail that may be there. Similarly, with a 1000-line image, the 25-inch monitor at the foot of the bed may look as good as the kitchen receiver, but a wall-size panel may require yet more lines and a higher frame rate.

This is the same approach to imaging that the computing industry uses. In personal computers and workstations, the number of lines on a display is determined by its size: Larger monitors have more lines, as do bigger pages. Lines per inch rather than lines per page is the operative parameter. Building a larger monitor by taking the same number of lines and literally stretching them to fit is counterintuitive and seldom done.

Similarly, in print, the measure of a picture is its point density. Laser printers are described in those terms; you would not expect a 400-dot-per-inch printer to print an image smaller than that of a 300-dpi printer. The image is the same size, but it's printed in more detail.

The approach is called "extensible" because it makes no attempt to define the "right" line count for TV systems that will come into existence in the indefinite future. Instead, the system is allowed to grow, as laster printers and computer screens do.

Extensible TV also brings with it some potential to solve the 50-Hz/60-Hz dilemma facing any new TV system proposed for worldwide use. By deliberately avoiding biasing its design toward one or the other of these numbers, extensible TV can be designed to work with either or both. In fact, this is desirable, since neither 50 Hz nor 60 Hz is the best number for a display.

Workstations are moving to higher frame rates to eliminate objectionable flicker. Popular personal computers have also deviated from the local broadcast standard to improve quality, and this has made interfacing to the world of video problematic. Ideally, a new TV system should be useful with workstations if only to allow sophisticated use of imaging components in those environments.

Some work has proceeded to define a video format that breaks up the 3-D spatial and temporal region defining resolution into smaller building blocks. In an extremely high-resolution and high-bandwidth TV system, all the blocks contain some important picture information—either fine-detail or precise-motion information. However, not all the blocks are equally important for a high-quality viewing experience, nor can they all necessarily be transmitted through existing channels or stored on available media. In some images, some of the blocks are empty.

For example, a high-resolution still image doesn't require as high a frame rate for transmission as it does for display. It is wasteful to send the same picture repeatedly when you could instead send additional detail—more spatial blocks.

The advantage of such a design is that each channel sends only as many blocks as it can afford. If you envision using floppy disks for TV, then the low-density ones can contain the same images as double-density disks, but the latter's images are clearer. Likewise, the computer prepared to display only a small image needs to interpret only the low-resolution blocks.

The cost of such an approach is that every signal source has to transform the signal into an intermediate format to

process the lines and frames of the image sequence and deal them into the appropriate block. This replaces the explicit format of the image that TV has used for the past 50 years. Also, each receiver must be built to recombine the blocks to suit its particular line count and frame rate.

Such an idea is anathema to those who believe that the electronics in consumer devices are expensive, and it is somewhat daunting to broadcasters and programmers as well. Many in those industries prefer a steadier ground on which to tread; they do not like the potential for obsolescence implied by an ever-growing standard.

Extensible TV is far more closely related to the computer industry. Computer users are acclimatized to systems that perform better with each generation and do a job with a speed and precision proportional to the investment that is made in them. The image of a TV broadcast whose very format is like a computer program is not as strange to that industry as it is to broadcasters.

Perhaps the only traditional video category interested in extensible TV is the production community. For them, the benefits of easy international interchange and evolution are valuable.

Intelligent TV

Another scenario for the development of TV requiring no new regulated standard involves the evolution of TV receivers into personal computers optimized for display. In many broadcasts, digital information is already included in the signal as closed-caption information; special equipment decodes this data and subtitles the broadcast for the hearing-impaired.

A complete set of options could exist for digitally augmenting the signal, both visually and with text, to generate higher-quality programs as well as individualized telecasts. Ultimately, the program could literally be composed in the TV set as the result of negotiation between the viewer and the information in the channel.

For example, the picture could depend on the screen size, with added width for large screens and added height for smaller sets. Or it could process only as many lines as the display technology is capable of rendering.

Even the camera angles used in a program could change from one household to the next. It is well known that TV shows are designed for a small screen and movies for the exhibition hall. There are more close-ups on TV and more panoramic views in the movies. Yet, if many of the viewers have wall-size screens, should those screens be used to enlarge the flaws in the newscaster's makeup or to give a broader view? Perhaps a way of avoiding this decision is to leave it to the viewer. Think of TV the same way you think of a CAD program that lets you select the viewpoint to suit the needs of the moment.

The data can also be used to vary the content of the program, allowing for alternative languages, additional data to print a higher-quality still derived from the broadcast, or an edited version suited to the tastes of a particular audience (see reference 4).

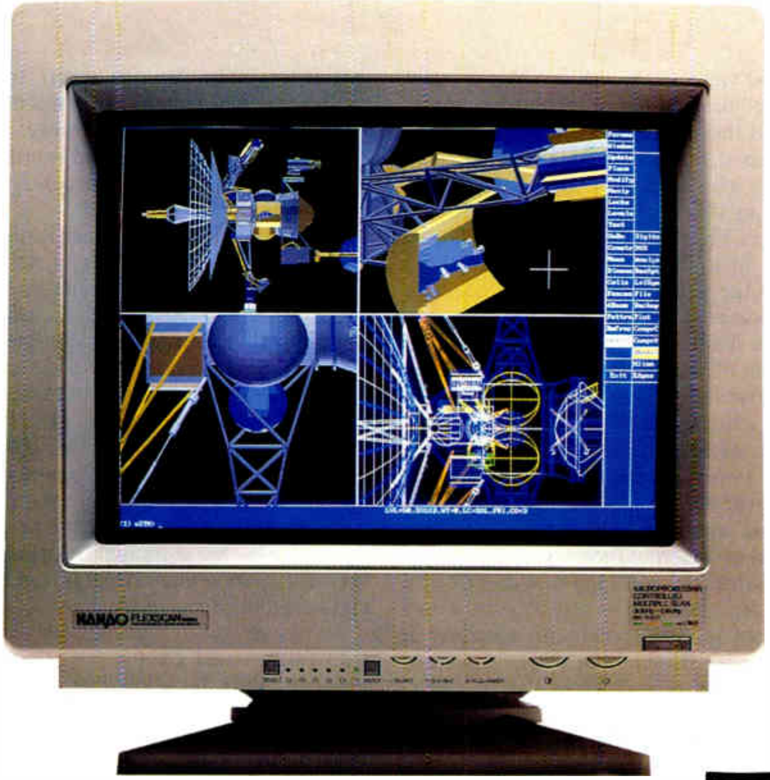
This intelligent receiver has been suggested in different forms by various people. Schreiber and Lippman describe an open-architecture receiver with a bus that can accept decoders for a variety of standards. This bus can also be the site of a processor that receives the transmission data as a generalized language, or a set of instructions that the receiver interprets to generate a picture.

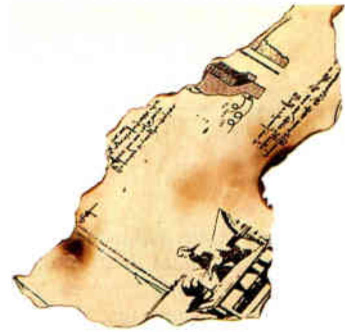
For example, the frame rate can be made variable, in trade for additional spatial resolution (or vice versa), to suit various types of content. Graphics can be locally generated to suit the viewer's situation: fewer characters for small displays, and greater screen percentage for larger ones.

At the limit, once the signal is digital, it is inherently divorced from synchrony with the broadcaster and from real time. The data stream exists independently of any physical constraints. A complete 2-hour program can be compressed to seconds of transmission time, allowing new freedoms of composition and diversity at the time and place of viewing. The receiver can "broadcatch" a plethora of information that becomes a program only when you decide to make it one. The channel can be dynamically allocated between spatiotemporal detail and content-based information.

Computers and TV

There is little question that all forms of image communication are poised to move into the digital era. HDTV is the most visible manifestation of this, but it is not the only one. While it may be true that new computers will appear similar





to HDTV consumer sets, the research done in the past few years on TV at all bandwidths and quality levels is the direct cause of much excitement in the computer world.

The same techniques used to squeeze a high-resolution image through a broadcast channel can also be used to compress high-quality images onto audio compact discs and to distribute movies through computer networks. Much of this work will bear fruit long before any agreement on HDTV occurs and will almost certainly exceed it in popularity for quite a few years.

Examples abound. In September 1990, Kodak announced a digital still-photography system in which a high-resolution digital version of each photograph is stored on CD. This high-resolution image can be viewed on home TV receivers or sent to a photo refinisher for digital darkroom effects and printing. By the time the system becomes available, you can expect those pictures to reside on a floppy disk and be printed in the home.

The General Instrument HDTV system that was introduced in June has extensions that make it useful at data rates as low as 2.5 megabits per second. At these rates, a full-resolution broadcast image looks better than that of home VCRs, and it approaches the best signal that you can get on a home set. Extensions of this to computers are obvious and inevitable.

An international group, the Motion Picture Experts Group, has been working for the past two years on a standard for digital images at bandwidths that are usable on audio CDs—approximately 1.1 Mbps for the picture. MPEG expects to release a draft proposal for a standard in December, with manufacturers beginning to construct chips for it in early 1991.

A still-picture standard, called JPEG, for the Joint Picture Experts Group, has drafted a standard for still images at any resolution, from teletext to graphic arts quality, and makers of new computer systems (e.g., NeXT) are preparing workstations that incorporate chips to process JPEG-encoded images at video rates. (MPEG and JPEG are discussed in detail in "Putting the Squeeze on Graphics" on page 289.)

Whether these systems are called HDTV or just advanced imaging is a moot point. E-mail that includes sync-sound movies is around the corner, and those pictures can be as good as you wish, from VCR quality to HDTV and beyond.

The Future

HDTV has placed us at a crossroads in the way we deal with moving pictures. The pictures will certainly get clearer, but the underlying technology will shift from low-capability analog receivers to high-power digital signal processors. As with all major technological changes, the transition may not be smooth, and mistakes may be made along the way, but the direction is inevitable.

You can expect high-end computer graphics to integrate HDTV technology into normal use as equipment drops in price. The wide screen is immediately useful in some applications. Recording equipment is critical in all cases where TV output is normally used, and it will become available. This is obvious and unquestionable.

For the rest of the personal computer world, the value is not hidden in the lines but between them. HDTV and its derivatives are initiating a digital revolution that is beginning now and gathering steam. The challenge is not the new definition of the image, but the new definition of programming that this technology forces us to make. ■

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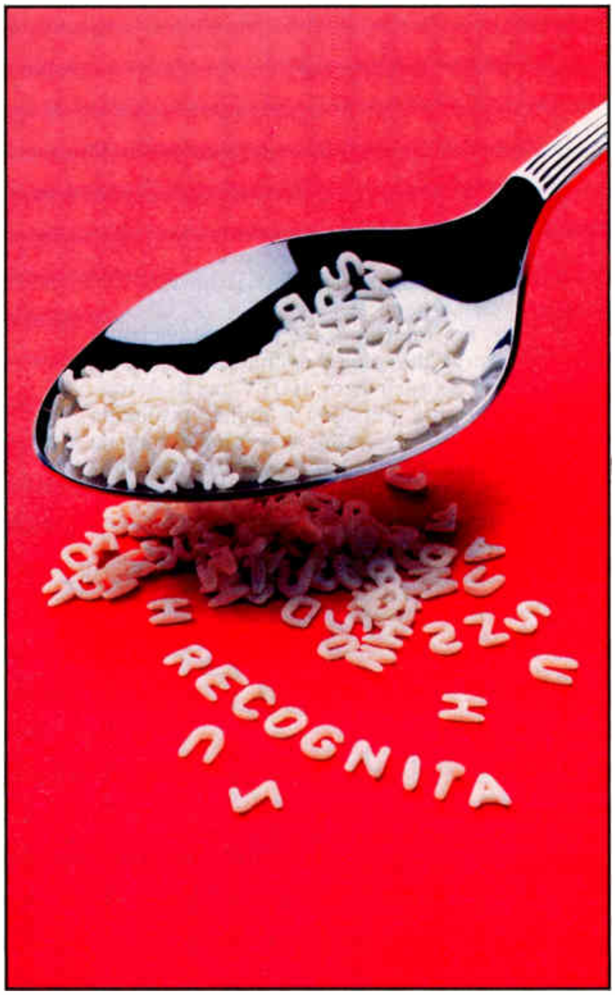

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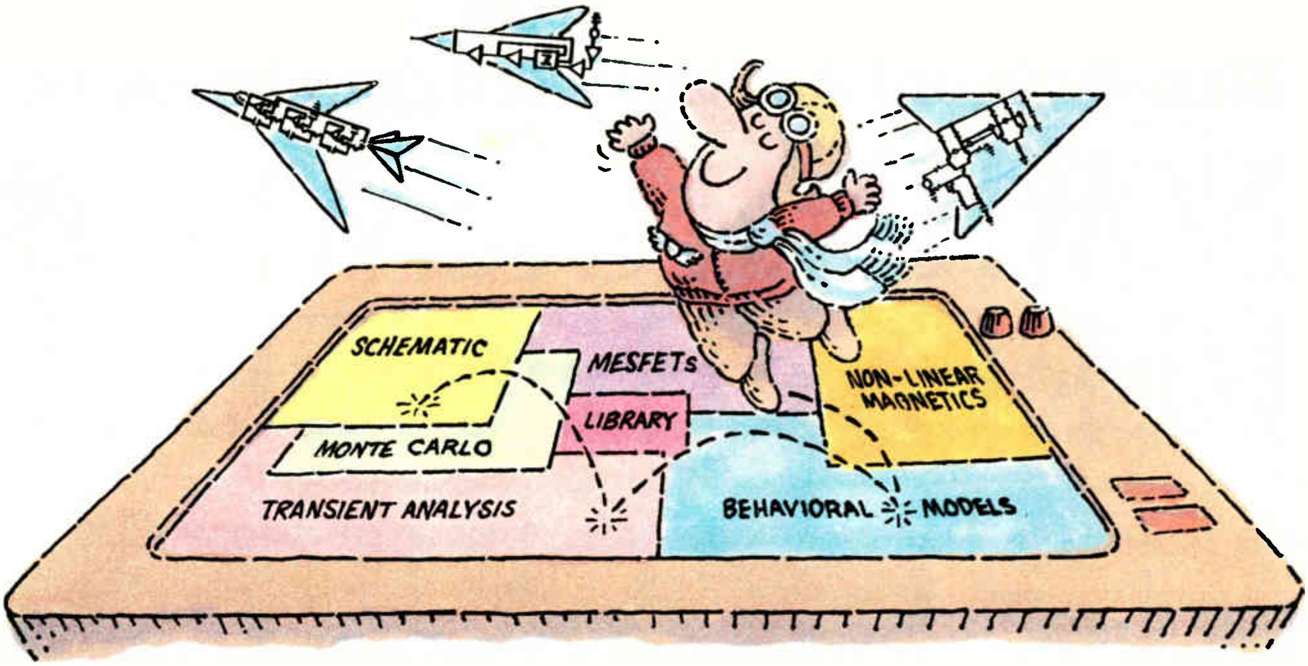

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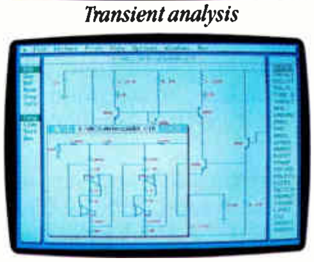

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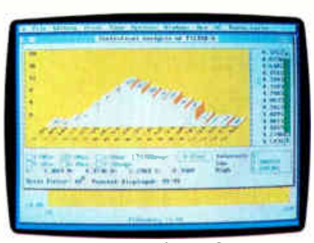

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PORTABLE CHIPS

Chip designers are helping make laptops smaller, more powerful, and more efficient

Owen Linderholm

The original IBM PC was designed with circuitry to help the CPU drive the other parts of the system: the bus, keyboard, display, peripherals, and memory. These logical functions required a number of ICs, which took up a great deal of board space and system real estate.

As other companies started to copy the PC, they looked for ways to build systems more economically. They began to make chips that performed a number of the functions involved in the system logic, a trend called *integration*.

Since the introduction of original PC, there have also been numerous technological developments in mass storage, memory, processors, and displays. IBM and others have used these techniques in ATs and compatibles, providing increasingly powerful solutions that nevertheless remain backward compatible. Driven by these factors, chip manufacturers have been able to decode all the logic required to build a PC compatible and put it on a few chips, simplifying the process of manufacturing a PC.

These manufacturers—companies such as Intel, Advanced Micro Devices (AMD), and Chips & Technologies—are always looking for ways to make their chip sets stand out above those of their competitors. One area where this is becoming increasingly possible is in the laptop market.

Let's Get Small

Laptops call for design philosophies and techniques that are substantially different from those of desktop systems. The manufacturers of laptop chip sets need to consider size, form factor, weight, power consumption, displays, mass storage options, memory, performance, and price. Interestingly, it is in laptops that manufacturers stray farthest from the IBM standard. IBM has never produced a successful laptop, so there are no de facto standards to adhere to except that of DOS compatibility.

The result has been a proliferation of laptop styles, ranging from the basic PC compatible with a single floppy disk drive and a crude CGA LCD screen (e.g., the Toshiba T1000) to the brand-new 4-pound, hard disk–equipped VGA wonders from Sharp and Texas Instruments to innumerable 386SX-based laptops that have more power but are heavier. Another innovation that may point the way to the future is the "palmtop" IBM compatible, such as the one from Poqet. A palmtop has more power than the original PC in a package that's not much larger than a calculator (see photo 1).

Chip-Set Basics

Before looking into the special nuances of laptop chip sets, I want to review the typical functions of the chip sets found in most PC or AT compatibles. Basically, the chip set provides support logic for the processor, transforming instructions and signals from the processor into signals that can be understood by other components of the system and vice versa. Typical chip sets now operate in four or five main areas:

- The *bus controller chip* carries signals from the processor to the system bus. It provides timing and arbitration signals for the bus and, when necessary, performs buffering to feed signals along the bus so they won't conflict with each other.
- The *peripheral controller chip* generally controls hard and floppy disk drives and, often, the parallel port. It controls the flow of data between the processor and these peripherals.
- *Memory-control chips* perform similar functions for the RAM and ROM in a system, physically fetching data from the RAM and returning it to the processor. They also control memory refresh, passing signals to periodically update memory so the RAM contents don't fade.
- There is usually an *I/O chip* that controls serial I/O and, sometimes, the parallel port and other peripheral devices in the system.
- Finally, most chip sets now include a *display controller* in some form. This may be combined with the I/O chip in the case of a simple monochrome display but is more commonly a separate VGA controller chip.

continued

Correct clocking is more important to a microcomputer than a steady heartbeat is to the human body.

Most chip sets also control timing for the whole system, including the processor. They take signals from the system's clock crystals and use them to keep the various parts of the system operating in sync. This is probably the single most important function of the chip set, since correct clocking is more important to a microcomputer than a steady heartbeat is to the human body. Chip sets also usually control parity generation, accesses to memory, shadowing RAM and ROM, data and address buffering, and other less important functions.

Currently, most computers use three or four chips to control these functions. However, several companies have announced that they have integrated all of them onto a single chip. This allows manufacturers to build systems using a processor, a chip set on one chip, some RAM chips, and various other nonsilicon electronic devices. Such high levels of integration are allowing manufacturers to make system boards that are only a few inches on a side. This means that it's possible to fit all the other components of a system—slots, disk drives, and the power supply—into a much smaller box than what used to be needed.

Today's Laptop

The average laptop today is an AT compatible with a floppy disk drive and a hard disk drive. It has a flat-panel LCD screen, which may be either high-quality CGA or low-quality VGA. There are numerous problems with building such systems, which is why far fewer companies are making laptops than there are companies making desktop systems.

The first issue is size. Generally speaking, the smaller the laptop, the more successful it will be. But it takes more engineering expertise to put all the components of a desktop system into a unit that will fit on your lap. Manufacturers want chip sets that are highly integrated so the motherboards will be more compact and take up less space. They also want chip sets to be flexible, making it easier to design a board layout that works well with the physical design of the system.

The next issue, and probably the most important, is power. This is the issue that drove the development of special chip sets for laptops, and it is the area that manufacturers almost uniformly focus on. Manufacturers either use a DC-to-DC converter to ensure a good-level voltage from the power supply to the system, or they try to supply a good voltage directly, in the form of a high-quality battery pack.

The battery approach is a little more risky, especially when a battery starts to run out. As power gets low, power levels can fluctuate. To avoid permanent damage to the system, manufacturers must use components that are more resistant to voltage fluctuations (and therefore more expensive). The disadvantage of using a DC-to-DC converter is that it has a small power overhead and decreases overall battery life by about 15 percent. In both cases, manufacturers try to extend the battery life as long as possible.

In addition, many components of a laptop system are sources of heavy power drain. The clearest example is a backlit LCD screen. Although backlighting makes the screen much easier to read, it drains a significant amount of power from the system. Chips & Technologies, perhaps the biggest chip-set manufacturer, estimates that under the best conditions the backlight uses about 12 percent to 15 percent of the system power.

A simple solution—found early on by the chip-set manufacturers—was to switch the backlight off when it wasn't needed. To do this, most chip sets monitor keyboard activity and turn off the backlight (and often the whole display) if you don't hit a key within a certain period of time. This solution, while saving power, has its problems. If you're simply looking at the screen thinking about what to do next, or if the system is performing a long and difficult calculation, turning off the backlight may not be desirable. Some chip sets are designed to monitor processor and video activity to determine when the backlight and display should go off.

Chip sets can also save power by powering down the whole system when it is not being used. This is not the same thing as

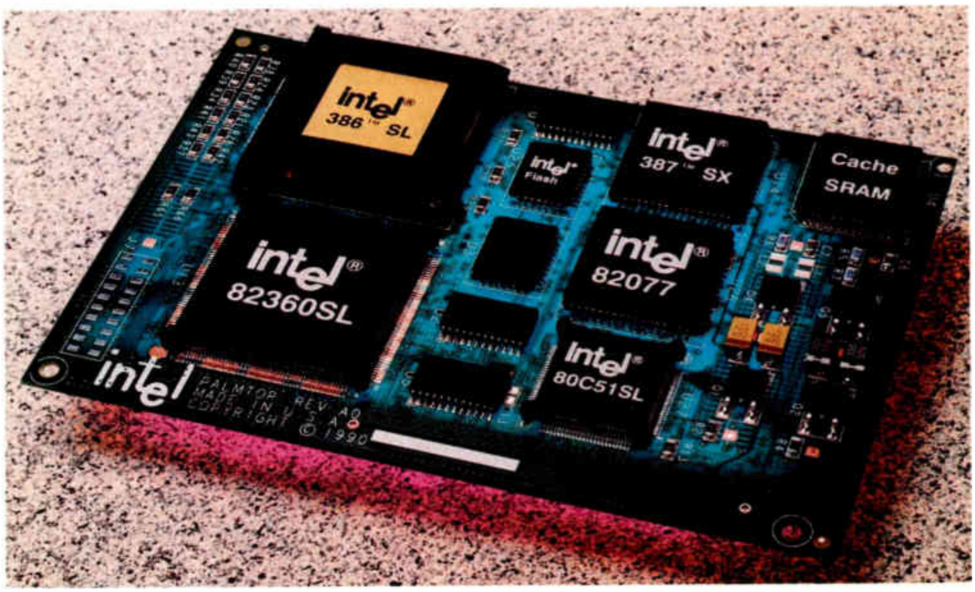

Photo 1: *The high levels of integration in Intel's 386SL and 82360SL chips allow all the basic components of a computer to fit on this 4- by 6-inch motherboard, an experimental design for palmtop systems.*

Intel has stated that its goal is a single-chip AT that includes processor, chip set, and memory.

turning the system off. Most laptops now have the ability to suspend and resume operation. They do this by powering down the entire system except memory and the processor—or even everything but the memory, if they take the trouble to store processor values in memory first. This technique is usually under the direct command of the user or kicks in after prolonged periods of inactivity.

Similarly, some disk drive manufacturers have now put low-power and power-down modes of operation into their drives. Chip-set makers are starting to support them by having their chip sets put hard disk drives into idle when they are not used, or even sometimes powering them down.

Following the trend toward using lower-power components, chip-set makers now provide versions of their chip sets that consume less power. These, of course, are more expensive, as are the chip sets that include power-saving features. Memory makers are also bringing out DRAM chips that need to be refreshed far less often. Chip-set manufacturers have not yet brought out many products to support these, but more should be available soon.

Controlling Displays

Another issue for laptop makers is what display to use. Users are voting for higher-quality displays by buying systems that have them. To meet this demand, chip makers are now supplying low-power VGA chips as part of their laptop chip sets.

Closely linked with the display is the question of the user interface. For most laptop users, this means the keyboard and DOS. However, since the advent of 386SX-based laptops, users have begun to use graphical user interfaces, such as Windows 3.0. This means that they will also want pointing devices, such as mice. Some systems now have built-in devices, such as trackballs, that let you control these graphical environments more readily.

Many manufacturers foresee pen-based and voice-based interfaces as the way forward for laptops, and perhaps for all computers. These kinds of interfaces and the applications driving them will require more computing horsepower—at the very least, a 386SX. The added horsepower in turn requires more power to drive it, taking manufacturers back to the question of power consumption.

Working Together

One last big issue remains for the makers of laptop chip sets: compatibility. This may seem trivial, but the specialized chip sets for laptops, particularly in the power management area, put an added strain on the processor and operating system. In particular, system logic chips make tremendous use of hardware interrupts to the processor to coordinate and deliver all the signals to and from the processor. Every interrupt slows down some other operation of the processor by a small margin. Power management features slow the processor down a lot,

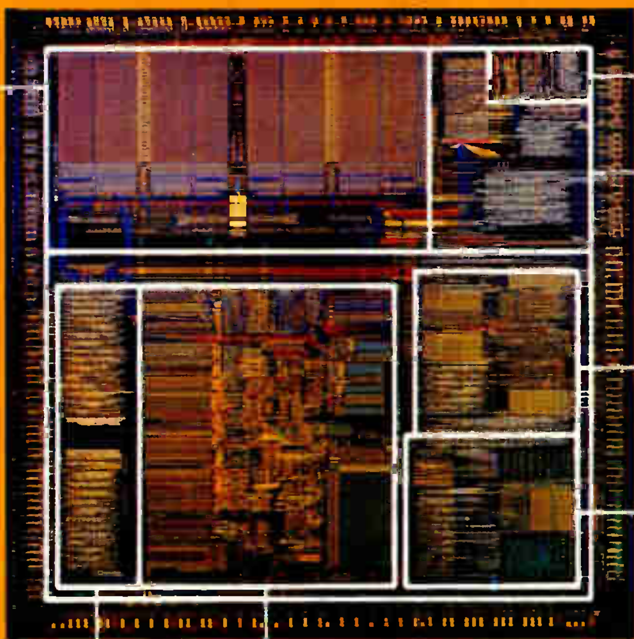

Photo 2: *The 386SL, a version of the 386 processor designed for laptops, is actually slightly faster than the 386SX. The 386SL features integrated cache memory control, a high-speed peripheral bus, and a system management interrupt (SMI) that will, among other things, let hardware manufacturers program in new power management features.*

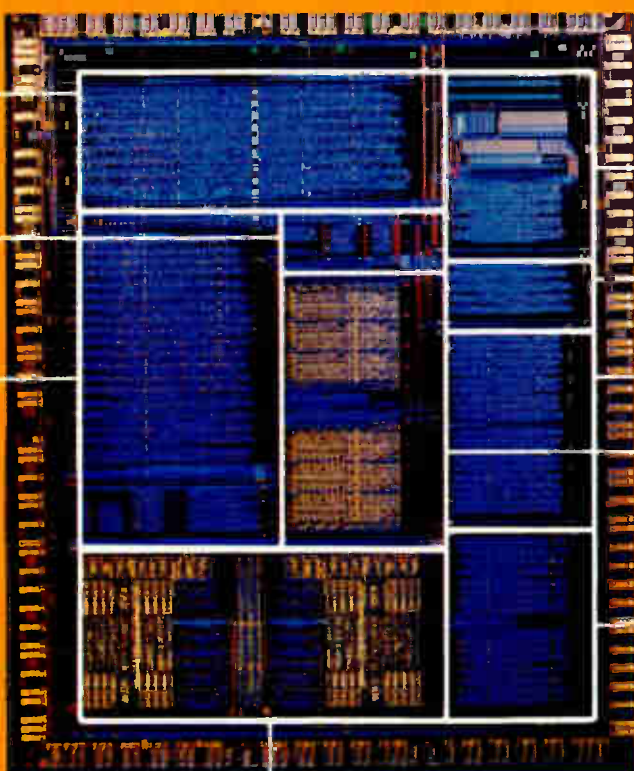

Photo 3: *The 82360SL, a companion chip to Intel's 386SL, provides the Industry Standard Architecture bus and most of the I/O necessary to build a complete system. The chip's power management facilities support Intel's Flash memory system, which, in suspend mode, can power the system for several weeks.*

286LX has a CPU-shutdown mode that turns off the 80C286 portion of the chip, and a standby mode that turns off all system clocking except for DRAM refresh. DRAM refreshing is staggered so that the power drain is more constant and peak current demands are reduced. This chip is extremely well integrated and could be used to build a laptop with fewer than 20 chips on board, including DRAM.

However, as advanced as this solution is, it doesn't save enough power to dramatically increase battery life. Chips & Technologies is taking an approach that, while similar, uses more on-chip intelligence to examine power usage and determine the best way to turn off parts of the system to reduce power requirements but keep the system operating efficiently. The new CHIPSlite chip set (see the figure) offers a less well-integrated solution that should, however, perform better at power management.

The CHIPSlite chip set uses between five and seven chips. It features Chips & Technologies' own BIOS, which includes power management routines. The chips provide address buffers, address and data multiplexers, a special power management chip, an integrated BIOS, a peripheral interface, an I/O interface, and a keyboard controller.

The important chip in this set is the 82C641 power management chip. It supports sleep modes, standby modes, automatic backlight shutoff, modem ring, and slow-refresh DRAMs. The 82C641 uses a new refresh technique that reduces power requirements, and you can program it to power on at a preset time.

However, what sets the 82C641 apart is a technique that Chips & Technologies calls SmartSleep. SmartSleep is an advanced algorithm that makes a statistical analysis of how often an application polls the keyboard. It looks at the number of calls between certain time periods and then sets minimum and maximum values. It then sets a spread of values to determine when it is safe to put the system into sleep mode.

Sleep mode conserves power by stopping or slowing clocks to the CPU, taking advantage of the CMOS property that CMOS gates do not consume power except when they are switched. Stopping or slowing the transitions thus reduces the amount of power used.

The 80C286 processor is a static chip that can keep values even when stopped, so sleep modes on 286-based laptops actually stop the CPU altogether. The 386SX and 386DX chips are dynamic and therefore need to be refreshed by clocking. This can be done at speeds as low as 2 or 4 MHz—rather than the usual 16 MHz or higher—saving a considerable percentage of the power consumed by the processor.

All these transitions take place so fast that it is often safe to put the processor into sleep mode between keystrokes while a user is typing. Thus, using sleep modes effectively can save a considerable amount of power. However, sleep modes must be used carefully because it is conceivable that some event may occur while the processor is asleep. For example, an extremely rapid typist might lose keystrokes if the processor went too quickly into sleep mode. Chips & Technologies estimates that up to 35 percent of system power is saved when it is operating in sleep mode.

It is clear that carefully planned sleep modes can save considerable power and protect users from losing data. Most chip sets take a conservative approach and use sleep modes only when a certain interval has passed without keyboard activity. The Chips & Technologies SmartSleep technique allows the system to analyze usage patterns and intelligently determine when to turn sleep on and off. The algorithm is coded in firmware on the 82C641 chip and is user-configurable. You can even save usage patterns for different applications to customize SmartSleep for the application being run.

Standby modes turn more of the system off—everything except the memory, which could be slow-refresh memory. This mode can save over 95 percent of the power required by full operation. Chips & Technologies claims that its combination of low power consumption, SmartSleep, and other power-saving devices can extend the battery life of a typical laptop by a third or more.

Intel's Solution

Most chip-set solutions may now be obsolete, however. Intel has recently introduced a new version of the 386SX processor, the 386SL, designed for laptops. It is slightly faster than the 386SX and works with the 82360SL, a new companion chip that provides the Industry Standard Architecture bus architecture and most of the necessary I/O for a system.

The 386SL (see photo 2) has several unique features. It has integrated cache memory control, consumes less power, and is a static design. It also includes a high-speed peripheral bus that is intended for use with high-performance graphics, Flash memory, and disk systems.

However, the 386SL's biggest innovation is the addition of a new system management interrupt (SMI) and separate system management memory and I/O address spaces. This new interrupt is transparent to the rest of the processor and to any operating system running on the processor. It is designed for use by hardware manufacturers who want to program in power management features. The SMI provides the ability to suspend and resume operations, send peripherals such as hard and floppy disk drives into standby modes, control the CPU clock speed, and control uninterruptible power supplies. The SMI can be externally programmed so that manufacturers can add their own extensions for any form of power management.

The SMI is a hardware-level interrupt that takes priority over all other interrupts on the system. As such, it could conceivably be used for functions other than power management. Intel claims that, despite the obvious performance penalty for the rest of the processor when the SMI takes over, the overall performance of the 386SL is better than that of the 386SX. Intel also anticipates that using these chips and other low-power parts could extend the battery life of a system by 50 percent.

Intel has also put power management facilities into the 82360SL support chip (see photo 3), which includes timers, controls I/O, and has event recognizers to trigger the SMI for the 386SL. It also can support Intel's Flash memory system, powering a computer for several weeks when in suspend mode, rather than the usual few hours.

Good Things in Small Packages

Chip manufacturers are currently prototyping chips that will be smaller and more efficient and will feature even higher levels of integration than today's chips offer. In the near future, you can expect to see a single-chip AT that will allow powerful systems to fit into very small packages. Features like Intel's SMI will allow portables to incorporate new power-saving techniques and other management functions.

It's only been in the last few years that manufacturers have taken laptop chip-set technology seriously, and already great advances have been made. It seems likely that chip sets will soon be able to make up for battery-life limitations and dramatically extend the lives of portable computers. ■

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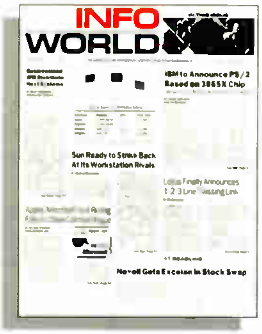

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RELATIONAL DATABASES: THE REAL STORY

Are you sure you're using a relational database manager? Think again.

Steven J. Vaughan-Nichols

Have you noticed that every food product in the land is now advertised as being "light"? It doesn't matter at all if there is any truth to the claims. *Light* is one of the new buzzwords, so everyone is using it.

Of course, food vendors aren't the only ones to play fast and loose with language. Computer companies do the same thing. Computer vendors use hype phrases like "turbo" and "object-oriented." One term with a precise definition, *relational database management system (RDBMS)*, has been bandied about so much that even veteran computer users have lost track of its meaning. Companies have been using this phrase for years. There's only one problem: Few programs even come close to being relational database managers.

A Rose by Any Other Name?

Even database professionals believe that an RDBMS is any program that can access more than one database at a time. Nothing could be further from the truth. Just because a program allows you to view two different tables with its procedural language doesn't mean it's relational.

The sad thing is that there's no real excuse for this confusion. The relational database model has been around since 1970, when Edgar Codd, then an IBM researcher, introduced it to the world in his classic *Communications of the ACM* paper entitled "A Relational Model for Large Shared Data Banks."

Since then, Codd and his colleagues have been beating the drum for RDBMSes, both within and outside the walls of IBM. To make certain that everyone got the idea, Codd summed up the definition of RDBMS in a set of rules (see the text box "Codd's Commandments" on page 322).

In a way it's funny that so many programs try to wrap themselves in the RDBMS mantle. During its first years of existence, nobody except Codd and his followers supported the RDBMS model. The concept, based firmly on mathematical theory and predicate logic, was disliked for its break with traditional database thought. It was reviled as being too theoretical. Many said that it would never be practical.

The prevailing database model of the day was the hierarchical model. In this still-popular system, data is stored in a tree structure, and every data element is defined as being a member of a group. These groups are themselves data elements and can be members of a higher group. Under this scheme, your ZIP code is a data element that is part of another data element, your address. These elements could then be a part of another data element—a mailing list,

ILLUSTRATION: DAVE CUTLER © 1990

Codd's Commandments

In the late 1960s, Edgar Codd was an IBM researcher who questioned the way DBMSes were designed. Over time, he became disgusted with the prevailing database theories of his day and decided to try to improve the situation. From his efforts, the relational model was born. As his model grew more popular, he was dismayed by the fact that DBMS designers were adopting only the word *relational* and ignoring the rest of the relational model. It was then that he formulated rules to define exactly what a relational DBMS is.

In theory, an RDBMS must meet Codd's rules or it isn't a relational database manager. In practice, most relational databases implement only some of these rules. Building a true RDBMS is easier said than done. A full discussion of Codd's rules is beyond the scope of a single article, but here is a brief summary of Codd's commandments:

Rule 0: Any RDBMS must be able to manage databases entirely through its relational capabilities. If a DBMS depends on record-by-record data-manipulation tools, it's not truly relational.

Rule 1: All data in a relational database is explicitly represented (at the logical level) as values in tables. Data cannot be stored in any other way.

Rule 2: Every data element must be logically accessible through use of a combination of its primary key value, table name, and column name.

Rule 3: Null values are explicitly supported. Nulls represent missing or inapplicable information.

Rule 4: The database description, or catalog, is also stored at the logical level as tabular values. The relational language—Structured Query Language (SQL), for instance—must be able to act on the database design in the same manner in which it acts on data stored in the structure.

Rule 5: An RDBMS must support a clearly defined data-manipulation language that comprehensively supports data manipulation and definition, view definition, integrity constraints, and transactional boundaries and authorization. SQL is the most well known of these languages.

Rule 6: All views that can be updated must be updatable by the system. This is a major stumbling block for would-be RDBMS designers. Many implementations don't allow updatable views at all. Those that do have many restrictions on when a view can be updated. In a true RDBMS, most, though not all, views would be updatable.

Rule 7: An RDBMS must do more than just be able to retrieve relational data sets. It has to be capable of inserting, updating, and deleting data as a relational set. Many RDBMSes that fail the grade fall back to a single-record-at-a-time procedural technique when it comes time to manipulate data.

Rule 8: Data must be physically independent of application programs. The underlying RDBMS program, or "optimizer," should be able to track physical changes to the data. For instance, an RDBMS's application programs should not have to change when an index is added to a table.

Rule 9: Whenever possible, applications software must be independent of changes made to the base tables. That is, RDBMS programs should not need to be modified to reflect any changes in the underlying data tables. For example, no code should need to be rewritten when tables are combined into a view.

Rule 10: Data integrity must be definable in the relational language and stored in the catalog. This law is another one that has proved difficult to put into practice. Data-integrity constraints can be built into applications. However, this approach is foreign to the intent of the relational model. In this model, data integrity should be inherent in the database design.

Rule 11: An RDBMS has distributional independence. This is one of the more attractive aspects of RDBMSes. Database systems built on the relational framework are well suited to today's client/server database designs.

Rule 12: If an RDBMS has a single-record-at-a-time language, that language cannot be used to bypass the integrity rules or constraints of the relational language. Thus, not only must an RDBMS be governed by relational rules, but those rules must be its primary laws. Simply tacking SQL onto a database program won't turn it into a relational database any more than painting racing stripes on a VW Bug turns it into a Ferrari.

for instance. These structures can grow quite complicated and require pointers and indexes to properly track information.

The "Real" Thing

RDBMSes take a much simpler view of data. In a relational database, two-dimensional arrays of rows and columns hold all the information. This structure seems too easy, and, to some extent, that criticism is valid. Not every kind of information can be conveniently accessed under an RDBMS. Imaging information, for instance, doesn't easily fit into an RDBMS's neat patterns of data. Still, an RDBMS works fine for most textual or numeric data. Although an RDBMS's structure may be simple, its inherent data-retrieval and manipulation powers are unparalleled.

In part, an RDBMS's theoretical underpinnings allow for easy coding. In a relational system, for example, finding records between two points (say, all names in an alphabetical list between "Vau" and "Vo") is a breeze. The same search in conventional databases requires many record-by-record comparisons.

In an RDBMS, even the most complicated data relationships can be reduced to 2-D table formats via *data normalization*, a data-analysis process used to find the simplest possible data structure for a given collection of information. This format makes changing and displaying information far easier than it is under a hierarchical system.

An RDBMS is a fundamental improvement over most DBMSes because you can add, delete, or change data throughout an entire database by treating it as a single set. Ordinary database managers require record-by-record updates that can drastically slow performance.

Ingres, Oracle, R:base 3.0, and IBM's mainframe-driven DB2 all attempt to meet the demands of the RDBMS model. At one time, Codd stated that an RDBMS needed to meet only seven of his rules. By that standard, some have been successful. Since then, Codd has declared that all his commandments must be met before a database manager can be called "relational." So far, none has, although a few have come close. The RDBMS concept sounds easy, but its full implementation is more difficult in practice than in theory.

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An RDBMS must meet Codd's rules or it isn't a relational database manager.

Playing by the Rules

The fundamental rule of an RDBMS is that all information must be manageable entirely through relational means. On the logical level, then, everything in a relational database must be represented by values in tables. Here is where many database managers fall short. It is all too tempting for database designers to take a shortcut in data representation or manipulation for the sake of short-term efficiency. Unfortunately, this easy road leads quickly away from the basic model.

Other rules reinforce this concept. In a true RDBMS, the database description, or catalog, must be contained in tables and controlled by the data-manipulation language.

Perhaps the most troublesome rule in relational theory is the one dealing with null values (rule 3). In an RDBMS, nulls represent missing or inapplicable data, and they are a vital part of the relational concept. But nulls aren't the same thing as empty or blank fields or the concept of zero.

Nulls represent information that isn't known at the time of a record's creation or modification. For instance, a hospital keeps birth records. Sometimes parents don't have a first name for their new offspring. The baby could be given a false name, such as "John Doe" or "Smith's daughter," and the record could later be changed to the real name. This method will work, but it makes both the updating and the reporting of records more complicated. Under an RDBMS, any missing information is represented by a null value.

But even within relational theory, there is no agreement on how to manipulate record sets containing null values. Debate continues on how to handle nulls. Since this question is at the heart of Codd's theory, it can't just be disregarded.

Structured Query Language, the most popular relational language, identifies primary record keys by the combination of their unique identities and by being "not null." Codd has further muddied the waters by suggesting that two types of nulls should be recognized. One would represent missing information, and the other would represent inappropriate data. There's no sign that a definite answer to this thorny question will be forthcoming anytime soon.

Another rule that is difficult to implement is that an RDBMS must have distributional independence. In other words, the data manager must be able to cope with distributed databases. In an RDBMS, data should be independent of hardware architecture and physical location. A true RDBMS would be able to display a view on your screen made up of a table from your PC and another table from a VAX located across the country.

Distributed database systems are an area in which developers are making rapid progress. Companies are rushing to bring distributed database managers to market. LAN database administrators lust after the power they provide; thus, database servers and clients are the hottest products in the DBMS field. The RDBMS model is well suited for this development, because the relational model's simple design and data-integrity rules have made it the cornerstone of most distributed databases.

The Best of Both Worlds?

Is it possible to combine the best features of an RDBMS with other systems? Many software companies have thought it could be done. They have tried to put a coat of relational paint on top of other systems. Codd addresses this in his final rule, the gist of which is that an RDBMS can have both relational and ordinary single-record-at-a-time elements. A relational system, however, must be governed by the logic of the relational model.

The reason why Codd devised his final rule is that the relational model is different from other ways of viewing and manipulating data. Therefore, a true hybrid system could never produce the full gains promised by relational theory.

In some circles, talking about database theory is like talking about religion or politics: You're sure to have an argument. I favor the relational model, but I'm the first to admit that it does have some problems—like nulls—that need a clearer definition.

RDBMSes have one practical problem as well. They require comparatively large amounts of RAM and disk storage. To put it more bluntly, they are resource hogs. Without sufficient hardware support, RDBMSes run extremely slowly.

Talking about database theory is like talking about religion or politics.

Most hierarchical database managers work quite well within their theoretical constraints. In point of fact, most database programs, including such popular favorites as dBASE, FoxPro, Clipper, Superbase, and Paradox, owe more to the conventional database model than they do to the relational one.

Still, as time goes by, the theoretically superior relational model will be successfully implemented on more platforms. Only then will there be products that can honestly be labeled as being relational. Until that time, the best one can say of most programs is that they include some relational features. ■

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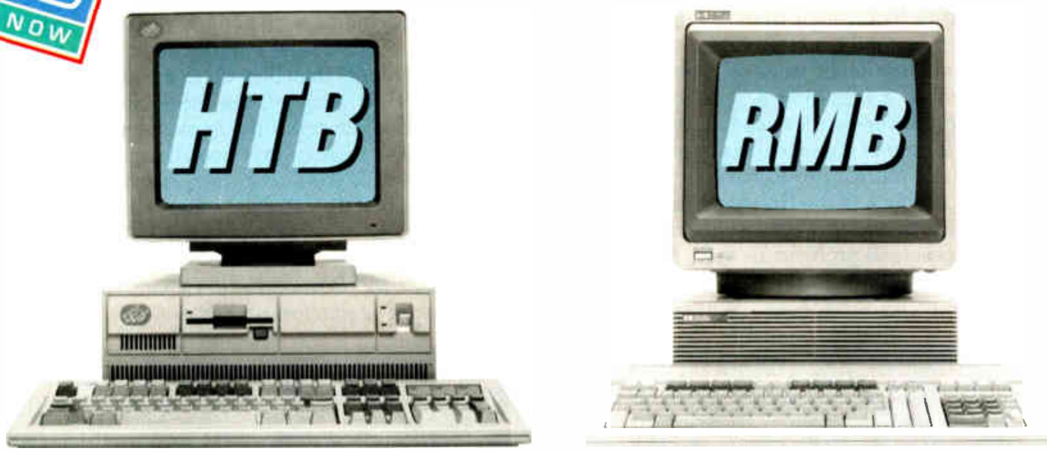

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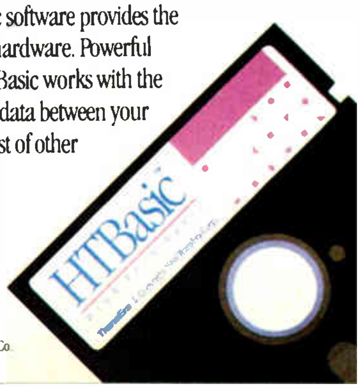

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CONCURRENT C

A language for programming multiprocessor systems

Narain H. Gehani and William D. Roome

Concurrent C is an upward-compatible superset of C that provides parallel programming facilities. Concurrent (parallel) programming has become increasingly important because multicomputer architectures, particularly networks of microprocessors, have become attractive alternatives to traditional mainframe computers.

There are some good reasons for programming in a language that supports concurrent processing:

- Concurrent programming languages usually provide the structure and have a convenient notation for writing programs for systems in which many events occur at the same time (e.g., operating systems, real-time systems, and database systems).
- A concurrent application is best expressed with the concurrency stated explicitly; otherwise, the program will not reflect the application's structure.
- Concurrent programming makes the best use of multiprocessor architectures.
- Concurrent programming can reduce program execution time even on uniprocessors, by allowing I/O operations (usually with DMA and an independent I/O processor) to run in parallel with computation.

Concurrent programming has only one disadvantage: It adds complexity to a programming language. On the other hand, writing a parallel application in a sequential language requires writing code to simulate the parallelism, a nontrivial task that requires knowledge of the hardware, the operating system, and the interprocess-communication facilities. Tailoring the application to specific hardware and system software results in code that is difficult to port to a different computer system.

A System of Processes

A Concurrent C program consists of a set of processes that execute in parallel and that interact with each other by sending messages. Messages are sent to and replies are received from another process by calling transactions associated with the process.

At Bell Labs, we designed Concurrent C to harness together numerous computers. We picked C as the basis for our work on parallel programming because it is an immensely popular language and we use it. However, since it does not have parallel facilities, we needed to enhance it. Our objectives were

- to provide a concurrent programming language that can be used for writing systems on genuinely parallel hardware, such as a network of microprocessors or workstations;
- to provide a test-bed for experimenting with high-level concurrent programming facilities; and
- to design a practical concurrent programming language.

Our first implementation of Concurrent C was done in 1984 and 1985. Since then the language has evolved; it has been integrated with C++ and is now in a fairly stable state.

In this article, we will give an overview of Concurrent C and Concurrent C++. Specifically, we will discuss the selection of the concurrent programming model and some of the initial design decisions, summarize the concurrent programming extensions to C, describe in detail the important facilities in Concurrent C, illustrate the use of Concurrent C with some examples, discuss the integration of Concurrent C with C++, and summarize our experience using Concurrent C. We will assume that you are familiar with C or C++.

Selection of the Concurrent C Model

We selected the *extended rendezvous* (or transaction) concept for Concurrent C. A *rendezvous* is an interaction of two processes when they establish a point of synchronization, exchange information, and then continue their individual activities. A simple rendezvous involves only unidirectional communications, whereas an extended rendezvous allows bidirectional information transfer using only one rendezvous.

After the synchronization is established, information is

Listing 1: *The specification for the* `lockMngr` *process.*

```
typedef long lockid;
process spec lockMngr()
{
   trans void lock(lockid id); /*wait if busy*/
   trans void release(lockid id);
};
```

Listing 2: *The body of the* `lockMngr` *process.*

```
#include "lock.h"
process body lockMngr()
{
   lockid xid;

   for (;;)
      select {
         accept lock(id) suchthat(isfree(id))
            xid = id;
         lock(xid);
      or
         accept release(id)
            xid = id;
         unlock(xid);
      }
}
/*isfree(id) returns true if id is unlocked*/
/*lock(id) locks id*/
/*unlock(id) unlocks id*/
```

Listing 3: *Using the* `lockMngr` *process. Pseudocode is in italics.*

```
#include "lock.h"

main()
{
   process lockMngr lm;
   lockid id;
   ...
   lm = create lockMngr();
   ...
   lm.lock(id);
   access item;
   lm.release(id);
   ...
}
```

copied from the process requesting service—the client—to the server. The client process is then forced to wait while the server process performs the requested service. Upon completion of the service, the results, if any, are returned to the client, which is then free to resume execution. From the client's viewpoint, an extended rendezvous is just like a function call.

Initially, we considered several categories of concurrent programming models:

- those based on shared memory;
- those based on asynchronous (nonblocking) message passing;
- those based on synchronous (blocking) message passing; and
- a combination of message passing and shared memory.

We rejected the shared-memory models because we wanted Concurrent C programs to run efficiently on nonshared-memory multiprocessors, such as workstations connected by a LAN. That left us with asynchronous and synchronous message-passing models. These two models are equivalent in that either set of primitives can be implemented using the other. We eliminated the asynchronous model for the following reasons:

- Most interprocess interactions are synchronous, not asynchronous: The client requests a service and waits for it. This matches the synchronous model perfectly. Thus, while the asynchronous model is more flexible, few people would actually use this extra flexibility.
- A synchronous model can be implemented more efficiently than an asynchronous model for which data must always be copied into and then out of a message buffer. For the synchronous model, data can be copied directly from the client process to the server, without going through an intermediate buffer, and the server's reply can be copied directly to the client. Thus, the synchronous model saves space and time.

Despite the theoretical equivalence of the asynchronous and synchronous message-passing models, some users of Concurrent C have a preference for asynchronous message passing because it maximizes concurrency. The debate over synchronous and asynchronous message passing has been the subject of much controversy among researchers. Preference for either can become a religious issue.

Reacting to this preference, we decided to take another look at asynchronous message passing. Eventually, we came to the conclusion that asynchronous message passing can indeed be beneficial in many situations. Consequently, we extended Concurrent C to provide this kind of message passing.

Some final comments about shared memory are in order. First and foremost, we wanted Concurrent C to allow (and encourage) programmers to write portable programs that will run efficiently on multiprocessors with or without shared memory. This is why we chose a message-passing model and why we have not added any language constructs for dealing with shared memory or for simulating shared variables in a nonshared-memory environment.

On the other hand, we did not want to forbid programmers from using shared memory altogether, as long as they accept the resulting limitations on portability. If we tried to prevent the use of shared memory in a shared-memory multiprocessor, programmers would just refuse to use Concurrent C. Therefore, Concurrent C does not forbid processes from referencing global variables, nor does it forbid processes from exchanging pointers. However, programmers do so at their own risk; such programs will not work as expected unless run on a computer with shared memory.

Overview of Concurrent C

Concurrent C extends C for parallel programming by providing facilities for

- specifying process types;
- creating processes;
- specifying the processor on which a process is to run;
- specifying, querying, and changing process priorities;
- synchronous and asynchronous transactions;
- delays and time-outs;
- interrupt handling;

- waiting for a set of events, such as transactions;
- accepting transactions in a user-specified order;
- process abortion; and
- collective termination.

A Lock Manager

You can get a taste of Concurrent C by seeing how you might implement a lock manager for large collections of items. In this demonstration, client processes can lock and release items. If an item is already locked, a process requesting a lock on this item waits until the item is released. Listing 1 is the specification of the lockMngr process. This specification declares two transactions: lock and release, which other processes can call to set and release locks.

Listing 2 is the body of the lockMngr process. This process accepts a lock request whenever the requested item is free, and always accepts release requests. Functions isfree, lock, and unlock manipulate a lock table. Only one process, lockMngr, calls these functions, so they do not have to worry about concurrent access to the lock table.

Listing 3 illustrates how a lockMngr process can be created and used.

A Simple Disk Scheduler

Listing 4 is the specification for a disk scheduler that uses the "elevator" algorithm. It is the same algorithm used to control elevators in high-rise buildings. An elevator alternates between handling all the calls from passengers wanting to go up and all the calls from passengers wanting to go down. This same algorithm implemented as a disk scheduler first handles all the calls to move the disk head in one direction. Then when there are no more such requests, the algorithm changes direction and accepts requests in the other direction. The elevator algorithm eliminates long delays in handling requests for cylinders at the edges of the disk.

The specification of the diskScheduler process declares one transaction, request, that can be called by other processes to read data from or write data to the disk. The body of the diskScheduler is in listing 5. The blkno parameter is the logical-disk block number for the block to be read or written.

The Concurrent C implementation of this scheduling algorithm has two phases. In phase 1, the scheduler does not have a current direction; all pending requests have already been handled (or none have yet been issued). The scheduler starts in phase 1 and returns to phase 1 when it again has no pending requests. In phase 1, the scheduler accepts the request for the cylinder nearest to the current disk head position. The scheduler moves the disk head in the direction of that cylinder, handles the request, and enters phase 2.

In phase 2, the scheduler has a current direction; it moves the head in this direction, accepting requests as it goes (see listing 5). The variable phase indicates the current phase, and in phase 2, the variable dir indicates the current direction.

The select statement has two alternatives: an *accept* alternative and a guarded *immediate* alternative. If the process has an outstanding transaction call that satisfies the accept alternative, the select statement takes that alternative. If not, and if the guard is true (i.e., it is nonzero), then the select statement takes the immediate alternative. And if the guard is false, the select statement waits for a transaction call to arrive.

The accept alternative has a suchthat clause. In phase 1, any request satisfies this clause. In phase 2, only requests for the current cylinder or those for cylinders in the current direction satisfy it. Of those requests that satisfy the suchthat clause, the by clause selects the one that is nearest to the current cylinder. Once a request has been accepted, if it involves disk movement, the scheduler sets the current direction and shifts to phase 2. The scheduler then does the disk operation. The immediate alternative is executed only when the scheduler is in phase 2 and when there are no pending requests that satisfy the suchthat clause. The immediate alternative returns the scheduler to phase 1.

Note that the scheduler does not poll. If the scheduler is in phase 1 and there are no pending requests, the scheduler waits for a request to arrive. When the scheduler is in phase 2, the immediate alternative is open and will be taken when there are no requests that satisfy the accept alternative. The immediate alternative returns the scheduler to phase 1. This closes the immediate alternative and causes the scheduler to wait for the next request.

Listing 4: *The specification for* diskScheduler.

```
typedef enum {D_READ, D_WRITE} opcode;
process spec diskScheduler()
{
   trans void request(long blkno, opcode op, char *buf);
};
```

Listing 5: *The body of* diskScheduler. *Pseudocode is in italics.*

```
#include "disk.h"
#define BLK_CYL (19*32)          /*blocks per cylinder*/
#define CYL(x) ((x)/BLK_CYL)     /*cylinder number*/
#define ABS(x) ((x)>0?(x):-(x))
process body diskScheduler()
{
   int pos = 0, phase = 1, dir;

   for (;;)
      select {
         accept request(blkno, op, buf)
               suchthat(phase == 1
                  || CYL(blkno) == pos
                  || CYL(blkno)>pos == dir)
               by(ABS(CYL(blkno)-pos)) {
            if (CYL(blkno) != pos) {
               dir = CYL(blkno) > pos;
               phase = 2;
               pos = CYL(blkno);
               seek to pos;
            }
            start disk operation;
            wait for disk operation to complete;
         }
      or (phase == 2):
         phase = 1;
      }
}
```

Concurrent C++

Concurrent C, as a compile-time option, also works with C++, an object-oriented superset of C. Although data-abstraction facilities are important for writing concurrent programs, we did not provide them in Concurrent C because we did not want to duplicate the C++ research effort. Instead, we decided that we would eventually integrate C++ and Concurrent C

A process that is called by many clients can become a bottleneck.

facilities to produce a language with both data-abstraction and parallel-programming facilities. This was a pragmatic decision. We decided that it would be better if it had the same data abstraction as C++ because this would make the new language upward-compatible with C++ and would then be more attractive for C++ users interested in writing concurrent programs.

Both C++ and Concurrent C have been implemented as C preprocessors. Anticipating the need for eventually merging C++ with Concurrent C, we used the C++ preprocessor as the starting point for the Concurrent C preprocessor. We also tried to use syntax for the concurrent programming facilities that was similar in spirit to the class syntax.

For example, as in C++, parameter types must be explicitly specified. A compile-time option determines whether the Concurrent C preprocessor accepts just Concurrent C or Concurrent C++.

Our goal was to accept both languages. Our reasoning for having both was to maximize our audience and at the same time keep up with the evolutions of C. Many potential users of our concurrent programming extension know C but not C++. We thought that many of those programmers would be reluctant to use our work if they first had to learn C++. And programmers who know C++ would be reluctant to use any programming language that did not provide data abstraction and would consider Concurrent C a step backward from C++.

Using Classes vs. Processes

Classes and processes are both abstraction facilities. You can use processes to implement abstract data types, such as queues and complex numbers, which are typically implemented using classes. However, this can be very expensive in terms of computer resources, because processes incur additional run-time overhead for context switching and process scheduling.

Some abstractions cannot be implemented as pure classes and must be implemented with processes (e.g., inherently parallel applications, such as operating systems; programs for controlling robots; and embedded tactical systems for airplanes).

Objects that are shared by multiple processes can be encapsulated in a process to enforce sequential access. For example, you can enclose a queue shared by many processes within a process to ensure that items are added to and removed from the queue one at a time.

So, when designing a new data abstraction, you must ask yourself how that abstraction should be structured. It can be structured purely as a class, or purely as a process, or as a mixture—an interface class hiding a process.

The advantage of classes is that the overhead of invoking a

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member function is much lower than the overhead of interacting with a process. The disadvantages of classes are that they do not provide concurrency and it is difficult to share an instance of a class among several processes (i.e., the processes must use some mechanism other than the class to ensure the necessary synchronization).

The advantages of processes are that they allow operations to happen in parallel and they provide mechanisms for mutual exclusion. The disadvantages of processes are that a transaction call is much slower than a member function call, and a process that is called by many clients can become a bottleneck.

We have devised some informal guidelines for selecting the structuring technique for a data abstraction. First, you should get a rough idea of the interface that the clients would like to see: one that is clean and convenient and natural. Then, if it is possible to implement the abstraction as a pure class, do so.

Classes should be used for passive data objects, such as strings, queues, complex numbers, or symbol tables. A key point is that these objects are not shared by several processes, so there is no need for synchronization.

Another point is that once an operation starts, it runs to completion. Thus, if the object is implemented as a process, then that process can only execute when handling a transaction call from a client. There is no performance increase from using processes, because the object process can never execute in parallel with its clients.

When you cannot implement the abstraction purely as a class, then you must use a process. The choice then becomes whether to implement the abstraction as a pure process or as a process plus an interface class. In other words, should the process be visible to the client of the abstraction, or should it be hidden?

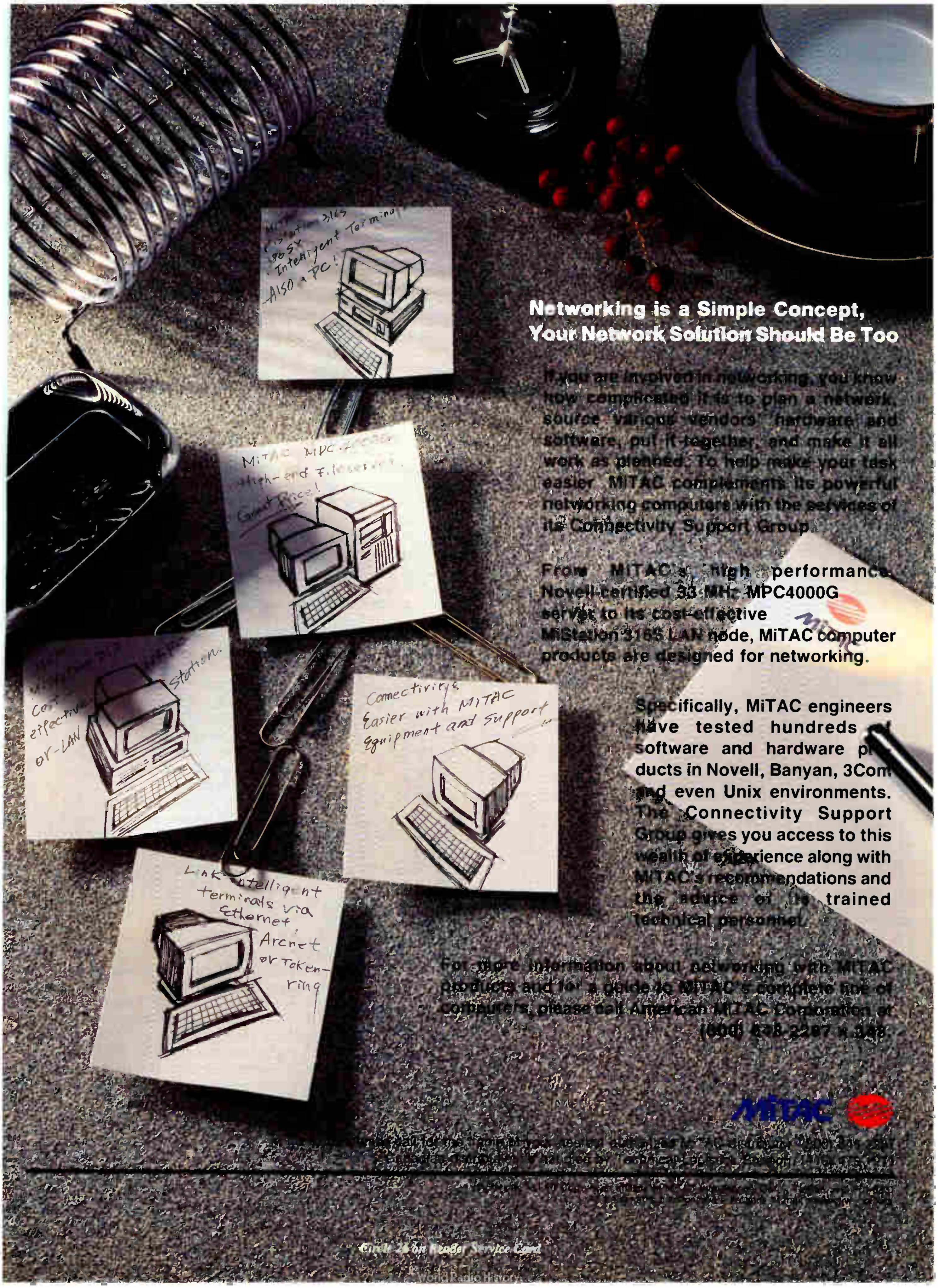
To decide which is best, first determine what kind of interface is needed between the client process and the abstraction (server) process: What transactions are needed, what data is passed and returned, what is the protocol for calling those transactions, how often are they called, and so on.

Design your process interface for efficiency. Keep in mind that transaction calls are relatively slow, so the number of calls should be minimized. If some operations can be done by either the client processes or the server process, then you must decide which will do them. If the client cannot proceed until these operations have completed, then, in general, the client should do them.

If you suspect that the server process could become a bottleneck—for example, if it is shared by many clients—then it is best to have the clients do as much as possible. But if the operations can be done in parallel with the client, and if the server is not a bottleneck, then the server should do them, because this will increase parallelism.

You should compare the interface to the server process with the desired interface for the data abstraction. If they are a good match—if the server-process interface is simple and natural, and you do not expect that it will change—then implement the data abstraction as a pure process. In this case, the process interface becomes the interface of the abstraction.

However, if the interface to the server process is complicated or unnatural, or if you think that the process interface might



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change, then hide the process interface from the clients by implementing the data abstraction as an interface class and a process. For example, you should use an interface class if some operations can be done by either the client processes or the server process but you do not know which would be better. Design the interface class so that it provides the abstraction that the clients desire. This class converts the client's operations into the appropriate transaction call to the server.

The Benefits

Concurrent C is a tool for writing distributed programs under several versions of the Unix system: System V, BSD 4.2, and NRTX (a stripped-down real-time version of Unix) running on VAX computers, AT&T 3B computers, and Sun workstations, among other uniprocessor machines. The Concurrent C program runs as one Unix process on these implementations; the Concurrent C run-time library provides a scheduler that switches between Concurrent C processes as needed.

Concurrent C has also been implemented on multiprocessor configurations. One is a loosely coupled network of independent computers connected by a LAN (Ethernet), each running the Unix operating system. Here, both the hardware and software are loosely coupled.

Another multiprocessor system, the AT&T 3B4000, also has several Unix processors connected via a bus, but this system looks like one virtual Unix system (e.g., the file system is shared among all processors). In this system, the hardware is loosely coupled, but the operating-system software is tightly coupled.

Another system on which we have Concurrent C is a shared-memory multiprocessor. Here Concurrent C is implemented on top of a real-time multitasking kernel. In this system, both the hardware and the software are tightly coupled.

Concurrent C is being used for such applications as simulation studies, graphics, image analysis, and network protocol experiments, and for a network file server that has an optical disk "jukebox." The file server is completely written in Concurrent C, including the disk drivers and interrupt handlers, and has been in production use since January 1989.

That file server has 30 processes of 20 distinct types and takes only about 20,000 lines of code. Even at that, more than half the code is in the drivers for the optical disks and for the jukebox robot that moves disks in and out of drives. As you can see, it is an efficient language for this kind of application.

In a large Concurrent C program, such as the optical disk driver, most of the code is ordinary sequential C, with a small amount of Concurrent C code used as "glue logic" to let the processes communicate. The advantage of Concurrent C is that it lets the programmer transform a large concurrent programming problem into a series of small sequential programming problems that can be solved independently.

AT&T recently announced the availability of Concurrent C to the general public. The Concurrent C translator and run-time source code are available from AT&T to both academic and commercial users. For more information on the translator, please call (800) 828-8649. For more information on the language, see the book *The Concurrent C Programming Language* by Gehani and Roome (Summit, NJ: Silicon Press, 1989). ■

Narain H. Gehani and William D. Roome are members of AT&T Bell Labs' technical staff. Both have doctorates in computer science from Cornell University and have worked on building operating systems, file servers, and languages. They can be reached on BIX c/o "editors."

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STRENGTH (AND SAFETY) IN NUMBERS

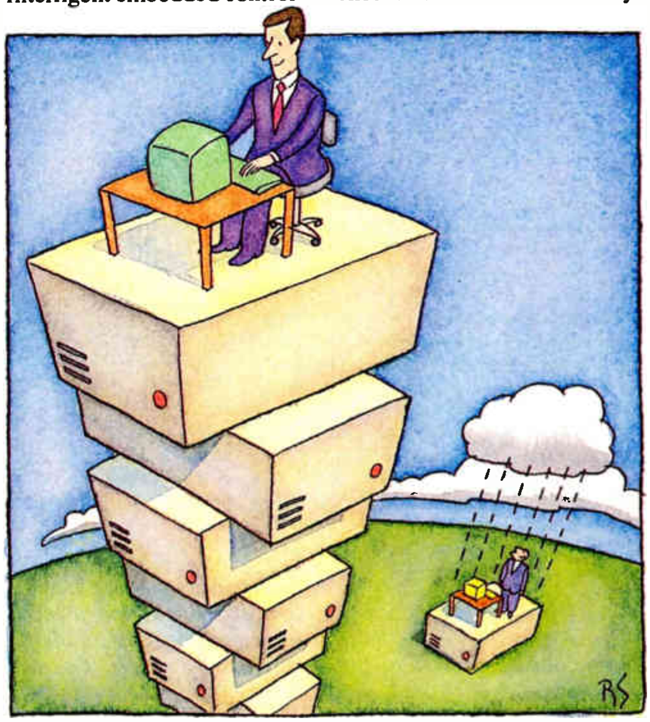
RAID, a new disk storage technology, offers PCs higher performance and reliability

Michael H. Anderson

An old adage says, "The difference between a computer and a supercomputer is the difference between a CPU bottleneck and an I/O bottleneck." As desktop computers move into the double-digit million-instructions-per-second range, I/O bottleneck is quickly becoming a reality.

Look at current technology. The newest generation of intelligent disk drives offers much higher performance than its predecessors. The data rates for 5¼-inch hard disk drives have reached 3 megabytes per second. Intelligent embedded controllers use sophisticated techniques to improve speed. SCSI controllers transfer data to host systems at speeds of up to 5 MB per second. Caching algorithms used by these drives maximize the use of on-board caches (from 64K to 256K bytes in size) with techniques that can double transaction rates.

Still, these performance improvements pale in comparison to advances in CPU technology. When benchmarks are run on new high-performance PCs, they often show a 30-to-1 performance increase (or better) over the standard IBM PC. In contrast, disk drive performance shows an increase of only 10 to 1 over the original 10-MB XT hard disk drive. This difference indicates that present systems achieve only one-third the relative performance from their disk I/O subsystem as the original IBM PC.



Performance benchmarks confirm this lopsided increase in relative performance. Figure 1 shows how the percentage of time devoted to disk I/O increases as the CPU speed increases.

Then there's reliability. Top-quality disk drives, in general, offer a *mean time between failures* (*MTBF*) of about 150,000 hours. Although this sounds like a lifetime, an installation with top-quality disk drives will experience a failure rate of about 6 percent per year. A system with 16 disk drives would experience a failure about once a year. For many installations, this failure rate would not be acceptable.

Network systems like Novell NetWare address the requirement for high data availability by using a technique called *mirroring*. This host device driver technique writes data to two disk drives simultaneously. If one drive fails, a copy of all the data is immediately available on the other drive. Data availability is ensured unless the second device fails before the first device is replaced, a very unlikely event. Mirroring is a good solution to data availability, but it requires users to purchase twice as much storage as they need to hold their data and programs.

RAID, a Better Solution

A better solution was described in a paper by David A. Patterson, Garth Gibson,

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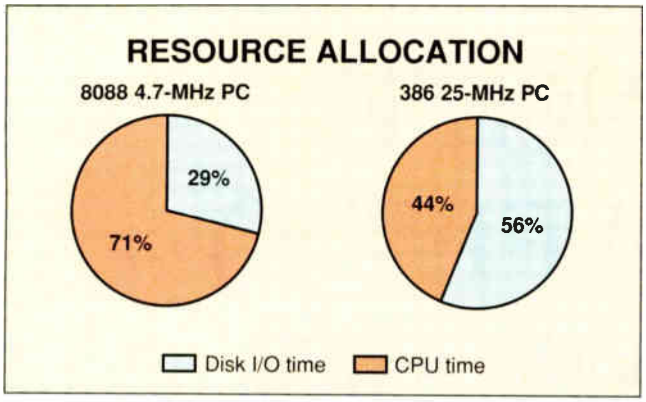

Figure 1: *As CPU speed increases, the percentage of time that programs wait for disk I/O to complete increases proportionately.*

and Randy H. Katz of the University of California at Berkeley, entitled "A Case for Redundant Arrays of Inexpensive Disks, or RAID" (Report No. UCB/CSD 87/391, December 1987).

A RAID system is a group of disk drives under the control of a single device driver. By grouping several drives together into a single subsystem and using clever techniques to arrange the data, a RAID offers much higher performance than single disk drives. You can build a RAID system from several types of disk drives, among them SCSI, which is an inexpensive approach commonly used by several vendors (see figure 2).

Figure 3 shows how data can be "striped" (i.e., a process of interleaving data blocks) across several drives so they can all work together. Since each drive transfers data in parallel with the others (multiplying the data rate), a four-drive RAID system can complete large read requests in one-fourth the time of a traditional system that puts all the data on a single disk.

Another benefit of a RAID is the rate at which small transfers can be satisfied. Since data from a single file is spread over multiple disk drives, each disk drive can satisfy a small read at the same time. A RAID can independently position each disk drive (multiplying the transaction rate) allowing a four-drive RAID to satisfy four times as many small read requests as a traditional disk drive. This high transaction rate is especially important to users of network servers.

The final benefit of a RAID is its ability to withstand the failure of any single disk drive. By storing "check bytes," the RAID can reconstruct data from the remaining drives, should any single drive fail. A check byte is a byte that holds the "sum" of the data stored on the other drives (in the same position).

Using check bytes takes up an amount of storage equivalent to the total capacity of a disk drive. Nevertheless, a check-byte system provides fail-safe operation at a much lower cost than a mirror system. While a mirror system uses half the drives in a group for fail-safe operation, a RAID system uses the storage equivalent of only one drive. Thus, larger RAID systems have proportionately lower overhead.

This difference is transparent to the host computer. All that has changed is that data transfers are performed faster and the host can continue to operate even if one disk drive completely fails. A RAID can use off-the-shelf disk drives. All the logic to arrange the data and provide high performance can be contained in a software driver.

Building a RAID

To understand how to build an effective RAID, take a look at how existing disks interface to PCs. Older device-level interfaces, such as ST506 and ESDI, did not allow more than one disk drive to be active at the same time. In addition, most older controller boards used a technique called *programmed input/output*. PIO is a software technique that uses the IN instruction, which requires the CPU to transfer data from the controller board to memory.

Newer "buffered" interfaces, such as SCSI, allow up to

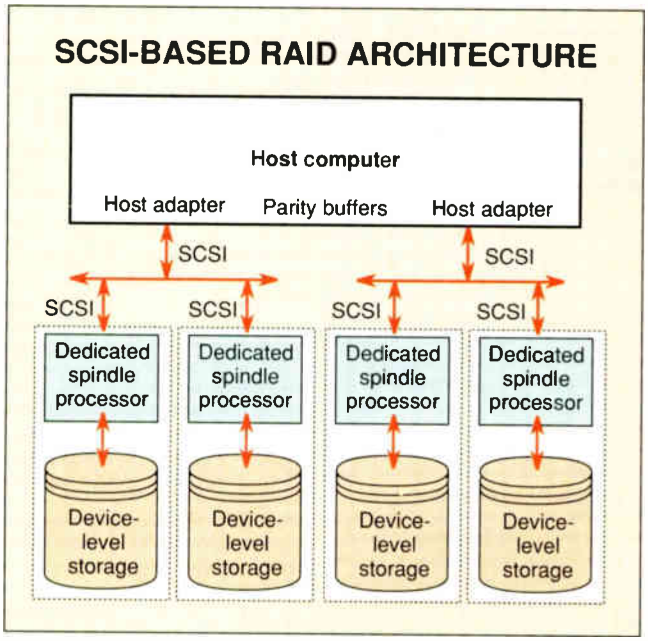

Figure 2: *PCs can use SCSI disk drives and controllers to provide RAID storage at low cost.*

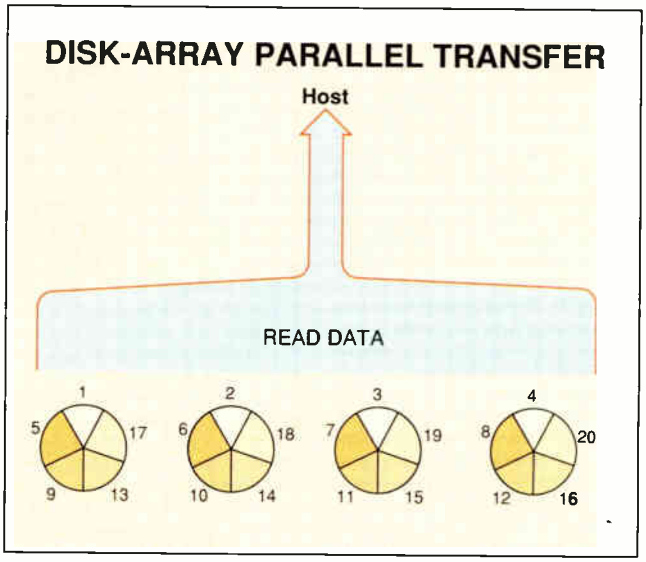

Figure 3: *Here you can see how data can be striped across four drives, allowing them to work in parallel and complete large read requests in one-fourth the time of a traditional single-drive system. The numbers represent the logical block number as defined by the RAID device driver.*

seven disk drives on a single bus to simultaneously stage data in high-speed memory. Also, many SCSI controller boards use a technique called *first-party DMA*. This is a hardware technique, defined by the AT bus, that does not require the CPU to transfer data.

In addition, first-party DMA uses only half as many cycles as PIO to read or write data, thus transferring twice the data in the same amount of time. Since the CPU is not involved in transferring data, multiple boards can work together to increase performance even more. Combined, these techniques can be applied to realize a twofold to 20-fold increase in disk subsystem performance.

Now I'll explain how you can generate check bytes and use them to provide fail-safe operation. Suppose you have three storage devices, each of which can hold 1 byte (8 bits) of data. Two devices will hold all the data that you wish to retrieve. The third device will hold a check byte generated by an arithmetic function called exclusive OR (XOR).

If device 1 holds the value 00110000, and device 2 holds the value 00000011, then the check byte stored in device 3 is generated by performing an XOR on these two values together, giving 00110011.

By storing this check byte in the third device, you can reconstruct the data of any of the three devices by examining the value of the other two (see table 1). This technique works for devices of any size, whether they hold a single byte or a billion bytes. Also, it works in systems with three devices or 300 devices.

This fail-safe feature is attractive to mission-critical systems. Even if one disk drive in the set fails, the RAID system can continue operating. However, the failed drive should be replaced right away. If a RAID system is properly maintained, it is likely to keep data on-line and available longer than the useful life of the host system.

How much does having this kind of data availability cost? Because of the high speed of current CPUs, check bytes can be generated rapidly without requiring any additional hardware. A typical 25-MHz Intel 386 can generate check bytes at the rate of 8 MB per second by using its powerful 32-bit instruction set. Higher-speed processors, like the i486, can generate check bytes even faster.

RECONSTRUCTING DATA FOR A FAILED DRIVE

Table 1: *Check bytes help multiple-drive systems provide fail-safe operation. The figures here represent three imaginary disk drives, each of which holds just 1 byte (8 bits) of data. By performing an XOR on the values on drives 1 and 2 (top), you generate a check byte, to be stored on drive 3. In the event that a drive fails (in this case, drive 1) you can reconstruct its data by performing an XOR on the check byte from drive 3 with the data from drive 2 (bottom).*

	00110000	Drive 1	(Data drive)
XOR	00000011	Drive 2	(Data drive)
	00110011	Drive 3	(Check drive)
	00000011	Drive 2	(Data drive)
XOR	00110011	Drive 3	(Check drive)
	00110000	Drive 1	(Data drive)

EFFICIENT RAID SUBSYSTEM DATA LAYOUT

Table 2: *Storing all the check bytes on a single disk drive can create a bottleneck. Spreading the check bytes over several drives allows multiple simultaneous writes to occur. Here, four drives store 12 blocks of data and the check bytes necessary to ensure the integrity of the data. As the number of drives increases, the performance increases proportionately.*

	Drive 1	Drive 2	Drive 3	Drive 4
Adr 1	Block 1	Block 2	Block 3	CB (1-2-3)
Adr 2	Block 5	Block 6	CB (4-5-6)	Block 4
Adr 3	Block 9	CB (7-8-9)	Block 7	Block 8
Adr 4	CB (10-11-12)	Block 10	Block 11	Block 12

Layout of Check Bytes

So far, I've shown how a RAID offers high performance by striping data, and how data availability is improved by using the XOR function to generate check bytes and to reconstruct the data of a failed drive. To complete the analysis, here's how to manage the data on your disk drives to attain the most efficient operation.

To keep your check bytes current, they must be modified each time you write data to any drive. If you choose to store all the check bytes on a single disk drive, you could create a bottleneck, slowing overall performance of your RAID system.

To avoid this problem, it is more efficient if you store some data and some check-byte information on each drive (as shown in table 2). Spreading the check bytes over several drives allows multiple simultaneous writes. In a four-drive RAID, this technique offers double the small-block-write performance of a system with all the check bytes on a single drive. As the number of drives increases, the performance increases proportionately.

RAID Performance Measurements

Measurements of prototype systems show that the RAID architecture can sustain data transfer rates of over 13 MBps on Extended Industry Standard Architecture and Micro Channel architecture systems. Transaction rates of 250 to 300 I/Os per second can be sustained under heavy load conditions. RAID systems can offer a 10-fold performance improvement over current disk I/O subsystems.

Many major computer suppliers already use SCSI disk storage devices and controller cards. These suppliers include IBM, Hewlett-Packard, Digital Equipment, AST Research, Wang, Sun Microsystems, and many others. The RAID architecture can be implemented as a device driver on any operating system in software. A large installed base already exists that could exploit the potential of RAID systems.

The cost, performance, and data-availability features offered by the RAID architecture are so attractive that there is little doubt a new generation of I/O subsystems will become available in the near future. As this technology emerges, you may notice that the incessant "blinkety blink" of your disk drive LED will fade to just a flicker. ■

Michael H. Anderson is director of subsystem engineering at Micropolis Corp. (Chatsworth, CA), a manufacturer of 5¼-inch hard disk drives. Previously, he designed large, fault-tolerant caching controllers and performance-analysis tools for IBM, CDC, and Unisys mainframe systems. You can reach him on BIX c/o "editors."

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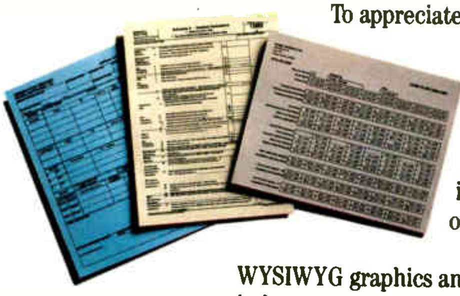

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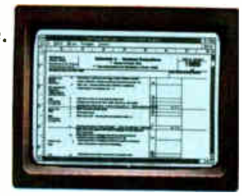

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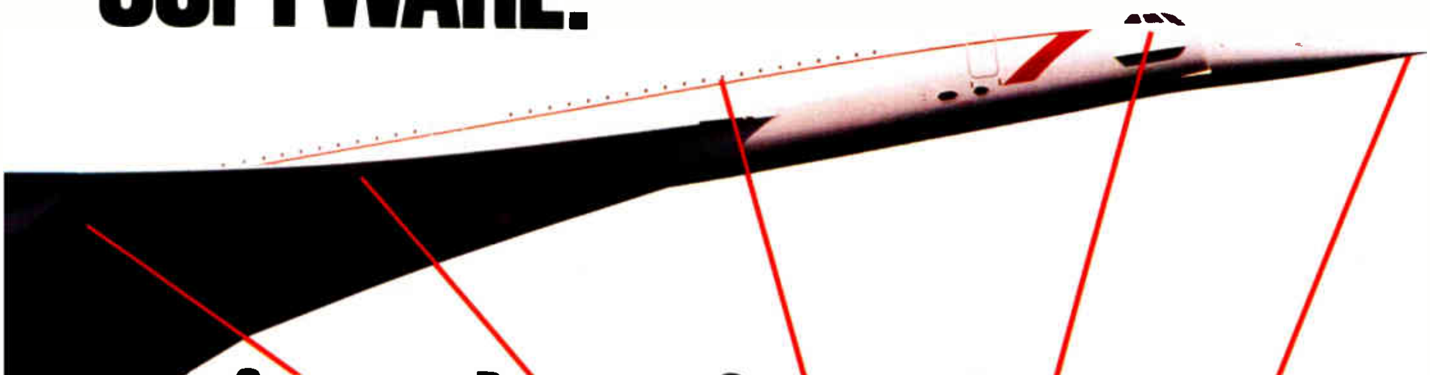

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Circle 142 on Reader Service Card (RESELLERS: 143)

X.400: STANDARDIZING E-MAIL

An OSI protocol brings new life to E-mail

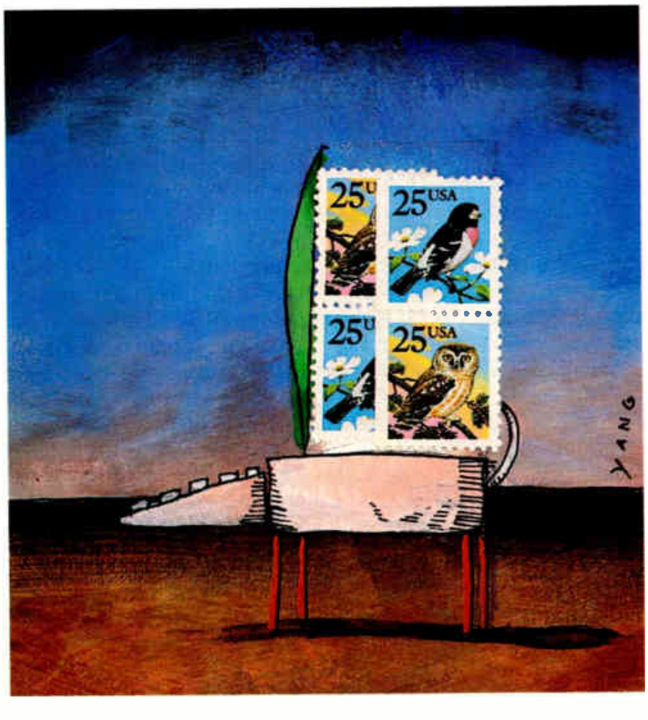
Steven J. Vaughan-Nichols

For many years, E-mail has not lived up to its promise. Early data communications prophets hailed E-mail as the next revolution in communications. It hasn't worked out that way. Instead, fax machines have become the mainstay of modern office communications. Messaging has been around a long time: Fax is a technology with its roots in the nineteenth century, and couriers date back to the runner bearing the results of the battle of Marathon to Athens.

In today's business world, where faster is always better, E-mail, which is unparalleled in speed, would seem to be the perfect mode of communication. However, few businesspeople and PC users have bought into this line of thinking. There are a number of reasons why.

E-mail requires users to do more than merely insert a document into a fax machine. And, more important, until recently E-mail systems were proprietary, closed systems—each an island unto itself. You could send messages from one isle to another, but it required telecommunications wizards to keep these links and their gateways working.

Each E-mail system was developing on its own path, and each evolutionary step meant that communications between networks needed constant adjustment. Even when the connections worked well, they required users to do a lot.



Every E-mail system has its own addressing scheme. To send messages to people at their ARPANET mailboxes, for instance, you had to use a totally different address format than if you were mailing a note to someone on MCI Mail. The result was that E-mail faltered from lack of public acceptance. X.400 may be the answer to this problem.

X.400 may sound like the name of the Air Force's newest stealth fighter, but it's really a telecommunications standard that lets E-mail users send messages to users on different E-mail systems. This rapidly growing telecommunications addressing standard is making E-mail an attractive alternative to fax and overnight mail services.

X.400 provides a single addressing scheme that works on every E-mail system. No longer do users have to remember whether an address has to include an exclamation mark, a slash, an at symbol, or some combination thereof.

The X.400 Standard's Family

X.400 is a CCITT standard that defines how an intersystem mail message is addressed. Working X.400 systems include not only an addressing standard but also a host of other CCITT standards. Among them are X.401, which describes the basic intersystem service ele-

ILLUSTRATION: JAMES YANG © 1990

Where once you could easily reach only subscribers to your own system, X.400's new addressing scheme allows you to reach out to E-mail users on all the major systems.

ments, and X.411, which defines message-transfer protocols.

The most important member of the X.400 family, though, is probably X.410, which defines mail-handling protocols. Specifically, X.410 is concerned with how standard Open Systems Interconnection protocols work to support E-mail applications. True E-mail connectivity is possible when you bring E-mail systems into accordance with OSI protocols—the backbone of network standardization. The first mature product from the topmost OSI applications layer is X.400.

Like any other new standard, X.400 has had its share of teething problems. A prime example is that you can't reliably send binary files or Group 3 faxes (today's most popular high-speed fax standard) from one network to another. The ability to do so is part of X.400, but real-world implementation has been spotty.

As X.400 becomes the international standard for E-mail, many systems are introducing foreign E-mail connections. U.S. Sprint, with its established base of systems using its Telemail software, leads the way in this area.

Telemail private mail domains, however, may not have access to all external systems. This situation is not the result of a technical problem. Rather, administrators of these networks have decided not to activate connections with all possible E-mail domains. Some IBM proprietary E-mail systems, though, have X.400 gateways to Telemail.

There are other difficulties to be overcome before a LAN E-mail system can use X.400. A gateway from a LAN to an X.25 packet-switching network like Telenet or Tymnet is a necessary part of an X.400 system, but X.25 gateways still aren't commonplace.

Many E-mail manufacturers are wrestling with how to implement and test X.400. In 1989, a group of vendors successfully founded the X.400 Application Program Interface Association. APIA's goal is to develop the application programming interface between LAN E-mail systems, wide-area-network E-mail systems, gateways, and X.25 networks. Now, products using the X.400 API can connect your office's mail system (whether it be LAN-based or built around Digital Equipment's All-in-One system on a VAX) to the outside world, but you still can't simply plug in a black box and go.

So Why X.400?

The advantages of X.400 outweigh the disadvantages, however. From a system administrator's standpoint, an X.400-equipped E-mail network can easily transfer messages to another X.400 system without any of the headaches of earlier methods.

New communications connections to foreign E-mail systems can take only a few days (and considerably less sweat) instead of months to implement. Tracking down why a message hasn't been delivered is also much simpler. In transfers between non-X.400 systems, though, it can be impossible to figure out the fate of a mislaid message.

For users, X.400 provides several clear advantages. The first is that they won't have to contend anymore with a dozen different, confusing addressing schemes filled with @ and % signs. But the most dramatic advantage that X.400 brings to the E-mail universe is that its standardized addressing makes contacting other systems' subscribers almost as easy as calling Frank next door. The number of people you can reach by E-mail has expanded enormously.

Where once you could easily reach only those on your own system, the new addressing scheme allows you to reach out to E-mail users on all the major systems, such as U.S. Sprint's Telemail and MCI Mail. With this ease of connectivity, E-mail visionaries with multiple mailboxes will be able to close down all but one of their network addresses.

Elementary, Mr. Watson

X.400 addressing is a straightforward process. The E-mail system administrator assigns a unique originator/recipient name to every user. The format for the O/R is "keyword:value, keyword:value." Each keyword represents an address element. More than 10 address combinations are possible, but most E-mail systems use far fewer for most O/Rs.

Every address contains some common elements. For instance, all X.400 addresses include an ADMD—Administrative Management Domain. An ADMD is a public mail system (such as MCI Mail, AT&T Mail, or Telemail) that serves as a message-transfer system. Private mail domains, or PRMDs, such as Goddard Space Flight Center (GSFC), NASA mail systems (NASAMail), or a LAN E-mail system, can be attached to public networks like Telemail or MCI Mail.

Individuals are uniquely identified in their home mail system by a user name, user number, or a combination of first name and surname. Each keyword must be assigned a value. So, for example, a NASAMail user O/R would look like this: ADMD:Telemail, PRMD:NASAMail, FN:John, SN:Doe. The exact order in which the keywords and values are listed is unimportant. SN:Doe, FN:John, PRMD:NASAMail, ADMD:Telemail would work as well.

In practice, it works like this: To send a note from MCI Mail to a user on Telemail, you would type in the receiver's last name and the letters EMS in parentheses. MCI Mail then prompts you with `EMS`. Here, you key in the ADMD name. The system responds with `MBX:`. At this point, you type in a single element of the O/R—for example, PRMD:NASAMail, for a recipient on this private mail system. You would continue in this vein until you have input enough pieces into the O/R for the receiving system to identify the addressee.

To be sure of getting a message to someone, however, you must have his or her exact electronic address. It is still difficult to determine when you must use an elaborate address to ensure that your message won't just disappear into the electronic haze. That is one important element of E-mail that has yet to be perfected before it can offer effortless, universal communication. X.500 will solve this problem, but it is still a few years away.

As defined by the CCITT, X.500 is a directory assistance system for the computer age. X.500 database systems will contain the E-mail addresses of all users with accounts in X.400-compliant systems around the world. This global directory may take a while to appear in final form. By 1992, though, enough of the system will be up to empower X.400 communications.

continued

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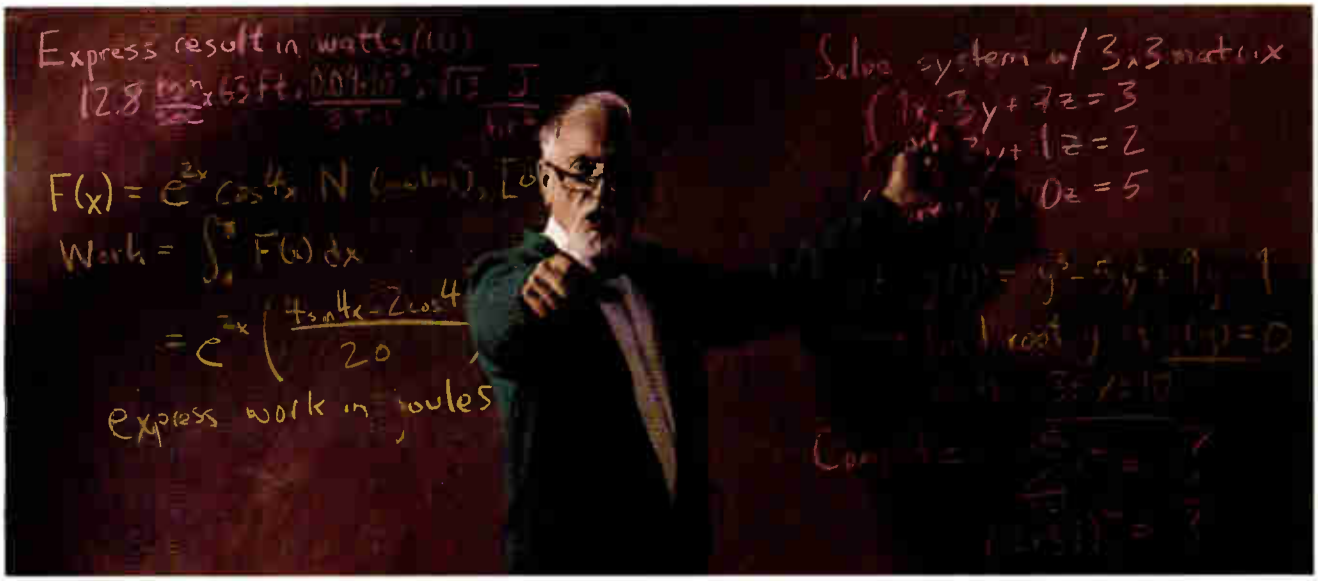

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Circle 182 on Reader Service Card

MAJOR U.S. E-MAIL VENDOR X.400 CONNECTIONS

More connections are being made between E-mail carriers every day. On-line services such as CompuServe are also working on implementing X.400. Telemail private mail domains may not have access to all systems.

E-mail service	AT&T	IBM	MCI	U.S. Sprint (Telemail)	Telecom Canada	Tymnet	Western Union
AT&T			X	X	X	X	X
IBM	X		X	X			X
MCI	X	X		X		X	X
U.S. Sprint (Telemail)	X	X	X				X
Telecom Canada	X						
Tymnet	X		X				
Western Union		X	X		X		

X = Presence of an existing X.400 link between the two systems.

This super phone book will remove X.400's last technical problem.

End of Message

There is one other business consideration that may delay the day when X.400 becomes the be-all and end-all in E-mail: billing—who gets billed, why, when, and how. With dozens of proprietary and open E-mail systems stretching around the world, it's not easy to agree on this matter. Progress has been made, though, and X.400 connections are either in existence or being completed among all major E-mail systems. See the table for current status of X.400 connections between major E-mail vendors.

X.400 has been a slow-growing force. Although the technical and administrative groundwork has taken years to complete, the first fruits are now available. With the maturity of X.400, E-mail may become the dominant force in business communications. ■

Steven J. Vaughan-Nichols is a freelance writer and a programmer/analyst for Bendix Field Engineering Corp. (Seabrook, MD). He can be reached on BIX as "sjvn."

UNIX WITH A MICROSCOPE

Minix isn't for everyone, but it's a great low-cost Unix to study

Tom Yager

PART Five

Imagine the benefits of writing your own operating system. You would know where everything was and just how everything worked. If anything stopped working, you'd merely make some changes to the source code and recompile.

Universities have long enjoyed this type of arrangement with Unix. Although the University of California at Berkeley is most renowned for its Unix work, many institutions have Unix source licenses and use Unix code as the subject of study. Those of us *not* involved in the educational system, however, have a tougher time of it. A Unix source license costs thousands of dollars, well out of the reach of most individuals.

A few years ago, Andrew Tanenbaum changed the face of computer education with his book *Operating Systems: Design and Implementation* (Prentice-Hall, 1987). The book describes a Unix-like operating system, Minix, and includes pages of source code and lucid discussions of operating-system concepts. I thought it was the best book on operating systems I'd ever read. Back then, you could send $79 to Prentice-Hall, and it would send you the disks for the Minix operating system, *with full source code*. What's more, Minix required only an ordinary PC to run and didn't need a hard disk drive.

Fast Forward

Some time has passed, and now Tanenbaum, along with Prentice-Hall and a handful of associates, has introduced Minix 1.5. It still runs on a plain old 8088 PC, but some new twists have been added.

The Minix of today includes software development, full-screen editing, and text-processing tools. On a 286 or better, Minix runs in protected mode, using all the extended memory you have available. It works with PC hard disk drives. Versions of 1.5 are also available for the Atari ST, the Amiga, and the Macintosh.

If you're one of those hung up on having "the real thing," you should know that Minix is system-call compatible with version 7 of Unix. That's about as close to complete emulation as you can get; an amazing feat, considering that no AT&T source code was used. Many of the Unix faithful believe that version 7 was the last worthwhile release of Unix (the argument is that it has become too fat and unmanageable since then).

Getting There

Minix comes on 17 360K-byte disks and is accompanied by a 680-page manual (over half of which is a source code listing). The packaging is almost suggestive of a commercial-quality product, but don't be fooled: You won't be running your spreadsheets and database managers in Minix.

PC Minix always boots from a floppy disk, according to the documentation. The operating system is small; booting it takes three disks but only a few seconds. It starts up with a menu that allows you to select the root device, change keyboard maps, and set the size of the RAM disk. That's an important point: Minix is optimized to run with its root partition on a RAM disk. Booting entirely from floppy disks includes loading a root file system image into the RAM disk.

Installing Minix on a hard disk is something of an ordeal, but it is an education in itself. As with the rest of the documentation, there is very little of the hand-holding typical of modern operating-system manuals. It is likely that, even if you're an experienced Unix user, you'll wind up going through the installation process more than once. In my case, I had to switch from a Compaq Deskpro 386/25e to a genuine IBM AT because the installation would not work properly on the Compaq.

As an example of how Spartan the Minix installation process is, consider the disk-partitioning software, `fdisk`. You need to supply it with the number of heads and sectors on your hard disk, and it won't stop you from allocating cylinders that extend past the end of the disk.

Is this a problem? Is the lack of a "do everything" installation script a problem? I guess users expecting a commercial Unix might see things that way, but anyone who bought Minix for the right reasons would see it instead as a challenge: If you

ITEMS DISCUSSED

Minix 1.5 .... $169
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don't like the way fdisk works, you've got the source code; change it or write your own!

A User's Point of View

I was surprised almost to the point of shock at just how complete the new Minix environment is. Not only will you find the standard Unix utilities but also some of the things that make living in Unix easier to bear: clones of popular Unix extensions, like the vi and emacs full-screen editors and even a slimmed-down nroff text-formatting tool.

A few key things are missing, with UUCP (Unix-to-Unix copy) topping the list. (Unix connectivity doesn't even start until you have UUCP.) You can achieve some file transfer in Minix with Kermit and ZMODEM, both of which, some would argue, have advantages over UUCP. You'll probably see UUCP eventually, since large portions of Minix 1.5 are the result of source code donations from some talented programmers.

The vi clone (called elvis), for example, is accompanied by the README file that identifies the author and places the code in the public domain. There are over 16,000 participants in the Usenet newsgroup comp.os.Minix, which is always overflowing with tips and new programs just for Minix.

Among the missing elements in Minix are certain features in a few of the programs. The nroff and emacs clones, for instance, are missing enough functionality that macro files imported from other systems probably won't run. Again, you should take these shortcomings as "exercises for the reader." Actually, most of the hard work has been done for you; if you see something you think you'd like, add it. As a courtesy to other Minix hackers, upload the changes to the Usenet. Your code may end up in the next release of the operating system.

Developing an Interest

A discussion of Minix would be worthless without talking about its most valuable asset—the source code. There are some 125,000 lines of C code—tiny by modern operating-system standards—all copied to your hard disk during installation.

I have worked with source code from AT&T, Berkeley (BSD Unix), and the Open Software Foundation, and I can attest that most Unix source code is abominable and obscure. In contrast, even the Minix kernel source code is impeccably commented. You can flip to any page in the source listing, read a few lines, and actually understand what's going on. With Tanenbaum's book as a companion, you could transform yourself into a qualified operating-system hacker in no time.

For those with less lofty aspirations, Minix's source code still holds value. As long as you don't resell it, you have the right to modify Minix any way you please.

For example, imagine that you wanted to set up a multiline BBS or customer-support system. Minix has all the building blocks in place: serial-line support, full-screen terminal control, text editors, file I/O, E-mail—everything you need to get started. A primary concern on a BBS is security, so you might set about "fixing" a number of utilities (e.g., log-in, mailers, and text editors) so they could save files only to a certain area, and they'd check to ensure that users weren't taking up too much space. You could climb all the way down to the code that controls the file system, making sure even the cleverest BBS buster can't touch restricted files.

Minix includes a Kernighan and Ritchie-compliant C compiler (for which source code is optional). The make files for each major operating-system component are provided; recompiling any portion of Minix usually requires only that you change to the appropriate directory and type make.

In addition to hacking on Minix sources, the Minix environment is quite useful for producing original programs. The console understands ANSI escape sequences, and a library of termcap-compatible display-control functions can be blended into your programs. Minix C supports over 225 library calls, and since version 7 compatibility is included, you can port some public domain Unix programs. But, here again, something is missing: a debugger. The Motorola 68000-based versions of Minix support debugging, but the PC version lacks any sort of debugging tool. There is a disassembler, but that's it. Some programmers can't work without debuggers, while for others, stuffing printf statements into their code is sufficient.

We Need to Talk

One unusual part of Minix, buried in the back of the manual, is its networking capability. The PC version of Minix includes support for a proprietary network using Western Digital Ethernet cards. At the protocol level, Minix's networking is based on remote procedure calls (RPCs) and works at a level very close to the hardware. The documentation claims that this results in file transfer rates three times higher than TCP/IP. It is *not* TCP/IP, so you won't be connecting it to your Unix LAN.

The networking support is not proprietary to Minix, but rather to another operating system called Amoeba. Developed at the Vrije University in Amsterdam, Amoeba is a distributed operating system built to handle dozens of processors. For Amoeba, its self-styled RPC mechanism is the method of choice for intermachine communications, and this mechanism is compatible with the one rolled into Minix.

Even though there is no Network File System-like file sharing, you can create seamless connections between machines with crafty use of the Minix networking utilities. A program called to, for example, allows Minix shell pipes to connect two machines. Minix also includes the tools necessary for creating and operating custom-built clients and servers.

Let's Hear It for the Little Guy

If you want to get your hands on a well-written Unix, including source, Minix is the most inexpensive way to do it. Be aware of what you need. If all you really need is a compact Unix system for the 286, get Xenix, for which there are hundreds of commercial application programs. Don't expect to run anything under Minix that you didn't compile yourself. This degree of do-it-yourself spells joy for some and misery for others.

Minix is not an operating system for general use, although it held up well to the beating I gave it. It is an operating system for studying, even if you're not a student. Those who have no use for the source code would be better off with Coherent or Xenix. But, even if you don't think operating-system hacking is for you, you won't lose from working with Minix. ■

Tom Yager is a technical editor for the BYTE Lab. He can be reached on BIX as "tyager."

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Filing vs. Archiving

Document image processing is a new technology which has just begun to evolve. The myriad of hardware devices on the market, and the lack of an industry standard protocol for communicating between them, make the integration of an electronic filing system a formidable task. And without intelligent software to control all aspects of the storage, management, and retrieval of documents, the filing system will be nothing more than a micro-fiche machine in disguise.

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Scanner, Fax, Word Processing, Host Computer, Etc.
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EASIER STRINGS FOR THE MAC

Get a handle on Mac strings with this C++ class

Jan G. Eugenides

One of the goals of any programmer is to write reusable code, especially when programming for the Macintosh. The C++ language structure encourages this goal, and I find it easier to "encapsulate" or consolidate routines that I once had to copy time and again into each new program. I'm making a real effort to put together a useful library of C++ classes. Here's one that lets you easily manage a certain resource.

The Mac has a STR# resource type (usually referred to as a *string list*) that's very useful in Macintosh programming. That's because text stored in a string list resource can be changed later, without recompiling the application code. This makes it easy to change an application's dialog box messages or menu items. This also allows the application's menus and dialog boxes to be converted to different languages (a process known as *localization*). The STR# resource begins with a short integer value that indicates the number of strings in the list, followed by a variable number of Pascal-style strings (which is a length byte followed by ASCII characters).

A Class Is Born

As useful as the STR# is, however, the Macintosh ROM Toolbox provides only one procedure, `GetIndString()`, for accessing an individual string from the list. There are no Toolbox routines for creating string lists, adding strings to lists, deleting strings from lists, or inserting strings into lists. That leaves it up to programmers to write their own code to accomplish this. To that end, I designed a C++ "StringList" class that provides all these missing functions in one easy-to-use package.

Listing 1 is the declaration of the StringList class. The source code for the functions is too long to include here, but it is available in electronic format (see page 5 for details).

Creating and Destroying Strings

Use the StringList class whenever you need to manipulate a list of Pascal strings, perhaps in a pop-up menu or a dialog box. Better still, the StringList class is valuable anytime your strings change dynamically at run time.

There are two constructors provided for the class, `StringList(short id)` and `StringList(short id,Str63 name)`. (A constructor initializes an instance of the class of which it is a member.) Using either of them is easy. You use `StringList (short id)` when you want to load and manipulate an existing STR# resource. If you assume the target STR# has a resource ID of 500, you pass this value to C++'s `new` operator, like so:

```
StringList* myList = new StringList(500);
```

If you want to create a new STR#, use the second constructor, passing in the value of the STR# ID you wish to create, along with a name for it, as a Pascal-style string. For example, to create an STR# with an ID of 600 and the name "Messages," you would write

```
StringList* myList =
            new StringList(600,"\pMessages");
```

When you are finished with a StringList, you can free the memory it occupies by calling the C++ `delete` operator, like this:

```
delete myList;
```

All changes you make to strings in the list are saved to disk continually. Calling `delete` removes only the copy in memory. If you need to remove the disk copy, use the Toolbox call `RmveResource()`, since string lists are resources.

Handling Strings

Once you have made a StringList (by either loading an existing STR# or creating a new one), you can use the six public member functions of the StringList class to manipulate it. These functions are listed in the table, and I'll provide brief descriptions of what they accomplish here.

continued

Listing 1: *The declaration of the StringList class, a group of routines for such functions as creating string lists, adding strings to lists, deleting strings from lists, and inserting strings into lists.*

```
#define INDEXOUTOFRANGE 100

class StringList{
protected:
     short    resID;      //The resource ID of this
                          //string list (STR#)
     OSErr    errcode;    //Error code of last operation
     Handle   stringsH;   //Handle to loaded resource

     Boolean Valid(short index);
     void Increment(void);
     void Decrement(void);
     void Save(void);
     void Revert(void);
public:
     StringList(short id,Str63 name);
     StringList(short id);
     ~StringList(void)
     void ReturnIndString(short index,Str255 str);
     void SetIndString(short index, Str255 string);
     void AddIndString(Str255 string);
     void InsertIndString(short index,Str255 str);
     void DeleteIndString(short index);
     OSErr Error(void){ return errcode; }
};
```

The `ReturnIndString()` function is analogous to `GetIndString()`: It returns in `str` a string from the list referenced by `index`. Passing 1 for `index` returns the list's first string, 2 returns the second string, and so on. `SetIndString()` replaces any existing string in the list with the contents of `string`. If `index` is out of range, an error condition results and no action is performed (see the description of `Error()`, below). `AddString()`, as its name implies, adds a string to the end of the list. `InsertIndString()` inserts `str` before the string indicated by `index`. For example, if there are five strings in the list, the following line of code would insert the string "Hi There" before the fourth string in the list:

```
myList->InsertIndString(4,"\pHi There");
```

"Hi There" becomes the new fourth string in the list, and the previous fourth string now becomes the fifth string. `DeleteIndString()` deletes the string indicated by `index` from the list and moves any succeeding strings to fill the gap. Finally, `Error()` returns the error code produced by the last operation on the class. It should be checked after any operation. It returns the appropriate Mac OS error code in most cases, such as insufficient memory (−108) or a resource error (−192 through −199).

Private Members

The StringList Class contains five private members. They are

```
Boolean Valid(short index);
```

STRINGLIST CLASS FUNCTIONS

Once you have made a StringList, you can use the six public member functions of the StringList class to manipulate it. See the text for descriptions of these functions.

Constructors for StringList class

StringList
(short id);

StringList
(short id, Str63 name);

Member functions of StringList class

void ReturnIndString
(short index,Str255 str);

void SetIndString
(short index,Str255 string);

void AddString
(Str255 string);

void InsertIndString
(short index,Str255 str);

void DeleteIndString
(short index);

OSErr Error
(void);

```
void Increment(void);
void Decrement(void);
void Save(void);
void Revert(void);
```

Because they are private members, they cannot be called by any code outside the class. They are used internally and are invisible to the caller. Another class may contain a routine called `Valid()`, for example, and it would not be confused with the `Valid()` routine in this class. Private functions are, well, private.

`Valid()` is called by the `SetIndString()`, `DeleteIndString()`, and `InsertIndString()` functions to ensure that the parameters are meaningful. This allows the calling program to detect error conditions via the `Error()` routine, which returns `errcode`. It also prevents the damage to the STR# that might be caused by operating with faulty parameters. The `Save()` and `Revert()` functions are used to save the STR# to disk, and to revert to the last saved version, respectively.

The `Increment()` and `Decrement()` functions simply modify the short integer at the beginning of the STR# to reflect the current number of strings in the list. Since this operation occurs regularly, I made them into separate functions for efficiency's sake.

Unfortunately, I don't have room here to describe exactly how the various functions work. I have commented the source code, however, so you should be able to tell what's going on fairly easily. If you have to deal with lots of strings inside your Mac application, I'm sure you will find the StringList class a handy addition to your private toolbox. If you have comments, I can be reached on BIX or by mail. ■

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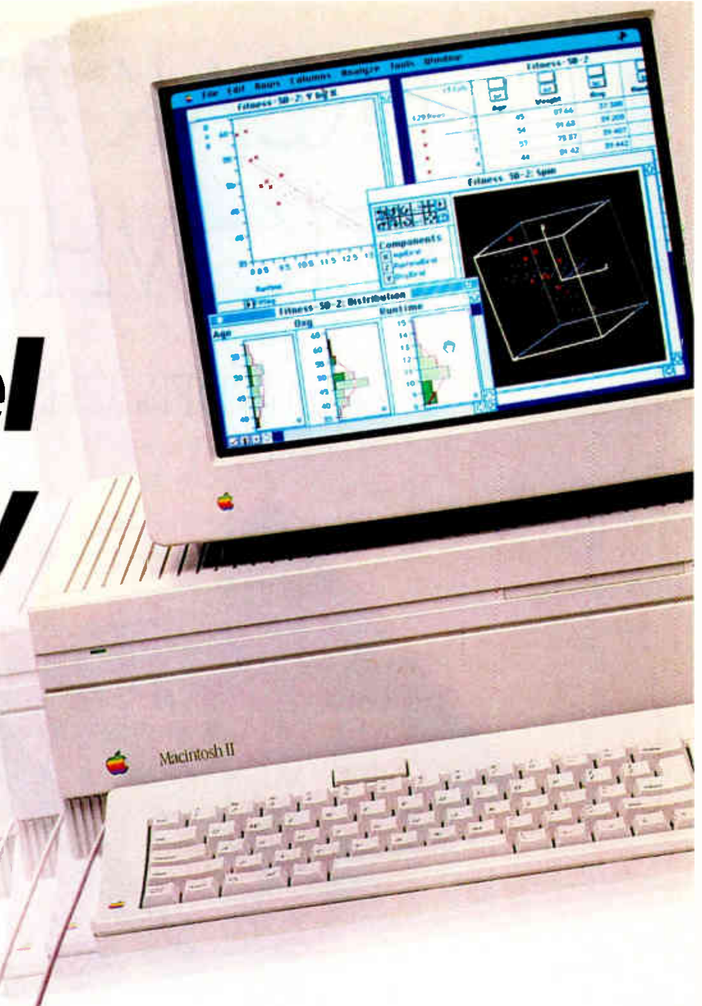

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VGA TO THE MAX

VESA creates a software standard for Super VGA

Ever since companies reverse-engineered IBM's EGA and produced compatible adapters, they have been pushing the IBM standards to their limits—first with Super EGAs, and more recently with Super VGAs. Both the EGA and VGA architectures (which are similar in many respects) suggest rather obvious extensions to accommodate higher resolution and more colors.

However, for many users, owning a Super VGA adapter hasn't been all it's cracked up to be. Dreams of glorious high-resolution color soon fade when you realize how few programs support the extended modes. Typically, you can get Super VGA-aware drivers for AutoCAD, Lotus 1-2-3, and, if you're lucky, Windows. But that's it. Most programs treat a Super VGA just like an ordinary VGA adapter. Why? There's been no standard way for programs to test for the presence of a Super VGA adapter, to identify what type of Super VGA is present, or to find out how to use its extended modes.

Enter VESA, the Video Electronics Standards Association, made up of several dozen leading manufacturers of graphics adapters, monitors, and software. The VESA Super VGA extensions let real-mode DOS programs recognize and exploit Super VGA hardware in a consistent manner. I'll focus on how manufacturers have extended Super VGA and how the VESA standard helps applications use those extensions.

Beefing Up VGA

The first natural VGA extension involves boosting the resolution of the display. Because of its bit-plane architecture, which locates several layers (or planes) of video memory in a single address range, VGA requires only 64K bytes of address space for its 256K bytes of on-board memory. Each high-resolution mode uses one linear bit for each pixel displayed. The highest standard VGA resolution, 640 by 480 pixels (hereafter expressed as 640×480), consumes only 38K bytes of the available 64K bytes. Boosting resolution to 800×600 fills 60K bytes of address space while maintaining square pixels and a simple addressing scheme. It also pushes close to the upper limit of the early multifrequency displays. Thus, 800×600 became one of the more popular high-resolution extensions.

The second natural extension is additional color. VGA memory is usually arranged in a planar configuration: four bit planes, or 16 simultaneous colors (2^4). But VGA has 8-bit registers. The Map Mask Register, which controls CPU writes to the various planes, usually reserves 4 unused bits. By enabling these (and making internal hardware changes to accommodate the extensions), Super VGA could support 256 colors. However, I've yet to see an adapter that works that way, probably because of the hardware modifications required.

Another possibility (implemented by the standard VGA mode 13 hexadecimal) is to address each pixel with one linear data byte, again allowing 256 colors. This method wastes CPU address space, requiring almost the entire 64K-byte segment for 320×200. But it greatly simplifies address calculations—you just multiply the x and y coordinates to get the byte offset of the pixel. This eliminates the bit offset calculation required by the planar modes.

The next step involves using more than one segment for linear byte-wise storage. The memory IBM reserved for video includes the 128K bytes that comprises the A and B segments. Fortunately, IBM

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VESA FUNCTION CALLS

Table 1: *With VESA calls, you can identify whether Super VGA is present and, if so, how to control its video modes and bank switching.*

4F00h	Return Super VGA information.
4F01h	Return Super VGA mode information.
4F02h	Set Super VGA video mode.
4F03h	Return current video mode.
4F04h	Save/restore Super VGA video state.
4F05h	CPU video memory window control.
4F06h	Set/get logical scan-line length (version 1.1).
4F07h	Set/get display start (version 1.1).

VESA MODES

Table 2: *Version 1.0 standardized the popular 800×600, 256-color mode and left plenty of room for growth. Version 1.1 added enhanced text modes.*

Version 1.0	
100h	640×400, 256 colors
101h	640×480, 256 colors
102h	800×600, 16 colors
103h	800×600, 256 colors
104h	1024×768, 16 colors
105h	1024×768, 256 colors
106h	1280×1024, 16 colors
107h	1280×1024, 256 colors
Version 1.1	
108h	80×60 text
109h	132×25 text
10Ah	132×43 text
10Bh	132×50 text
10Ch	132×60 text

chose to start VGA address at A000h (the older CGA standard began at B800h), so it is possible to extend resolutions by addressing two segments.

Of course, this technique won't work with a dual-monitor configuration. Programmers prefer two monitors for debugging: a monochrome monitor (and adapter) for viewing debugging information, and a VGA for the actual graphics display. Some spreadsheet users like to have a monochrome spreadsheet with color graphics on the other display. And some CAD users appreciate a full screen of graphics with the menus on a separate display. But in all such cases, the monochrome adapter uses address B000h, eliminating the B segment for VGA memory expansion.

Nevertheless, there are Super VGAs on the market that support 1024×768, 4- and 16-color modes (a 96K-byte footprint), and high-resolution 256-color modes with linear addressing (up to 480K-byte footprints). And these adapters still allow dual monitor configurations.

How do they squeeze such a large footprint into a 64K-byte segment? With an old technique popularized by the LIM/EMS standard: bank switching. The adapter lets the program select which bank (usually 64K bytes) of memory should appear at the A000h segment. Thus, a 1024×768 mode might have two 64K-byte banks, numbered 0 and 1. The first 512 rows would be in bank 0 and the last 256 rows in bank 1.

Extending VGA does create some problems. The easiest ones to deal with (from the programmer's view) are the adapter's internal timings and addressing. Such parameters are set once and, except for unusual applications, never altered. Adding new bits to a few key registers for additional colors is not very difficult, either. But which mode number should set an 800×600 mode, or any other Super VGA mode? How do you know if a Super VGA mode is available? With the more complex bank-switching schemes, how do you request a bank switch? How large are the banks, and what are their attributes?

VESA: Passport to the Extended Modes

The first VESA standard, which was created in April 1989, established mode 6Ah as an 800×600, 16-color mode. Except for the larger address space, programming mode 6Ah is identical to working with standard mode 12h (640×480, 16 colors). Both are planar modes with a 64K-byte address map—one plane for each primary color, and one to represent intensity. With the palette registers and the D/A converter, you can map a plane combination to any one of 262,144 different colors.

Before writing data to the adapter, a program must set the color to be written or the bit planes to modify. When reading data, the program must select a single plane (four reads to retrieve all data in a byte) or a particular color (16 reads to retrieve all data). In Super VGA mode 6Ah, a program accomplishes these tasks just as in mode 12h—that is, by standard VGA registers.

The Super VGA modes require faster scan rates for the display. Other timings, such as the retrace and overscan, require compensating adjustments. These timings can affect image size and placement on the display. In some cases, you may find yourself adjusting the screen controls every time you switch applications (for example, from an older 640×480 program to a newer Super VGA program). Accordingly, VESA has also set some display signal-timing specifications for 800×600 modes.

The next set of standards (October 1989) extended the BIOS calls. It established eight new graphics modes (all the way up to 1280×1024, 256 colors), five function calls, and several attribute tables. All the new calls are implemented as subfunctions of interrupt 10h, function call 4Fh. As with the IBM-defined video BIOS calls, register AH takes the function call (4Fh), and the subfunction goes in register AL. A revision of these standards (May) added five new text modes and two new function calls. All VESA revisions will be backward-compatible to the original. A list of the functions appears in table 1. The new modes appear in table 2.

VESA Functions

Function 0 (Return Super VGA information) confirms that a VESA adapter exists. The calling program must reserve a 256-byte area and pass a pointer via registers ES:DI. The VESA function returns a table of information that includes the current VESA version supported and a pointer to the valid video modes.

The program may determine the attributes of a mode by calling function 1 (Return Super VGA mode information). Like function 0, a pointer to a 256-byte reserved area passes through register ES:DI. The CX register receives the mode number. This function returns operational information such as memory layout and window properties (discussed later). The standards define enough detail so that a vendor can describe unusual non-VESA modes such as nonstandard resolutions or memory mapping (e.g., extended CGA).

Functions 2 and 3 simply set and return the video mode. Unlike the standard video BIOS routines, which use an 8-bit

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mode number, the VESA routines use a 16-bit mode number. Programs get and set the mode number by way of the BX register.

Function 4 saves all, or selected portions of, the Super VGA video state. The complete video state includes all the registers (including vendor-specific registers) and BIOS data areas, but not the video memory.

Function 5 (CPU video memory window control) sets or reads the current window (bank); it's a prelude to bank switching. Register BH sets the current mode (0 for set, 1 for read), BL selects the window (0 for A, 1 for B), and DX holds the bank number. VESA also provides a direct call for setting the current window—the address of the call is returned through function 1.

Version 1.1 of the specification adds two function calls that support scrolling and multiple display pages. Function 6 sets the logical screen width. A line longer than the display width may be subject to horizontal scrolling. Additionally, longer logical lines are useful for rounding out odd-length lines, so windows always break between scan lines rather than within scan lines. For example, a 640-column graphics mode (80 bytes wide) does not divide evenly into 64K bytes. This can be fixed by rounding up to 128 bytes (1024 columns).

Function 7 sets and reads the display start address. This allows for panning across wider logical screens set through function 6, for scrolling vertically, or for switching between two or more display pages.

The standards recognize that some adapters have unique modes or limited abilities. VESA provides information about vendor-specific modes in the form of mode lists and mode attribute tables. A program can search for a specific resolution, find the closest matching resolution (either VESA or vendor-specific), and determine the necessary programming information—all with VESA calls. Note that an adapter does not have to support each, or any, of the VESA standard modes. For example, I have yet to see a 1280×1024 VGA.

Figure 1: *In this diagram (right), the offset in video memory has changed from 0 to 1000h (the CPU continues to address segment A000h). The shaded area is the displayed memory in 1024-by 768-pixel, 16-color mode.*

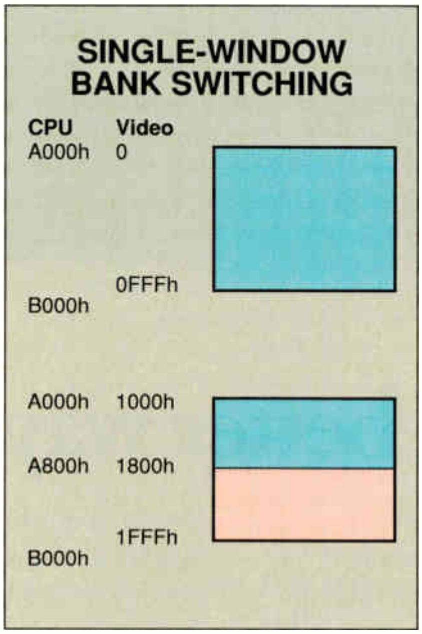
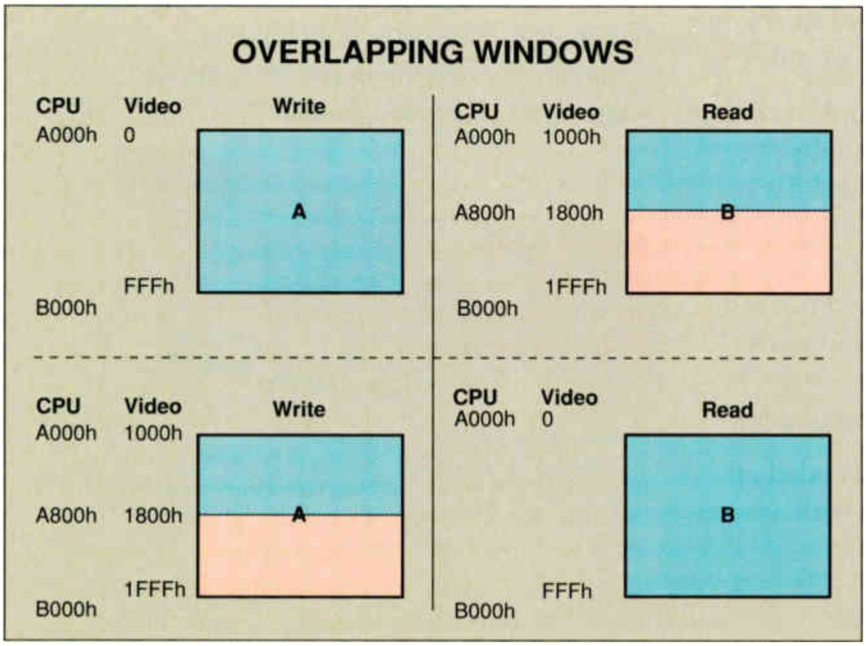


Figure 2: *Window A (below) is write-only, and Window B is read-only. Both are 64K bytes in length and addressed at segment A000h. The top half of the diagram represents an arbitrary initial state where you can read video memory at offset 1000h and write to video memory at offset 0. You might use this configuration to transfer an object from the nondisplayable memory in Window B to Window A. Moving to the bottom, both banks are switched, so you read from video offset 0 and write to video offset 1000h (e.g., to store background information from Window B in the nondisplayable area).*



Memory Windows

The standard VESA modes return information, too. This is especially critical for the bank-switching modes, such as 1024×768, and all the extended-memory modes (e.g., those that require VGA with 512K bytes of memory). There are three separate bank-switching techniques: single-window (see figure 1), dual overlapping windows (see figure 2), and dual non-overlapping windows (see figure 3). In each case, programs accomplish bank-switching with a VESA call or with a direct call to a bank-switch routine located with a VESA call.

With the *single-window* technique, the CPU can both read and write to the same address range—typically, a full 64K-byte segment. *Dual overlapping windows* map to the same address, but one window is read-only while the other is write-only. The two windows can map to the same bank, thus emulating the single-window technique (but requiring two function calls to switch banks). *Dual nonoverlapping windows*, a variation on the basic dual-window theme, occupy different segments—typically A000h and A800h—and are 32K bytes long. Nonoverlapping windows can also emulate a single window, in this case by selecting consecutive 32K-byte banks (also requiring two calls to switch banks).

Most programmers will probably emulate single windows to simplify their plotting routines. So why bother with dual windows? To improve performance when you are moving data between display areas. Since each window is independently addressable, you can move data from one area to any other without reloading segment registers. Applications that do animation or that maintain libraries of frequently drawn images (e.g., fonts) will work much faster if they exploit dual windows.

Programmers must be very careful not to assume that attributes for one adapter will apply to another, similar adapter (or even from mode to mode on a single adapter—I've seen multiple windowing methods on a single adapter). For example, you cannot assume that single-window systems will have 64K-byte banks—the banks may be smaller than the window size. The smallest address step is called the *granularity*.

Most Super VGAs use a 64K-byte window and 64K-byte granularity, but Paradise Super VGAs use dual nonoverlapped Windows with a 4K-byte granularity. Each window is 32K bytes: one at segment A000h and the other at A800h. Each window can be individually programmed to 4K-byte offsets within the adapter memory. A single-window emulation would use banks 0 and 8, not banks 0 and 1.

Once you master the bank switching, programming with VESA is basically the same as with the standard VGA modes. The addressing generally follows either the 4-bit planar model (e.g., 640×480, 16 colors) or the linear packed-pixel model (e.g., 320×200, 256 colors).

What VESA Means to You

One of the unique features of the VESA standard is that it supports existing hardware. In an industry that is driven by selling new hardware, I think it's exciting to see some recognition of a large installed base that has been underutilized. By August of this year, most of the major manufacturers had implemented version 1.0 VESA BIOS calls as TSR programs for their existing VGAs. A few had the VESA calls in BIOS.

The next big step is software that supports VESA. As of August, several shareware programs supported VESA. Two CAD applications, Microstation and Generic CADD, had VESA drivers. Although CAD and paint applications will be the first adopters of VESA, the extended text-mode support in version 1.1 will make VESA attractive to spreadsheet and word processing applications.

Of all the people I've talked to about VESA, Everex's Gary Lorenson is the most enthusiastic, and it's easy to see

In an industry driven by selling new hardware, it's exciting to see some recognition of a large, underutilized installed base.

why. Everex has several Super VGA models with different architectures. With VESA, Everex can distribute programming information that applies to all its VGA models rather than trying to document the differences.

Of course, there are still benefits to be had by writing for a specific chip set. By knowing which registers control bank-switching, or through special features such as direct-latch register writes, a programmer can improve the performance of an application—at the expense of portability to different adapters. I expect to see growing support for generic VESA drivers within programs over the next few years. But I doubt that customized drivers for popular programs will disappear. VESA primarily helps the software developer and those hardware vendors who have to support multiple architectures.

Note, however, that VESA is distinctly a real-mode standard. Writing a VESA driver for Windows 3.0 (which is something of a real-mode/protected-mode hybrid) would be a very difficult task due to the tight integration of the virtual device driver with the underlying hardware. Microsoft is looking into VESA but has not yet decided whether to participate. VESA is not useful for protected-mode applications such as Xenix, Unix, and OS/2. This is perhaps the biggest weakness of VESA—it is a software standard rather than a hardware standard. This is what makes VESA a significant advance, insofar as it supports old hardware, but it also restricts it from advancing to new operating systems.

VESA is unlikely to adopt a Super VGA hardware standard, for several reasons. Foremost, perhaps, is the fact that a hardware standard would give some companies an edge, since it would likely be built around an existing architecture. Also, a hardware standard would not be backward-compatible to the installed base of Super VGAs.

The VESA committee is looking at a generalized protected-mode library that could work across platforms such as the Phar Lap extensions, Xenix, Unix, and OS/2. But a generalized driver would be difficult to design and may not be practical if Super VGA is only a transitory phase on the way to graphics coprocessors.

continued

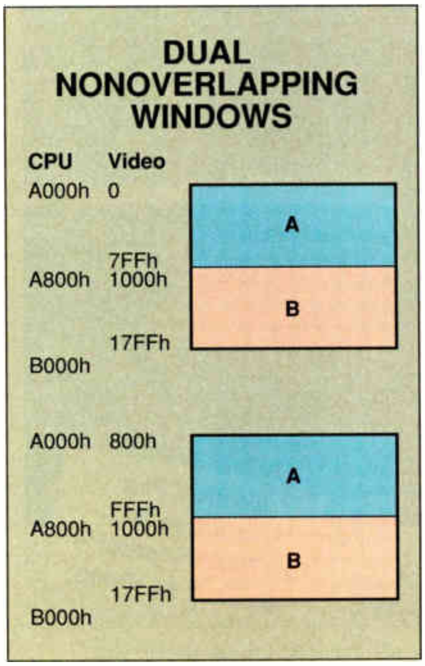


Figure 3: *The CPU addresses two segments: A000h and A800h. In the top half, the CPU can read or write to either the first or last 32K-byte portion of displayable memory. In the bottom figure, Window A has been moved to the second 32K-byte bank, while Window B continues to address the last displayable bank. In 1024- by 768-pixel, 16-color mode, there will be at least one more 32K-byte bank of nondisplayable memory, which could be used as supplementary storage for commonly used characters or objects.*

A Graphics Coprocessor in Every PC?

Will graphics coprocessors make VESA obsolete before it establishes a significant installed base? I doubt it. Already, VESA is available to most Super VGA owners for the price of a software update (either free or for a minimal charge) or a call to a vendor-supported BBS. This gives a potential installed base of millions of computers. The next stage is VESA support in applications software. I expect rather quick adoption here. It's difficult for developers to ignore higher resolutions and additional colors when the conversion from existing VGA programs is straightforward.

Despite the initial excitement over the Texas Instruments Graphics Architecture and the 8514/A, adoption of these graphics coprocessor standards has been slow. I think the primary factor working against graphics coprocessors is price. You still pay a premium for a graphics coprocessor—not just for the adapter, but for the monitor, too. Once resolutions push past 800×600, monitor prices go up dramatically. And although many coprocessors work at lower resolutions, the target market is 1024×768 and above.

Even when coprocessor prices drop (and they almost certainly will), the changeover from VGA to graphics coprocessors may be more evolutionary than revolutionary. One of the interesting aspects of the IBM-compatible market is that every aspect of a system must be cost-justified. Each computer is a collection of components tailored to an individual's budget and needs. Thus, even a few hundred dollars' difference between a coprocessor and Super VGA could tilt the balance in favor of VGA unless the coprocessor appears to improve performance significantly.

There are plenty of character-based applications that form the cornerstone of DOS-based computing. Graphics is more of a perk than a foundation for programs such as spreadsheets, databases, and, to some extent, word processors. Does it matter whether a 1-2-3 graph displays a few tenths (or perhaps only a few hundredths) of a second faster? Compared to spreadsheet recalculation times, minor improvements in graphics speed are practically insignificant.

The fate of Super VGA is probably more closely tied to acceptance of graphical-user-interface systems, such as Windows and OS/2—the areas where the VESA extensions are weakest. And since all GUI applications rely on graphics, a coprocessor begins to look more like a requirement than an option.

I think the VESA Super VGA standards have at least a few good years ahead. They should fill an important gap in the transition from VGA to whatever coprocessor standard establishes itself in the marketplace—and may have some staying power considering the older hardware standards that are still in use.

The VESA standard demonstrates a commitment to improve products that have already been sold, rather than to always push for something newer and better. It's a refreshing example of how cooperation between competing manufacturers can benefit the entire computer industry. ■

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MORE THAN JUST FAST

How to control SCSI devices on Macs and MS-DOS machines

Some time ago, I got the documentation on SCSI from ANSI. The documentation came in a binder I was reluctant to open. It was large, and any skimming I did got me lost in pages of command descriptor blocks. I decided I'd let someone else investigate SCSI.

But then the 300-megabyte hard disk drives started rolling into the BYTE Lab for our November Product Focus. There were printers, too, and optical-character-recognition devices. And they were all SCSI. So, I decided maybe SCSI was something I should investigate after all.

This month, I'll look at what goes into building programs to talk to a SCSI port. I hope you can take this information and carry it on to more sophisticated applications. And make no mistake, SCSI will let you get as sophisticated as you can bear.

You probably think (as I originally did) that the only place you'll see a SCSI bus is between a computer and some storage device—usually a hard disk drive or a tape drive—but I have seen SCSI ports tacked onto more and more peripherals. I've already mentioned some. My favorite, however, was a device that lets you connect a large-screen color video monitor to a Mac Plus through the SCSI port.

SCSI and the Mac

Macintoshes, beginning with the Mac Plus, have included a built-in SCSI port for attaching hard disk drives. Although the internal details of the SCSI hardware have changed (more on this later), externally the SCSI connection looks much the same on all Macs. There are some minor variations regarding power for terminating resistors, but most Mac-compatible SCSI peripherals are designed to work across the Mac line.

From the perspective of a programmer, the Mac Toolbox provides a remarkable amount of "precooked" support software. Table 1 shows a list of the functions offered by the Macintosh's SCSI manager. Communicating with a SCSI device involves a detailed series of phase transitions that your driver software must cope with. The SCSI manager will do much of that coping for you.

In particular, the manager includes routines for reading and writing data to a target device: `SCSIRead` and `SCSIWrite` (also, `SCSIRBlind` and `SCSIWBlind`—the "blind" I/O routines, which I will cover in a moment). When you ask the SCSI manager to execute a `SCSIRead` or `SCSIWrite`, you also pass in the address of a transfer instruction block, which is actually a series of instructions in a kind of pseudo assembly that the manager interprets and executes.

This pseudosubroutine tells the manager what to do with the bytes being transferred: how many there are, the buffer address in the Mac's memory to read from or write to, whether to do a byte-by-byte comparison while the data is incoming, and more. I've given a more detailed discussion of the SCSI manager routines in the March Some Assembly Required, "Foreign File Systems."

Differences and Details

All members of the Mac family (beginning with the Mac Plus) use at least some version of the NCR 5380 SCSI chip as the heart of their SCSI port. As with any family, though, the siblings have their differences. In the Mac family, these differences are in the hardware, which translates into differences in any software you build that has to talk to the SCSI port.

The difference between regular and

MACINTOSH SCSI MANAGER FUNCTIONS

Table 1: *Notice that the SCSI manager handles the protocol details for common I/O—reading and writing—so you don't have to.*

0	SCSIReset. Resets the SCSI bus.
1	SCSIGet. Manages the arbitration phase.
2	SCSISelect. Selects a target for future SCSI communications.
3	SCSICmd. Lets you pass a SCSI command to the SCSI bus.
4	SCSIComplete. Returns status and message information at the completion of a SCSI command.
5	SCSIRead. Reads bytes from a SCSI target.
6	SCSIWrite. Writes bytes to a SCSI target.
8	SCSIRBlind. Reads bytes from a SCSI target. Unlike SCSIRead, SCSIRBlind performs no handshaking. It's not a good idea on the Mac Plus.
9	SCSIWBlind. Writes bytes to a SCSI target without handshaking.
10	SCSIStat. Returns a 16-bit word whose bits reflect the condition of various SCSI signals.
11	SCSISelAtn. Identical to SCSISelect, with the exception that this command sets the SCSI ATN line. This signals the target device that you want to send it a message.
12	SCSIMsgIn. Receives a message from a target device.
13	SCSIMsgOut. Sends a message to a target device.

NCR 5380 REGISTERS

Table 2: *A short description of each of the 5380's internal registers.*

Current SCSI data: A read-only register that provides a snapshot of the current state of the SCSI data bus.

Output data: This write-only register is your program's portal to the SCSI data bus.

Input data: Provides latched data from the SCSI bus. This is distinct from the current SCSI data register, which simply reads the bus's current state. Data is latched into this register in response to an active-going signal on either the SCSI ACK or REQ lines (depending on whether the 5380 is in the initiator or the target mode; ACK is driven by an initiator, and REQ is driven by a target).

Initiator command: You can read and write this register. In read mode, it lets you monitor most of the SCSI bus status signals. Information gleaned from this register will also tell you whether arbitration is in progress and whether you've lost arbitration. In write mode, you can set most of the SCSI bus status signals. One bit in this register controls gating the output data register onto the data bus.

Mode: This is also a register that you can read and write to. As the name implies, flags in this register control the behavior of the chip: whether it's acting as target or initiator, whether DMA mode is active, and whether parity checking is enabled. Other bits in this register enable interrupts for the chip: parity error interrupt and end-of-process interrupt (used to signal the completion of a DMA transfer).

Target command: Yet another readable and writable register, it monitors those signals on the SCSI bus that determine the current bus phase. A target device would write to this register to set bus phases.

Current SCSI bus status: A read-only register whose contents reflect the current state of the SCSI bus status signals. Signals coming in through this register that indicate the current bus phase must match those you've written into the target command register before some bus transactions can proceed.

Select enable: A write-only register that lets you mask out a single ID during a selection phase. Simply put, you can use this register to trigger an interrupt if you attempt a selection to a specific target and the selection succeeds.

Bus and status: This read-only register returns the state of status signals not covered by the current SCSI bus status register. You can also monitor several internal states using this register—if a DMA transfer has completed, for example.

Note: *The remaining four registers are not registers in the true sense; there is nothing "in" them. Rather, an I/O operation on these locations triggers a specific event.*

Start DMA send: A write operation to this register begins a DMA send operation.

Start DMA target receive: Writing to this location causes the 5380 to begin a DMA receive operation in target mode.

Start DMA initiator receive: Same as the above register, only the 5380 acts as an initiator.

Reset parity/interrupt: This is a read-only regiser. A read operation to it resets the parity error bit, the interrupt request bit, and the busy error bit in the bus and status register.

blind I/O routines on the Mac Plus is obvious: The first mode is very picky about handshaking and checks the DRQ (data request) line on the 5380 before transmitting each character; the second mode checks DRQ only at the start of the transfer. Although the regular mode is slower (because an extra fetch and comparison must take place for each byte transferred), it is "safe" when compared to the blind mode (which checks DRQ only at the outset of a multibyte transfer).

Furthermore, on the Mac Plus, there are no real handshake connections between the CPU and the 5380, other than through the read/write control and data lines. Thus, if you want to watch goings-on on the SCSI bus, you have to monitor the 5380's internal registers.

Because the Mac SE and Mac II have hardware handshaking, their versions of `SCSIRBlind` and `SCSIWBlind` take advantage of this hardware. However, the blind versions on those machines can run aground on CPU bus errors if the bytes don't arrive quickly enough (about 270 milliseconds on the Mac SE and 16 microseconds on the Mac II).

Even if you use blind mode on the Mac Plus, you won't be violating any speed limits. You can only get up to a transfer rate of about 260K bytes per second on the Mac Plus. (In regular mode on the Mac Plus, the transfer rate is down to around 170K bytes per second.) However, blind mode I/O on the Mac II and Mac SE/30 can crank along at over 1 MB per second.

The Mac IIfx uses a custom SCSI chip—the SCSI DMA. This circuit has a built-in 5380. Thanks to the SCSI DMA, the Mac IIfx is the first Mac that can handle true DMA transfers along the SCSI bus; all Macs before it could—at best—use CPU-assisted pseudo-DMA transfers. Even with true DMA, it's important to point out that the CPU is not entirely out of the picture. DMA transfer moves only data; driver software must continue to execute on the CPU to handle all the protocol details.

DMA transfers can be 32 bits wide (doubleword-wide) rather than byte-wide. In fact, the SCSI DMA adjusts transfers to perform them at the 32-bit width. If you try to transfer, for example, data that begins on a word—rather than a doubleword—boundary, the SCSI DMA will perform the first transfer as a 16-bit word and the remaining transfers as 32-bit doublewords.

Having pointed out all the strengths of the SCSI DMA chip, I must finally pop its balloon and point out that, under Finder and MultiFinder, the DMA capabilities of that chip provide no real performance win. You'll get a speed advantage only when you're using a preemptive operating system—A/UX, for example. Happily, most SCSI software will run as is on the SCSI DMA (Apple's documentation indicates that software that uses hardware handshaking will have to be modified).

NCR 5380

The SCSI bus is really nothing more than a special-purpose bidirectional parallel interface. It doesn't take a great deal of hardware to put together a SCSI. In fact, I've seen some IBM SCSI cards that are not much more than bidirectional bus transceivers. These interface cards required software drivers that carried all the intelligence; that is, the software handled all the details of the protocol (e.g., when to set this bit and when to look for an active condition on that line).

I believe it was Don Lancaster who, in a *Kilobaud Microcomputing* article, said that the most efficient microcomputer solutions aren't all software and aren't all hardware; they are a proper combination of both. Enter the NCR 5380.

The NCR 5380 is much more than a parallel-interface adapter chip; it is specifically designed to support the SCSI bus. The 5380 has special on-chip high-current drivers that permit you to wire it directly to the SCSI bus. The only additional components needed are terminating resistors that SCSI cabling demands.

The NCR 5380's critical internal organs are its registers. There are 13 registers on the chip; some you can only read, some you can only write, and three you can read or write. I don't think a painfully complete table of the registers and their contents would be worthwhile here. It will be more informative if I present them in the context of a SCSI data transfer example. For your convenience, table 2 gives a short description of each member of the 5380's register set. If you want a more intricate description of the 5380, see the May and June 1986 BYTE Circuit Cellar columns.

Life as Seen by the 5380

A good way to get an idea of using the 5380 is to step through the different bus phases, examining how you must set—and respond to—the 5380's registers. I'll assume that the 5380 is connected to a host as an initiator. I'll also assume that the SCSI transaction that's about to take place is a simple one, consisting of the following phases (in order):

1. Arbitration
2. Selection
3. Command out
4. Data in or data out
5. Status
6. Message in

As you will see, there's also a possible message-out phase that can take place between steps 2 and 3. Before the arbitration phase and after the message-in phase, the SCSI bus is said to be in the "bus free" phase.

Arbitration is where contenders vie for the right to use the bus. In the simplest case—a host computer talking to one or more disk drives—this is no big deal. There's no one else to fight over the bus with. First stop: the mode register.

As its name implies, you use the mode register of the 5380 to set the chip's personality. Flags in this register control items like the following: whether the chip is operating as initiator or target, whether DMA is active, and whether interrupts are enabled.

To enter arbitration phase, you clear bit 0 of the mode register (the arbitration bit), load your SCSI ID into the output data register, and flip the arbitration bit to 1. That last flip sends your SCSI ID out on the data bus and starts arbitration.

Your next job is watching for bit 6 of the initiator command register to spring to a 1. This is the arbitration-in-progress bit, and it indicates when the 5380 has recognized that an arbitration phase is in the works. Once bit 6 is a 1, you look at bit 5 in the same register; bit 5 is the lost arbitration bit. If it's set, you've been beaten by someone else with a higher SCSI ID, and you'll just have to wait for the bus to become free again. Otherwise, you win, and you're allowed to go on to the next phase.

Now that you've won the arbitration, it's time to decide whom you want to talk to. This is the selection phase. When you pick whom you'll be conversing with, you've got to mention who you are as well. (This is to support reselection, which I won't get into here. It lets the initiator and target break their connection—letting others use the SCSI bus—while the target completes some time-consuming task. The understanding, of course, is that the initiator and target will renew their transactions in the future.)

To start the selection phase, you set

SCSI INFORMATION TRANSFER PHASES

Table 3: *You can determine the current bus phase by watching the three SCSI status lines: I/O, C/D, and MSG.*

Phase	I/O	C/D	MSG
Data out	0	0	0
Command out	0	1	0
Message out	0	1	1
Data in	1	0	0
Status	1	1	0
Message in	1	1	1

READ AND WRITE COMMAND BLOCKS

Table 4: *SCSI command blocks for read and write operations. Block numbers are 21-bit values. The command format shown is for group 0 commands; the group 1 versions of the commands allow for 32-bit block numbers and 16-bit transfer sizes.*

Byte offset	Description
0	Operation code; 8 for a read command, 10 for an operation mode.
1	Logical unit number in high 3 bits combined with the most significant 5 bits of the block number in bits 0 through 4.
2	Bits 8 through 15 of the block number.
3	The least significant 8 bits of the block number.
4	The number of blocks to transfer.
5	Various flags. The top 2 bits are vendor-unique. The low 2 bits control command linking, which lets your program construct a series of commands that are logically treated as a single operation.

the bits corresponding to both IDs. The result goes into the output data register on the 5380. You then set bit 0 (assert data bus) and bit 2 (assert select) of the initiator command register. This places the ID onto the data bus and turns on the selection bit. Immediately, you turn off the arbitration bit (by clearing bit 0 in the mode register), disable the select enable register (by filling it with zeros), and clear the BSY line by clearing bit 3 of the initiator command register.

Now you wait. The target, if it's there, should set the BSY line in about 250 ms. You monitor this line by polling bit 6 of the current status register. If it goes active, you've got a partner. Otherwise, it's time to jump to an error handler.

Assuming you've linked up with a target, you clear all the bits of the initiator command register except for bit 3, which keeps the BSY line active.

Next comes "Command out," which says, "Here's what I want you to do." (The SCSI protocol allows for any of the other phases at this point—a message-out phase is typical. The message-out phase lets the host send a message to the target. SCSI defines a number of message codes, ranging from the simple [e.g., "command completed successfully"] to the complex [e.g., "can you support synchronous data transfers?"]. The Mac, however, is atypical, and most targets skip directly to the command-out phase. I'll stick to the Mac as the host here.)

In this and the remaining phases, your job as initiator is the job of a servant; what you do—whether you send or receive—is selected by the target. (Seems backward, I agree, but I didn't write the standard.) You can determine the bus phase by watching bits 2 through 4 of the current SCSI bus status register. These bits reflect the condition of the SCSI bus I/O, C/D, and MSG lines, which in turn determine the current bus phase. (Table 3 shows status line settings and associated bus phases.) Additionally, you must set the low 3 bits of the 5380's target command register to reflect their counterparts in the current status register.

The rest is simply a repeated four-step process. Assuming you're in the command-out phase, it goes like this:

Step 1: Place the data byte to be sent in the output data register.

Step 2: Poll the current status register, waiting for bit 5 (REQ) to go active. This indicates that the target is requesting a byte.

Step 3: Set bit 4 of the initiator command register, turning on ACK and informing the target that the requested byte is on the bus.

Step 4: Poll the current status register, waiting for REQ to go inactive. When it does, you know the target has received the current data byte and is ready for the next. Turn off ACK, return to step 1, and repeat the process for the number of bytes you need to send.

During a command phase, the bytes you send down the SCSI bus in the above steps constitute the command descriptor block. Depending on the command type, the CDB can be 6, 10, or 12 bytes long. (Since the first byte of the CDB is the command code, the target can immediately determine how many bytes to expect during the command-out phase.) In table 4, I have shown the format of the 6-byte command versions for read and write operations.

The other phases—data in, data out, status, and message in—proceed just like the command phase. The only operational difference is the setting of the three SCSI status lines (MSG, C/D, and I/O). Finally, each phase I haven't mentioned yet serves a separate purpose; here are their typical uses:

Data in: Data requested with a read command is transferred from the target to the initiator.

Data out: The host has issued a write command; during the data-out phase, the data passes from the initiator to the target.

Status: The target sends a status byte to the initiator. It's hoped that the contents of the status byte indicate that the target has successfully completed the command.

Message in: The reverse of the message-out phase described above. The target sends a message to the initiator. The pseudocode in listing 1 should clarify the machinations of the SCSI phases I've described. There are three pseudoroutines in the listing that show arbitration, selection, and data transfer phases.

DOS and ASPI

The preceding discussion of the Mac and 5380 should have you seasoned for a visit to the DOS world. I will use Adaptec's advanced SCSI programming interface (ASPI) as a segue into SCSI programming on PC clones.

ASPI seeks to simplify the job of talking to a SCSI port; in a lot of ways, it's a

Listing 1: *These pseudocode routines show how to pilot the 5380 through fundamental SCSI operations. They presume the presence of a number of functions named after the 5380's registers (see table 2). These functions let you manipulate bits within the 5380's registers. For example, translate* `SCSI_MODE(ARBITRATE,SET);` *to mean "set the arbitrate bit in the 5380's mode register." These routines assume that you're operating as an initiator.*

```
{ This routine handles the arbitration phase and assumes
  that you've already loaded the global variable MY_ID
  with your SCSI ID bit set. }
DO_ARBITRATION:
{ Clear arbitration bit, place our ID in the
  output data register, and set arbitration. }
SCSI_MODE(ARBITRATE,CLEAR);
SCSI_OUTPUT_DATA:=MY_SCSI_ID;
SCSI_MODE(ARBITRATE,SET);

{ Place contents of output data register onto
  SCSI data lines. }
SCSI_INITIATOR_COMMAND(ASSERT_DBUS,SET);

{ Wait for arbitration in progress bit. }
REPEAT
WHILE(SCSI_INITIATOR_COMMAND(ARB_IN_PROG,VALUE)<>1);

( Get result of arbitration )
RESULT:=SCSI_INITIATOR_COMMAND(LOST_ARB,VALUE)

( Disable output data register )
SCSI_INITIATOR_COMMAND(ASSERT_DBUS,CLEAR);

RETURN(RESULT);
{ This routine selects the target device identified by
  the value stored in global variable HIS_ID. }
DO_SELECTION:

{ Logically OR together target id (HIS_ID) and
  initiator id (MY_ID). }
OUR_IDS:= HIS_ID OR MY_ID;
SCSI_OUTPUT_DATA:=OUR_IDS;

{ If you wanted to send a message to the target, you'd
  set the ATN bit in the next step. }
SCSI_INITIATOR_COMMAND(ASSERT_DBUS,SET);
SCSI_INITIATOR_COMMAND(ASSERT_SEL,SET);
SCSI_MODE(ARBITRATION,CLEAR);
{ Not generating an interrupt for the selection of
  our intended target. }
SCSI_SELECT_ENABLE:=0;
SCSI_INITIATOR_COMMAND(ASSERT_BUSY,CLEAR);

{ Wait for the BSY line to become active. This loop
  should have some sort of time-out control to handle the
  situation of an unresponsive-possibly absent-
  target. }
REPEAT
WHILE(SCSI_INITIATOR_COMMAND(ASSERT_BUSY,VALUE)<>1);

{ Turn off output data register to bus. }
SCSI_INITIATOR_COMMAND(ASSERT_DBUS,CLEAR);

RETURN;

{ The following pseudoroutine assumes global variables
  BUFADDR, which points to the start of a buffer that
  will hold the bytes received from the SCSI bus, and
  NBYTES, the number of bytes to read.
  DO_POLLED_READ reads bytes from the target using the
  polled mode; the CPU monitors the handshaking lines. }
DO_POLLED_READ:

I:=0;{ Will act as index. }

REPEAT
{ Wait for the REQ line. }
REPEAT
WHILE(SCSI_CURRENT_STATUS(REQ,VALUE)<>1;

BUFADDR[I]:=SCSI_CURRENT_DATA;
I:=I+1;

{ Handshake loop. }
SCSI_INITIATOR_COMMAND(ASSERT_ACK,SET);
REPEAT
WHILE(SCSI_CURRENT_STATUS(REQ,VALUE)=1);
SCSI_INITIATOR_COMMAND(ASSERT_ACK,CLEAR);

NBYTES:=NBYTES-1;
WHILE(NBYTES<>0);
RETURN;
```

potential PC counterpart to the Mac's SCSI manager. (I'm not endorsing ASPI, just pointing out its parallel to the Mac SCSI manager.) From what you've seen to be involved in communicating directly to the 5380 on the Mac, the concept of ASPI is a welcome one. In a capsule, the ASPI driver suffers all the timing headaches so your application doesn't have to. You simply tell ASPI what SCSI command you want executed, and it does all the rest. You don't even see arbitration phases and message phases and so on.

The ASPI routines are loaded as a device driver. You insert a DEVICE = ASPI4DOS.SYS line in your CONFIG .SYS file, and when your machine boots, the driver is loaded into RAM. (There are a number of options you can specify when the driver loads; in the interest of simplicity, I won't go into them.) You can then access the driver using the DOS file-open function (INT 21 hexadecimal, function 3Dh). The driver's name is SCSIMGR$, and the open call will return the handle to the ASPI driver. Next, you issue a DOS IOCTL (I/O control) read function (INT 21h, function 44h), which returns to your application with the entry point to ASPI tucked into the DS:DX registers. With the entry point in hand, you're ready to roll; you can close the driver with a DOS close (INT 21h, fucntion 3Eh).

Calling ASPI is simply a matter of filling up a table called the SCSI request block and issuing a FAR CALL to the driver's entry point. The SRB varies from command to command; each, however, is preceded by a header whose format I've shown in table 5. Bluntly put, the SRB holds everything ASPI needs to know to complete the current request.

ASPI decodes your command, does your SCSI dirty work for you, and returns the results to a location you've designated in the SRB. Your program has a choice of methods to use for watching for the completion of the command: polling the status byte or specifying a post routine. In polled mode, your application simply samples the status byte in the SRB. A 0 in the status field means the command is still in progress; a 1 means the command has completed successfully; anything else means something went wrong.

continued

ASPI'S SCSI REQUEST BLOCK HEADER

Table 5: *The SRB varies from command to command; each, however, is preceded by this header.*

Offset	Description
0	A 1-byte command code. The ASPI documentation I used defined six commands and reserved the rest.
1	A 1-byte status code. This code is returned by the ASPI driver and indicates whether the command is still in progress, completed successfully, or completed with an error.
2	A 1-byte host adapter number. ASPI supports multiple adapters in a single machine.
3	A 1-byte flags field. The ASPI documentation I used defined only one command—execute SCSI I/O request—that used this field. You set the field to zero for all other commands
4	A 4-byte field reserved for expansion.

Posting mode lets the driver and your application operate in a multitasking fashion. If you enable posting (by setting bit 0 in the SRB's SCSI request flag) and store the address of a "post routine" in the SRB prior to calling ASPI, the driver will return control to your program *before* the SCSI command is completed. You application can then proceed while ASPI does its job. When the SCSI command is completed, ASPI will call your designated posting routine. It then becomes the task of your posting routine to do any necessary cleanup work.

The documentation that I had recommended using post routines only for TSR programs and device drivers under DOS. Applications should use the polling technique. However, posting routines under a multitasking operating system (e.g., OS/2) should be mandatory if you expect to achieve maximum performance.

Widely read readers will recognize the SRB as being similar in function to the NetBIOS control block. As with the SRB, the NCB was the command and its attendant data all bundled in one structure that you handed to NetBIOS saying, in essence, "Here, do this."

One member of the NCB—the NCB_RETCODE field—is set to 0FFh by NetBIOS to indicate that the command associated with the NCB is "in progress." Your software polls NCB_RETCODE to determine when the command completes. A zero value in NCB_RETCODE is an "all's well" indication; anything else is an error condition.

NetBIOS also supports the idea of the post routine. In fact, post routines are critical in network applications, which must frequently operate concurrently with foreground applications. When you consider such concurrent operation, you uncover a programmer's bear trap that is also hidden in the ASPI implementation of the SRB. Specifically, once you've handed an NCB to NetBIOS, your application may not tinker with the internals

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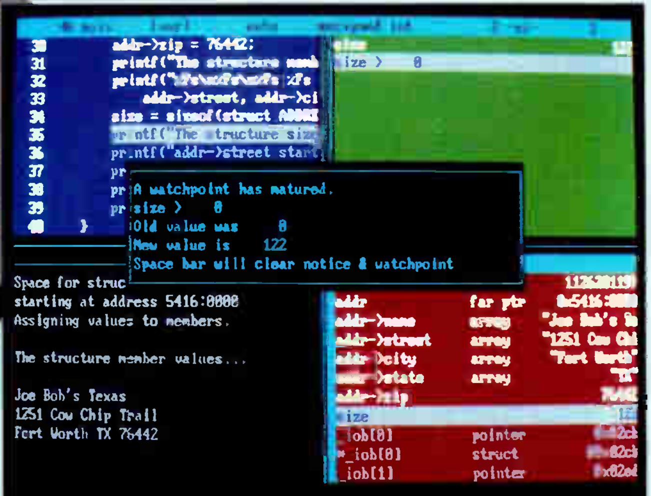

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Cloak and Data Revisited: The Winners

Regular readers of this column will recall that in the June installment ("Cloak and Data") I presented a code-cracking contest. I am happy to announce the winners of that contest; the first five win BYTE sweatshirts.

For those of you unable (or unwilling) to break the code, I'll simply say that the message was doubly encrypted. The first encryption technique was a Vernam cipher; the second was a simple 16-element knapsack cipher.

The first-place winner is Emil Wacker, a founding partner of Harcom Security Systems in New York, who began the decryption under the mistaken belief that I had used a Vignere cipher. He soon discovered that such was not the case and proceeded to put together a quick program in Debug to XOR the ciphertext with "BYTE"—an obvious choice for the first key. This got enough text deciphered so that it wasn't long before he guessed "BYTEMAGAZINE" as the complete key.

At first, Mr. Wacker didn't know that the message was doubly encrypted. He was surprised to find the string of numbers in the text and thought that they constituted the winning message that he would have to recite over the phone. More decrypting revealed that it was a message encrypted with a knapsack. He wrote a brute-force knapsack decryption program in C and ultimately refined it to execute in about 7 seconds on an IBM PS/2 Model P70.

Second place goes to the two-man team of Peer Wichmann and Hans-Joachim Knobloch, who work at the European Institute for System Security at the University of Karlsruhe in Germany. These fellows are also members of the International Association for Cryptologic Research.

They used a Mac IIci, keyed the cryptogram in by hand, and began examining the cipher for repetitions. They found the pattern "4444" repeated frequently and determined that the greatest common divisor of the distance between instances of this pattern was 24 (which is simply the least common multiple of the key length, 12).

Knowing that the file was produced on an MS-DOS machine, they attacked the code based on the fact that <carriage return><linefeed> characters would be frequent digraphs. This ultimately led them to part of the key: "MAG." From this, they took a first guess at "BYTEMAGAZINESANNIVERSARY"—which turned out to be incorrect—and finally got "BYTEMAGAZINE."

The rest was easy for these guys. They immediately recognized a 16-element Merkle-Hellman knapsack and wrote a C program that hammered out a solution the brute-force way. The program takes about 0.8 second on the Mac IIci to decipher the text.

Third place goes to Owen Michael of Oakdale, Pennsylvania, who cracked the code using Turbo Basic on a 20-MHz 386 system. He found that the hardest part of cracking the first level was keying in the listing as printed in the magazine. Decrypting the knapsack was simple, once he discovered his mistake of inverting the bit-ordering.

Fourth place goes to Etienne Cornu of Toronto, Ontario, Canada.

Fifth place was claimed by Douglas French of Clinton, Connecticut, who actually used Brief to inspect the code and determine the Vernam key.

Honorable mentions (in no particular order) to:

Bob Martin at the Department of Mathematics and Computer Science at Middlebury College in Vermont, who began decrypting the message on a computer at work. That evening, his son was on the home computer, so Bob finished the knapsack by hand.

Vernon Crawford, who sent in a *one-line* Vernam-cipher program written in—what else?—APL.

Benny N. Cheng, an applied statistician, who fought his way through the first level of decryption with nothing more than pen, paper, and the SideKick pop-up calculator. He conquered the second level using Scheme.

James Grinter of Lincolnshire, England, who broke the code using a 6502-based Acorn BBC microcomputer running BBC BASIC.

And to Richard Langlois of Quebec, Canada, Ton Dennenbroak of The Netherlands, Steve Tate at Duke University, and all the others who broke the code—my congratulations.

of the NCB—other than to read the contents of NCB_RETCODE—until the command has completed.

The same applies to the SRB: It becomes the property of the ASPI driver until the command defined by the SRB has finished. Consequently, if your program allocates memory to the SRB (e.g., using `malloc()` or the DOS memory allocation function), that SRB must remain allocated until the command has finished. . . even if the command was something simple like a SCSI reset. Failure to do so means that ASPI could go stomping through memory that *used* to be the SRB but has been allocated by some unrelated and unsuspecting program.

What's Inside

As I write this, ASPI defines six commands—the rest are reserved for either vendor-unique operations or future expansion. The defined commands are as follows:

Host adapter inquiry, which lets you determine how many SCSI adapter cards are plugged into your system. You can also retrieve a 16-character manufacturer-supplied name that is programmed into each card.

Get device type, which retrieves a device-type code (1 byte) from a SCSI peripheral device. The code indicates what sort of peripheral you're dealing with (e.g., readable and writable hard disk drive, CD-ROM drive, or tape drive).

Execute SCSI I/O request requires that you append a SCSI CDB to the end of the SRB. ASPI will execute the command defined in the CDB and manage all the phase transitions for you. This is the real workhorse command of ASPI.

Abort SCSI I/O request is handy if you want to attach a time-out to a particular SCSI command. You pass this command the pointer to an SRB that defines an operation that is still pending completion, and the abort SCSI I/O request will pull the plug.

Reset SCSI I/O device resets a target peripheral. This is what comes from all these intelligent peripherals. Occasionally, one will get confused, and you've got to restart it from square one.

Set host adapter parameters is more or less a software DIP-switch block for an adapter card: You can custom-configure the card to your installation.

On the Bill

This month's source code includes offerings for both the Mac and the IBM PC. Admittedly, the programs for this month are more "experimental" than usual, but you can use them for guidance as you explore SCSI programming. For the Mac users, I've provided LLSCSI.4TH, written in Mach II Forth on the Mac. The routines included let you perform polled reads and writes using either CPU-controlled or pseudo-DMA transfers.

On the PC side, there is F83-compatible source code for SCSI read and write routines using ASPI. I've also included source code for talking to Western Digital and Future Domain SCSI controllers.

As you begin working with SCSI, expect to be daunted by the number of commands and the complexity of the bus phases. Stick with it, and once you've put together a library of working routines, you'll find it's a lot easier than you expected. The benefits are sizable, too; SCSI is a lot more than just fast. ■

Editor's note: *Listings are available in electronic format. See page 5 for details.*

FURTHER INFORMATION

Aside from the two-part Circuit Cellar article mentioned in the text, L. Brett Glass has provided a good treatment of SCSI's ins and outs in "The SCSI Bus" (February and March BYTE). Macintosh users should delve into chapter 31 of Inside Macintosh, *volumes IV and V. Additionally, it wouldn't hurt to order a copy of* Macintosh Family Hardware Reference *(Addison-Wesley, 1987). For SCSI in general, the contact is John B. Lohmeyer, NCR Corp., 3718 North Rock Rd., Wichita, KS 67226, (316) 636-8703. You can also find SCSI-related information on the SCSI BBS at (316) 636-8700.*

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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likely to see that you've made a mistake. Likewise, a compiler can cause a program to check its own answers for reasonableness. If a pointer points to an invalid location, a variable isn't initialized, or a value falls outside a specified subrange, run-time error-checking code can detect the problem at once.

Some languages are better than others at checking their (and your) work. C, for instance, performs only very weak static checks, and it has no facility to generate automatic run-time checks. It was a procedure in the standard C library—which failed to include a check on array boundaries—that allowed Robert Morris's worm program to enter and infect thousands of machines on the Internet two years ago.

Pascal, Modula-2, and Ada do better; they allow programmers to specify the range of values that a variable can assume. And Ada, the most robust language of the group, has built-in features to allow graceful recovery should an integrity check fail.

Alas, even these languages don't go as far as they should. Few implementations check to see that a variable is initialized before its value is used—one of the most common programming pitfalls. Nor can these languages automatically check a variable if the constraints on it are more complex than a simple maximum and minimum—if, for example, the variable *a* should always be an odd number between 3 and 17 or between 51 and 73.

Another essential feature lacking in many of today's programming tools is the ability to make certain that every straight-line path of execution is tested before the program goes out the door. Too often, it's an option none of the testers bothered to try that causes a program to fail in the real world. Programmers and testers should use a profiler—a utility that can tell which parts of a program are executed, and how often—to ensure that all the code is covered.

Finally, programming environments should provide simple ways to "bench test" individual pieces of a program. Each time a programmer writes a procedure or function, it should be possible to automatically provide that subprogram with a range of inputs and watch the output—without having to build an entirely new program for the test.

Ethics, Pride, and Programming

Many programmers have such complete faith in their ability to write bug-free programs—or are so sure that bugs will be caught during testing—that they scoff at the idea of using a language that provides automatic consistency checking. This attitude not only is highly unprofessional, but is, in a very real sense, unethical. As users trust computers to handle more and more aspects of their daily lives, it becomes increasingly important that developers supply them with reliable software. Even the best programmers make mistakes. It's hubris to believe otherwise. And, certainly, if programmers feel strongly that they produce high-quality software, they should have no fear of putting it to the test.

Some programmers may also grouse that integrity checks will slow down their code—but this, again, is a specious argument. Today's fast, cached 386s and 486s are more than 50 times as fast as the original IBM PC, and even faster chips are on the way. Wouldn't you, as a user, be willing to sacrifice 5 percent to 10 percent of your machine's performance for some convincing assurances that it was coming up with the right answers?

When hardware engineers design a new chip, they adhere to rigorous design rules at every stage of the engineering process. Then, when the work is complete, they subject their designs to exhaustive automatic tests. Software designers, by contrast, usually test their programs by allowing users to experiment with them—when they test at all. Perhaps that's why advances in software technology have been so slow in coming, while hardware performance has increased by leaps and bounds.

Now that the hardware is fast enough to shoulder the burden, it's time to start designing operating systems and languages in which software and system integrity are paramount. I want my computers to run an operating system with full memory protection and complete task isolation, developed in a type-safe language with advanced run-time consistency checks. I'm sure that anyone who uses computers for "mission-critical" tasks would agree. Companies cannot afford to lose millions of dollars every year due to software bugs. And I can't afford to wonder why Windows—said to be among the most heavily tested applications ever—crashes so often during relatively simple operations.

It's time for consumers to expect more than software that runs fast; they must demand that it run *right*. Speed is important, but it's far more important to have software that works. ■

Brett Glass is a programmer, hardware designer, author, and consultant in Palo Alto, California. He can be reached on BIX as "glass."

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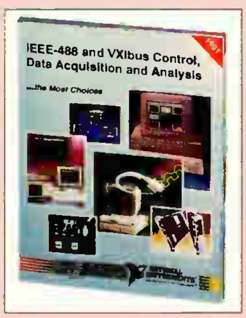

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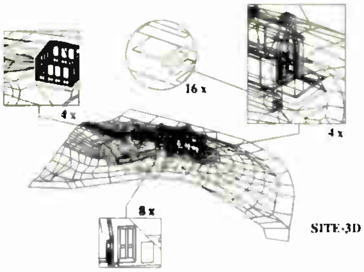

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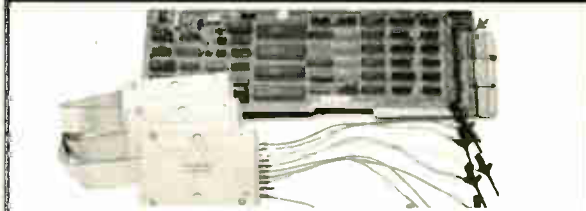

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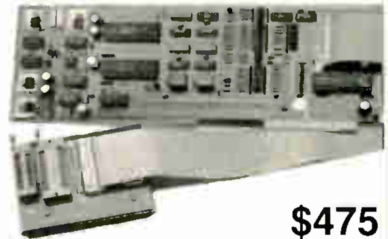

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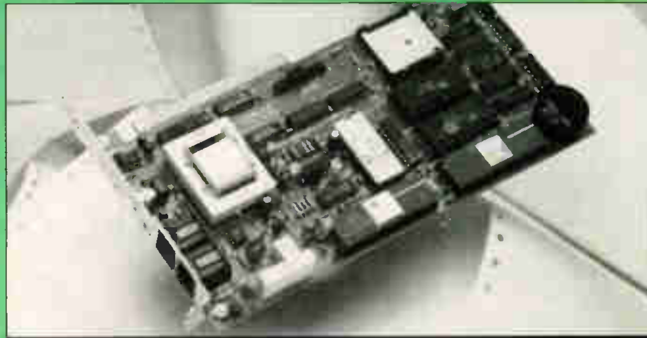

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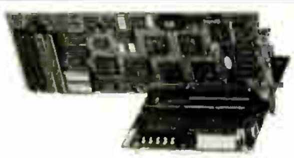

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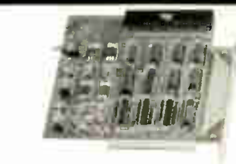

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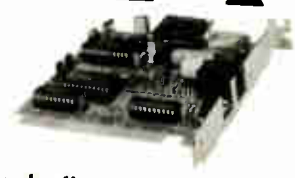

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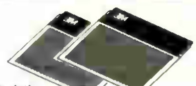

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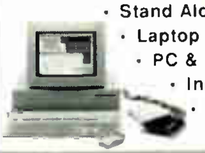

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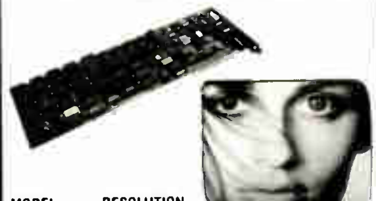

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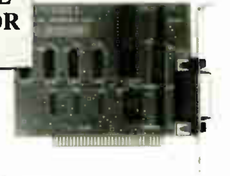

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SLT/286		$279			

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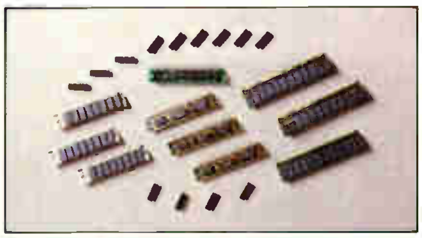
Memory Products



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958	959	960	961	962	963	964	965	966	967	968
969	970	971	972	973	974	975	976	977	978	979
980	981	982	983	984	985	986	987	988	989	990

Inquiry Numbers 991-1479

991	992	993	994	995	996	997	998	999	1000	1001
1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012
1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023
1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034
1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045
1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056
1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067
1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078
1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089
1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100
1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111
1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122
1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133
1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144
1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155
1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166
1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177
1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188
1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199
1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210
1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221
1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232
1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243
1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254
1255	1256	1257	1258	1259	1260	1261	1262	1263	1264	1265
1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276
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1286	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298
1299	1300	1301	1302	1303	1304	1305	1306	1307	1308	1309
1310	1311	1312	1313	1314	1315	1316	1317	1318	1319	1320
1321	1322	1323	1324	1325	1326	1327	1328	1329	1330	1331
1332	1333	1334	1335	1336	1337	1338	1339	1340	1341	1342
1343	1344	1345	1346	1347	1348	1349	1350	1351	1352	1353
1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364
1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375
1376	1377	1378	1379	1380	1381	1382	1383	1384	1365	1388
1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397
1398	1399	1400	1401	1402	1403	1404	1405	1406	1407	1408
1409	1410	1411	1412	1413	1414	1415	1416	1417	1418	1419
1420	1421	1422	1423	1424	1425	1426	1427	1428	1429	1430
1431	1432	1433	1434	1435	1436	1437	1438	1439	1440	1441
1442	1443	1444	1445	1446	1447	1448	1449	1450	1451	1452
1453	1454	1455	1456	1457	1458	1459	1460	1461	1462	1463
1464	1465	1466	1467	1468	1469	1470	1471	1472	1473	1474
1475	1476	1477	1478	1479						

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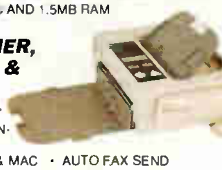

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

Leading Edge Format

Dear Jerry,

While reading your description of Symantec's Q&A Write, I was struck by the similarities to my experiences with the Leading Edge word processor that I use. It is very easy to learn, is fast (at least by my standards), and has more bells and whistles than I ever need. It doesn't have the old WordStar commands built in, but I don't miss them, because I never learned WordStar. It does have one feature that Q&A Write doesn't—automatic save, which can be either a blessing or a curse, depending on your temperament. And, like Q&A Write, the Leading Edge word processor stores its files in its own strange format, which wastes disk space, is difficult to exchange with anyone else, and can't be accessed by third-party programs.

When I mentioned the strange format of Leading Edge word processing files to a friend, his curiosity impelled him to look at one of them with a HEXDUMP program. Serendipitously, his HEXDUMP blocked the output in the same 512-character sectors that the Leading Edge word processor uses in manipulating its files. The first 10 sectors contain header information, and the actual text begins with the eleventh sector. If entered without any heading or modification, the text runs continuously from sector to sector, filling all but the last byte of each sector.

The text is straight ASCII with embedded control sequences in a single-line format. However, when the text is edited, the corrections are entered into the text stream in their normal location, and something has to give.

At each automatic save, the program looks to see if the text has been shortened or lengthened enough so that the sector is overfilled. If the text will not overfill the sector, the new and old material in that sector is written seamlessly at the beginning of the sector. If the old and new material will overfill the sector, the text is broken at the end of the new material, and the remainder of the material in that sector is put in a new sector at the end of the file. Unused space at the end of any sector is stuffed with nulls (00 hexadecimal). Even though there are also some conditions that recombine under filled sectors, an edited document frequently gets to be highly fragmented and contains huge blocks of nulls. I've seen Leading Edge word processing files that are two to three times as big as the ASCII file would be.

John Laidig
Holmdel, NJ

Symantec has published the file format of Q&A Write; the important parameters are that in the decimal twenty-seventh byte of the file is a long integer that says where the text starts (in hexadecimal, of course), and the thirty-first byte gives the text size in bytes.

I don't like automatic save, since I experiment with text a lot and don't necessarily want to save what I'm doing over what I have.—Jerry

A Writer's Secret

Dear Jerry,

I appreciate Computing at Chaos Manor. The direct comparisons between products and the best product awards are valuable information that I can't get from German magazines. I am fascinated by the style of your articles—how you get data and technical information into a form that is enjoyable to read.

I am a senior engineer in a system house, and I do a lot of writing. There are technical articles for technical newspapers, training courses for our customers, product information for our marketing, internal specifications for our engineers, and requirement and functional specifications for our customers. At a given time, I have five to eight papers in different stages of completion. It normally takes several weeks to collect and sort out all the information for an article.

I have a problem that you must have solved: I am looking for a system to organize this kind of work according to personal performance. On some days, as you know, writing does not run smoothly, but on those days I collect information that is valuable for the articles, or I have a good idea for improving the structure of an article. Do you know of a system for organizing all this information? Do you write all your information into a database or word processor, or on paper? When you start writing an article, do you mix properly formulated texts with short notes and sketches of ideas and do the complete formulation iteratively?

Can you tell me, or are these the secrets of a successful writer?

Dr. Rainer Winz
Idstein, Germany

Well, let's see: usually I keep a bunch of subdirectories under the "QW" directory, where Q&A Write resides. There's a BYTE subdirectory, one for each novel, and one for articles, under which I have different projects.

I also keep a GrandView outline called Projects, which has each major job, along with deadlines and suchlike; I collect random notes in there. Some projects will have their own GrandView file; others don't.

The secret of all this is Desqview and the Big Cheetah 386, which let me jump back and forth among all these and even have multiple Q&A Write windows.

I keep swearing I'm going to go to a different word processor, but I always end up back with Q&A Write, which is the easiest of the lot to use, at least for me, and the new GrandView imports and exports Q&A Write files, making it all even easier.

Finally, I do keep a hardbound log book in which I collect all those notes that one is forever making; I tape business cards, scraps of paper, and everything else in there, in chronological order.

I doubt my system would make sense to anyone else, though.—Jerry ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

PRINT QUEUE

Hugh Kenner

A Fairy-Tale Future

Machines that can read, write, make music, and draw. What hath man wrought?

Although Raymond Kurzweil is a scant 43, his name, like "Xerox," seems in danger of becoming generic. A "Kurzweil," that would be a pattern recognizer. Examples: a machine that can read books aloud to the blind; another machine that can type to human dictation; yet another that combines acoustic patterns so accurately that professional musicians have thought they were hearing a $40,000 concert grand. These are none of them dreams; they're real products. So who is better qualified to offer us a big book called *The Age of Intelligent Machines*?

Kurzweil has; and, faithful to his track record, the book (MIT Press, 1990, $39.95) is, yes, superb. Not surprisingly, its hinge chapter is the long one on pattern recognition, something to be distinguished from the kind of sequential thought most computer programs mimic. "The trillions of computations required for the human visual system to view and recognize a scene can take place in a split second." It's all massively parallel: simultaneous processes, not sequential.

But chess is something you *can* analyze sequentially; that's why pretty good chess programs could be developed fairly early. The rules being unambiguous, an intensive search of position after position can be counted on to isolate "strong" moves. In about the same time as a grand master takes to decide, the machine has checked out many thousands of options. The human mind being slow at IF...THEN...ELSE, the grand master will have examined only a few. Yet (as of 1990) the grand master tends to play rather better than the machine. Somehow, pattern recognition seems to be focusing analytic energies.

If chess can fall back on brute-force programming, reading text cannot; it's too slow. Text-scanning hardware geared to a specific font can run fast because it's simply matching templates. Font-independence, as in the Kurzweil Reading Machine, relies on "multiple experts," watching for patterns. One expert concentrates on closed loops: *A* has one loop, *B* has two, *C* has none, and neither has *I*. A concavity expert, though, can distinguish those last two because *C* has an "east concavity" but *I* hasn't. Conversely, when east concavities are spotted in both *C* and 6, it's up to the loop expert to make a choice. And what about *N* and *H* (each with north and south concavities, but no loops)? Well, we can keep a line segment expert on call, to distinguish "northwest to southeast" from "midwest to mideast." You see the principle.

Which is all very well, but "even a well-printed document contains a surprisingly large number of defects"; thus, a broken crossbar could deprive *A* of its loop. The solution? "Redundant experts, and multiple ways of describing the same pattern." All those experts make simple choices very fast, while an expert manager busily weighs their findings. The present version of the Reading Machine can handle 30 to 75 characters per second, with remarkable tolerance for degraded input.

Kurzweil's running exposition is punctuated by 23 guest contributions, one of which, by Harold Cohen of San Diego, describes what I'd have sworn was impossible, a program (Aaron) that draws elaborate pictures with intricate vegetation plus numerous human figures, variously posed. After coloring by Cohen, they've been shown worldwide, from Boston's Museum of Science to London's Tate Gallery. By Cohen's account, just making a drawing is no miracle at all; like a human artist, Aaron simply "knows how to draw." And "if one can draw, then anything that can be described in structural terms can be represented in visual terms." (As the great animator Chuck Jones likes to say: If you can draw a human figure, skeletal similarities can free you to draw a rabbit, a coyote.)

ILLUSTRATION: JERE SMITH © 1990

Analogy from Cohen: We can get a picture of a kangaroo from an artist who's never seen one. We say that it's ratlike but much bigger; has a long, thick tail and a pouch. Corrections to the first attempt: No, it doesn't carry the pouch; the pouch is part of its belly. And it doesn't walk on all fours like a rat, but on hind legs much bigger than front legs. Further correction: The tail rests on the ground. End result? Not quite right, but close enough. Aaron works something like that, from a repertoire of structural descriptions.

Human figures? Aaron knows (1) what the body parts are, and how big in relation to each other; (2) what the type and range of movement is at each joint; (3) how movements are coordinated—for instance, what the body must do to keep its balance. Aaron elaborates a stick figure with something resembling musculature and generates the visible result, bestowing greater concentration on hands, say, than on thighs. So, "Remarkably little of the program has anything to do with art; it constitutes a cognitive model of a reasonably general kind."

A cognitive model for literary art? That's been more elusive. Racter, which I reviewed in the May 1986 BYTE, uses a store of words, random selection, and some "syntax directives" to generate stuff like this:

"Bill sings to Sarah. Sarah sings to Bill. Perhaps they will do other dangerous things together. They may eat lamb or stroke each other. They may chant of their difficulties and their happiness. They have love but they also have typewriters. That is interesting."

"Crazy thinking," Racter's creator concedes, albeit expressed in "perfect English." (Not artificially intelligent, adds A. K. Dewdney; no, "artificially insane.") It works something like this. Starting, like a chess program, from a present position ("They may eat"), Racter searches its word list for something edible, plugs in *lamb*, on a second search opts for an *or* construction, needs a further verb, searches, comes up with *stroke*, and then gladdens the programmer's heart by chancing, during yet a fourth search, on *each other* when it might have chanced on *drizzle*. Hence, "They may eat lamb or stroke each other." Artificial insanity, yes, and perfect English, the way chess programs, however dubious their moves, never violate the rules of chess. The most important contributor to a Racter session is the human who cuts it off when it's commencing to rave.

No, the root problem isn't lack of real-world knowledge. If Racter's *The Policeman's Beard Is Half-Constructed* (Warner Books, 1984) is "the first book ever written entirely by a computer," I'll add the claim that *Sentences* (Half Moon Press, sometime in 1991) will be the first book of computer-generated poems to be at all interesting as poetry. Its title page will list me as coauthor, along with Charles O. Hartman, an accredited poet. He wrote one of the programs the book derives from; I cowrote the other.

And the only real-world knowledge the programs had was embodied in 487 "sentences for analysis and parsing," prepared circa 1870 for the use of Rhode Island schoolchildren. They range from "School begins. Dogs barked." all the way to "He spoke in as noble strains as ever fell from human lips." From them, two sequenced programs quickly derived 15 works fit for performance by a cantor and massed choirs. Excerpt:

. . . What could ye desire not for not for
John
for glory

glory

providence learn glory . . .

There imagine a diapason. . . . And it does make quite as much sense as most librettos.

Kurzweil entitles his tenth chapter "Visions." Computer

Computer performance per unit cost has doubled every 22 months, an improvement factor of 2000 in 20 years; if Detroit had done as well, the typical auto would cost two dollars.

performance per unit cost has been doubling every 22 months, an improvement factor of 2000 in 20 years; if Detroit had done as well in the past two decades, the typical auto would now cost about two dollars. There's no reason for such improvement to abate. So, down the road, the affordable translating telephone, moving words from language to language in real time as we speak, possibly "in the first decade of the next century." An intelligent answering machine that converses with the caller and seeks you on identifying an emergency. Invisible credit cards and keys (scanning fingerprints and voice patterns). . . . On and on. But what about the Sorcerer's Apprentice, who didn't know when to stop? Are we being seduced into a frustrating future where djinns beyond our control run blithely amok?

Well, Allen Newell has a happy answer to that. First, the djinn that kept fetching water regardless of flooding was just "a program with a bug in it." The bug was an infinite loop, and detecting those is standard practice now. Second, the better computer technology gets, "the less of our environment it consumes." Clean, unobtrusive, it uses up "little energy and little material." And it can be "saturated with intelligence, to keep accounts, to prevent errors, to provide wisdom for each decision." Newell calls that a fairy tale: a dream with a happy ending. Happy endings, he reminds us, are not forbidden.

So runs the dream. And, lo, George Gilder, whose optimism I discussed here last February, reliably chimes in: "Israel, a desert-bound society, uses microelectronic agricultural systems to supply eighty percent of the cut flowers in Europe and compete in avocado markets in New York. Japan, a set of barren islands, has used microelectronic devices to become one of the world's two most important nations. . . ."

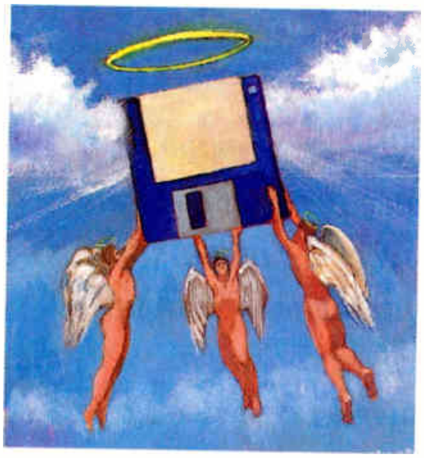
Newell's delighting "fairy tale," he warns, will not come true of itself; it's barely past its "Once upon a time." We'll have to learn to learn, and grow into growth. But in fairy tales, "magic friends sustain our hero." Here, we're still in early stages of discerning the magic.

Meanwhile, magic has been at work. The guest contributions to this book, Kurzweil tells us, were scanned as they came to his desk by his read-to-the-blind machine, although it didn't speak audible words but sent characters to a formatter. And portions at least of his own text he spoke aloud to his type-to-dictation machine. How much editorial fiddling either process required we're not told. Under the rug: That's where glitches had best go, as we await the glitchless millennium. ■

Hugh Kenner is a professor of English at Johns Hopkins University. He writes for publications ranging from the New York Times *to* Art & Antiques. *His recent books include* Mazes *and* Historical Fictions. *He can be contacted on BIX as "hkenner."*

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

STOP BIT ■ Brett Glass



A PLEA FOR SOFTWARE THAT WORKS

Let's have software that runs *right*, not just fast

Like most computer users, I like using programs that run fast, have pretty, ergonomic displays, and are easy to learn and use. Some days, however, I'd gladly settle for software that is simply reliable.

This week, for example, I attempted to use the Paintbrush accessory in Windows 3.0 to create a large bit-mapped image—1024 by 512 pixels—to be printed on my 300-dot-per-inch laser printer. When I told the program the number of pixels I wanted in the drawing, it offered no complaint. However, as soon as I tried to use the scroll bars to move about the image, the program crashed.

The next day, I was using a Windows 3.0 DOS session to connect to BIX. Suddenly, Windows decided that my terminal emulator—a faithful program that had exhibited no bugs—had "violated system integrity" and terminated it automatically, aborting my on-line session. In theory, the system's Virtual 8086 mode should have been able to keep any one application from damaging the system. In this case, however, Windows warned me to shut down all my applications and reboot my system at once.

Finally, I decided to sidestep my problems with Windows by moving to Desqview. Alas, my disk cache program, Power Cache Plus, got into a tussle with Desqview, and it was big red switch time. Which program was at fault? Who could tell? All I knew was that I still couldn't get things to work reliably.

Stop Bit is an open forum for informed opinion on topics related to personal computing. The opinions expressed are those of the author and not necessarily those of BYTE or its staff. Your contributions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

House of Cards

If your computer crashes, it's easy to blame an application or the operating system for your woes. But if you look at the big picture, you see the real problem: Nearly every personal computer, regardless of make, is essentially a house of cards, ready to come crashing down as a result of a single erroneous instruction or bad memory location.

In an IBM PC, a program can change a single location—for example, the timer tick interrupt vector—and instantly cause the system to lock up solid. On the Mac, trashing the heap or the system globals can cause a brilliant, sizzling display of random pixels. It's no trick to cause a Guru Meditation on the Amiga. Even in OS/2, which in theory provides isolation between tasks, you can lock up the keyboard simply by calling the system routine `DOSEnterCritSec`. The security holes in most operating environments are not simply Achilles' heels; metaphorically speaking, they're the size of Achilles' entire body.

Such weaknesses may have been tolerable in the early days of microcomputers, but today—when millions of people trust computers with health, welfare, and livelihood—there's no longer any excuse. Operating systems must provide good protection against errant applications, and applications themselves must be designed to prevent bugs or catch them when they occur.

Button Up That OS

Unfortunately, most microcomputer operating systems do not offer consistency checking on operating-system calls. The Mac OS is one of these.

For this reason, Apple Finder author Steve Capps created a program called Discipline, which intercepts Mac OS calls and reports erroneous parameters. His results were startling: Virtually every Mac program that he tested—including Apple's own applications—made serious illegal calls to the operating system.

OS/2 1.x, by contrast, checks every parameter passed to the operating system before it allows a system call to go through. What's more, it uses the segmentation hardware of the 286 to check every memory reference, ensuring that a program never steps out of bounds—by even a single byte. If a program tries to use any memory that does not belong to it, it is instantly terminated.

The 32-bit version of OS/2—OS/2 2.0—also checks memory references, but, ironically, it checks 32-bit programs far less stringently than it does 16-bit ones. A memory reference can be as much as 4K bytes or more off the mark before the problem is detected—if it's caught at all. This regrettable step backward is the result of Microsoft's desire to give 32-bit programs a "flat" memory model at the expense of the 386's built-in error-checking capabilities.

Writing Applications That Work

While theoreticians have shown that proving programs to be absolutely correct is an arduous task, the programmer can flush out many subtle bugs by adding *sanity checks* to the compiled code.

Every physics student learns an error-checking technique called *dimensional analysis*, which verifies that the units of measure in a result match those of the required answer. If, for example, you derived a formula to solve a problem, and the formula proceeded to add apples and oranges, you could immediately recognize the problem and correct the formula before using it on any data. This is called a *static check*, because it can be applied to a formula or program without actually running the numbers through it.

Another way of checking your answer is to ensure that it falls within a reasonable range. If you compute the weight of an apple to be 100 kilograms, you're

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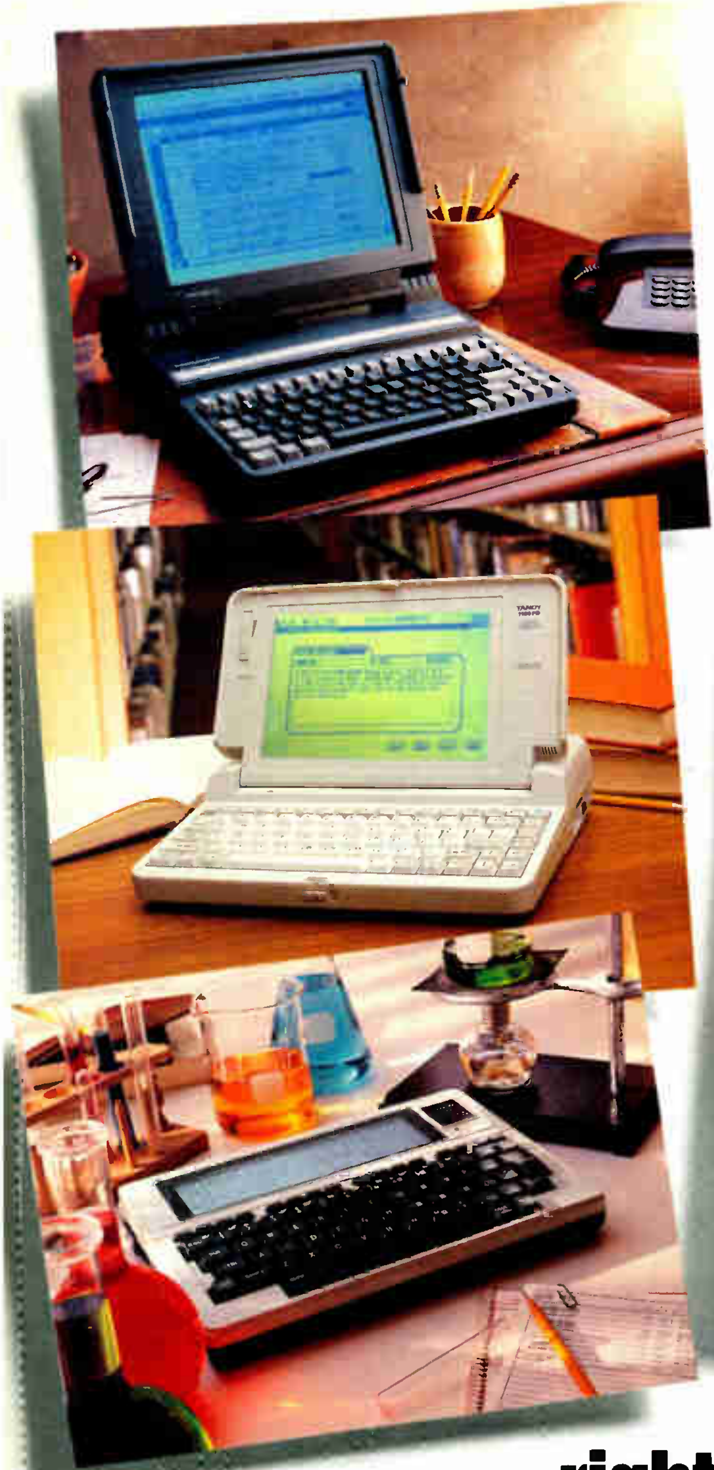

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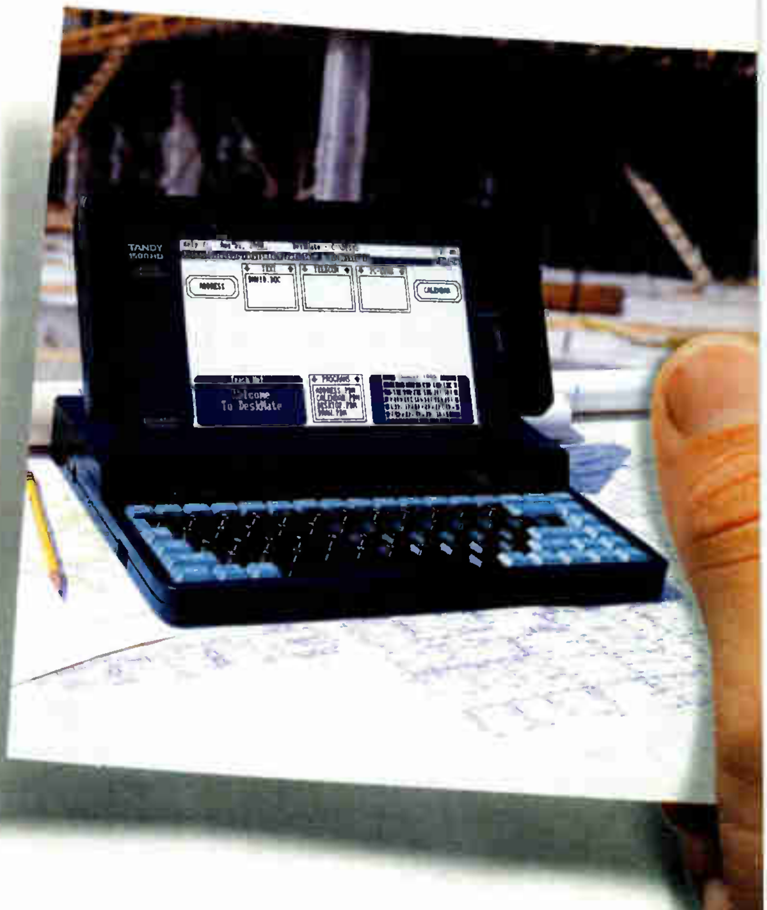

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