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BYTE

MARCH 1989

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- 1 parallel and 2 serial ports.
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STANDARD FEATURES:

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- 1 MB of RAM* expandable to 16 MB using a dedicated high speed 32-bit memory slot.
- Advanced Intel 82385 Cache Memory Controller with 32 KB of high speed static RAM cache.
- Page mode interleaved memory architecture.
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BYTE

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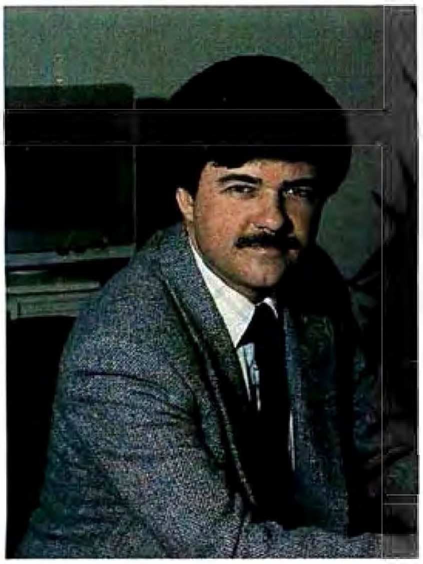

OS/3 AND UNIX'S LAST, BEST HOPE

The next 90 days will be historic in the operating-system wars

Last month, I briefly examined the current fit between OS/2's Presentation Manager and IBM's Systems Application Architecture—IBM's grand scheme for top-to-bottom software uniformity. PM brings SAA to the desktop.

That's nice, you might say, but so what? Yes, it will be good to be able to share data transparently among all manner of True Blue machines. And yes, it will be a plus to be able to sit down at almost any IBM box and find a familiar-looking interface staring back at you.

But the Macintosh is already more or less uniform within its own family and has been for some time. And the chaos of Unix is rapidly boiling down to a few major and reasonably similar choices. For example, X Windows is the underlying structure for AT&T/Sun's Open Look, the Open Software Foundation's OSF/Motif, Sony's NWS interface, and others. Apple has even announced X Windows for A/UX.

Thus, an asset such as a standardized GUI (graphical user interface)—while welcome and necessary—won't, by itself, give OS/2 any particular edge.

The edge—if there is to be one—will have to come from planned enhancements to OS/2. At a recent two-day briefing staged by IBM and Microsoft, Steve Ballmer of Microsoft offered some glimpses into the future:

- OS/2 will be made faster ("although people are surprised at how quick OS/2 already is," Ballmer said). It will also be made smaller. "You can run a functional OS/2 with 1.6 megabytes if you forgo the compatibility box or with about 4 megabytes full-blown; and that compares well with other powerful operating systems," he said.
- The FAT (file-allocation table) file system will get an overhaul. "It can stand a scrub-up," Ballmer admitted. "We'll improve performance in file access and in smart caching to produce a superfast, supercompetitive file system using the fastest techniques known to man." He's not one for understatement.
- The eight-dot-three filename restriction will finally be lifted, allowing additional attributes for items like subject, author, and file revision dates.
- OS/2 will support larger disk volumes and provide standardized access to different media, including WORM (write once, read many times) drives.
- OS/2 LAN Manager enhancements will include services to enable you to browse a network's users, resources, and so forth, which can be important on very large systems; additional security services; additional program-to-program communications support; improvements in transport efficiency; and "full coordination" with the planned file system enhancements mentioned earlier.
- And most significantly, within the next few months, we'll see the first toolkits for OS/3, or OS/386, or whatever the 80386-specific version of OS/2 will be called. This is the version we've all been waiting for—the version that will finally deliver on the full promise of OS/2. It will, of course, support a true flat address space; it will demand-page (in 4K-byte blocks); and it will offer "full binary compatibility with all OS/2 applications—all OS/2 applications will run unchanged," Ballmer said, although they'll run faster.

Best of all from a user's perspective, this new version of OS/2 will at last support multiple concurrent DOS sessions, which will make the transition from DOS to OS/3 fairly painless and avoid the hassles and limitations of OS/2's current compatibility box.

As for DOS extensions, watch for many of the enhancements listed above for OS/2 to show up in future versions of DOS. Many of them are already available from third parties anyway: Norton's File Info lets you work around the eight-dot-three filename limits (albeit clumsily). Many vendors offer add-on support for disk volumes larger than 32 megabytes. And there are numerous solid multitaskers available that work just fine with vanilla DOS.

PM intentionally bears a strong family resemblance to DOS-based Microsoft Windows. Over time, the available DOS interfaces and PM will become even closer, partly to move DOS at least a little within the SAA fold, and partly for pure marketing reasons. "People can safely stick their toes in the GUI waters with Windows and migrate to OS/2 PM when their favorite applications show up there," Ballmer explains.

All this makes DOS attractive in the short term, and Microsoft apparently concedes the point: Ballmer restated what BYTE's COMDEX polls have been telling us for some time—that it will be at least 1991 before OS/2 will be able to pass DOS.

But Unix is also an attractive alternative. After years of ineffectual internal wrangling, the Unix community is finally getting its act together. Within the next few months, Unix will take its last, best shots at becoming a "mainstream" operating system outside of the academic and scientific venues. There will be a great deal of activity: Very soon, OSF will release its Motif user interface, followed by preliminary versions of OSF/1 (its proprietary version of Unix); NextStep will leave beta testing and ship version 1.0; AT&T will release its response to OSF; and more.

Things are about to get very, very interesting.

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

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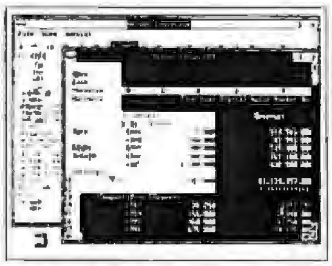

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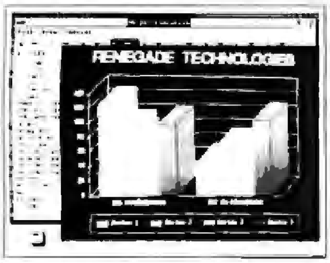

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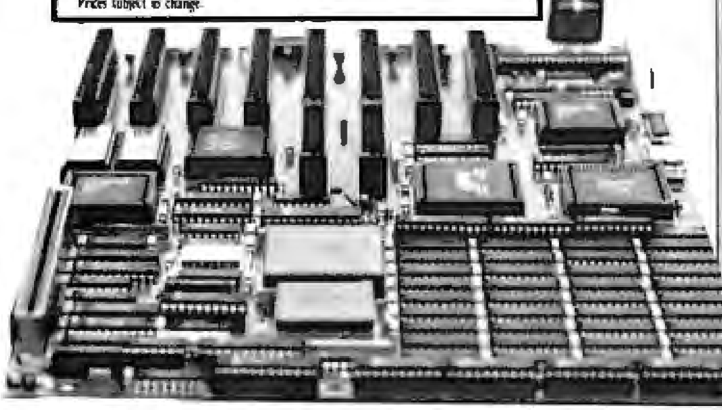

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Staff-written highlights of developments in technology and the microcomputer industry, compiled from Microbytes Daily and BYTEweek *reports*

TI's Prototype Transistor Takes a Quantum Leap

Laptop supercomputers that run off flashlight batteries may be the stuff of science fiction, but Texas Instruments has developed an experimental transistor that may very well make such advanced electronic devices possible within a decade. At the company's Dallas research center, physicists have built the world's first quantum-effect transistor, a device that operates on a fundamentally different principle than the transistors that currently make up our electronic world. Quantum-effect devices potentially will fit 100 times as many functions in the same space as, and consume far less power than, today's ICs.

At dimensions less than 0.02 micron, principles known as quantum mechanical effects dominate the behavior of matter. The quantum transistor—called the bipolar resonant tunneling transistor—is the first semiconductor to directly control a quantum well, an almost unimaginably thin layer that allows only electrons with certain energy levels to pass through.

Quantum transistors have active regions that are about 100 times smaller than the corresponding areas on a contemporary IC. These regions range between 10 and 20 nanometers in size, which is about 10,000 times smaller than a human hair. And future generations of the devices will be even smaller. At these microscopic dimensions, electrons act more like waves than particles. They occupy discrete energy levels, known as bands, and resonate when they're confined to a region that's the size of their wavelength. These properties let quantum transistors switch at speeds thousands of times faster than today's conventional devices.

Transistors are made up of three parts: Current flows between an emitter and a collector, controlled by a base. In standard transistors, the current flow is controlled by varying the voltage that's applied to the base. The base controls physical barriers of semiconducting material called P-N junctions and depletion layers.

TI researchers say the breakthrough that made the quantum-effect transistor possible was the discovery of a means to directly control the tunneling current by modulating the voltage potential inside a quantum well, which is the device's base. The modulation takes place by putting a charge into the energy well at an energy level that's just below the energy level where the actual current "tunnels" across the base from the emitter to the collector.

The speed at which the current travels between the emitter and collector—known as transit speed—is several orders of magnitude faster in a quantum transistor than in today's conventional devices, TI researchers say. The TI scientists estimate that the transit speed is in quadrillionths of a second.

The quantum transistor, which is only a laboratory prototype now, was fabricated using a combination of gallium arsenide, aluminum gallium arsenide, and indium gallium arsenide.

Practical applications for the quantum transistor are at least 10 years away. And before the transistor can be commercially feasible, techniques will have to be developed to manufacture and interconnect the tiny structures reliably in production quantities. Moreover, TI scientists admit that quantum transistors will require the development of "whole new circuit architectures." But they predict that once the problems are solved, the cost of quantum transistors will quickly compete with that of conventional devices.

Meanwhile, TI is touting quantum transistors as the next generation of solid-state devices. George Heilmeier, the company's chief technical officer, says that "comparing quantum effect devices with today's semiconductors is like comparing semiconductors with vacuum tubes."

Don't Worry About the Bus, Some Say

From operating systems to interfaces to file formats, the microcomputer industry is uniquely confusing. Industry executives say things should straighten out in the next year or so. But one much-publicized issue du jour isn't confusing at all, say some industry leaders, and that's personal computer bus architectures.

Micro Channel or the EISA (for extended industry

continued

NANOBYTES

• Expenditures for **research and development** in the U.S. will reach **$129 billion** this year, according to a report from Battelle (Columbus, OH). That's an increase of 3.4 percent, or about $4 billion, over what the National Science Foundation says was spent on R&D in 1988. Battelle's forecast says American industry will fund most of that research, to the tune of $92 billion. The remaining spare change will come from academic institutions, nonprofit organizations, and the federal government.

• **Texas Instruments and Hitachi** have agreed to work together to develop a new series of **16-megabit DRAM circuits.** The American and Japanese chip giants say they'll jointly design technology that both can use. As part of the deal, each company will have access to the other's DRAM technology "as it relates to 16-megabit development," a TI spokesperson said. While some Japanese companies are currently sampling 4-megabit memory chips, Fujitsu recently publicly detailed its design for 64-megabit DRAMs.

• **Bill Gates** put it down as ho-hum, but what do other industry captains say about the **NeXT computer?** Apple's John Sculley said that if anyone can pull off a start-up company

continued

standard architecture) bus? It's not so confusing after all, said industry heavyweights at the recent PC Outlook conference in San Francisco. Tandy Corp.'s John Roach dismissed all the "vapor talk" in the micromedia about the "bus wars." "Users don't need to worry about the bus, anyway, yet we continue to debate and debate and debate," he said.

Roach suggested that companies should "do more strategizing within rather than in full view of our customers." Microsoft chairman Bill Gates agreed that the bus architecture has no effect on software compatibility and is therefore not very important to users. Rod Canion of Compaq, figured to be the ringleader behind EISA, agreed with that, but he put in a plug for 32-bit bus architectures, which he said will be more important in the 1990s, when mainframe/personal computer connectivity becomes widespread.

"Chasing After Change": Life Gets Harder for Software Developers

Despite mostly glowing predictions of computing in the next decade, industry executives at the recent PC Outlook conference agreed that the lag in software development will get worse. Developers at the conference talked about the overwhelming complexity of designing new software applications for today's market.

The problem is keeping up with the competing hardware and operating system platforms as well as designing for graphical interfaces. Jerry Kaplan, CEO of Go Corp. and a former executive at Lotus, pointed out that Lotus 1-2-3 version 3 is actually six different products because of the different operating systems it will run under (including DOS, OS/2, and Unix). Kaplan said that small software companies are faced with tremendous financial risks if they pick the wrong environment for their application.

The problem is largely caused by hardware vendors "chasing after annual change" to differentiate themselves, thus making it hard for software developers to keep up, says Adele Goldberg of ParcPlace Systems. Goldberg also blamed the lack of software tools for allowing one application to work on multiple platforms.

Software developers face a tough challenge. But as Reese Jones of Farallon Computing put it, "There will be no more home-run products. We can't do that anymore." The trick is to work on small pieces incrementally. Developers need to continue working in small teams. Throwing lots of people at a project doesn't work. And companies will have to hope they chose the right environment for their product, he said.

Software companies have learned from the famous delays at Lotus and Ashton-Tate. Companies will be more cautious about preannouncing upcoming products and providing timetables for their availability, and they will, in general, be more tight-lipped about their plans. This may be tough for the press covering these subjects, but it certainly will help software companies avoid the embarrassment that Lotus and Ashton-Tate have had to face because of products missing announced shipping dates.

Kodak Packs 4 Million Pixels onto Image Sensor Chip

Capping a five-year development effort in electronic imaging, Eastman Kodak has announced a 4-million-pixel image sensor chip that could have long-term implications for both commercial and consumer applications. Officially dubbed the KAF-4200 Full-Frame Imager, the chip is similar in design to charge-coupled device (CCD) sensors used in such applications as TV cameras. But there's a very large resolution difference.

A typical CCD chip in a consumer-type video camera has a resolution of 510 by 389 pixels, while the Kodak chip has a resolution of 2048 by 2048 pixels. This results in "near-photographic" quality, and it's all packed onto a package that's just 19 millimeters square.

But the KAF-4200 isn't designed for full-motion video. Using a pair of 20-MHz output channels, it's capable of delivering only 10 frames per second, well below the 30 frames per second required for full motion.

Potential applications for the chip are numerous, including ultrahigh-resolution scanners and ultrahigh-quality electronic still cameras. Consumer applications, however, are many years away, largely because of the KAF-4200's price. Although Kodak hasn't announced a price yet, a similar chip with 1.7 million pixels sells for $25,000 for perfect

continued

NANOBYTES

successfully, it's Steve Jobs. But Sculley said it will be at least a few years before NeXT becomes a competitive threat. "The key will be software. Many of the technical features [of the hardware] are not new to the industry." Regarding Jobs's prediction that the Macintosh will start to decline in the 1990s, Sculley said, "I have a lot of respect for Steve, but his track record on predicting the Macintosh is not as good as his track record on creating new products. The Macintosh will only get better."

"We'll compare it to Sun's mid-1989 product and we'll compare apples to apples," said Scott McNealy of **Sun Microsystems**. Sun is expected to announce, any day, week, or month now, a **"desktop workstation"** that, if you listen to rumors, will be so good that it will take people away from the Mac II, the Personal VAX, souped-up PCs, and other systems aimed at number- and image-intensive applications.

"The only thing I see in **NeXT** that's really unique is the **operating system**. The hardware features may appear on other machines before NeXT is even on the market," said Steve Dow of **Calera Recognition Systems**.

Reese Jones of **Farallon**, which develops Macintosh products, said he thinks programmers will like the **NeXT cube**. He cited the Display PostScript imaging model as a very attractive feature. **Go's Jerry Kaplan** said he thinks NeXT's "great-

continued

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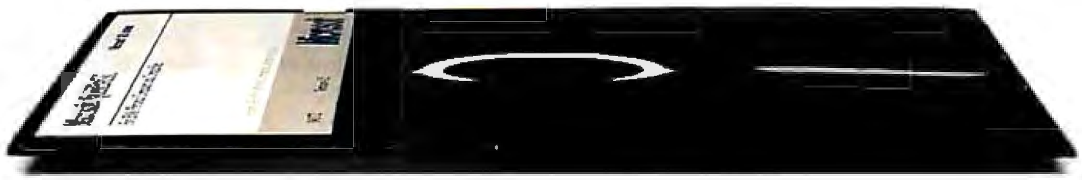

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est innovation was the deal with IBM." Kaplan also said that NeXT may have an uphill battle trying to capture users who don't care about programming as well as scientists who don't care about high-level interface tools.

"Steve is king of ease of use," said Adele Goldberg of ParcPlace Systems, adding that the main feature of the **NextStep operating environment** is "putting control on the desktop."

• Vendors like **Aldus, Ashton-Tate, and Interleaf** have been working with **DECwindows** for several months now, say DEC officials. DECwindows is "quite portable," said DECwindows team leader Scott McGregor. DECwindows applications will be ported to the OS/2 environment once his team knows what users want, McGregor said.

• **Prentice-Hall** (Englewood Cliffs, NJ) is finishing up publication of two 10-volume series of **AT&T documentation** to go with version 3.2 of **Unix System V**. One set covers plain Unix; the other, Unix for 80386-based systems.

• **Computer software and computer systems** were two of the **"worst performing industry groups"** during 1988, according to a report released by Standard & Poor's. Collective financial performance of software companies fell 13 percent last year (2 percent better than gold mining), while companies involved in computer systems declined by 3.6 percent, S&P analysts said. On the happy side of that scale, with gains

continued

chips, with the price going as low as $1000 for chips with defective pixels. A Kodak spokesperson said the price for the KAF-4200 is "likely" to be somewhere in the $50,000 to $100,000 range. That will limit its initial applications primarily to the military and to sophisticated applications, such as medical imaging.

Dr. Michael McCreary, manager of product development for Kodak's Microelectronics Division, told Microbytes Daily that one of the reasons the chip will be so expensive is that the yield of perfect chips during the manufacturing process is extremely low. In addition to the problems of producing a chip with 4,194,304 perfect individual microscopic diodes on a 19-mm square, the fabrication process has to be held to close tolerances to eliminate what's called "dark current," spurious noise in the semiconductor substrate that causes bright speckles in the image.

Kodak had planned to start shipping samples of the chip in January, with full-fledged production scheduled by the middle of this year, the company said.

For further information, contact Eastman Kodak, Microelectronics Technology Division, Rochester, NY 14650, (716) 477-7053.

Novell to Offer Tool for Distributed Processing

Novell plans to soon offer a software tool that will help programmers develop applications that feature distributed processing. The new NetWare RPC (for remote procedure call) is a C preprocessor and a set of network-specific library files designed for various network protocols. NetWare RPC is actually a Novell version of a product developed and already being sold by Netwise (Boulder, CO). NetWare RPC is scheduled to be available in the first quarter of 1990 for both DOS and OS/2.

In designing a distributed-processing or client/server application, a programmer will divide the application so that part of it will run on a user's workstation (the client side) and part on a central file server. With Netware RPC, the programmer will not have to be concerned with any of the communications-oriented code that is needed by each particular type of network operating system. For example, the programmer could use a single set of network functions and compile an application to run on a NETBIOS-compatible network. Later, the programmer could recompile the program with a different library file to have the application run on a network that uses OS/2's Named Pipes protocol or the Sockets protocol used in Berkeley Unix. In addition to these library files, Netwise will also have library files for the TCP/IP protocol used in Unix and the SPX protocol used by Novell. A library file for IBM's APPC protocol used in its System Network Architecture is scheduled to be available next year.

Initially, Novell will offer only the SPX library file. Developers, however, will be able to obtain the other network protocol files directly from Netwise. Also, Netwise's own version of the product, called RPC Tool, is available for several environments, including DOS, OS/2, Unix, and DEC VMS. The DOS version starts at $1250; the OS/2 version, $1750. When the Novell version of the product becomes available (planned for the first quarter of 1989), the DOS version will sell for $950; the OS/2 version will sell for $1750.

For further information, contact Novell, 122 East 1700 St., P.O. Box 5900, Provo, UT 84601, (800) 453-1267, or Netwise, 4745 Walnut St., Boulder, CO 80301, (303) 442-8280.

Different Drum Uses Computer, Radio Waves

Imagine playing a Beethoven sonata with a pair of drumsticks. The location and force of the drumstick as it strikes the drum determines the tempo and the shape of the notes played in the sonata. Or, if you can write music, imagine composing a piece for an orchestra and then adding expression and tempo with a pair of drumsticks. That's what Max Mathews's Radio Drum is all about.

Mathews, a former Bell Labs scientist specializing in acoustics, retired last year to join Stanford's Center for Computer Research in Music and Acoustics (CCRMA, pronounced "karma"). Actually, the Radio Drum was invented by R. A. Boie, Mathews's former colleague at AT&T. But it is based on a concept developed by Mathews, who hopes it will become a commercial product.

The drum is a sheet of metal, approximately 18 inches square, covering an array of radio sensors. In response to how the player

continued

NANOBYTES

in performance, were textiles, retail food chains, shoes, tobacco, and manufactured housing.

• Apple II designer/industry icon/electronics whiz-guy **Steve Wozniak** sat in as disc jockey for the morning drive-time slot at a San Jose, California, radio station recently, apparently to good reviews. Woz, who also cofounded Apple Computer, produced two rock festivals, and recently coauthored what may be the worst collection of computer jokes ever published, hosted the morning spot on KSJO, an FM rock station. It was a one-day-only gig; the usual disc

continued

positions and strikes the drumsticks, these sensors send signals to a D/A data acquisition board in the computer. The computer stores these signals in memory and uses them to modify the frequencies and duration of the notes played in a score of music, which is also stored in the computer. The resulting signals are sent via a MIDI interface card to an electronic music synthesizer for playback. Mathews's original drum used strain gauges to determine the deflection of the drum membrane after each strike of the drumstick. The radio-wave model, developed by Boie at AT&T, allows more precise modulation of the sound.

The Radio Drum performs the role of a conductor of a symphony. Mathews calls the software that interprets the signals from the Radio Drum the conductor program. The drum allows the performer to modify the tempo and tone of the lines of the composition stored in memory. The scores for any number of instruments can be stored, so the Radio Drum can conduct an entire orchestra. Tempo is controlled by the frequency with which you strike the drum. Each strike of the drum represents a beat in the musical score. Using the conductor program, you can add the beats to the composition as desired. As you strike the drum, the beats are then played sequentially. Each beat can represent any number of instruments. The tone, or "shape," of the note is controlled by moving the second drumstick in the horizontal and vertical dimensions of the drum surface (the horizontal or x-axis controls bass, and the vertical axis controls treble).

The Radio Drum allows the performer to play electronic music without using the keyboard of the synthesizer. Mathews says a synthesizer played on a keyboard always sounds like a keyboard. The Radio Drum lets you modulate tones much more flexibly than with a keyboard, he says. And you don't have to be an accomplished pianist to play the Radio Drum.

Currently, Mathews has the Radio Drum hooked up to a Data Translation acquisition board in an IBM PC-compatible. The conductor software can be used with Mathews's own text editor for entering scores or with a more elegant scoring program developed by Dr. Leland Smith of Stanford (and marketed by Passport Design

continued

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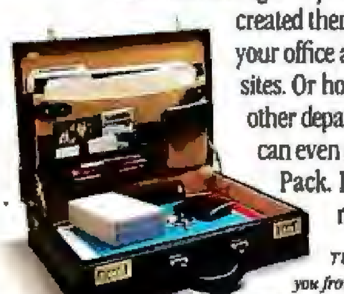

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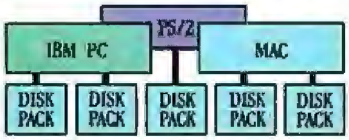

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NANOBYTES

jockey, a shock-jock by the name of Perry Stone, was on vacation. According to KSJO station manager David Baronfeld, the phone response to Woz was "really excellent."

• A kind and gentle correction: **Interstate Electronics** (Anaheim, CA) wrote, most politely, and without even a hint of the "nyah-nyah" tone we hear so often when we goof up, to tell us of an error in our September 1988 Microbyte on its chip set and 80-MFLOPS boards (page 12). We stated that the Analog Devices 32-bit digital signal processors being used by Interstate are limited to fixed-

continued

of Half Moon Bay, CA, as Score). Mathews has also written an improvisation program for the Radio Drum; it allows you to play music interactively, without first entering a musical score. One drumstick controls the sequence up and down the musical scale; the other controls the interval.

Mathews hopes to develop a commercial version of the Radio Drum that will produce MIDI interface signals directly, eliminating the need for the data acquisition board. The MIDI model would allow the user to play the Radio Drum directly connected to a synthesizer or to send the MIDI signals to the Conductor Program for use in composition. It would also allow the drum to be used with any brand of computer.

For further information, contact Max Mathews at the Center for Computer Research in Music and Acoustics, Stanford University, Stanford, CA 94305.

Analysts, Developments Offer Bright Chips Forecast

Memory chips will remain a dynamic market, spurred by innovative designs, greater densities, and growing demand, a group of industry watchers we heard recently agreed. At a panel convened in New York by Hitachi America, analysts predicted that the current shortage in DRAM chips will be over by the middle of this year.

The rosiest projection for the chip industry was delivered by Dan Klesken of Montgomery Securities (San Francisco): He predicted that total DRAM shipments would surge from 52.7 terabytes in 1988 to 480 terabytes in 1992, an increase of over nine times, fueled by growing demand for personal computers, laser printers, and fax machines and by the emergence of such high-tech consumer products as digital VCRs and high-definition TV. By 1995, Klesken said, 25 percent of DRAMs will be used for consumer products, 65 percent for microcomputers and peripherals, and only 10 percent for minicomputers and mainframes.

Klesken, however, cau-

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NANOBYTES

point arithmetic. "Not true," says Interstate. "The Analog Devices chip sets being used in our QUEN family processors perform both fixed- and floating-point arithmetic." We stand corrected and apologetic.

• Scan this deal: **Microtek** (Torrance, CA) is tossing in some fine software with its Macintosh scanners. Buy a Microtek gray-scale scanner (MSF-400G, MSF-300GS, MSF-300G, MSF-300QS, or MSF-300Q) and you'll get a **free copy of Silicon Beach's Digital Darkroom.** The company said it will also bundle in **a free SuperPaint 2.0** with every Mac scanner.

• Several software publishers were quick to state their **support for DEC's new desktop computers. Oracle** said its relational DBMS will be available on the new VAXstations and DECstations, under VMS, Ultrix, and MS-DOS; **Autodesk** will port AutoCAD to the RISC-based DECstation 3100; **LSI Logic** will offer its Modular Design Environment (for engineering ASIC designs) on the 3100; and **Mathsoft** is moving its MathStation problem solver/document producer to the new DECstations and VAX-stations.

• **Silicon Graphics** (Mountain View, CA) says it has so far shipped 1000 **Personal Iris systems.** As we reported here when the machine was announced last October, the $16,000 Personal Iris represents a substantial drop in cost for a three-dimensional graphics workstation.

tioned that chip makers may not be able to meet new demand unless they raise levels of capital investment. Between now and 1990 alone, he said, the equivalent of 11 major fabrication plants running round the clock must be brought on line, at an investment of over $5 billion, and chip yields must more than double. But he doubted that U.S. chip makers will gain in the market, predicting instead they will retain their current share of 15 percent to 20 percent, or at best 25 percent.

The picture for Asian producers is different: Capital investment by Japanese chip makers is still two and a half times greater than by U.S. companies, he said, and Korean manufacturers—especially Samsung, Goldstar, and Hyundai—are pouring billions of dollars into developing capacity.

Analyst Amy Wohl, of Wohl Associates (Bala Cynwyd, PA), said she sees hope in EEPROM chips, saying they will resolve the age-old "duality" of memory—the division between volatile and permanent storage.

Recent technical developments signify that innovation will continue to drive the chip industry. Hitachi has confirmed that it is working on a 16-megabit CMOS DRAM and has offered tantalizing glimpses of other future developments: 100-megabit DRAMs and chips based on superconducting ceramics. Researchers at the company's lab cautioned that developments in materials physics will be necessary to achieve these aims.

IBM and Texas Instruments both recently claimed breakthroughs in chip technology. IBM researchers said they have devised a way, using advanced lithographic techniques such as electron beams or x-rays, to make CMOS chips with circuits one-quarter of a micron wide, permitting transistors that switch 30 billion times per second and chips with up to 256 megabits of storage. And TI said it has built the world's first quantum-effect transistors, which occupy 100 times less space and switch thousands of times faster than the transistors used in today's ICs.

Mainstream Will Look More Three-Dimensional

Three-dimensional imaging and animation has comprised a small, expensive, and very specialized segment of the computer hardware and software market. But there are signs that three-dimensional technology this year will begin to emerge into the mainstream of personal computing. And one of the big players in this small field will be Wavefront Technologies (Santa Barbara, CA).

You've probably seen Wavefront's work on TV commercials and network spots, most notably during last year's Summer Olympics. Most of the slick graphics NBC used in the summer games were created on a Silicon Graphics machine using Wavefront's three-dimensional animation software.

While the big push for "fancy pictures" in 3-D came from Hollywood, Wavefront's cofounders Bill Kovacs and Larry Barels say that scientific and engineering computing—not the entertainment industry—will bring 3-D into the mainstream.

People in the technical market aren't interested in theatrical animation. They're interested in "describing their problem," says Kovacs. They can get part of the way with CAD and finite-element analysis. But to achieve true, realistic modeling of a physical design, either you construct a physical model or you use three-dimensional rendering, in which you add color, shading, and texture to the wire-frame or line image, and then apply motion to it.

With sophisticated three-dimensional graphics hardware like the Silicon Graphics Personal Iris, priced under $30,000, the opportunity is there to make three-dimensional modeling and animation available to a much broader base of users. The missing link is affordable software. Wavefront's current software costs in the neighborhood of $40,000. Pixar (San Rafael, CA), which is a competitor of Wavefront, offers a complete hardware and software system priced over $60,000.

The next step is to offer products at a much lower cost with easier user interfaces. We can expect these kinds of products to emerge some time this year. Barels expects IBM to offer three-dimensional capabilities on its RT PC, using a Silicon Graphics add-in board and Graphics Library.

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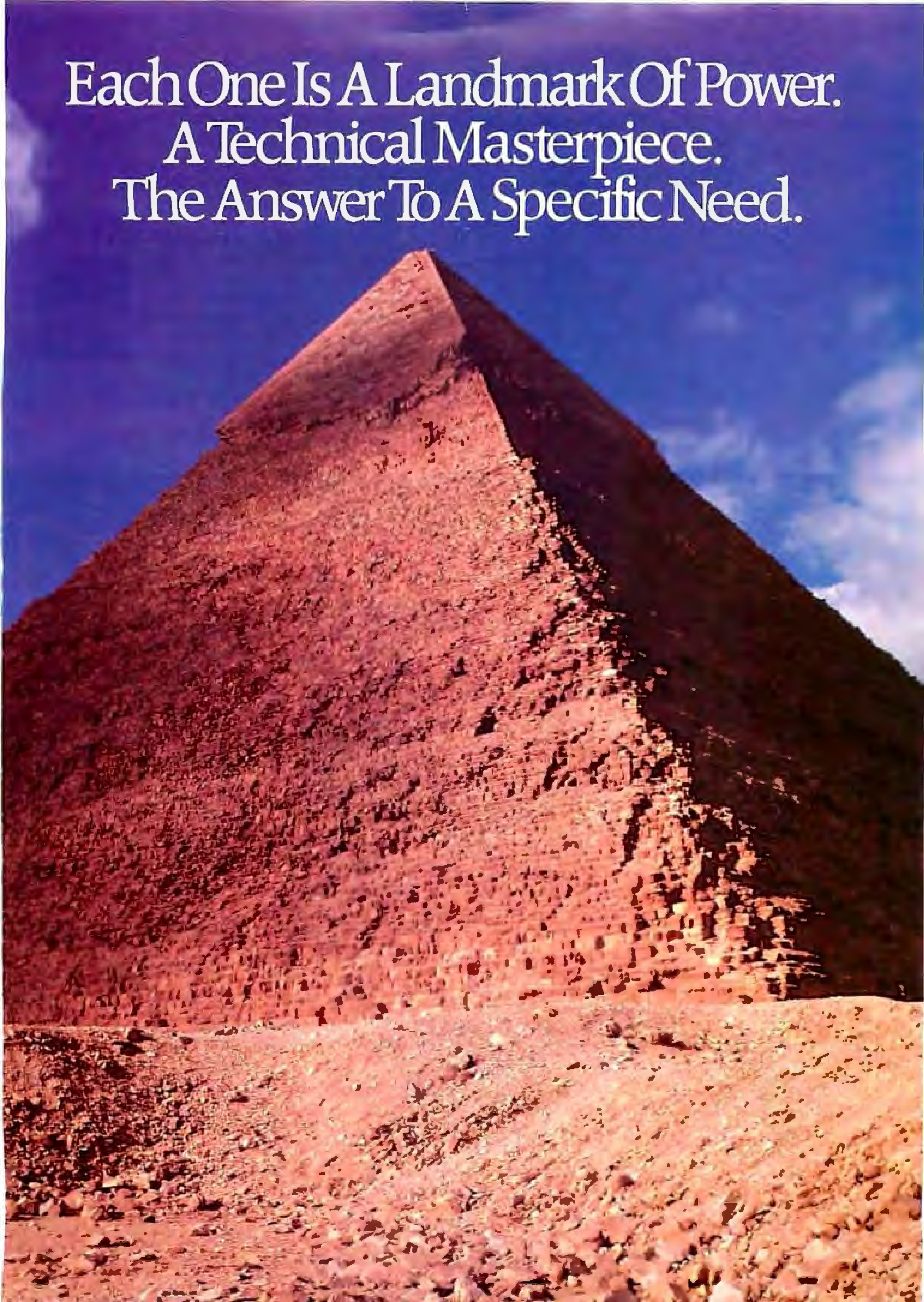
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*Source: PC Week, Nov. 14, 1988

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LETTERS

OS/2 Common Sense

Didn't it occur to you that if Mark Minasi's absurd claim ("The Good News and the Bad News," October 1988) that "background OS/2 processes slow down by a factor of 10 to 500 times" was even remotely realistic, others would have already noticed? A 10-second compile, for example, that suddenly started taking an hour would be fairly obvious, it seems to me.

It hasn't been noticed because it doesn't happen. There have been a lot of ridiculous benchmarks over the years, but these were some of the most egregious.

String compares and such all run at exactly the same speed on a given processor, no matter what the operating system. If you think you see a difference under OS/2, it's only because you don't get an infinitely large and instantaneously available time slice. When, as in Minasi's cases, the benchmark execution times are on the same order as these scheduling characteristics, of course the results are nonsensical.

In a multitasking system, when and how much of the processor you get depends on the relative level of competition for resources, the task switch time, and the scheduling parameters. For example, if you have too many processes chasing too little RAM, any multitasking operating system will thrash, producing a very sudden and dramatic decline in throughput. (For OS/2 1.0 with the compatibility box, the threshold appears to be just below 2 megabytes.) Also, it's well known that getting in and out of real mode on an 80286 is expensive, but this is hardly the fault of OS/2. (Switching between protected processes or threads is quite fast.)

OS/2 may have its warts, and if Minasi is suggesting that the scheduling parameters (e.g., the way priority is calculated) should be tweaked, he may be right. But on other than toy problems, I think most designers are finding that OS/2's superior kernel services (especially multithreading) make significant performance gains easy to achieve.

Douglas A. Hamilton
Wayland, MA

Others have noticed. Page 63 of the November 1987 PC Tech Journal *showed a test wherein a large assembly language program was run through MASM under different circumstances. The people there found that running the assembler in the background while running the BRIEF text editor in the compatibility box in the foreground slowed down the compile by 4640 percent. Not all DOS programs cause this effect—I suspect it is the constant keyboard polling of most text editors that causes the damage.*

For some reason, I found that VEDIT slowed down the background more than IBM's Personal Editor, which in turn slowed down the background more than BRIEF. The bottom line is that you're not going to use the compatibility box any more than you have to.

"Nonsensical" is a term that's meaningful only when there is common sense of some kind. No one yet has common sense about OS/2, because it's so new. It's the common sense that I'm trying to help establish.

Your comment about the 2-megabyte value in OS/2 1.0 is well taken but really doesn't apply, because the test was done on a 4-megabyte machine and swapping was disabled.

I never disagreed with your contention that "switching between protected processes or threads is quite fast." By now, you have seen my November 1988 column, where I discuss that.

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

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Thanks for reading the column. The feedback is always helpful and interesting.—Mark Minasi

More on OS/2

In "All Together Now" (September 1988), Mark Minasi tests OS/2 1.0's virtual memory manager. His BASIC program runs 650 times slower when using the virtual memory. (The execution time is 5487 seconds.) He claims that each memory access becomes a disk access once virtual memory is activated.

The program was similar to this:

```
for i=1 to 500 : for j=1 to 500 :
a(i,j)=100 : next j : next i
```

(where 500 is the value of Minasi's "ad").

Did he try a(j,i) instead of a(i,j)? Execution must be some 500 times faster, almost as fast as in RAM.

BASIC stores the matrices in column-wise order, so the offset of memory locations (2-byte integers) is as follows:

```
a(1, 1) : 2*0 ; a(1, 2) : 2*500 ;
          ... ; a(1, 500) : 2*24500
a(2, 1) : 2*1 ; a(1, 2) : 2*501 ;
          ... ;
a(1, 500) : 2*24501
a(500, 1) : 2*499 ; a(500, 2) : 2*999 ;
          ... ; a(500, 500) : 2*24999
```

If the virtual memory page size is 2K bytes, in each second memory access a full page must be written to and another read from disk. In other words, the whole array must be read and written 500 times. If the disk transfer rate is 100K bytes per second and the array size is 500 × 500 × 2 bytes = 500,000 bytes, then it takes some 2 × 500 × 500,000 / 100 = 5000 seconds.

This example clearly shows that if you have a memory system with more than one level, the programmer and/or the optimizing compiler must rearrange code sequences to keep the number of data transfers between the memory levels to a minimum.

And for the sake of correctness, the "time to process each byte" of data in the article must be in milliseconds, not in seconds.

G. Mark
Budapest, Hungary

See my December column for a discussion of this. By the way, since the December column was printed, two readers have asked why I ran the virtual memory tests on OS/2 1.0 rather than on the beta

continued


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Microsoft OS/2 1.1. (These tests were conducted in July 1988, before the general release of 1.1.) In fact, I did try the virtual memory test on 1.1, but the early release crashed when OS/2 started swapping. This has since been fixed.

—Mark Minasi

Excel Above

The matrix-handling capability of Excel is indeed a cut above statistical processing features in other spreadsheets, as "Multiple Regression with Excel" by Charles W. Kyd (November 1988) points out. In fact, using Excel and a little diligent effort, a user can replicate the functions of many statistical packages and provide individual tailoring of formats and reports. I have been using Excel in that manner in quality assurance and testing applications.

Statistically significant outcomes, however, are judged according to what you might expect to see when only chance is at work. The tables in the back of statistics books assume that you are testing the relationship between only two of many possibly related collections of measurements. Kyd suggests that you should test all possible relationships, looking for the red herring that is now much more likely to appear by chance alone. That's like looking for a coin to come up heads once in 10 tosses and continuing to toss the coin in sets of 10 until it happens.

A safer and more statistically defensible method would be to plan which comparisons you will make before collecting the measurements and look only for the significance of those in the back of a statistics book. There is ample opportunity here to fudge and announce that you were looking for the relationship that turned out to be the strongest when you weren't. Oh, well . . . some people cheat at solitaire, too.

Charles E. Cliett
Duluth, GA

The Latest Road to True Salvation

Walter J. Rottenkolber, complaining of being deluged by a flood of YAPL (yet another programming language), writes, "In the 30 years after the Mark I computer switched on in 1945, I estimate that some three dozen programming languages kept computers humming" (Letters, November 1988). Three dozen? Nonsense! You don't count programming languages by the dozen, you count them by the gross.

The heyday of YAPL was the 1960s. The programming language was the philosopher's stone of computing. The typical nerd fantasy was "to design my own computer language."

Was the best version of ALGOL BALGOL, MAD, or JOVIAL (Jules's own version of IAL)? Should you do your text processing in COMIT? TRAC? TECO? SNOBOL? For list processing: Lisp? SLIP? or IPL-V? Should users of DEC equipment choose DECAL, DIBOL, FOCAL, or MUMPS?

Champions of problem-oriented languages hotly defended their superiority over general-purpose languages. Should a civil engineer learn FORTRAN when COGO was available? Weren't problems of soil mechanics best dealt with in SEPOL?

Naturally, programmers soon perceived that the real barrier to progress was the difficulty of writing new language compilers. So they addressed this problem (naturally) by devising new languages for the purpose. The Brooker-

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Morris Compiler Building System was spoken of with awe. PSYCO (Princeton syntax-directed compiler) was well known. And there must have been quite a few more, because in 1972 Steve Johnson named his contribution to the genre YACC (yet another compiler-compiler).

A book by Jean Sammet appeared whose cover depicted a picture of the Tower of Babel, completely covered in tiny lettering with the names of computer languages. Three dozen? No, no, no, Walter! By her count, at that time, there were approximately 600 of them.

In the 1970s, the tide shifted as people began to think that the real answers lay in YAOS (yet another operating system). Today, of course, the flood is down to a mere trickle, because we now understand that true salvation is to be found only in YAUI (yet another user interface).

Daniel P. B. Smith
Norwood, MA

Staying Alive

The reports of our death are greatly exaggerated. In Chaos Manor Mail (November 1988), Jerry Pournelle mourned the passing of our company, Minnow Bear Computers. Considering that we are doing just fine, this came as quite a surprise to us.

We'd appreciate your printing this letter, as many BYTE readers may mistakenly believe we are no longer in business.

Michael E. Nunamaker, President
Minnow Bear Computers
Champaign, IL

FIXES

• The text box entitled "Digitizers with a Twist" in our January Product Focus on digitizing tablets ("Graphic Details") gave incorrect and incomplete information. The sonic digitizer mentioned there is made by Science Accessories Corp. (SAC), not Scientific Accessories, as we stated. The product's correct model name is the GP-7 Grafbar Mark II. It provides an active area of 20 by 26 inches and sells for $1315.

SAC also sells a three-dimensional digitizer called the GP-8-3D, as well as nine different sizes of its two-dimensional GP-8 line. SAC can be contacted at 970 Kings Highway W, P.O. Box 550, Southport, CT 06490, (203) 255-1526.

We also omitted the address and phone number for Polhemus Navigation Sciences: P.O. Box 560, Colchester, VT 05446, (802) 655-3159.

• Our December 1988 Review Update, "Benchmarks at a Glance," gave an incorrect FPU index rating for the Everex Step 386/20. The correct rating is 8.14.

• Table 2 in "Multiple Regression with Excel" (November 1988, page 372) contained an error for cell B41. The expression `DataAvg` should have been `Data-Avg`, as shown below:

```
B41=(MMULT(TRANSPOSE
(Data-Avg),Data-Avg)/
(TRANSPOSE(Std)*Std))/(n-1)
```

• Our January What's New item on Pocket Soft's .RTLink program (page 84) should have noted that it does not work with Turbo Pascal, rather than Turbo C, according to Borland International.

• The book review of *Using QuickBASIC 4* (December 1988) listed the location of the publisher, Que Corp., as Carmel, California. Que Corp. is in Carmel, Indiana. ■

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

DESQview Debate

Dear Jerry,

As a man who respects your opinions a great deal, I was appalled to read that you highly recommend DESQview.

It seems to me that when I purchased DESQview, I wasted my money. I haven't been able to get this turkey to do anything that I need it to do.

Some of the applications that I use regularly are Windows-specific (e.g., PageMaker and In a Vision). So when I read of Quarterdeck's advertising to the effect that DESQview could run this type of application, I was quite excited; DESQview appeared to be able to blend into the DOS environment a little better than Windows, and I liked the idea of multitasking, which Windows does only with its print spooler.

So far, the only way I've been able to get a Windows application to run under DESQview is to set up the command WIN PM, for example, which runs PageMaker under Windows, which in turn runs under DESQview. Is that what they call running a Windows-specific application? If so, I'm underwhelmed by this achievement. Windows is still doing all the work.

I'm sure it's different for you. When Pournelle asks, I would think that an answer is generally forthcoming. But for those of us among what Quarterdeck obviously views as the great unwashed, I must seriously question the usefulness of a completely unsupported product such as this.

Chris Doole
Winnipeg, Manitoba, Canada

Maybe your problem has been compounded by the Canadian mail. Quarterdeck is not a very large company, but the people there have been quite responsive to requests, and not just from me. Meanwhile, I'm using DESQview to write this.

I don't particularly recommend it for 80286 users (although it's probably better than nothing); with an 80386, you do need QEMM, Quarterdeck's 80386 memory manager.

I've used a lot of programs that attempt to let me do task switching, and I keep coming back to DESQview.—Jerry

Easy Draws It

Dear Jerry,

In Computing at Chaos Manor (September 1988), you talked about your aborted project of drawing maps on the Atari ST using the Atari laser printer. I own an Atari 1040 ST, and I considered upgrading to a 2-megabyte Mega ST and Atari laser printer. However, I made the following observations:

- Atari supplies only a very bad Diablo emulator driver with the printer.
- Most of the ST applications now support the Hewlett-Packard printers as well as the Atari laser printer.
- The Hewlett-Packard DeskJet is an excellent ink-jet printer, capable of 240 characters per second (cps) in test mode and 300 dots per inch (dpi) in graphics mode, and it is supported by all the applications supporting the HP LaserJet (because both printers use the same command codes).

For those reasons, I bought my DeskJet. A wealthier person would have bought the HP LaserJet II. However, I like to see what a printer is doing. The laser printers buzz and whir for sometimes minutes (especially when you print graphics) before regurgitating a sheet that does not always satisfy you. With the slow but open-air DeskJet, I can actually see my work being printed, and I can stop the device if something goes wrong.

For drawing your fantasy maps, I recommend Easy-Draw 2 for the Atari ST, along with the SuperCharger utility and the Easy-Tools desk accessory. As a freelance fantasy role-playing game-

continued

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. He can be reached c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "jerryp."

module writer, I used it and found it quite comfortable. Easy-Draw lets you create complex vector drawings, just like MacDraw. You can mix these objects with freehand drawings and bit-mapped graphics (converted from other utilities through the SuperCharger utility).

Once you've drawn a coarse freehand contour of, say, a shoreline or frontier, you can zoom in closely and break it into fine segments with Easy-Tools (called in from the accessory menu) and refine each segment, adding or deleting some, until the whole frontier looks perfect. Your drawings can be larger than one 8½- by 11-inch cut sheet (the DeskJet driver I have allows 11- by 17-inch drawings, printed on two pages—a little cut-and-paste work is required in this case).

The package is sold by Migraph, 200 South 333rd St., Suite 220, Federal Way, WA 98003, (206) 838-4677, for less than $200. The bottom line for a 1040 ST, a 20-megabyte SH 205 hard disk drive, and Easy-Draw is under $1500, which makes the combination very attractive.

Frederic Mora
Williamsburg, VA

I certainly agree that the DeskJet printer is an excellent buy, perhaps the most versatile one you can get in its price range.

As to laser printers laboring like Aesop's mountain, I completely agree: I also like to see what's being printed. On the other hand, lasers are fast enough that if things are mucked up, you haven't lost a great deal.—Jerry

Update from West Germany

Dear Jerry,

The German government is moving to split up the Bundespost! 1992 is bearing down on West Germany, and the government figured it had to do something about German protectionism. So the Bundespost will be split into three or four "babyposts" à la Ma Bell a few years ago. Net result: nil.

I've read a few analyses of the proposed splitting action, and they all seem to say that the "new, improved" Bundespost(s) will be less efficient, more entrenched, and less friendly to new technology—if such a thing is possible.

I am amazed at the number of people in Europe who write to BYTE and brag about how they have outfoxed their local postal, telegraph, and telephone services (PTTs) by importing U.S. communication hardware. European PTTs are notorious for their lack of humor in such matters. And advertising your crimes (from the PTT point of view) is pretty foolish. I wonder how these people feel when they come to work and find that all phone service has been shut off "for investigation of technical irregularities."

I read recently that you are preparing a tome on OS/2. Have you ever tried the Pilot operating system? I am using it at work (*not* on PC-style hardware), and it is everything that OS/2 should be. And it works.

So Apple is now suing Microsoft over the "look and feel" of Microsoft Windows. How does that affect OS/2 and Presentation Manager? As a denizen of the Xerox realm, I look on this with glee. I hope that Apple sets all sorts of precedents. And I hope that the Xerox legal department is preparing a nice sharp stick to whack Apple with when Apple is through with its fun and games.

Chuck Kuhlman
Dossenheim, West Germany

Thanks for another excellent report from Europe!—Jerry ■

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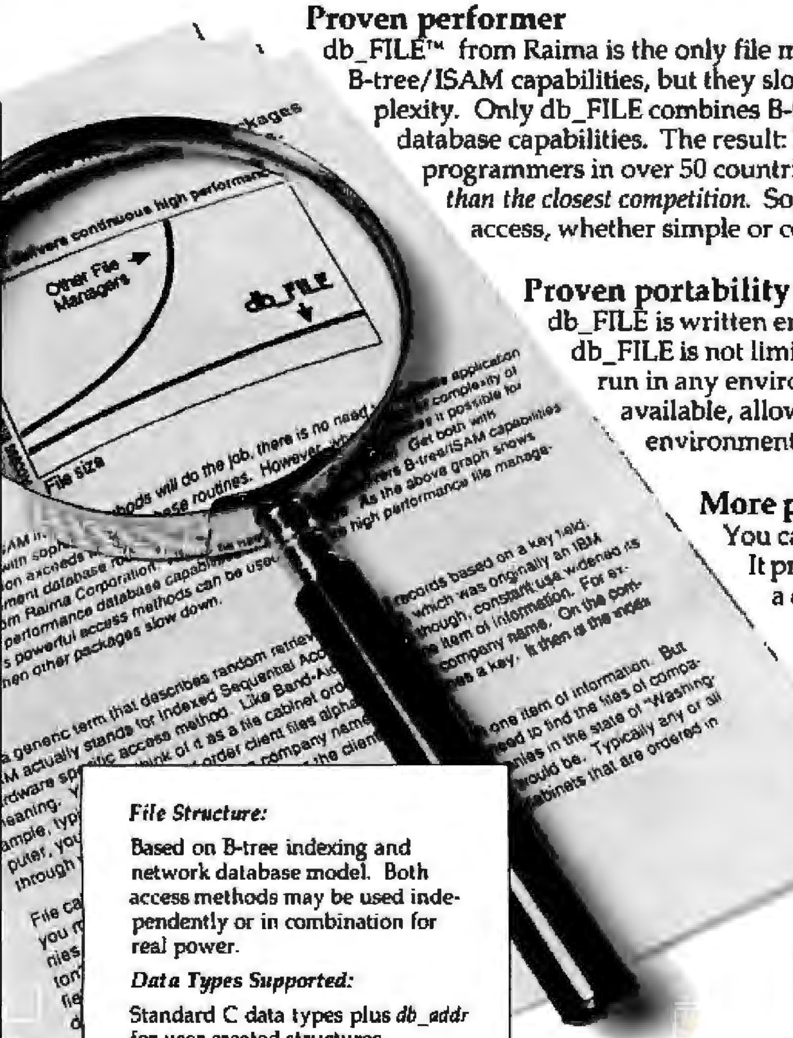

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ASK BYTE

BYTE technical editors answer your questions on microcomputing

Upgrading a Keyboard

I have an IBM PC AT clone and a PC-style keyboard that I'd like to use together. My AT clone isn't one of those that can accept an original PC keyboard, nor is the keyboard one that you can switch between a PC and an AT.

I am aware that a keyboard controller chip has to be changed on either the motherboard or the keyboard. To me, it's worth it—I've tried more than 50 PC clone keyboards, and the one I want to use is best for me. However, I don't want to mess with my motherboard if I can help it.

The keyboard I have was originally supplied with the TeleVideo TS-1605 Tele-XT (as its name implies, a long-defunct PC clone). With stiff keys and a giant palm rest, it is claimed to be electronically identical to the original IBM PC keyboard; I opened it up, and I found a Toshiba 8035 microprocessor and a socketed ROM chip.

Obviously, connecting this keyboard to my Databank AT, which has a Phoenix BIOS, gets me only a `keyboard failure` message and a keyboard that doesn't work. I'm hoping I can upgrade the keyboard to AT functionality by upgrading the ROM chip.

Jonathan Angel
Palo Alto, CA

I can understand your falling in love with the feel of a particular keyboard. But the technical problems involved in analyzing the circuitry of your TeleVideo keyboard and burning a new ROM are more complicated than I can describe in this column. I suggest you try out some of the high-quality keyboards from Northgate or Keytronic.—S. W.

IN ASK BYTE, BYTE editors answer questions on any area of microcomputing. The most representative questions will be answered and published. Send your inquiry to

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Surprisingly Slow Card

I need your help to understand the jumper and pin positions on my Western Digital WD1002A-27X hard disk drive controller card. I use it in conjunction with a Seagate ST-238R hard disk drive formatted to 30 megabytes. The setup runs OK, but when I execute the Norton Utilities 4.0, the disk index gives me a value of 0.5. I'm using this on a Turbo IBM PC XT compatible, switchable from 4 to 8 MHz, so I should get a disk index of at least 1.0.

I suspect that the jumper positions on the controller card may have something to do with the surprisingly low number. I tried varying the interleave factor to no avail. Can you suggest some cure or perhaps pass on the address of Western Digital so I can refer my questions to the people there?

Basse O. Bondtote
Kajang, Malaysia

The Western Digital WD1002A-27X is a run-length-limited, 8-bit hard disk drive controller. It is compatible with your Seagate ST-238R hard disk drive.

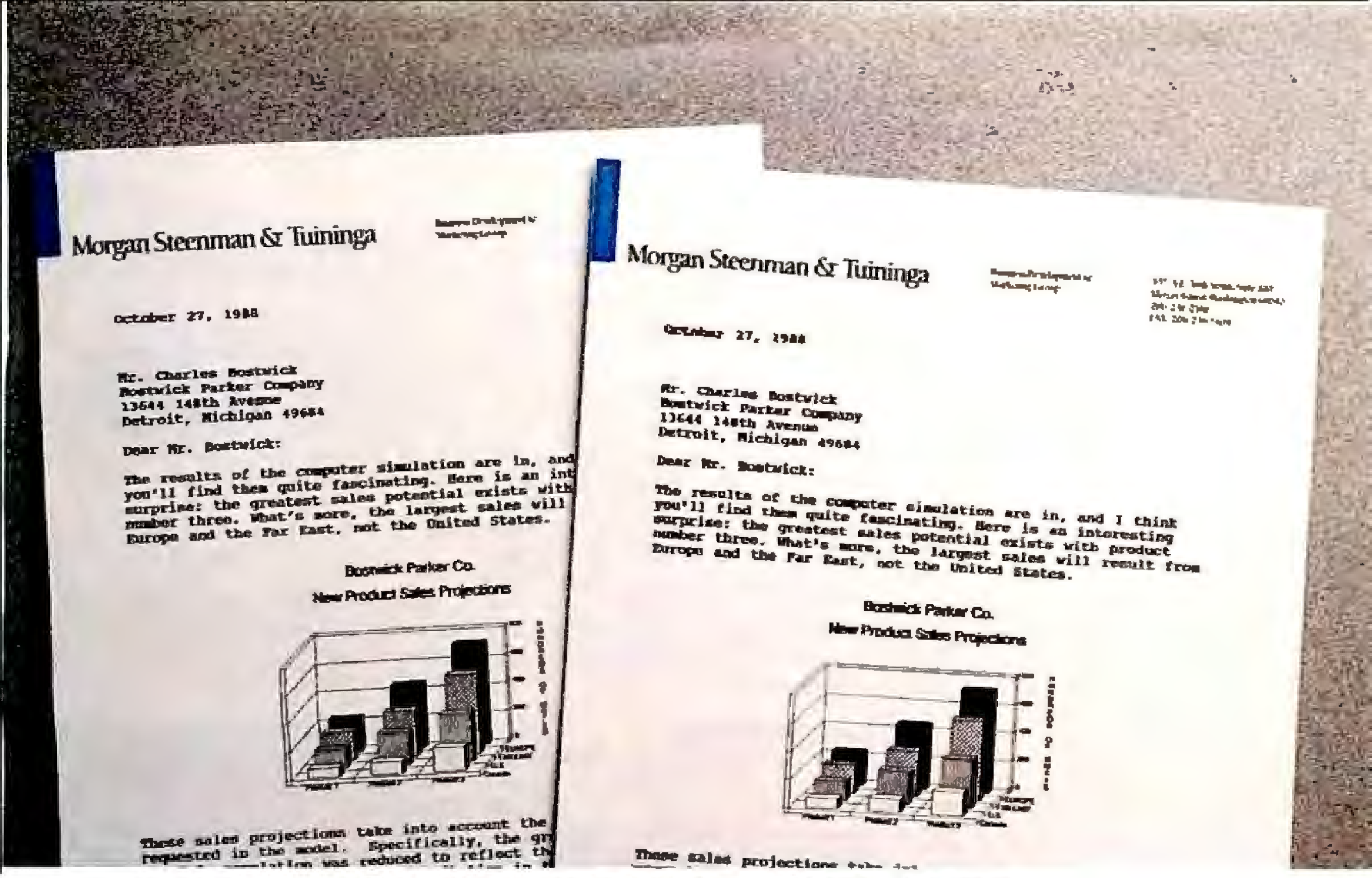
I suspect you're correct in thinking that the jumpers on the board are set incorrectly. The specifications for your board are available from Western Digital Corp., 2445 McCabe Way, Irvine, CA 92714, (714) 863-0102.—S. W.

An XT Goes Overseas

Having graduated to an IBM PC AT, I have decided to give my XT to my brother in England. There's only one problem: I don't want to carry the monitor to him because of its bulk.

My brother questions whether my U.S.-manufactured XT will work with a British monitor. He seems to think that because the raster-scan rates of British and U.S. TV sets are related to the AC power of the respective countries (50 Hz

continued



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for the U.K. and 60 Hz for the U.S.), the same is true of monitors. Can you tell us whether or not this is true?

William Brown
Katy, Texas

Most monitors manufactured and sold as "PC compatible" are just that; they will work at a scan frequency of 30 Hz to maintain compatibility regardless of their country of origin. Problems would arise only if you attempted to use a composite or TV monitor; the European standard, as you mentioned, is different from that of the National Television System Committee. European monitor manufacturers that sell in the U.S. can sell the same unit in both markets, provided it has dual power inputs.—S. A.

Little Orphan Lisa

Some years back, my department bought five Lisa (Macintosh XL) microcomputers, which Apple Computer no longer manufactures. We have problems with them, and we have contacted Apple, but to no avail. We'd like to know sources of parts and kits, as well as books, because we want to keep our Lisas running. Could you give us suggestions for where to start looking?

Shen Xioyang
Department of Physics
Shaanxi Teachers University
Xian, PR China

A good place to start looking is at Sun Remarketing, P.O. Box 4059, Logan, UT 84321, (801) 752-7631. Not only does the company provide upgrades that allow the Lisa to run Macintosh software, but it also is an authorized Lisa service center. Check it out.—T. T.

High-Speed Microcomputing

I race a Limited Inboard Hydroplane in the 5-liter stock class. I use a 305 Chevrolet as my power plant. The boat is capable of 120 mph.

I would like to develop an on-board computer to monitor engine functions while testing and racing. Eventually, I would like to be able to output performance data.

I have gone through past issues of BYTE looking for a project that might fit my application. I have found other on-board computers, but their manufacturers want an arm and a leg for them, and I run a low-budget operation. For example, I looked at a computer that monitored the eight exhaust temperatures, had room for an additional eight engine and clutch monitors, and cost more than $5000. I'm certain that the job can be done for a lot less than that.

My problem is that I'm not exactly an electronics whiz. My background is in accounting.

I also want to develop a digital device that would tell exactly what the timing of the engine is. I think this would be an easy device to develop, but I need someone with the expertise and knowledge.

Can you give me some direction? I have ideas, but not the skills to develop them.

Rod Lewis
Lake Oswego, OR

There are several directions you could choose. Your options depend on whether you need monitoring and process control or just a way to record data for later analysis.

Real-time process control would require some on-board intelligence; the width of the processor bus is dependent on the number of inputs and outputs you require. Since you also need high temperature sensors, it might be best to contact an industrial control firm; you may be able to put together a small chassis PC bus, VME bus, or Multibus solution with a processor and a few interface cards. The cost, however, is likely to be quite high because you're looking for development for a single system, and the effort would require writing application software.

Data acquisition without control would require only the sensors and a recording device, and it may be a more cost-effective solution. Data could be strobed, read in, and stored in memory with only a low-end processor (depending on the speeds and the amount of data required), the sensors, some memory, and some interface logic. You could even put together the timing monitor with no intelligence: A clock, an input line tapped (and stepped down) from the distributor circuit, and a counter would form the heart of the system.

Your best bet if you are looking for a do-it-yourself solution is probably to check out some advanced hobbyist books and look for a design that would best suit your needs. You might also check out the single board computers that have appeared in BYTE in recent years.—S. A.

A Correct Connection

I have a Sony KX14CP1 monitor that functions very well as a CGA output device. What's bothering me is whether its analog input is able to accept VGA analog output. Is it just a question of the correct connectors? I am assuming that all

continued

analog RGB input monitors are the same. Is that correct?

I would also like to clarify the impression that I get from reading some of the computer ads in BYTE and other magazines. ATI seems to imply that its EGA card is able to output any mode to any monitor. This would mean, for example, that an EGA mode could be displayed on a monochrome monitor with shades rather than colors. This appears wonderful, since it is then possible to run any software with just the ATI card and whatever monitor you happen to have. Is this right?

Dr. Ono Meng Soon MRCP
Petaling, Jaya

You can use any analog RGB monitor as a VGA output device, provided the monitor has the proper bandwidth and you are able to make the proper connection. While I don't have the specs for the Sony monitor, a bandwidth of over 10 MHz is required for VGA adapters. You'll have to make sure that the monitor is capable of 640- by 480-pixel resolution, a quality not found in many displays sold for use under the CGA standard.

EGA systems have a monochrome mode (mode 15) that can display graphics on a two-color monitor. Monochrome (black-and-white) monitors with gray-scale capability are usually sold for graphics work and offer high resolution. Any EGA card will work only with a TTL monitor or a multifrequency monitor with a TTL switch. —S. A.

Resurrecting the Dead

I'm a beginning electronics/computer hobbyist (with a strong emphasis on "beginning"). Recently, I intercepted a venerable (circa 1976) Lanier LTE-3 "no problem" dedicated word processing system on its last trip out the back door of a local attorney. The system seems to be in good operating condition and includes a large integrated terminal (a 13-inch CRT, two 5¼-inch floppy disk drives, five card slots, and a full keyboard), some software, and a Qume daisywheel printer.

I'm not interested in wrestling with an antiquated typing system in a modern business environment, but I would like to convert the terminal into a multifunction personal computer. Can I accomplish this in a cost-effective manner?

I have no technical specs on the system, but the motherboard seems to be built around the following chips: the Intel 1D912, NEC D8080AFC, and NEC D8257C microprocessors, and 16

continued

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A Pattern Matching Language

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A. J. Daniels Jr.
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I'd consider taking up wrestling. At least, be happy that the system works and see what mileage you can get out of it as is.

The D8080AFC is none other than the wonderful old 8-bit 8080, grandfather of the 8088. The 8080 was at its peak in the early days of CP/M and the S-100 bus. The D8257C is not a processor but a programmable direct-memory-access controller for the 8080/8085 family. Your 16 TMS4116-15s add up to 32K bytes' worth of 150-ns dynamic RAM.

To update the system, lift it up and move your desk underneath an AT clone. Perhaps the Qume has a Centronics-compatible parallel port (though the Qume daisywheel printers I'm familiar with came with wide, multiline cables compatible with only Qume's interfaces), and you can use it with some PC or AT clone.—R. G.

Parallel ATs

Let's take a hypothetical case. I have two IBM PC AT compatibles. One I use all the time. I use the other 10 percent to 20 percent of the time, but I cannot do without it. Both have 640K bytes, a 1.2-megabyte floppy disk drive, a 20-megabyte hard disk drive, and a parallel port. My dream is to use the second AT in a parallel/multiprocessing mode.

Is this feasible under DOS or OS/2? If so, what additional hardware (e.g., memory, bus-to-bus link) would I need? Is such hardware available? If I have C source code, can I—using some overlay software—recompile that software so that it makes use of both machines?

Do other readers find themselves needing a second AT but underutilizing it? Would the kind of software and hardware I'm dreaming about be a viable alternative to upgrading to a faster, more expensive machine?

Ameesh Oza
Martinez, CA

It sounds like what you're dreaming about is building a parallel-processing system, not an easy feat by any means. First, you'd want to get the systems communicating with one another at high speed, so you'd probably need to set up a bidirectional parallel port. You can do this by either buying a couple of parallel I/O boards or seeing if you can modify your existing parallel ports as described in "Why Microcontrollers, Part 2" by Steve Ciarcia in the September 1988 BYTE. Then you'll have to work out handshaking details, communication protocols, and so on; you're pretty much on your own in all this.

And your problems have just begun, because getting high-speed communications set up doesn't guarantee that any of your software will make use of it. Unless the whole point of this exercise is the enjoyment you'll derive from creating what amounts to your own operating system and application software, you're in for months and possibly years of hassle.

Of course, another alternative is to set up a small network between the machines. You could make this as simple or as elaborate as your pocketbook allows. But the computers could at least share disks and printers. So, for example, you could turn one AT into a remote print-spooling station so that it manages large print tasks while the other AT is free to

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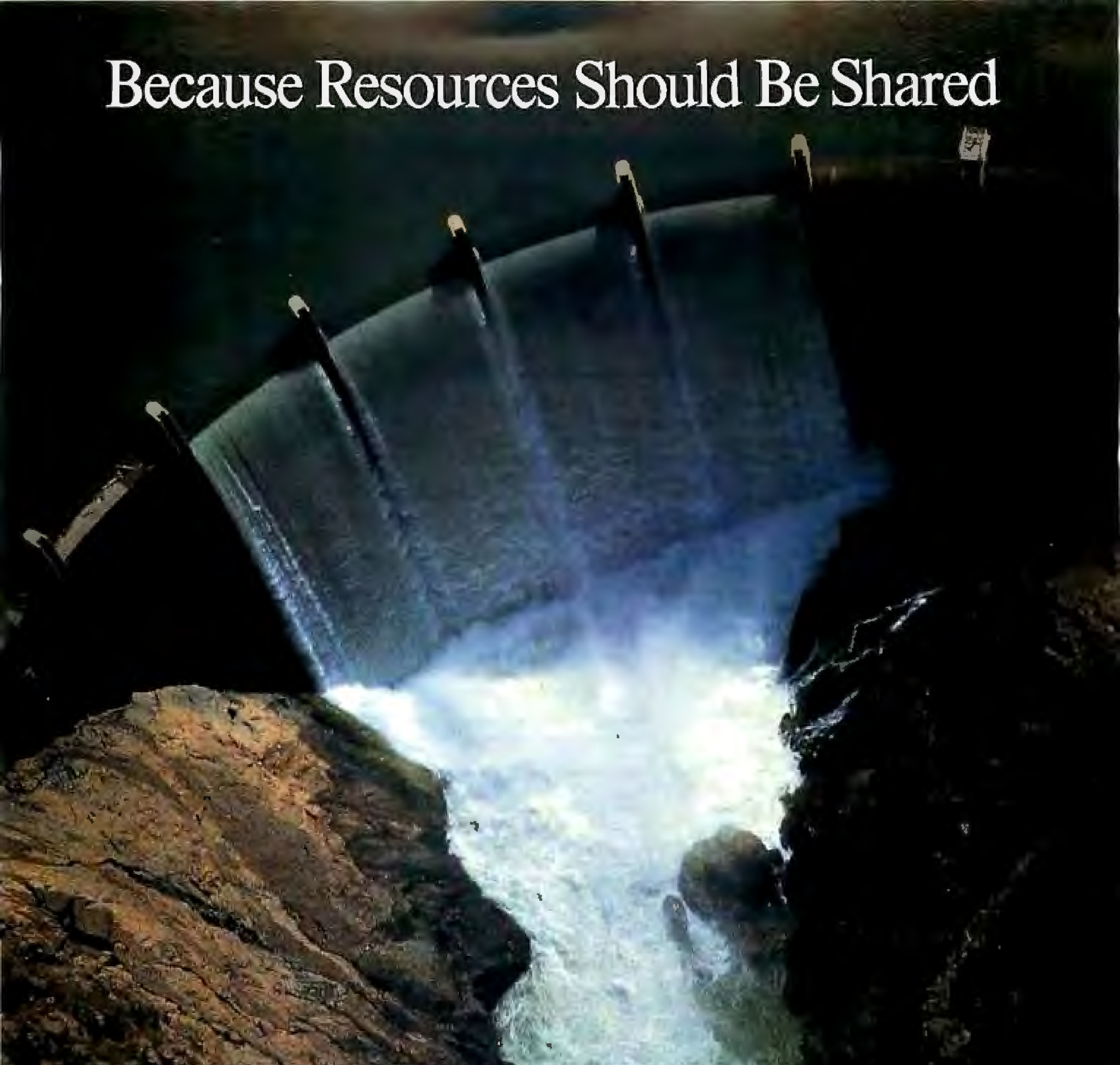
Because Resources Should Be Shared

work on a spreadsheet or database operation. (An example of a low-cost network system is EasyLAN from Server Technology, 1095 East Duane Ave., Suite 107, Sunnyvale, CA 94086, (408) 738-8377. You'll spend $99 per system, and all you need in the way of hardware is a serial port on each machine and an RS-232C cable.)—R. G.

Emergency Shutdown

At my company we have several IBM PC XT and AT computers operating in an unattended environment where it is important to determine if a system is not operating because of a power, hardware, or software failure.

Once failure is detected on a system, we want to energize or deenergize a relay that can be used to enable and disable other equipment. At some later point, we would analyze and correct the actual problem.

We believe we need a device that could be signaled periodically via software control and would then begin a countdown process. If another signal was received before the countdown terminated (indicating valid operation), the counter would be reset; otherwise, the counter would expire and the relay would be switched. We can tolerate a time-out period of several seconds (say, 2 to 5) to a few minutes (say, 1 or 2). Expansion slots are at a premium, so we would like to signal via an existing port: serial, parallel, or, perhaps, keyboard. The cost needs to be low—$20 to $50.

We have found some watchdog timers, but either they require special signals via an expansion board, they're too expensive, or both. Since we don't want to design or build this device, do you know of any vendors that supply a device we could use for this purpose?

Fred Schumann
Boulder, CO

The PC XT and AT already have their own timers, so you probably don't need to buy an additional one. Programming the timer in assembly language and BASIC is covered in good detail in Robert Jourdain's Programmer's Problem Solver for the IBM PC, XT, and AT *(Simon & Schuster, New York: 1986). This book also contains good information on programming parallel printer and serial ports. You should be able to use either the RDY line on the parallel printer port or one of the serial port's handshaking lines as input for your triggering signal. So there's a good chance that, with some clever software, you don't need any additional hardware.*—R. G. ■

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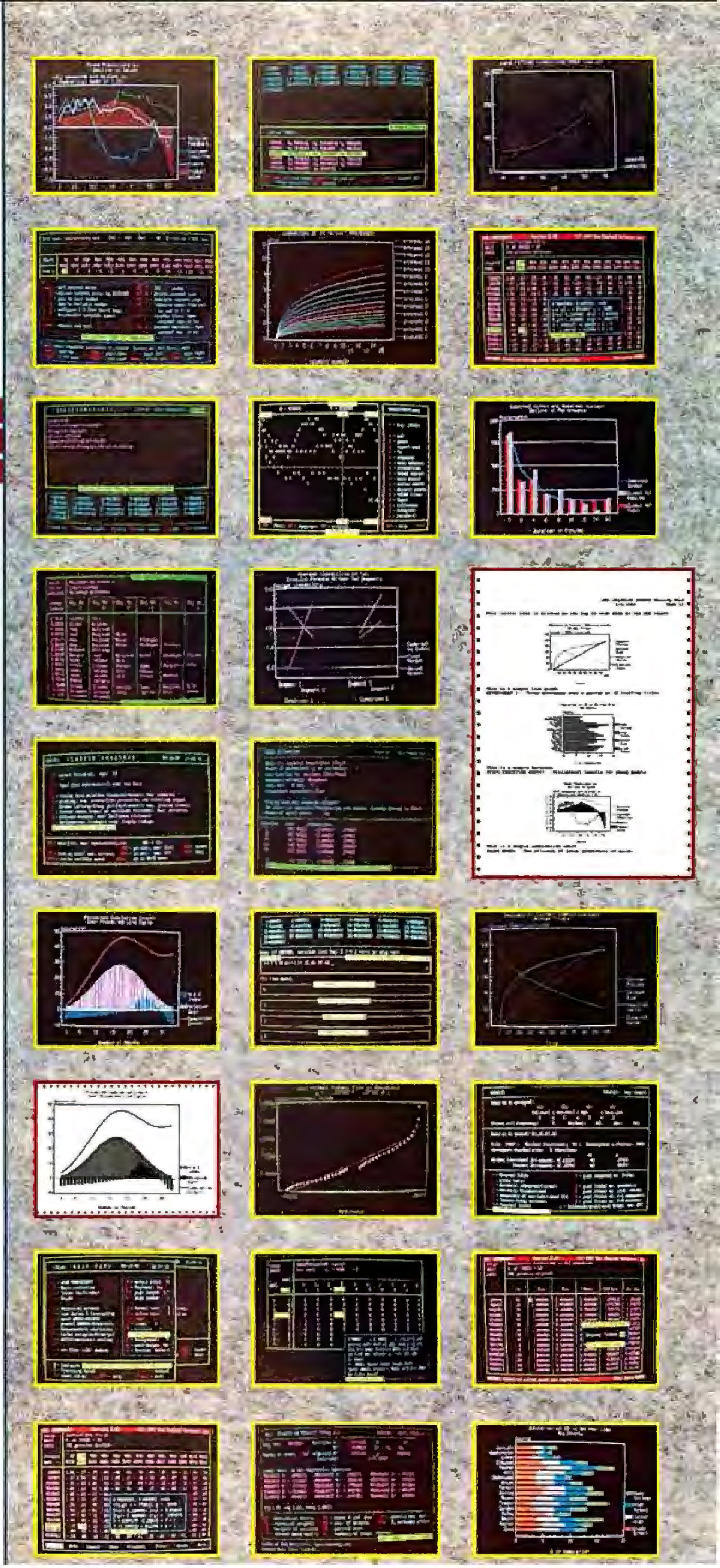

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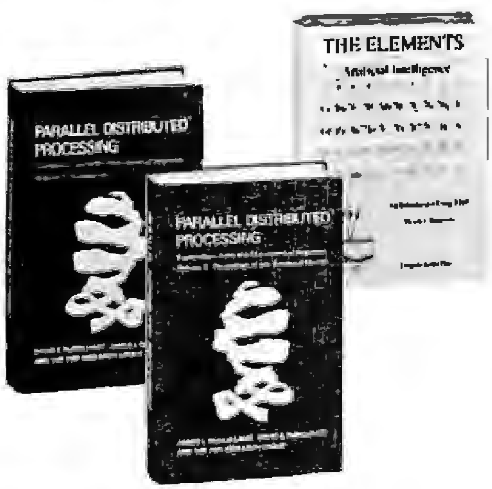

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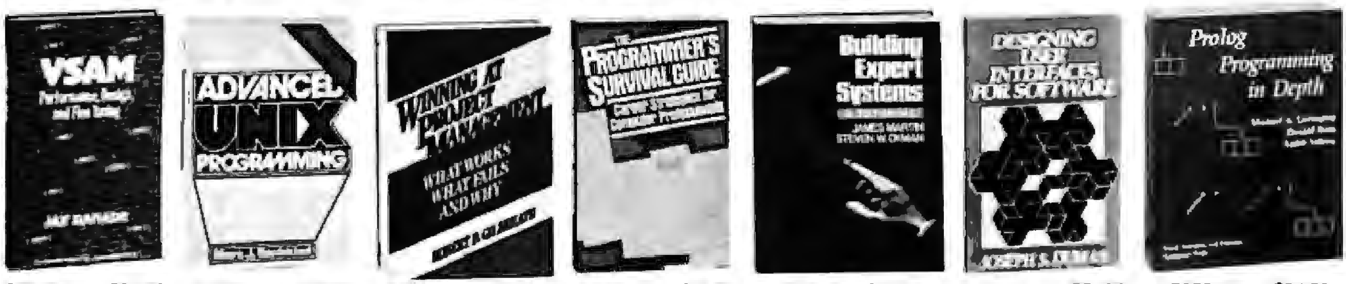

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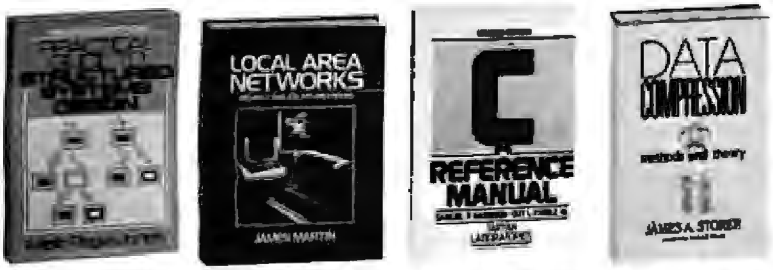

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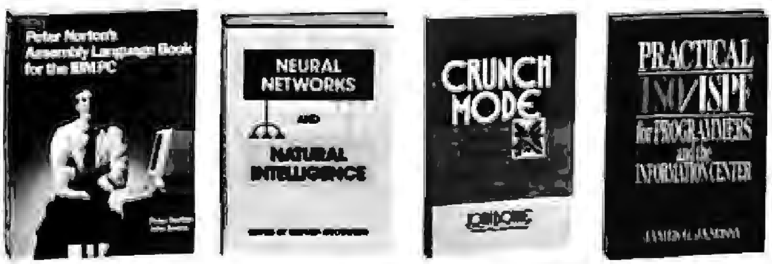

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Text, Context, and Hypertext: Writing with and for the Computer

Edited by Edward Barrett

MIT Press, Cambridge, MA: 1988, 368 pages, $29.95

Reviewed by David A. Mindell

New methods of creating, manipulating, and storing text are changing the nature of written language, and not necessarily for the better. Electronic machination can easily transform the wonderful and elusive ambiguity of language into a strictly regimented system of signs: Text becomes "strings," writers become "word processors," and readers become "users." Writers, technologists, and critics alike are asking how these developments will change both the practice and the profession of writing.

Text, Context, and Hypertext, a collection of essays edited by Edward Barrett of MIT, attempts to address these difficult issues, as summarized in the book's subtitle, "Writing with and for the Computer." The essays deal with three general categories: technical documentation and the position of the writer in the computer industry, the education of technical writers, and hypertext and hypermedia.

Writing, or "Information Development"?

In "Information Development Is Part of Product Development—Not an Afterthought," Roger Grice of IBM outlines a strategy wherein technical writers become involved in software development in order to create more user-friendly products. This essay, however, is more revealing as an example of how large corporations assimilate and mutate writing and how technology and its associated jargon transform the role of the writer.

Grice describes IBM's renaming of the writer as an "information developer" whose function becomes an engineering-like design of "information units." According to Grice, what distinguishes these new professionals from writers is that they "tend to get information from people rather than from books," work "as part of a team," and "test the information for its usability."

Other articles in the book make similar suggestions that improved writing does not require improved language but rather the proper placement of writers within the corporate hierarchy. Such changes will make the writer serve better as "communicator, integrator, and facilitator." To me, writers have always been these things, and this rhetoric diminishes the power of written text in favor of structure, hierarchy, and euphemism.

Teaching on the Network

Editor Barrett's own contribution (which was coauthored by James Paradis) concerns the application of computer networks to the teaching of writing in the classroom. Instead of attempting to model "the cognitive processes of the mind" operating within writing instruction, they chose to model the "social setting" of the classroom. The blackboard is replaced by the computer terminal, students hand in their work over a network, and the instructor reviews and returns the work with electronic notes.

The authors found their classroom model quite successful, but students preferred teachers' comments in old-style hard copy covered with red ink. Barrett and Paradis seem enthralled with technology; they are so concerned with being in the technological avant-garde that they hesitate to accept such a low-tech solution as paper and pen.

Classroom-oriented approaches are useful as a kind of textual public-address system, but I doubt if one could really learn to write over a network. While computers can imitate and even improve so-

continued

ALSO REVIEWED

C: An Advanced Introduction, ANSI C Edition

Supercharging OS/2: Batch Files and Utilities

Advanced QuickC

Advanced Turbo C, A Programmer's Guide

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ILLUSTRATION: ROWENA SMITH © 1989

cial settings, they should not replace them, and face-to-face instruction will always be more valuable than screen-to-screen instruction.

Text, Context, and Hypertext makes a significant contribution to the current debate on computer writing, but it suffers from an overly "techie" emphasis. That several of the essays are poorly written and carelessly edited is a symptom of insufficient attention to language as the root of all writing. Furthermore, a $30 book like this one, with a section on desktop publishing, should not have several different typestyles and low-quality dot-matrix prints.

The Poetics of Hypertext

The most thoughtful essay of the book, "Hypertext and the Teaching of Writing" is written by John Slatin of the English department at the University of Texas. His thesis, that "hypertext is a literary concept," parallels problems of hypertext with problems of poetry such as intertextuality (the essentially referential and connected nature of all texts). Slatin reminds us, through Ezra Pound and Marianne Moore, that "nodes, links, and structure" have long been prominent in literature, and that hypertextual writing is merely an explicit form of these connections. Furthermore, it is through such nodes and the links between them that ideas emerge, so hypertext is a powerful tool for both educators and writers.

Slatin's essay also represents what I see as a new direction in the critical thinking about writing and computers. It is among the few in *Text, Context, and Hypertext* to be free of a certain technological utopianism and disdain for what Barrett calls "rhetorical tradition." All too often, computer/cultural theorists fall prey to the "in 10 years we'll be able to do everything" syndrome. Critical dialogue on these subjects certainly needs technically informed thinkers who can seriously engage new technologies. At the same time, these thinkers must be able to remove themselves from the thrill of progress and place such developments in their proper historical and cultural perspective.

Text, Context, and Hypertext covers a broad spectrum of technical and professional issues. But, when considering the impact of computers, we must ask ourselves, How did the invention of the typewriter affect the nature of writing, or the printing press, or, for that matter, the pen?

BRIEFLY NOTED

C: An Advanced Introduction, ANSI C Edition *by Narain Gehani, Computer Science Press, New York: 1988, 265 pages, $32.95.* The denizens of AT&T's Bell Laboratories create a lot of language products and the books that are needed to document them. Narain Gehani developed Concurrent C, a superset of C that facilitates parallel programming, for Bell Labs. He has written extensively about C, Concurrent C, and even Concurrent C++, as well as Ada.

The first edition of this book appeared in 1986; this edition reflects the changes in C required for conformance to the new ANSI standard. Gehani's two books nicely complement the existing C Bible, *The C Programming Language*, by his colleagues Brian Kernighan and Dennis Ritchie.

The style of *C: An Advanced Introduction, ANSI C Edition* will be familiar to readers of K&R. Gehani states up front that he assumes that you already know a fair amount about programming in languages like Pascal, FORTRAN, and Ada. His book helps you learn how to use C but not necessarily how to program. But along the way, he explains C concepts that frequently take a long time to learn on your own. The book

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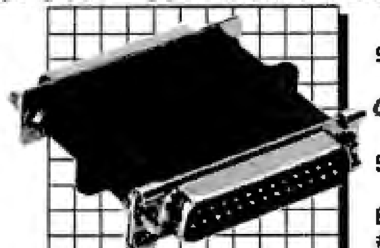

sticks to "advanced" C topics, such as type declarations, data abstraction, exception handling, and the C preprocessor.

In addition to covering the fundamental areas, like control-flow statements and operators and expressions, Gehani concentrates on advanced information, and he manages to be very readable and easy to follow, as well. For example, the chapter on functions explains how to declare and call functions, the basics, but it then goes on to discuss functions with a variable number of parameters and the control of function visibility.

Gehani devotes an entire chapter to independent compilation and data abstraction. This chapter provides a good discussion of breaking programs up into modules so that you can protect data structures by making them local to a given module using the *static* storage class.

This book contains a lot of code. While most of the listings are short, they illustrate C concepts meaningfully; many of the fragments come from larger, working programs.

The book provides appendixes for both C++ and Concurrent C that provide an overview of these C supersets. While you cannot learn C++ or Concurrent C from these pages, you can get an idea about whether or not you could benefit from a more detailed explanation in another source.

I can recommend this book to programmers who think they know C well and to programmers who write a lot of code in other languages and want to learn C. Both will find many useful nuggets of information from a true programming wizard.

—*G. Michael Vose*

Supercharging OS/2: Batch Files and Utilities *by David D. Busch. Addison-Wesley Publishing Company, Reading, MA: 1988, 276 pages, $22.95.* At first glance, the title of this book grabs your eye and makes you take notice. The promise of making OS/2 even more powerful makes you want to know more. But then you begin to wonder if batch-file utilities are really going to improve OS/2. The answer is, probably not for most users.

Not that some of the 48 utilities offered aren't useful—many of them are, like the STAMPER.CMD utility that marks files with the current date, or ARCHIVE.CMD, which copies files not already backed up to an archive disk. In addition to some useful utilities, this book nicely explains how each of these batch files works so that you can learn how to be a batch-file programming expert.

But there's a fundamental problem here. OS/2 hasn't caught on up until now mostly because the world was awaiting the Presentation Manager, OS/2's graphical user interface. With PM, you won't be using batch files because you won't be talking to OS/2 from the command line. You won't have to worry about path names and subdirectories, because the OS/2 world will appear in pictures you move with a mouse, not as filenames you copy and delete.

Supercharging OS/2 seems to be caught in the OS/2 vaporware time warp, appealing to the people who used OS/2 like an advanced version of MS-DOS in the days before the arrival of the PM. It has introductory chapters on OS/2 that rehash why this operating system will be important to personal computing's future; there's nothing new here. It briefly explains OS/2 concepts like multitasking and time-slicing and concisely, albeit simplistically, summarizes what's different between OS/2 and MS-DOS.

Reading this book was hard for me. I know a fair amount about OS/2, and I didn't like its condescending tone.

I can't recommend this book as a way to supercharge OS/2. As a tutorial on using batch files, however, it is useful though not unique; most of

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the techniques will apply to MS-DOS as well as to OS/2. To learn about OS/2 batch-file programming, you might want to read a magazine article or your OS/2 user's manual instead and save $22.95.

—*G. Michael Vose*

Advanced QuickC *by Werner Fiebel, Osborne/McGraw-Hill, Berkeley, CA: 1988, 711 pages, $21.95.* A few years ago, it was fashionable to claim that "Real programmers eat meat" as a parody on the consciousness-raised early-1980s male who was man enough to eat quiche. While that was a joke, programmers do want "meat" in their programming texts. Werner Fiebel's latest book satisfies such an appetite.

Not really a book about QuickC as much as a book about C programming that happens to use QuickC, *Advanced QuickC* features over 600K bytes of source code. This code is not short snippets written just to explain a C concept; these fragments perform serious, useful tasks. The lists of routines in the book reads like a computer science cornucopia: stacks, queues, linked lists, binary trees, parsers, data compressors, encryption routines, quadratic random-number generators, simulations, statistics models, and graphing routines. All this code is available on a disk from the author for an additional charge.

The text accompanying the code describes the algorithms, sometimes in great detail, and is easy to follow. Long programs are broken down with paragraphs that explain what each function in the program does. These explanations explore problems with any given algorithm, like the discussion of Quicksort's poor performance on small data sets, and presents programs that don't work the way you expect them to, followed by a corrected version of the code.

The section on data encryption offers some puzzles you can play with to exercise and better understand the encryption algorithms.

The appendixes in this book summarize the QuickC commands and probably offer enough information about QuickC to let an experienced Pascal programmer jump to QuickC with little difficulty. But since QuickC offers extensive on-line help and comes with a reference manual, the material here probably won't be of much use. But if you're like me, you'll use the vast selection of routines that make up the rest of the book over and over.—*G. Michael Vose*

Advanced Turbo C, A Programmer's Guide *by Donna Mosich, Namir Shammas, and Bryan Flamig, John Wiley & Sons, New York: 1988, 339 pages, $21.95.* All too often, programming books, even advanced ones, end up being no more than expanded reference manuals. *Advanced Turbo C*, however, covers material that is absent from the Turbo C manuals (including version 2.0) but also provides genuine insight into the unique and often complex nature of C programming.

The book begins with a concise C summary but quickly moves into deeper waters, developing in the next few chapters a mouse-based text window system. The authors should be complimented on the handiness of their programs. The code is clear, well commented, and good for learning. It is also efficient and useful (conveniently divided into header files and program files). Some readers may want to include it in their own libraries.

Advanced Turbo C goes on to cover standard Turbo C subjects, such as file I/O, memory allocation, and "generic" programming. The window system from the earlier chapters, for example, is adapted for graphics. The book concludes with a final project of a mini hypertext system, a composite of techniques previously discussed.

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What sets *Advanced Turbo C* above other programming guides is that the examples it uses are both educational samples and useful routines.

—*David A. Mindell*

The Book of Fax *by Daniel Fishman and Elliot King, Ventana Press, Chapel Hill, NC: 1988, 134 pages, $12.95. The Book of Fax* is a simply written feature- and benefit-oriented overview of fax machines aimed at businesspeople and other would-be fax purchasers who have a minimal interest in the technology. Even at 134 pages, including the index, the book contains considerable padding, but when the authors get down to their subject, they cover the basics well.

In this case, the basics are such things as features and benefits, price ranges and what you can expect to get for your money, channels for buying a fax machine, and the advantages and disadvantages of each. Some attention is paid to computer fax boards, as well. Throughout, the emphasis is on *using* fax.

The authors discuss the technical aspects of fax only insofar as they affect the user. They only touch on differences between group 1, 2, 3, and 4 coding, for example, and there is no discussion of coding methods or transmission characteristics. If you want to understand how the technology works, look elsewhere.

Because *The Book of Fax* is so determinedly nontechnical in its orientation, it doesn't attempt to discuss installation and troubleshooting. It gives you tips on where to buy a fax machine and what to look for, but it won't help you connect up your purchase or deal with the common problems with fax.

The weakest parts of the book are the authors' attempts to discuss the strategic and business applications of fax machines. The strongest parts are the wealth of practical tips for using fax machines. Fishman and King alert the reader to the problem of fax junk mail, for instance, and they offer suggestions on how to deal with it.

The Book of Fax is best used as an orientation tool. It will give a nontechnical person interested in fax an overview of the field. It provides a starting point for a would-be fax purchaser, but it is far from a complete guide.—*Rick Cook*

Defense Applications of Artificial Intelligence: Progress and Prospects *edited by Stephen J. Andriole and Gerald W. Hopple, Lexington Books, Lexington, MA: 1988, 385 pages, $65.* This is a collection of 20 essays about the "marriage of artificial intelligence technology and a host of Department of Defense problems." The essays are grouped into four categories: the national defense agenda, applications exploring the AI–national defense interface, case studies, and prospects and prognosis. The contributors offer up a good deal of new information and food for thought. Naturally, most of the articles are strictly military in scope, but a few have wider application.

What does it all boil down to? Hopple, using a somewhat strained metaphor, concludes that "the marriage between defense and AI has become a mature and fertile union—past the hype of the honeymoon but reassuringly distant from the divorce court as well." *Defense Applications of Artificial Intelligence* definitely offers most AI readers an unusual perspective on their field of interest.—*Jack D. Kirwan* ■

CONTRIBUTORS

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The newest version of WENDIN'S VAX/VMS look-alike operating system is self-bootable, and will run most DOS software while offering multiuser and multitasking capabilities.
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Greenleaf ViewComm
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"VM/386 should be considered mandatory software as important as MS-DOS." ...Computer Language 10/88

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List: $245 Ours: $199

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List: $299 Ours: $229

PANEL PLUS II

The latest offering of this reliable, time-tested screen design product includes all new documentation, support for virtual screens, scrolling windows with mouse-controlled scroll bars, a screen design editor enhanced with new pop-up dialog boxes, and an improved C code generator. The full library source code included with PANEL Plus II allows your applications to be ported royalty-free between DOS, OS/2 (including dynalink and Presentation Manager support), Unix, VMS and other operating systems.

List: $495 Ours: $395

PANEL Plus II

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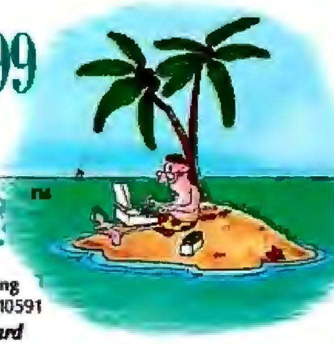

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The AST Bravo/286 makes BASIC look easy.

AST Gets Lower Than Low

If you're interested in the most cost-effective business or home computer from a reputable company, the AST Bravo/286 might fit your bill. It has a low price, a small footprint with plenty of room for extras, and surface-mount technology.

The system has an 8-MHz Intel 80286 microprocessor with no wait states and 512K bytes of system RAM. A CMOS memory module permanently stores your installation and setup information so you don't have to configure jumpers and DIP switches.

The Bravo/286 also comes with a floppy disk drive controller for a 1.2-megabyte 5¼-inch floppy disk drive, a 101-key AT-style keyboard, an RS-232C port, a bidirectional parallel port, and support for an 80287 math coprocessor. The monitor is optional.

Price: $1245; diskless version, $1095.

Contact: AST Research, Inc., 2121 Alton Ave., Irvine, CA 92714, (714) 863-1333.

Inquiry 1150.

Bondwell Laptop Packs Desktop Punch

The superslim B200 laptop from Bondwell includes just about everything you need for applications like word processing and spreadsheets.

The tried-and-true 8-MHz 80C88 chip processes information at a respectable clip from a standard 720K-byte 3½-inch floppy disk drive mounted in the side of this 2-inch-thick machine. Also standard is 256K bytes of RAM, expandable to 640K bytes, a built-in nickel-cadmium battery, and an AC power adapter.

The keyboard includes 81 keys with 10 programmable function keys. The display is a 10½-inch-wide LCD with an 80-column by 25-row text display capability and 640- by 200-pixel resolution.

MS-DOS 3.3 and GW-BASIC 3.22 come bundled. Connections can be made with the B200's Centronics parallel port, an RS-232C port, and an RGB port. The laptop weighs 8 pounds.

Price: $995.

Contact: Bondwell Industrial Co., Inc., 47485 Seabridge Dr., Fremont, CA 94538, (415) 490-4300.

Inquiry 1151.

Is Your Networking Terminal Wyse?

While the WY-212m network terminal seems to have all the components that the great-selling "dumb" network terminals have, it also has its own 12.5-MHz 80286.

The system comes with 1 megabyte of RAM, a 102-key PC-style keyboard, two RS-232C ports, a Centronics parallel port, and a smaller footprint than you'll find on almost anything save laptops.

Each WY-212m is designed to boot off a NetWare or 3+Share file server through an optional Ethernet or Token Ring card in the system's only 16-bit (AT) card slot, or you can add proprietary networking hardware.

Price: $1999.

Contact: Wyse Technology, 3571 North First St., San Jose, CA 95134, (408) 433-1000.

Inquiry 1152.

SEND US YOUR NEW PRODUCT RELEASE

We'd like to consider your product for publication. Send us full information, including its price, ship date, and an address and telephone number where readers can get further information. Send to New Products Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Information contained in these items is based on manufacturers' written statements and/or telephone interviews with BYTE reporters. BYTE has not formally reviewed each product mentioned. These items, along with additional new product announcements, are posted regularly on BIX in the microbytes.sw and microbytes.hw conferences.

Wang 80386 for Power Users

The PC 382 is a 20-MHz 80386-based machine available in either a tower or desktop configuration that's especially designed for communications- and graphics-intensive applications, Wang Microsystems claims.

A typical system includes 2 megabytes of RAM, a 1.2-megabyte 5¼-inch floppy disk drive, a VGA controller, and a 68-megabyte hard disk drive. But in the tradition of big-business systems suppliers, Wang can also supply the PC 382 stripped or with a multitude of upgrade capabilities.

For example, you can expand memory to 16 megabytes on the 32-bit paged/interleaved memory controller card, and there's room for two 8-bit and six 16-bit cards on top of that. You can add a second 1.2-megabyte floppy disk drive or a smaller-capacity 5¼-inch floppy drive, or you can add a 1.44-megabyte 3½-inch floppy drive. Hard disk drives range from 20 megabytes to 321 megabytes.

Monitors of the 12- to 16-inch monochrome and color variety are optional.

Price: Typical system, $6825.

Contact: Wang Microsystems, 10 Technology Dr., Lowell, MA 01851, (800) 962-4727.

Inquiry 1153.

continued

Light Pen Input Made Easier

The FT-1000 is a redesigned light pen from FTG Data Systems, the company that made the light pen a popular alternative to the mouse for the health care industry and others.

Surface-mount technology allows the new pen to be 42 percent smaller, and it's also lighter than before. The cabling that previously coiled all the way to the back of the pen has been replaced: There is about a foot of straight cable from the back of the pen before the cable curls to finish its journey to the computer. The new pens are compatible with the IBM XT, AT, and Micro Channel architecture (MCA) machines.

Virtually all the programs written for Microsoft Windows work with the FT-1000, especially with the new N-33 Windows driver that Microsoft recently completed.

To solve many of the jitter problems associated with previous pens, FTG has added continuous tracking counters and vertical and video interrupts to the MCA board.

Price: FT-1000, $249; XT, AT, MCA, or compatible board, $129 to $189.
Contact: FTG Data Systems, 10801 Dale St., Suite J-2, P.O. Box 615, Stanton, CA 90680, (714) 995-3900.
Inquiry 1154.

The FT-1000 light pen is half the size of the original.

Digitizing Images Made Simple

No need for a frame grabber here. The EDC-1000 is a complete package providing a method to input image or picture data into your computer at near-real-time rates.

The EDC-1000 is computer powered from a standard XT bus, and it provides a stream of 8-bit data corresponding to spacial brightness in a scene. It uses a charged-coupled-device image sensor, packaged in an almost 2-inch-square housing, to help the camera sample an image into 192 by 165 pixels; computer-controlled exposure and frame-scanning times range from 50 milliseconds to 2 seconds. Power, timing, and video signals are carried on a single cable from the computer to the camera at up to 20 feet away.

Your computer must have a floppy disk drive, 256K bytes of RAM, and a half-length XT or AT slot. The operating system must be DOS 2.1 or higher. And you can use either color or monochrome monitors. The software has CGA, EGA, VGA, and Hercules adapters and can save images in either Tag Image File Format or PC Paintbrush format.

Price: $400.
Contact: Electrim Corp., P.O. Box 2074, Princeton, NJ 08543, (609) 799-7248.
Inquiry 1155.

A Scanner for Every Desk

The Kyocera A-800 flatbed scanner can scan anything from 8½- by 11-inch photographs to pages in books.

Once the document is scanned, you can scale it from 25 percent to 1066 percent at resolutions of up to 800 dpi and then store it on your hard disk. (Because one 800-dpi-resolution letter-size image can consume as much as 3 megabytes of hard disk capacity, Kyocera recommends a few megabytes of disk space for scanned material.)

Scan mode includes line art, six selectable patterns of halftone, and four, eight, and 16 selectable gray levels.

You need an XT or AT compatible with at least 512K bytes of free RAM operating under Microsoft Windows 1.03 or higher. The A-800 hooks into your computer's parallel port.

Price: $1985.
Contact: Kyocera Unison, Inc., 3165 Adeline St., Berkeley, CA 94703, (415) 848-6680.
Inquiry 1156.

Laser Printers Invade the Home Office

The Blue Chip Compact Laser Printer features an 8-page-per-minute print speed in a 17- by 18- by 11-inch package. It's aimed at the home computer market, with serial ports and a Centronics parallel port.

On-board memory comes standard at 512K bytes, expandable to 5 megabytes. Up to 128 fonts can reside in memory at once, or they can be downloaded or loaded from font cartridges.

Price: $2499.
Contact: Blue Chip International, Inc., 7305 West Boston St., Chandler, AZ 85226, (602) 961-1485.
Inquiry 1157.

continued

Economy Ricoh Drive Rewrites on Optical Cartridges

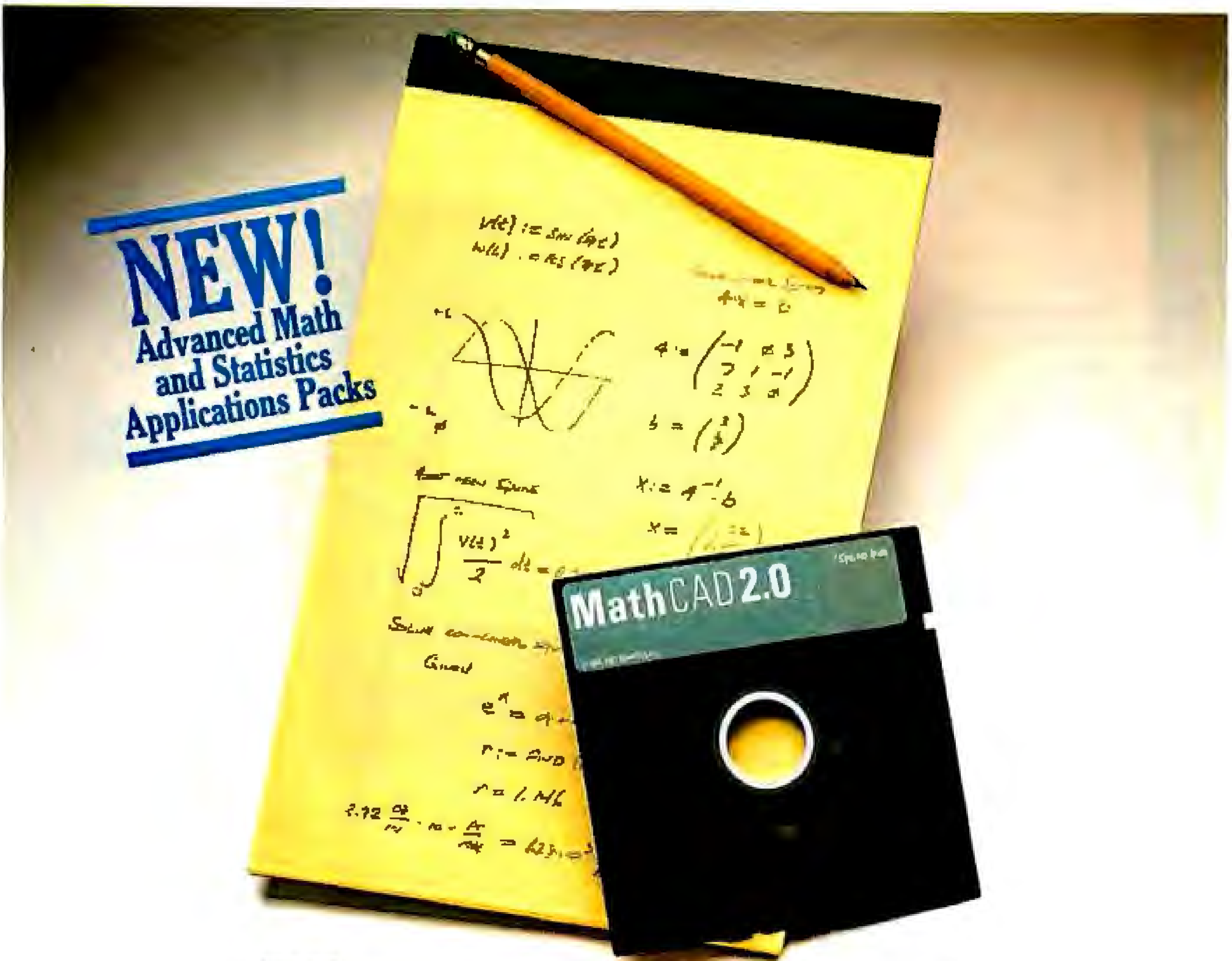
With the introduction of the RO-5030E rewritable optical disk drive, Ricoh could be trouble for such companies as Sony, Maxtor, and Hitachi.

With what Ricoh calls "constant angular velocity tracking," each RO-5030E has a data transfer rate of 1.4 megabytes per second and an average access speed of 61 ms. Data buffer memory for the 5¼-inch internal drive is 256K bytes.

Sustained data transfer rate is as fast as 100K bytes per second for recording, and up to 300K bytes for reading.

The drive incorporates a SCSI controller and uses ISO-approved 5¼-inch optical disk cartridges. Any rewritable optical media meeting ISO standards can be accessed using the magneto-optical writing/reading technology. Capacity is 512 or 1024 bytes per sector, 297 or 326 megabytes per side, and 594 or 652 megabytes per disk.

Price: $3800; cartridges, $250 each.
Contact: Ricoh Corp., Five Dedrick Place, West Caldwell, NJ 07006, (201) 882-2000.
Inquiry 1158.



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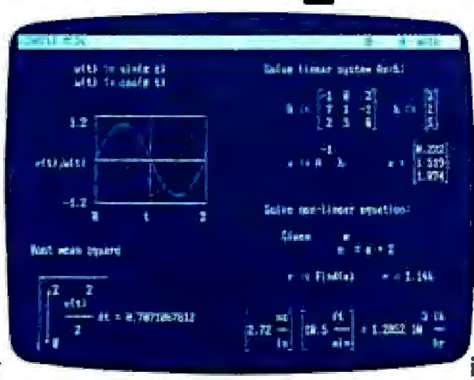

Just define your variables and enter your formulas anywhere on the screen. MathCAD formats your equations as they're typed. Instantly calculates the results. And displays them exactly as you're used to seeing them—in real math notation, as numbers, tables or graphs.

MathCAD is more than an equation solver. Like a scratchpad, it allows you to add text anywhere to support your work, and see and record every step. You can try an unlimited number of what-ifs. And print your entire calculation as an integrated document that anyone can understand.

Plus, MathCAD is loaded with powerful built-in features. In addition to the usual trigonometric and exponential functions, it includes built-in statistical functions, cubic splines, Fourier transforms, and more. It also handles complex numbers and unit conversions in a completely transparent way.

Yet, MathCAD is so easy to learn, you'll be using its full power an hour after you begin.

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The **Advanced Math Applications Pack** includes 16 applications like eigenvalues and eigenvectors of a symmetric matrix, solutions of differential equations, and polynomial least-squares fit.

The **Statistics Applications Pack** lets you perform 20 standard statistical routines such as multiple linear regression, combinations and permutations, finding the median, simulating a queue, frequency distributions, and much more.

MathCAD lets you perform calculations in a way that's faster, more natural, and less error-prone than the way you're doing them now—whether you use a calculator, a spreadsheet, or programs you write yourself. So come on over to MathCAD and join 45,000 enthusiastic users.

For more information, contact your dealer or call **1-800-MATHCAD** (In MA: 617-577-1017).

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MathSoft, Inc., One Kendall Sq., Cambridge, MA 02139

Circle 156 on Reader Service Card

Taxan Goes Where No Standards Have Gone Before

The Ultra Vision 1000 from Taxan is designed with very high horizontal-scan-rate ranges—between 30 kHz and 78 kHz for higher-than-standardized graphics boards.

The 20-inch monitor is compatible with IBM and Apple Macintosh computers for desktop publishing and CAD/CAM environments. Input can include analog RGB and horizontal/vertical signals on separate lines.

The horizontal scan rates are barely low enough to handle the 31.5 kHz of VGA and the 35.5 kHz of 8514/A. Lower-frequency boards designed for CGA and EGA graphics won't work with this monitor, but some CGA and EGA boards operate at higher frequencies.

The board is partly designed for 1024- by 768-pixel, noninterlaced graphics with 256 colors—an unspoken standard, according to Taxan—at 48.5 kHz horizontal and 60 Hz vertical. On the Macintosh computers, horizontal scan rates of 64 kHz produce 1024- by 768-pixel resolution. The board will also support the 78-kHz horizontal frequency that provides 1600- by 1200-pixel resolution for high-end imaging boards; these are useful in medicine, for example, for laser surgery, modulating laser wavelengths for image modifications.

High resolution is partly due to the proprietary Dynamic Beam Focusing feature, Taxan says. DBF allows electron focusing from the center of the screen all the way to the outer edges.

In addition, the Ultra Vision 1000 includes a high-contrast black background, and the screen is treated with an antiglare coating developed by the Optical Coating Lab in Santa Rosa, California. Dot pitch is 0.31 millimeters.

Price: $3695.

Contact: Taxan USA Corp., 161 Nortech Pkwy., San Jose, CA 95134, (800) 544-3888.

Inquiry 1159.

Taxan's Ultra Vision 1000 monitor reaches scan rates of 78 kHz.

Sony's Multiscan Monitor Features Video Inputs

The GVM-2000 is an National Television System Committee-compatible 20-inch multiscan monitor that also accepts composite video inputs.

It provides CGA, EGA, PGA, VGA, 8514/A, and Mac II modes for IBM compatibles and for compatibility with Apple's Mac II. That compatibility to synchronize to RGB inputs of 15 kHz to 36 kHz (horizontal scan) is the nice thing about multiscan technology. Vertical scan ranges from 40 Hz to 100 Hz.

Yet the monitor also receives analog or digital input from other video devices for applications like business presentations. VCR output, for example, is 15.5 kHz. The GVM-2000 accommodates composite video inputs such as ¾-inch tape, ½-inch tape, video tuners, videodisk players, ED Beta, and Super VHS.

Dot pitch is 0.55 millimeters. Resolution is 720 by 480 pixels, and maximum video resolution is 560 television lines. Standard broadcast television video is 525 lines, even though most televisions can display only about 420 lines. High Definition Television video is 1125 lines.

Price: $2495.

Contact: Sony Corp. of America, One Sony Dr., Park Ridge, NJ 07656, (800) 222-0878; in New Jersey, (800) 222-0879.

Inquiry 1160.

NEC MultiSync Features Digital AutoSync

The MultiSync 3D monitor from NEC Home Electronics has digital controls that automatically tune its 14-inch screen to 10 preset frequencies. You can also program an additional 19 frequencies between the horizontal scan range of 15.5 kHz to 38 kHz.

The MultiSync 3D can automatically identify TTL and analog input signals and find matching synchronizing information among the 10 presets, or it can adjust to one of your nonstandard frequencies.

It performs this function with a Z80 microprocessor, an EPROM, and 64K bytes of RAM. When you begin to receive a new image on the monitor, the microprocessor scans memory for similar digital maps of incoming waveforms. If none of the waveforms that are in memory match the incoming image, you can manipulate the image with two buttons for vertical height adjustments, two for horizontal width adjustments, and two for horizontal positioning.

A few seconds after your adjustments are made, the monitor writes the parameters to memory.

Support for Super VGA resolution is standard, along with support for the lower-resolution EGA and VGA graphics boards. The monitor is also compatible with the Macintosh II video card, which supports a 1024- by 768-pixel interlaced resolution. Dot pitch is 0.28 millimeter. The MultiSync 3D weighs 35 pounds.

Price: $1049.

Contact: NEC Home Electronics (U.S.A.), Inc., 1255 Michael Dr., Wood Dale, IL 60191, (312) 860-9500.

Inquiry 1161.

continued

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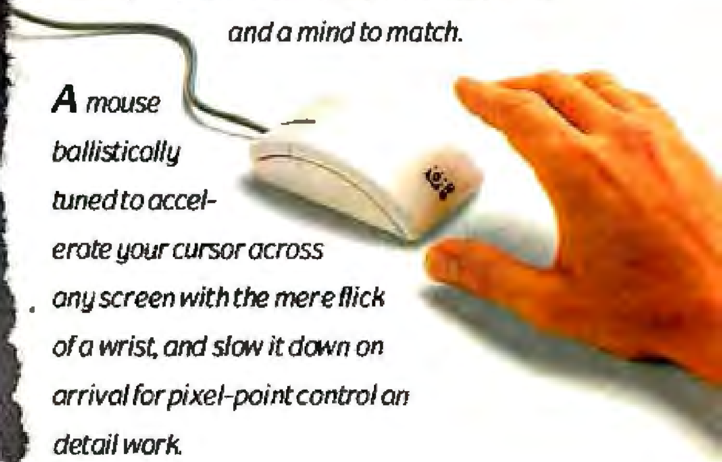

LOGITECH
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Board Masters Voice Mail, Fax, and Communications

The Complete Communicator is an XT- and AT-compatible board that provides your computer with fax, modem, and sophisticated voice-mail capabilities. All you need is one standard analog telephone line from your local telephone company.

With an on-board 6502 microprocessor and software that takes up 75K bytes of RAM space, the board operates in background mode. The voice-mail system allows up to 999 voice mailboxes, each of which can hold as many as 999 messages; each message can be up to 999 seconds long, the manufacturer claims. Once that mail is stored, you can program the board to call you and deliver your messages to whatever phone number you choose.

The board also has a call-transfer function for when you're away from the phone.

The fax capabilities are what you would normally expect from any $800-range, stand-alone, Group III fax machine, minus the scanning capabilities. You also get many features you can't get on an inexpensive stand-alone fax machine, including auto-redial and scheduled transmission for sending faxes when telephone rates are lowest; broadcast capability, with a distribution list that can be as long as 99 names; a pop-up window for sending faxes from within applications; personalized cover sheets; and on-screen display of faxes, with zoom and scaling.

The modem operates at the standard Hayes-compatible rate of 2400 bps.

Price: $899.

Contact: The Complete PC, 521 Cottonwood Dr., Milpitas, CA 95035, (408) 434-0145.

Inquiry 1162.

With The Complete Communicator, voice-mail sophistication greets fax and modem pragmatics.

Exploit Your Apple IIGS's Ensoniq Sound Chip

The Sonic Blaster is a stereo digitizer that takes advantage of the Ensoniq sound chip on every Apple IIGS, according to the manufacturer, Applied Engineering.

The Sonic Blaster is perhaps most impressive when it's used for audio with a popular helicopter game called Tomahawk. But it's also quite effective for manipulating sounds for audio production from a number of sound sources, like home stereos, CD players, televisions, and microphones. The interface is a standard DIN connector.

Included software lets you add effects such as echo, stutter, backwards, amplification, and variable rate.

Price: $129.

Contact: Applied Engineering, 3210 Beltline, Suite 154, P.O. Box 5100, Dallas, TX 75234, (214) 241-6060.

Inquiry 1163.

Speak Your Mind with the CAD Voice System

The Bug Voice Command System is a speech recognizer for CAD workstations. It features a 25-MHz TMS-320 microcomputer.

It includes its own 64K bytes of system RAM and uses only 15K bytes of memory on your AT-compatible computer. That RAM allows it to store up to 100 voice commands to perform such tasks as change screen perspective, change from line-drawing mode to circle-drawing mode, and move the cursor to the endpoint of lines.

The board and accessories are shipped with a starter lexicon of 65 commands. Any CAD package that runs under DOS and accepts keyboard input is compatible, Command Corp. says.

Price: $799.

Contact: Command Corp., Inc., 6045 Atlantic Blvd., Suite 400, Norcross, GA 30071, (404) 662-1598.

Inquiry 1164.

continued

Upgrade Your AT with Disk-Caching Controller

The PM3011 controller card has its own 68000 microprocessor to enhance AT performance. It works with a variable-size RAM cache that allows your AT or compatible to read and write to the controller cache while the controller card simultaneously accesses the disk.

This allows disk-intensive applications to run a dozen times faster than without the controller card, claims Distributed Processing Technology, because data access time can be increased 50 to 150 times over that of conventional hard disk drives. The operation is transparent to the operating system, however, so special software drivers and ROM BIOS changes aren't needed.

The cards use the same disk format as the Western Digital disk controller, so installation means that you unplug the existing controller and plug in the PM3011. Then you format the disk drive with the DPTFMT low-level format utility, enabling the controller to remap the disk drive geometry so the operating system thinks the drive is a standard ST506 drive.

Four versions of the card are available—for an ST506 interface; a run-length-limited interface; an ESDI interface; and ST506, ESDI, and surface-mount-device interfaces for the SCSI host bus used in minicomputers. Each board contains 512K bytes of cache RAM, expandable to 16 megabytes with an optional cache expansion card.

Price: $1150; with the optional cache expansion card, $1280.

Contact: Distributed Processing Technology, 132 Candace Dr., P.O. Box 1864, Maitland, FL 32751, (407) 830-5522.

Inquiry 1165.


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Produce Your Own 35mm Motion Picture Films

The Imprint system for the Amiga or Macintosh II with the Polaroid Palette film recorder lets you generate slides, negatives, transparencies, or instant prints. With an optional film "back," you can even produce 35mm motion picture films.

With the Amiga system, Imprint can expose images composed in more than 16 million colors to develop visuals from HAM (hold and modify), IFF (Interchange File Format), and DigiView's RGB-IFF files. You can use several types of film with the systems and produce slides, prints, and transparencies.

With the Mac, the Imprint supports PICT and PICT2, the standard picture formats.

Optional "backs" are available in 4- by 5-inch and 8- by 10-inch sizes, bulk film (for as many as 250 exposures, versus the standard 36), spectra-type (the kind of instant film that develops before your eyes), and the 35mm motion picture version.

With the motion picture option, you bypass the NTSC conversion necessary to go from the computer screen to 35mm film because you transfer digitally encoded images directly to the film. This gives you up to 1500 frames on 100 feet of film. Of course, you must have the conversion between the film and videotape performed at your local full-service photography store.

Price: Amiga peripheral with Polaroid Palette, $2495; Mac II board with American Liquid Light film recorder, $3995.

Contact: American Liquid Light, Inc., 2301 West 205th St., Torrance, CA 90501, (213) 618-0274.

Inquiry 1166.

Liquid Light's Imprint system features quality photo output.

Board Combines VGA and Frame Grabber

Publishers' VGA combines a computer VGA card with a frame grabber and allows you to preview images prior to capture without a second monitor.

The IBM PC XT- or AT-compatible VGA portion of the board has 256K bytes of RAM (expandable to 512K bytes) for graphics modes ranging from 640 by 480 pixels with 16 colors up to 1024 by 768 pixels and 256 colors (with extra memory). You need a VGA-compatible multifrequency or fixed-frequency analog monitor.

Drivers are included for Microsoft Windows and Digital Research's GEM.

The frame grabber portion of the board captures 320- by 200-pixel images in 64 gray scales in one-sixtieth of a second, from video cameras, videotape players, and other video sources. Unlike a flat scanner, the board captures three-dimensional images. And if the board is set up to capture a photo or other two-dimensional image, it can replicate a scanner.

Price: $699.

Contact: Willow Peripherals, Inc., 190 Willow Ave., Bronx, NY 10454, (212) 402-0010.

Inquiry 1167.

Greater Than the Mighty 8514/A?

The Verticom HX-Series of add-in graphics coprocessor boards offers more than five times the performance of IBM 8514/A display adapters, claims Western Digital Imaging. Yet all the boards are software compatible with the IBM 8514/A display adapter and can default to VGA.

The Verticom HX16/AT and the HX16/MC (for the AT and Micro Channel architectures, respectively) feature 1 megabyte of RAM and can display 16 on-screen colors at up to 1024 by 768 pixels. The HX256/AT and the HX256/MC provide 2 megabytes of memory, 256 colors, and the same resolution as the two 1-megabyte boards.

The boards are shipped with several drivers. These include the 8514/A adapter interface, AutoCAD versions 9 and 10, AutoSketch, AutoShade, Microsoft Windows 2.1, and Verticom Twin Focus. Only multifrequency monitors are supported, however, because of the need to work up from the VGA standard of 31.5 kHz to the 1024- by 768-pixel requirements of 48.5 kHz.

Kits are available for upgrading the cards to 256 colors, and software developers can choose from on-board palettes of 256,000 or 16.7 million colors.

Price: HX16/AT, $2495; HX16/MC, $2795; HX256/AT, $3495; HX256/MC, $3795; HX-256C upgrade kit, $1195.

Contact: Western Digital Imaging, 800 East Middlefield Rd., Mountain View, CA 94043, (415) 960-3353.

Inquiry 1169.

Synchronize Amiga Graphics with NTSC

The Commodore A2300 Genlock board lets you merge Amiga 2000-generated graphics with output from standard National Television System Committee (NTSC) video sources like VCRs, video cameras, and laser disk players. Or you can merge the Amiga graphics with PAL graphics.

The board fits into the Amiga's video expansion slot, coupling video with the Amiga's inherent multitasking capabilities. For Amigas, standard resolution (in pixels) is either 320 by 200, 320 by 400, 640 by 200, or 640 by 400.

The Amiga 2000 is easily upgradable, with seven Amiga or full-length XT or AT expansion slots; a CPU expansion slot for a 68020, a 68030, or math coprocessor boards; and a video expansion slot.

Price: $399.

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

Inquiry 1168.

continued

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Mac Reaches for Businesses' Minis

The IDEAcomm Mac is a board for the Mac SE that allows twin-axial or twisted-pair connection to the IBM Model AS/400, System 36, or System 38 minicomputers. It also enables the Mac SE to connect to IBM 5294 minicomputers and IBM 5251 Model 12 cluster controllers.

Once connected with proprietary file transfer protocols, the Mac emulates IBM terminals (Models 3180 and 3196 and 5291 Model 1). Until now, that's something only IBM PCs have been able to do. The single Mac SE requirement is that it include 2½ megabytes of RAM.

Macs and IBM PCs are thus allowed bidirectional file transfer at 1 megabit per second and access to four concurrent host sessions (including one printer session). You can observe all the host sessions simultaneously through a windowing feature. You can also accomplish several tasks at once if you're operating under MultiFinder.

Other standard features include password security and dynamic keyboard remapping.

Price: $995.

Contact: IDEAssociates, Inc., 29 Dunham Rd., Billerica, MA 01821, (508) 663-6878.

Inquiry 1170.

IDEAcomm Mac brings IBM terminal emulation to the Mac SE.

Eliminate Ethernet Downtime with FTEL

If your Ethernet application can't afford downtime, even for a minute, the fault-tolerant LAN system FTEL might be your answer.

When the Novell NetWare network operating system and FTEL software on the file server detect a cable or transceiver fault, the FTEL adapter on the file server switches from the primary transceivers and cabling scheme to the backup transceivers and backup cabling.

Price: FTEL 1.0 software and file server board, $10,080; adapter boards for nodes, $780 each.

Contact: Alantec, 101 Hammond Ave., Fremont, CA 94539, (415) 770-1050.

Inquiry 1171.

Get the Fax from Your Modem

The WorldPort 2496 is a tiny, battery-powered device combining a 9600-bps Group III fax modem with a full-featured 2400-bps data modem. It's designed for portable and laptop computers.

The WorldPort 2496 has two standard RJ-11 telephone jacks for direct connection and an interface for acoustic coupler operation. It has a self-contained battery and measures 5 by 3 by 1 inches.

The data modem portion retains all the features of the Touchbase Systems' WorldPort 2400 portable modem, including a speaker and LED indicators.

Price: $699.

Contact: Touchbase Systems, Inc., 160 Laurel Ave., Northport, NY 11768, (516) 261-0423.

Inquiry 1172.

Removable Module Featured in V.32 Modem

A removable, programmable, checkbook-size module sets the V.32 modem apart from CCITT V.32-compatible luxury modems from AT&T, Codex, Hayes, and others. Yet the N9635 from NEC America performs as well as or better than its industry siblings, according to the company.

For example, the N9635 can keep up with Microcom's de facto data compression/error-control software standards of up to MNP Level 5, allowing data transmission over standard analog telephone lines at up to 19.2 Kbps. (However, MNP 5 can only allow 19.2-Kbps transmission if both the transmitting and receiving modems operate under MNP 5 protocols.)

The N9635 is also backward compatible with both the V.22bis standards and the Bell 212 and 103 standards, allowing the N9635 the capability of transmitting to and receiving from modems that operate in asynchronous modes of under 1200 bps. Adherence to the above standards also allows backward compatibility with synchronous modems operating at data transfer rates under 9600 bps.

But the NEC N9635 module gives you several added benefits. For example, you can store dialing parameters and move them from one modem to another. You can also run diagnostic programs on it to test the functionality of the other N9635 modems in your office.

If you're paranoid about office politics, you can always remove the module and hide it when you're not using it. And when NEC adds additional data compression and error-control software to its modems, it has promised to try to implement those enhancements on the module.

Price: $1495; with module, $1595.

Contact: NEC America, Inc., Data and Video Communications Systems Division, 110 Rio Robles, San Jose, CA 95134, (800) 222-4632, ext. 1277; in California, (408) 433-1277.

Inquiry 1173.

continued

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MMC MICROCOMPUTER MARKETING COUNCIL

Battery-Powered Data Logger

The Tattletale Model 6 is a feature-packed data logger for applications not only where AC isn't readily available, but where the machine sometimes has to run for months on end without attention. Manufacturer Onset Computer claims that an application that takes two weeks to fill the power-switched 20-megabyte hard disk drive uses only eight alkaline AA cells.

The Model 6 offers up to 2 megabytes of storage capacity for about the price of 28K bytes on the popular Model 5. It has 11 10-bit A/D channels, 14 individually programmable I/O lines, a UART (the RS-232C interface), four power modes, and its own operating system, TTBASIC.

The 10-bit converter can sample and store all 11 channels at 100 Hz. Most of its 14 individually programmable I/O lines have optional alternate functions, including counting, square wave generation, software UART, and shift register I/O.

A separate serial interface contains the drivers for the main 9600-bps UART. You offload stored results either using XMODEM or formatting with TTBASIC Print statements.

TTBASIC is much like BASIC, as the name implies, but it has an in-line symbolic assembler. You can also tailor the speed-critical portions of your applications with assembly language subroutines that you invoke directly from the BASIC program.

A daughterboard accommodates signal conditioning and I/O expansion while it provides physical support and brings up power and the digital and analog I/O signals. One row of pins brings out internal bus lines, allowing you to add specialized hardware.

Onset Computer's Tattletale data logger.

Price: $1750.
Contact: Onset Computer Corp., 199 Main St., P.O. Box 1030, North Falmouth, MA 02556, (508) 563-2267.
Inquiry 1174.

Protect Expanded and Extended Memory

The UniSaver 100 is an uninterruptible power supply that provides power protection for LIM 4.0-compatible expanded and extended memory on your IBM XT, AT, or compatible system.

In fact, it works to preserve and restore the actual computer processes taking place in RAM at the exact point of power interruption, claims manufacturer Universal Vectors.

When AC power is restored to your computer, the contents of both the expanded/extended memory files and the RAM/system board files are transferred back to your operating RAM. Then processing resumes exactly where it left off.

Price: $1495.
Contact: Universal Vectors Corp., 580 Herndon Pkwy., Suite 400, Herndon, VA 22070, (800) 777-7860; in Virginia, (703) 435-2500.
Inquiry 1175.

Postmortem Diagnoses IC Faults in Seconds

The Postmortem card is an in-circuit diagnostic module for the IBM XT, AT, and compatibles that attaches to the bus and detects faults on every IC in the motherboard down to individual pins.

A set of BIOS chips replaces the motherboard BIOS for power-on self tests; a complete diagnosis of the entire base RAM is also made. Manufacturer Swisscomp says that up to 98 percent of IC faults are detected—and in less than 30 seconds.

When the Postmortem detects a fault, it displays the code relating to the specific fault on an alphanumeric display. Or, if the video circuit is operational, it will display the diagnostic results on the screen. The manual has IC diagrams and an index for quick fault-finding.

Price: $459.
Contact: Swisscomp, Inc., 5312-56th Commerce Park Blvd., Tampa, FL 33610, (813) 628-0906.
Inquiry 1176.

continued

Mouse Makes Lotus 1-2-3 Input Faster

A luxury mouse with an optical scanner add-on, an audio module, and software makes it quick and easy to input vast columns of numbers into Lotus 1-2-3.

The MarqMouse lets you input numbers as fast as you can move the mouse scanner across them and audibly recognize that the number is correct. That's about four times faster than the fastest accountant could possibly key those numbers into a computer, the company claims.

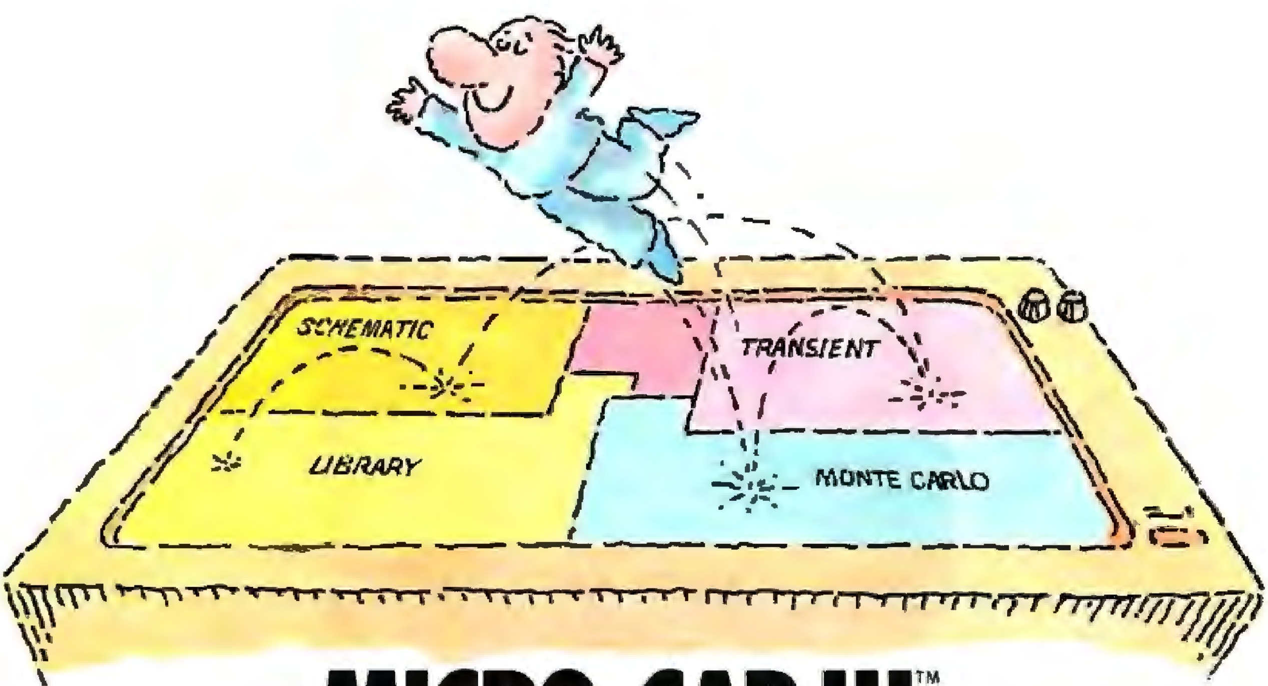
Besides the scanner components, the MarqMouse provides many features, including up to 600-dpi resolution, ballistic control (i.e., if you move the mouse quickly, the curser jumps to attention; if you move it slowly and carefully, the cursor doesn't accelerate beyond first gear).

You also get 16 levels of gray scale, the transparent scanning window, and a feature for paintbrush-type scanning with wide strokes.

When the MarqReader is upgraded for optical character recognition (OCR), you get numeric recognition of even handwritten numerals, the transparent window, and the audio feedback for accurate input.

The MarqMouse is compatible with the IBM XT, AT, PS/2s, and compatibles; your system should have at least 256K bytes of RAM.

Price: Mouse, $199; scanner, $799; OCR system, $1299.
Contact: Marq Technologies, 6285 Nancy Ridge Dr., San Diego, CA 92121, (619) 452-2373.
Inquiry 1177.

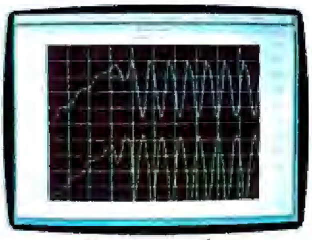


MICRO-CAP III.™ THIRD-GENERATION INTERACTIVE CIRCUIT ANALYSIS. MORE POWER. MORE SPEED. LESS WORK.

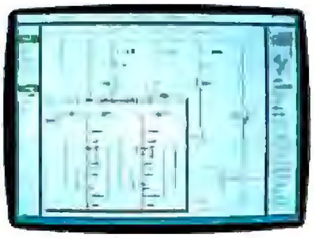
MICRO-CAP III,™ the third generation of the top selling IBM® PC-based interactive CAE tool, adds even more accuracy, speed, and simplicity to circuit design and simulation.

The program's window-based operation and schematic editor make circuit creation a breeze. And super-fast SPICE-like routines mean quick AC, DC, Fourier and transient analysis — right from schematics. You can combine simulations of digital and analog circuits via integrated switch models and macros. And, using stepped component values, rapidly generate multiple plots to fine-tune your circuits.

We've added routines for noise, impedance and conductance — even Monte Carlo routines for statistical analysis of production yield. Plus algebraic formula parsers for plotting almost any desired function.



Transient analysis



Schematic editor

Monte Carlo analysis

Modeling power leaps upward as well, to Gummel-Poon BJT and Level 3 MOS — supported, of course, by a built-in Parameter Estimation Program and extended standard parts library.

There's support for Hercules,® CGA, MCGA, EGA and VGA displays. Output for laser plotters and printers. And a lot more.

The cost? Just $1495. Evaluation versions are only $150.

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Spectrum

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(408) 738-4387

Let Your Fingers Do the Walking Through Turbo C

You can add a special menu to Turbo C's main menu with Vizit! and have a host of C functions at your fingertips. To use Vizit!, you select the type of function you need, and then browse through more than 400 functions and descriptions.

You can search by category, by last used, or by wild cards. A quick reference to the C language is available, and an auto-insert feature instantly types in functions.

Vizit! runs on the IBM PC with DOS 2.0 or higher and 58K bytes of RAM.

Price: $49.95.

Contact: Computer Ties, 4948 Thunderhead, El Sobrante, CA 94803, (415) 223-6944.

Inquiry 1111.

The Vizit! menu offers over 400 Turbo C functions.

CrossView Analyzes Volumes of Data

CrossView is a data-analysis tool that works by identifying key patterns in large volumes of data. It offers an unlimited, multidimensional view of your data.

You first collect data from micro, mini, or mainframe computer sources, and CrossView compresses it with its Transformation Module. The Analysis Module lets you view and analyze any cross section of the array by identifying cells, rows, columns, and pages from the data elements. You can also revise the view with just a few keystrokes, according to DataEase.

CrossView analyzes data using advanced compression and access methods such as tensorial analysis, using vector-processing technology and *n*-dimensional geometry, which are transparent to the user. The program stores only unique values within the data set, rather than each of the records, thus reducing the size of the data file.

CrossView runs on the IBM PC with at least 640K bytes of RAM and DOS 3.0 or higher. The company recommends a hard disk drive and a CGA monitor.

Price: Single-user version, $2000; multiuser server pack for up to six users, $3000; workstation pack for three additional users, $1000.

Contact: DataEase International, Inc., 7 Cambridge Dr., Trumbull, CT 06611, (800) 243-5123; in Connecticut, (203) 374-8000.

Inquiry 1107.

GCLISP Developer Upgraded

Gold Hill Computers has what it claims is a faster and smaller version of GCLISP Developer, a Common Lisp that offers an improved graphical environment and support for Gold Hill Windows.

Version 3.1 runs 20 percent faster and uses up to 40 percent less memory than version 3.0, according to the company. Another enhancement is that it generates code faster.

GCLISP Developer 3.1 runs on 80386-based IBM PCs with at least 640K bytes of RAM and at least 3 megabytes of extended memory.

Price: $1995.

Contact: Gold Hill Computers, Inc., 26 Landsdowne St., Cambridge, MA 02139, (617) 621-3300.

Inquiry 1108.

continued

Build a Bridge to Windows

Microsoft Windows, unlike other windowing environments such as Quarterdeck's DESQview, has never exactly been friendly to applications that aren't written specifically for it. Although it's possible to run popular applications such as Lotus 1-2-3 or dBASE in a system that uses Windows, it requires extra steps, and you need to exit Windows.

But help is on the way. Softbridge Microsystems is shipping Bridge/286 and Bridge/386, programs for integrating non-Windows-specific applications into the Windows environment. You can think of the programs as a sophisticated batch language that lets you integrate both Windows and non-Windows applications under Windows' common graphical user interface.

Besides features that are similar to DOS's familiar batch language, Bridge also allows you to design custom menus and dialog boxes, and set up sophisticated connections including interapplication messages. It's all done using a standard ASCII file. The Bridge program itself is actually a Windows program that makes it appear that all applications on a system are running under Windows.

Both versions of Bridge work with all major DOS applications, but Bridge/386 takes advantage of the 80386's power to deliver true multitasking of both Windows and non-Windows applications.

Bridge/286 works with all 80286-based systems and requires Windows/286.

Bridge/386 requires an 80386-based system and Windows/386.

Softbridge has also developed the Bridge Tool Kit, with specific interfaces for Microsoft Excel, dBASE III, and both C and assembly language. According to the company, an OS/2 version of Bridge for Presentation Manager will be available by the middle of this year.

Price: Bridge/286, $149; Bridge/386, $299; Bridge Tool Kit, $695.

Contact: Softbridge Microsystems Corp., 125 CambridgePark Dr., Cambridge, MA 02140, (617) 576-2257.

Inquiry 1106.

Cut loose from the LAN tangle with SCO XENIX and SCO FoxBASE+!

With industry-standard SCO™ XENIX® System V and SCO FoxBASE+,™ you'll enjoy a *real* multiuser system that runs your existing dBASE III PLUS® code faster, easier, more reliably—and at half the cost!

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Enhanced dBASE III PLUS Functionality. SCO FoxBASE+ works just like dBASE III PLUS, only better. It reads and writes the same data files, and runs your source code at compiled speed—without having to compile—for a shorter development cycle.

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By migrating your dBASE III PLUS applications to The SCO Solution, you can cut your costs and increase your profits—both today and tomorrow.

So cut loose from LANs and relax with a *real* multiuser solution — The SCO Solution—SCO XENIX and SCO FoxBASE+!

SCO FoxBASE+ is also available for larger UNIX® systems, and FoxBASE+ is available for DOS systems.

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Circle 286 on Reader Service Card (DEALERS: 287)

SCO XENIX System V and the SCO XENIX family of software solutions are available for all 80286- and 80386-based industry-standard and Micro Channel™ computers.

EVERYBODY

But they're not all switching to the database management system you might expect.

In a recent industry survey,* two-thirds of the respondents who intended to buy a DBMS did not intend to buy dBASE.

And, perhaps coincidentally, two-thirds of recent R:BASE® buyers have used another DBMS before.

Why are they switching to R:BASE?

Because nobody really needs a DBMS: they only need what a DBMS can do.

And users find that the friendly facade of other software is fine for questions. But R:BASE has the right answers for their information management needs.

With R:BASE, you can handle all your data management (not just queries) without learning a single command. Our Prompt By Example (PBE) lets you point-and-pick, then R:BASE does the work.

When you find that you're repeating yourself, you automate simply by recording your actions in a macro file.

Or use our application generator to quickly create complete, correct business programs without touching a line of program code.

Data is data, but information is power.

R:BASE gives you that power.

And even impartial judges seem to agree: *PC Magazine, Software Digest, Datapro* and *InfoWorld* all just gave

IS DOING IT.

R:BASE their highest marks.

Because to its ease-of-use, R:BASE adds speed, functionality and data integrity in a combination you don't get with dBASE, Paradox, DataEase, Oracle or any of the other contenders.

R:BASE is optimized for speed, with an intermediate code compiler that makes your applications sing. And a true compiler is on its way.

You can use its English-based language in command mode, to modify programs R:BASE writes for you, or to write your own solutions from scratch.

Simple menus, prompts and our "paint-the-screen" techniques make sophisticated screens, forms and reports quick and easy to create. With R:BASE forms, you can view and update data from several tables at the same time. Create computed fields. Include scrolling regions so you can work with all the data from other tables. Add rules for data integrity.

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We also give you an SQL implementation that even novices can use to create simple yet powerful queries.

PC MAGAZINE

Software Digest

datapro

INFO WORLD

And networking is free for up to three users. It's also easy, so any single-user application can be run on a multi-user LAN with a single command. And our advanced concurrency control, unlike earlier-generation auto-refresh in other DBMSs, won't bring your network to its knees when you expand with our Six-Pack or Network Unlimited versions.

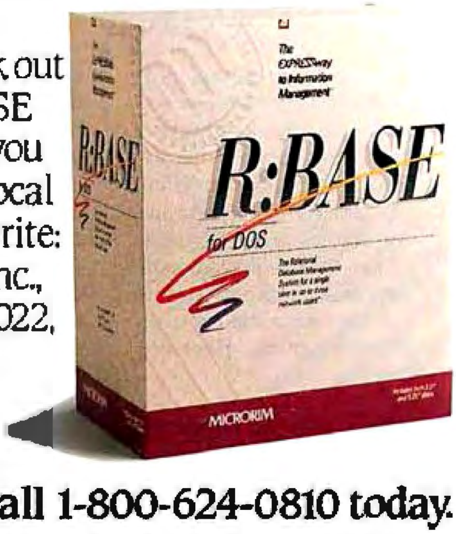
Applications that just won't quit.

R:BASE is the second-largest selling PC DBMS in the world, and it's backed by all the training, service and third-party support you'll ever need.

It's providing end-users with the information they need in large businesses and small. On stand-alone PCs and in networks sharing data with minis and mainframes. In insurance and real estate companies, factories and universities, government offices and the storefront down the street.

DO IT.

Check out what R:BASE can do for you with your local dealer, or write: Microrim, Inc., P.O. Box 97022, Redmond, WA 98073-9722.



Call 1-800-624-0810 today.

Circle 169 on Reader Service Card (DEALERS: 170)

Schematic Design with Extended Memory

The original CapFast CF1000 schematic design program from Phase Three Logic is now available in a version that bundles what used to be a 16-megabyte extended-memory option package. The new program also includes a packaging program that assigns reference designators and pin numbers to physical packages. And CF1000 now supports the Apple LaserWriter and HP LaserJet.

Other features included with the new CapFast are a schematic editor, a general-purpose symbol editor, a 2000-part symbol library, a parts list program, and interfaces to many printed-circuit-board CAD systems.

The program runs on the IBM PC or PS/2 with up to 16 megabytes of extended memory.

Price: $495.

Contact: Phase Three Logic, Inc., 1600 Northwest 167th Place, Beaverton, OR 97006, (503) 645-0313.

Inquiry 1118.

CapFast flexible property editing.

A Math Assistant

Direct from Hawaii comes a program to help you with algebra, trigonometry, calculus, and matrix algebra. Derive goes beyond statistics programs, the company reports, by performing two- and three-dimensional plotting, integer factoring, and more.

As a sort of expert system, the program includes probability, statistical, and financial functions.

The program is menu-driven and runs on the IBM PC with 512K bytes of RAM and DOS 2.1 or higher. It is available in 5¼- or 3½-inch versions.

Price: $200.

Contact: Soft Warehouse, Inc., 3615 Harding Ave., Suite 505, Honolulu, Hawaii 96816, (808) 734-5801.

Inquiry 1116.

Math on the Mac

Maple, a mathematics program that previously ran on workstations and mainframes, is now available in version 4.2 for the Macintosh. The program was developed by the Symbolic Computation Group at the University of Waterloo in Canada to perform computation including integers, rational numbers, polynomials, tensor manipulation, symbolic and numeric approximation, indefinite integration, statistics, linear algebra, calculus, and differential equations.

The program comes with a library of over 1500 mathematical functions, which you can modify or extend.

The Mac version of Maple includes a Session Window where commands and results are entered and displayed; a Text Window, where you develop commands, annotation, and programs; and a Graphics Window that you can scale and size.

Maple 4.2 runs on the Macintosh with at least 1 megabyte of RAM and a hard disk drive.

Price: $395.

Contact: Brooks/Cole Publishing Co., 511 Forest Lodge Rd., Pacific Grove, CA 93950, (408) 373-0728.

Inquiry 1117.

continued

Three for the Measure

Converting units of measurement from one system to another is always a pain, especially with the different systems used in different parts of the world, and for various scientific disciplines. The past few months have seen a rush of programs that use your computer to do jobs like these. Here are three:

According to Geocomp, SI Plus (Standard International Units Plus) contains all the unit conversion factors commonly used by engineers and scientists, as well as those involved in education, commerce, and design. SI Plus has over 80 classes of units, and the company claims over 70,000 different conversions are possible. SI Plus runs on the IBM PC.

Price: $79.

Contact: Geocomp Corp., 66 Commonwealth Ave., Concord, MA 01742, (800) 822-2669; in Massachusetts, (508) 369-8304.

Inquiry 1113.

For you Mac users, ConvertUnits is a unit-conversion program that's available in both desk accessory and HyperCard stack versions. GraphicText Applications claims the program contains over 1500 different measurement units.

ConvertUnits runs on any Mac with at least a megabyte of RAM. The HyperCard stack version occupies 242K bytes and requires HyperCard 1.2 or higher.

Price: Desk accessory or HyperCard stack, $59.95; both versions, $74.95.

Contact: GraphicText Applications, 815 Princess Ave., Vancouver, BC, Canada V6A 3E5, (604) 255-8077.

Inquiry 1114.

Finally, there's UNITize, which is shipped in both desk accessory and application versions and runs on the Mac. The program lets you choose from more than 150 of the most commonly converted quantity sets. UNITize also lets you create your own custom quantity sets, or create customized versions.

Price: $59.95.

Contact: Rainbow Bridge Software, Inc., 4243 Hunt Rd., Suite 210, Cincinnati, OH 45242, (800) 548-8871; in Ohio, (513) 984-6861.

Inquiry 1115.

Presentations on the Mac Desktop

PresentationPro runs on the Mac and is compatible with Crosfield Design Systems' computer slide-production equipment. You can create presentations on your Mac and send the files to a Crosfield Design Systems design station for enhancements or to a Crosfield film recorder for imaging.

The program offers user-definable formats and stylesheets. You have global control over background colors, including 10 predesigned custom backgrounds, plus the ability to have custom backgrounds created. You can import object-based PICT files with proportional or random scaling or positioning.

PresentationPro runs on a Mac with 1 megabyte of RAM.
Price: $295.
Contact: StradeWare Corp., 12600 West Colfax Ave., Suite B110, Lakewood, CO 80215, (303) 232-8282.
Inquiry 1123.

PresentationPro works with the Crosfield Design System.

Unix Project Management on the Mac

Micro Planner for the Macintosh now comes in a version that runs under A/UX, enabling you to take advantage of the networking, file sharing, and centralized storage capabilities of a Unix host computer system. You can access data from a Unix host, create project management modules on the Mac, and then share the information with others on a Unix-based network.

Micro Planner uses the critical-path method for determining schedules and pinpointing critical deadlines and potential problem areas within a schedule. Logic diagrams show the sequence and interrelationships of tasks in a project. You also have the ability to select the best use of people, equipment, and money for single or multiple projects using the resource analysis method.

The program supports "what-if" analyses and instantly recalculates schedules and budgets when you revise your input. You can compare different what-if scenarios on-screen.

Micro Planner is also available in an IBM PC version, and you can use files on either platform, according to Micro Planning International. The Macintosh version runs on the Mac 512KE, Plus, SE, and II. The IBM PC version requires Windows and runs on any PC that supports Windows.
Price: Mac or PC version, $595.
Contact: Micro Planning International, 235 Montgomery St., Suite 840, San Francisco, CA 94104, (415) 788-3324.
Inquiry 1126.

ZIPping around the U.S.

The ZIPwhere programmer's toolkit from Effective Data Solutions helps you with business chores such as address processing, inquiry handling, invoice processing, shipping and delivery, and sales management.

The toolkit includes a function library and data file that let your programs retrieve, check, and manipulate ZIP codes. ZIPwhere also determines the local time of any place in the U.S. or the time difference between any two places. And it can calculate the distance between any two points in the U.S.

Your program specifies the name and location of the ZIPwhere Data File, and then you have access to all ZIPwhere functions. The company reports that a file with all data items included requires less than 1 megabyte of storage. A minimum-configuration file requires only 53K bytes.

ZIPwhere runs on IBM PCs running DOS 2.1 or higher.
Price: $139; one update, $39; two semi-annual updates, $59; four quarterly updates, $99.
Contact: Effective Data Solutions, 28225 Agoura Rd., Agoura Hills, CA 91301, (800) 777-8818.
Inquiry 1122.

Organizationware

In describing Vortex, Robotronics coined the term "organizationware." The program is an information management system that combines a database with software that you use regularly.

The program comes with two word processors, a communications program, an import/export utility, and a variety of business-oriented modules.

Vortex run on the IBM PC with 640K bytes of RAM and DOS 3.3 or higher.
Price: $595.
Contact: Robotronics, Inc., 11103 San Pedro, Suite 107, San Antonio, TX 78216, (512) 344-5511.
Inquiry 1124.

ProQube Goes Three-Dimensional

FormalSoft's new spreadsheet, ProQube, is the successor to QubeCalc. The new three-dimensional spreadsheet provides 512 rows by 512 columns by 512 individual pages in its worksheet. The program has the ability to rotate and slice across multiple sheets, allowing you to view, enter, and manipulate data from multiple worksheets on the same screen.

ProQube also has presentation-quality graphics, which include the ability to generate 3-axis bar and area charts with various fonts and colors, according to FormalSoft.

ProQube runs on the IBM PC with 640K bytes of RAM and DOS 2.0 or higher.
Price: $247.50.
Contact: FormalSoft, P.O. Box 1913, Sandy, UT 84091, (801) 565-0971.
Inquiry 1125.

continued

It's a fruitless comparison when ALR is the obvious choice.

ALR FlexCache 5X386Z

ALR FlexCache 25386Z

ALR FlexCache 20386Z

No one compares with our three year warranty.

ALR's quality is backed by an unprecedented three year warranty on all main CPU boards and a full one year warranty on entire systems. We also offer extended warranty programs and on-site servicing.

And there's comparably more.

Each system includes PC-Kwik®. The disk caching utility voted PC Magazine's Editor's Choice.

In addition, Info World's product of the year, DESQview 386®, the powerful multitasking and windowing program is included with the FlexCache Z systems until May 31, 1989.

For more information on the FlexCache Z-Series or the name of your local authorized ALR reseller please call:

1-800-444-4ALR

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For our Canadian office: 1-800-443-4CAN
For our UK office: 1-800-444-4ALR
For our Singapore-Asia/Pacific office: (65) 258-1286 FAX: (65) 258-1285

Circle 12 on Reader Service Card (DEALERS: 13)

DataLAN PC Network

DataLAN is compatible with DOS, the IBM PC LAN Program, and other MS-NET-compatible network operating systems, according to Datapoint. The program supports Novell record-locking protocols and uses the NETBIOS application program interfaces. It works with Ethernet, Token Ring, and ARCNET.

The program can run using nondedicated servers. In addition, Datapoint has also introduced a dedicated server. The multitasking server can cache up to 32 megabytes and supports up to 12 gigabytes. An unattended network archival server supplies the backup, which supports up to 35 gigabytes of archival storage.
Price: Four-user version, $595; eight-user version, $1195; 255-user version, $1995; dedicated server, $2495.
Contact: Datapoint Corp., 9725 Datapoint Dr., San Antonio, TX 78284, (800) 334-9968; in Texas, (512) 699-7000.
Inquiry 1129.

Receiving messages with DataLAN.

Micro-to-Mainframe File Transfer

Working with Digital Communication Associates' IRMAlink, FT/Express transfers files from IBM mainframes and IBM PCs faster than any of its current file transfer products, the company reports. The program comes in two versions: one supports the VM/CMS operating system, and the other supports the MVS/TSO operating system.
Price: CMS or TSO version, $9000 per CPU plus $1800 for yearly maintenance license.
Contact: Digital Communications Associates, Inc., 1000 Alderman Dr., Alpharetta, GA 30201, (404) 442-4000.
Inquiry 1131.

Face-2-Face

Recently, a slew of remote control software programs have appeared on the market. Face-2-Face is another, but this one has the ability to communicate with Carbon Copy Plus.

Face-2-Face is written in assembly language and uses as little as 65K bytes of RAM on an IBM PC. The program comes preconfigured for a variety of standard modems.

The program was written with laptops in mind, according to Modem Controls. A phone book included with the program has a field for area codes: You type an area code, and the phone book automatically dials the number.
Price: Host end, $149; remote end, $99.
Contact: Modem Controls, 432 North Clark St., Suite 202, Chicago, IL 60610, (312) 321-0018.
Inquiry 1128.

From Mac to PC and Back

The Mac Mail Gateway lets you send electronic mail between Macs and PCs over the Banyan VINES-based Network Mail and QuickMail. The Gateway consists of the listener and the bridge. The listener runs as a VINES service on Banyan's VINES/386 or 80386-based servers. The bridge runs with the QuickMail Administrator program on a nondedicated Mac. The two communicate using the AppleTalk networking protocol. You can connect Macs directly to the VINES server via Ethernet or through an Ethernet-to-LocalTalk bridge.

Banyan reports that the Gateway is easy to install and requires no administrator intervention. With the Mac Gateway, you can also take advantage of other VINES mail gateways, such as SoftSwitch and EasyGate Fax, according to Banyan.
Price: $795.
Contact: Banyan Systems, Inc., 115 Flanders Rd., Westboro, MA 01581, (508) 898-1000.
Inquiry 1127.

Vaccinate Your File Server

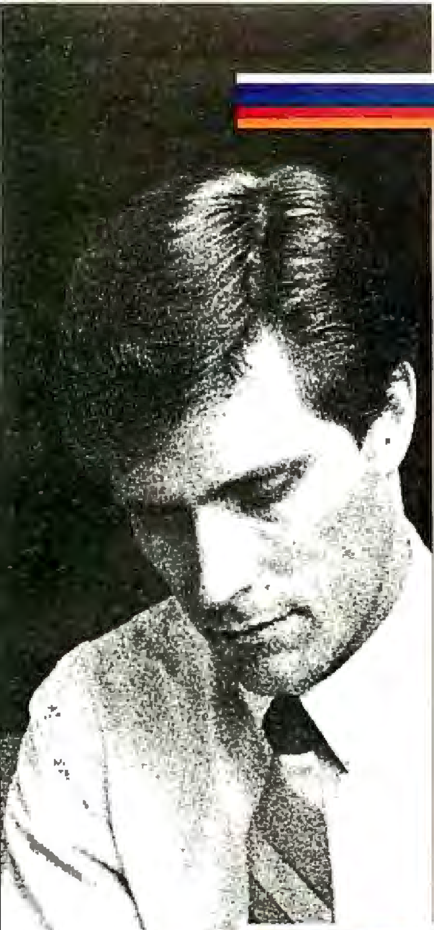
FoundationWare, the maker of Corporate Vaccine, has a vaccine for your file server. The program, called Certus, works with most network operating systems and hardware, according to the company.

When installing a LAN, the manager uses Certus to create a database of signature checks of programs approved for a given user or workstation. The database then verifies the integrity of all programs before loading them into memory, FoundationWare reports.

The program monitors and audits systems used and keeps logs of all software use. It will intercept malicious or accidental attempts to write damaging information to hard disks.

The company reports that Certus is the only product that can automatically recover file servers or hard disks from crashes due to damaged partition tables, boot tracks, File Allocation Tables, root directories, and CMOS information. This automatic recovery feature, however, does not work on Novell file servers or other file servers with non-DOS partitioning and formatting. FoundationWare expects to solve this problem in a future version of Certus.
Price: $495.
Contact: FoundationWare, Inc., 2135 Renrock Rd., Cleveland, OH 44118, (800) 722-8737; in Ohio, (216) 932-7717.
Inquiry 1130.

continued



Make your point without a trace of doubt.

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If you've ever used a digitizer, you probably were surprised that it didn't do what you thought it would. You assumed that whatever you picked or moved or drew on the tablet would be accurately displayed on the screen and precisely reflected on output. In spite of its straight-forward appearance, it didn't take you long to learn that all digitizers were not created equal, or accurate, or even easy to use.

Today there's a new line of digitizers that can meet your expectations. It's the new HIPAD Plus™ series. With sizes ranging from a compact 12″×12″ to a drafting-size 44″×60″, each model reflects HI's tradition of price/performance excellence.

Compare, for example, the sleek 9012 and 9018 models (shown below) which contain HI's exclusive tilt-correction feature. This uniqne feature lets you use the stylus like a pencil—no need to hold it in an awkward perpendicular position. HI's tablet captnres only the points touched by the tip of the stylus, so you can make menu selections, create freehand drawings, move the screen cursor, or edit pixel-by-pixel—without a trace of doubt.

If you prefer a handheld cursor, you'll find HI's new four-button cursor has the same pin-point precision. (You'll also like the way it feels in your hand.)

The HIPAD Plus digitizers are compatible with both your CAD and graphics systems. Each model processes coordinates rapidly (up to 200 pairs per second) and has a resolution of up to 2,540 lines per inch. This all adds up to high performance and accuracy—and it means you won't be replacing your tablet to meet the high-resolution demands of the future.

And, with prices like $495* for the 12″×12″ tablet and $795* for the 12″×18″ tablet, HIPAD Plus is affordable. Make your point without a trace of doubt. For details, call 1-800-444-3425 or 512-835-0900.

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Circle 125 on Reader Service Card

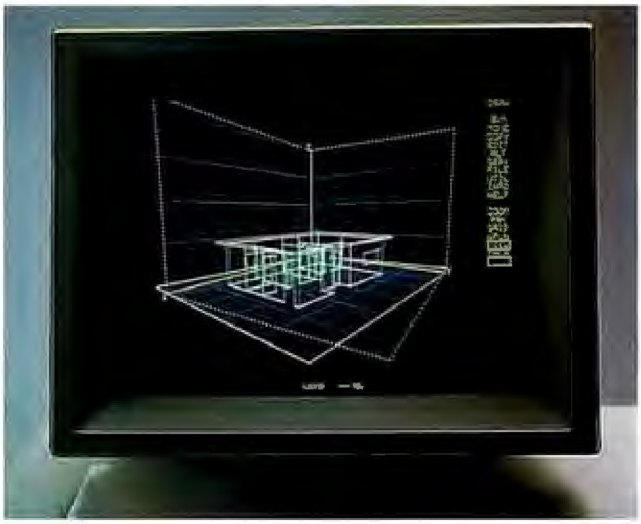
CADvance Upgraded

Three-dimensional capability, information management, and expanded mechanical and international engineering features have been added in the latest version of CADvance.

Version 3.0 uses Visual Guidance System's user interface, which makes it possible to use any three-dimensional program, according to IsiCAD. The interface also offers a three-dimensional reference grid, a dynamic working plane, and a three-dimensional cursor that helps you to see your drawings on-screen as three-dimensional images.

CADvance 3.0 offers a two-way link with dBASE II Plus. This eliminates the two-step process of converting CAD files to ASCII, then ASCII to database, according to IsiCAD.

CADvance 3.0 runs on the IBM PC with 640K bytes of RAM, DOS 2.0 or higher, and a CGA or compatible graphics adapter. The program supports a mouse and a variety of digitizers.
Price: $2995.
Contact: IsiCAD, Inc., 1920 West Corporate Way, P.O. Box 61022, Anaheim, CA 92803, (714) 533-8910.
Inquiry 1136.



CADvance 3.0 uses the Visual Guidance System user interface.

Schematic Editor for $99

SuperCAD is a schematic-entry program that comes with a netlist generator, a library parts builder, and an ASCII screen editor.

Library part files are categorized according to generic, memory, microprocessor, programmable-logic-device, and digital-signal-processing chips. There is also a library of package outlines that assists you in laying out boards.

SuperCAD is compatible with narrow and wide-carriage, Epson or IBM-compatible dot-matrix printers. And you can print A- through E-size pages in low or high resolution.

SuperCAD runs on the IBM PC with at least 320K bytes of RAM, DOS 2.0 or higher, CGA, EGA, or Hercules graphics capability, and a Mircosoft-compatible mouse.
Price: $99.
Contact: Mental Automation, Inc., 5415 136th Place SE, Bellevue, WA 98006, (206) 641-2141.
Inquiry 1133.

Generic Caters to Novice CAD Users

The CADD Starter Kit, which includes Generic CADD Level 2, gives users a workbook tutorial, Generic's Basic Home Design symbol library, and tutorial and sample drawings—all bundled together to offer a complete introduction to drawing and drafting.

The beginner will learn to create floor plans, elevations, product drawings, and alterations with the Starter Kit. You can also create flow charts, graphics, presentations, organizational charts, forms, and flyers.

The CADD Starter Kit runs on the IBM PC with 384K bytes of RAM, DOS 2.0 or higher, and a graphics card.
Price: $159.95.
Contact: Generic Software, Inc., 11911 North Creek Pkwy. S, Bothell, WA 98011, (800) 228-3601; in Washington, (206) 487-2233.
Inquiry 1134.

CAD on the Mac

FlexiCAD is a two-dimensional CAD program for the Macintosh. It is the first product from the new Amiable Technologies.

The CAD and drafting program takes advantage of the icons and windows environment of the Macintosh. The program offers unlimited undo/redo features, a graphical macro builder for frequently used procedures, and context-sensitive on-line help and prompts. You can position tear-off menu boxes anywhere on the screen, and customize typefaces, line styles, colors, symbols, and more.

FlexiCAD cannot accept scanned images because it uses object-oriented rather than bit-mapped graphics. It does accept input from tracing tablets and can import and export PICT files or, with an optional conversion utility, DXF files.

The program uses the cut-and-paste clipboard for text and image swapping with desktop publishing packages.

With FlexiCAD, you can have up to four drawing files active at once, and each can have multiple viewing windows. You can also have an unlimited number of layers in each drawing. Drawing functions include move, copy, rotate, mirror, scale, and fill, plus dynamic rubberbanding, and a constraint tool that can restrict lines both to a grid and to angles that you specify.

The program also offers Bézier, B-spline, and Cardinal curve commands for tracing and technical illustration. Other features include auto-dimensioning with labels in both English and metric units for linear, radial, and angular dimensions; user-defined icons; and the ability to merge drawings and abort redraws in process.

FlexiCAD runs on the Mac II or IIx with at least 2 megabytes of RAM and a hard disk drive. The program also runs on the Mac SE with a 68881 math coprocessor.
Price: $895; with DXF file-conversion utility, $995.
Contact: Amiable Technologies, 3508 Market St., Suite 210, Philadelphia, PA 19104, (215) 222-9006.
Inquiry 1132.

continued

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When you see what it can do, you won't believe your eyes.

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Assistance for Quattro Users

Quattro-Assist 1.0 is a tutorial for Borland's Quattro. It works in conjunction with the Quattro user's manual and covers data entry, spreadsheet functions, graphing, macros, and printing.

The tutorial was created with Instant Replay and is actually a simulation of the Quattro program, letting you work directly with Quattro in a controlled environment.
Price: $79.95.
Contact: Nostradamus, Inc., 3191 South Valley St., Suite 252, Salt Lake City, UT 84109, (801) 487-9662.
Inquiry 1140.

A Model Language

Model is a high-level object-oriented engineering language, according to its manufacturer. It is designed to provide solutions for real-time distributed process simulation and control.

The language consists of math, logic, process control, man-machine, alarm, file management, and program control algorithms. Options include steam tables, front-end drivers, and LAN local/remote system control.

Model comes with a natural-language interface preprocessor, a compiler, a screen display generator, and support utilities.

To run Model, you need an IBM PC with at least 384K bytes of RAM. A math coprocessor, color screen, and hard disk drive are recommended.
Price: $395.
Contact: Model Software, 52 Curtis Court, Broomfield, CO 80020, (303) 469-0826.
Inquiry 1119.

The Hunt for the Cursor Has Ended

If you're spending too much time looking all over the LCD screen of your laptop for the cursor, the No-Squint Laptop Cursor from SkiSoft is a memory-resident utility that may brighten your day—as well as your cursor.

The software slows down the blink rate of the cursor. Since the cursor is controlled by hardware, the software has to take control.

The No-Squint Laptop Cursor uses about 1K byte of RAM and runs on DOS-based laptops.
Price: $39.95.
Contact: SkiSoft Publishing Corp., 1644 Massachusetts Ave., Suite 79, Lexington, MA 02173, (617) 863-1876.
Inquiry 1138.

Automatic Page Reader

Using intelligent page analysis, ReadStar VI lets you convert hard copy into an electronic file regardless of multiple column structure, graphical images, varying fonts, and portrait or landscape format, according to Inovatic.

ReadStar VI uses a mathematical modeling algorithm to analyze character shapes globally. The program recognizes normally contrasted characters from 4 to 20 points. It can also read extended ASCII text, proportionally spaced characters, and kerned text, along with foreign characters, stylized fonts, near-letter-quality print, boldface, italics, and underlined text.

Inovatic reports an accuracy rate of 99.9 percent and claims that ReadStar VI recognizes text at a rate of 4500 characters per minute. The program outputs ASCII text.

The program runs on the IBM PC with 640K bytes of RAM, DOS 3.0 or higher, and a hard disk drive. It is compatible with most scanners, according to the company.
Price: $2495.
Contact: Inovatic, 1911 North Fort Myer Dr., Suite 708, Arlington, VA 22209, (703) 522-3053.
Inquiry 1137.

Macro Collection for R:Base Users

R:Macros is a collection of over 60 utilities and techniques for automating common R:Base database tasks. These include a basic library of reusable code, instructions for their use, and tips from programmers who designed the applications.

R:Macros is divided into five sections: ready-to-use macros, database and application utilities, forms and report utilities, tips and techniques, and financial macros and templates.

The program runs on the IBM PC with at least 456K bytes of free RAM and DOS 3.1 or higher.
Price: $99.
Contact: Microrim, 3925 159th Ave. NE, P.O. Box 97022, Redmond, WA 98073, (206) 885-2000.
Inquiry 1141.

The Repair Engineer's Clone

Instead of boxing up and shipping your broken PC off to the repair shop, you can fix it yourself with an interactive guidance system from Cess Computers. Compu-Fix for Generic PCs runs on a separate, working machine, and offers trouble-shooting techniques and diagnostics to help you repair your malfunctioning system.

The program takes you through steps, instructing you to perform simple actions and then querying you to determine the result of that action. This process continues until all malfunctioning parts are properly identified and the unit is repaired.

Instructions are displayed on-screen. The program is menu-driven, and repair actions and results are described in the form of yes/no questions. At the end of a repair session, the program produces an audit report summarizing the actions taken, which parts are in working condition, which parts need replacing, and the actions taken to verify that these parts need replacing.

The company reports that you don't need any experience with computer repair, although it helps if you can recognize basic computer parts.

The program works to repair most DOS-based systems, including those with 8086-, 8088-, 80286-, and 80386-based microprocessors. Cess reports that it works on laptops as well.
Price: $499.
Contact: Cess Computers, One Kendall Sq., Cambridge, MA 02139, (800) 888-2377; in Massachusetts, (617) 494-4770.
Inquiry 1139.

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A MATCH FOR YOUR FILES—find disk information fast, no matter how it's formatted. No need to index or keyword your files—just describe what you want in plain English or regular expressions, and it's on your screen *fast.*

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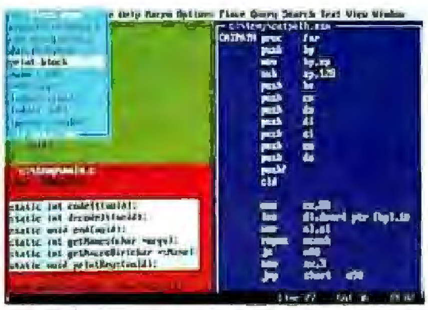
A MATCH FOR YOUR PATH—quickly search a file, a whole disk, or anything in between to find all the files with a match to your search pattern, then display each match *in full context!*

After a query, Vq lists the files containing the target pattern and displays the matching text, highlighted in context.

WHEN YOU FIND IT, USE IT with *Vq*'s full-featured editor or your own word processor, compiler, or custom macro.

A MATCH FOR YOUR CREATIVITY—expand your creativity into a screenful of windows for different files or different parts of a file. Zoom them, compare them, edit them in parallel, or copy-and-paste to a new file.



Vq's Block command menu is pulled down for processing the marked block of text.

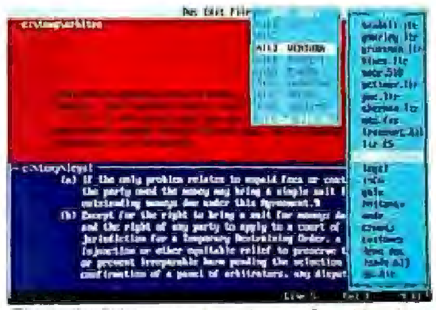
A MATCH FOR YOUR STYLE—everything you want for creating and manipulating text, plus a few things you never thought to ask for—paragraph formatting, text centering, auto-indent, search-and-replace, copy, cut, delete or print blocks—*effortlessly!*

A MATCH FOR YOUR DISPLAY—25, 43, or 50 line display modes, and you pick the screen colors!

A MATCH FOR YOUR MOUSE—full mouse support with pull-down command menus means you don't have to remember *anything.* All *Vq*'s power is delightfully accessible—just point and shoot!

A MATCH FOR SYSTEM FAULTS—while you're working, *auto-save* is working too, so you can automatically start each session where the last one ended—*even if it ended unexpectedly!*

A MATCH FOR YOUR APPLICATIONS—add *Vq*'s access and editing talents to the applications you know and love.



The small-pull down menu lists Vq's preconfigured Hot Links to other applications.

Vq comes with Hot Links to popular applications, and creating more is a snap. Pass your desktop publisher the file you created, format it, print it, then return to *Vq* to find your sales summary and jump-start your spreadsheet program, or write brilliant code and Compile-and-display-next-error. *Vq* shrinks to just 7K bytes during linkage and gives your applications room to run!

A MATCH FOR YOUR CHORES—teach *Vq* whatever you do over and over. *Vq*'s macros learn any input sequence for flawless playback at your command, for infinite customization!

Vq operates with OS/2 or DOS 3.0 or higher in IBM-compatible systems with 256K bytes.

Vq is a trademark of Golden Bow Systems

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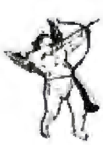

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The Fourteenth West Coast Computer Faire

This year's West Coast Computer Faire, which is scheduled to last only three days instead of the usual four, is expected to attract 40,000 people. The annual show, now in its fourteenth year, is one of the longest-running for small systems users.

More than 50 conferences are planned on topics such as multimedia, including digital video, interactive voice, music, and animation; graphics, including a market overview, desktop publishing, where novices should start, and graphics for professionals; and operating-system debates.

Other scheduled conferences include what's around the corner in computer games, shareware, peripherals, and computer gizmos; networking issues of LANs, BBSes, E-mail, and linking IBM PCs to Macintoshes; data security; and the transition of the Macintosh into the corporate environment. Jerry Pournelle is scheduled to speak.

The Faire will be held at the Brooks Hall and Civic Auditorium in San Francisco from March 17 to 19.
Price: Preregistration before February 27: three days, $14; one day, $10. On-site registration: three days, $20; one day, $12.
Contact: The Interface Group, Inc., 300 First Ave., Needham, MA 02194, (617) 449-6600.
Inquiry 894.

How to Produce High-Performance Documentation

Strategies for Developing High-Performance Documentation is a seminar designed to help you create user documentation for software, hardware, and internal systems.

Topics of the seminar will include project analysis, information analysis and management, effective use of team writing, on-line considerations, and reference-based training systems.

The seminar uses analytical methodology based on human factors research and cognitive sciences. The seminar will be held in San Jose, California, from March 21 to 23 at the Holiday Inn.
Price: $795 per person; $895 for groups of two or more.
Contact: Information Mapping, Inc., 275 Wyman St., Waltham, MA 02154, (617) 890-7003.
Inquiry 892.

Consortium to Sponsor CAD Conference

SPOCAD, a CAD training and educational consortium, will sponsor its fifth annual CAD conference at Coeur d'Alene in northwest Idaho. SPOCAD reports that the conference will be primarily a regional show and will focus on the microcomputer-based CAD market.

continued

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Everex STEP 386/20	4.9	32.8	24.3
Compaq Deskpro 386/20	4.6	32.5	26.2
Everex STEP 286/20	4.2	27.4	23.0
Everex 386/16	3.9	24.3	19.8
IBM Model 70 80 (20 MHz)	3.5	24.7	22.0
Everex STEP 386/16	3.2	21.0	17.6
Everex STEP 286/16	3.2	21.0	18.0
AST Premium 386/20	3.1	19.6	21.0
Wyse 386/16	3.0	20.0	17.6
Acer 386/16	3.0	20.0	16.2
Compaq Deskpro 386	2.9	19.0	17.6
IBM Model 70 80 (16MHz)	2.9	18.0	12.9
Compaq Deskpro 386s	2.5	16.4	12.5
Everex STEP 286/12	2.5	15.7	13.7
AST Premium 286	2.0	12.7	11.1
Compaq Deskpro 286	1.9	11.7	11.5
IBM Model 50z	2.0	12.8	11.2

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SPOCAD consists of 85 industries, educational institutions, and government agencies in the inland Northwest. The consortium was founded in 1984 in Spokane, Washington, to provide CAD training and support services for businesses, schools, and individuals.

The community colleges of Spokane and Gonzaga University contributed funds to establish the center, located in Gonzaga's engineering building.

Any company, school, or individual can join SPOCAD and gain access to CAD courses, PC- and mainframe-based CAD systems, digitizing and plotting services, and other aspects of CAD technology. SPOCAD membership fees range from $100 to $500.

SPOCADE V will feature 30 technical sessions, including Macintosh and other non-IBM-compatible platforms, architectural/engineering/construction platforms, management and networking issues, OS/2 and Unix, architectural facilities, and other CAD issues. Last year's exhibitors included Apollo Computer, Intergraph, Digital Equipment Corp., Tektronix, Synthesis, and Unisys.

SPOCADE V will be held from June 29 to July 1.
Price: Technical sessions: for SPOCAD members, $150 for two days; for nonmembers, $200 for two days; discounts are available for educators and students.
Contact: SPOCADE V, East 502 Boone Ave., Spokane, WA 99258, (509) 484-6812.
Inquiry 893.

University to Sponsor Seminars

Over 50 seminars and 100 vendors will be featured at the University of Washington's Computer Fair, which is free and open to the public.

The fair will be held at the university's student union (the HUB), and it will feature seminars on image processing, three-dimensional modeling and animation, supercomputing, and many others.

The fair's hours will be from 10 a.m. to 8 p.m. on March 15 and 9 a.m. to 5 p.m. on March 16.
Contact: Sheryl Blix Burgstahler, Desktop Computing Services, University of Washington, FK10, Seattle, WA 98195, (206) 543-0683.
Inquiry 895.

Hi-res Video Focus of Next SVCS Meeting

Video Seven and Hercules technology will be the topic of the next general meeting of the Silicon Valley Computer Society (SVCS) at the Tech Mart in Santa Clara, California, on March 8 at 7:30 p.m.. The meeting is open to the general public.
Price: Annual membership fee, $30.
Contact: SVCS, 1330 South Bascom Ave., Suite D, San Jose, CA 95128, (408) 286-1271.
Inquiry 965.

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- ☐ **Ticklex 4.2** — Great tickler program for appointments, deadlines, reminders and timetables. Can handle up to five people at once.

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- ☐ **Catalist 3.2 (2 disks)** — Powerful list manager. Generates mail merge files for 15 different word processors. (Hard disk recommended)
- ☐ **Wampum** — An excellent dBase clone with menus.

EDUCATION

- ☐ **Amy's First Primer 1.4** — Six different learning programs for children ages 4-8. (Color graphics required)
- ☐ **Bible-Q 3.3** — Test your bible knowledge with this fun and educational program.
- ☐ **Funnels and Buckets** — A fun way to teach children basic math skills!
- ☐ **Play 'n' Learn 2.03** — A collection of six programs for children 18 months to 4 years.
- ☐ **Typing Teacher** — This disk contains 2 programs designed to improve the speed & accuracy of your typing!
- ☐ **World 2.93** — The ultimate globe! Learn about cities, countries and continents with this computer version of the globe. (CGA compatible graphics required)

GAMES

- ☐ **Arcade Games 1*** — Pac-man (3 versions!), Hopper, Space Invaders, Janitor Joe and others.
- ☐ **Arcade Games 2*** — Q-Bert, Donkey Kong, Mario Bros., Breakout, Beast and others.
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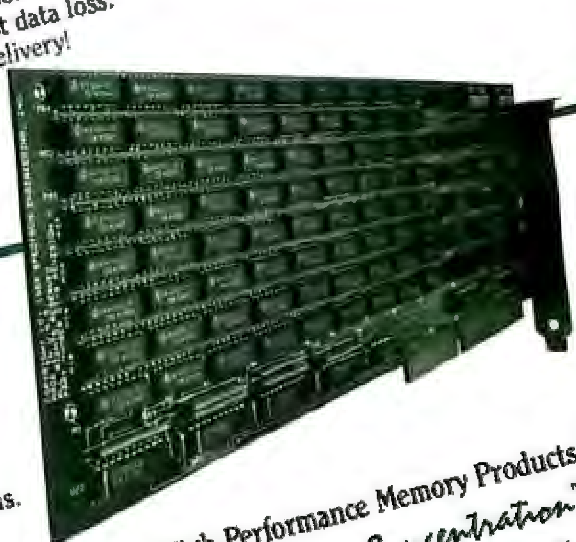

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SHORT TAKES

BYTE editors' hands-on views of new products

CarrierNET

Turbo EMS

PC-Write 3.0

CCC Model 2400

Picture Publisher

Current Events

What would happen if you plugged your IBM PC's serial port into a 110-volt power outlet? If you're using **CarrierNET**, you'd have a LAN. From Carrier Current Technologies, CarrierNET includes communications software and a specialized modem that attaches to your PC's serial port and transmits at up to 38,400 bps.

The key to CarrierNET lies in a small putty-colored box that connects the PC's serial port to a power outlet. The box accepts serial transmissions from the PC, assembles the data into packets, and broadcasts it asynchronously over the neutral and ground connections that run to every power outlet.

Each node is essentially a modem that uses a proprietary set of communications protocols, including an error-correction scheme that detects and retransmits lost or damaged packets. The box also includes a surge suppressor that protects your serial port.

Every LAN requires a medium access scheme. CarrierNET relies on a collision-avoidance method in which each modem listens for a carrier tone before attempting to transmit. If the line is in use, the modem waits and tries again. If a collision occurs during a transmission, each modem issues a time-out and resumes transmitting after a random period.

THE FACTS

CarrierNET
$298 per PC; $219 for peripheral sharing only

Requirements:
IBM PC, XT, AT, or compatible with a floppy disk drive, 256K bytes of RAM, a serial port, and DOS 2.0 or higher; a hard disk drive is recommended.

Carrier Current Technologies, Inc.
1804 West Southern Pkwy.
Building A-112
Durham, NC 27707
(800) 222-0377; in North Carolina, (919) 490-4970
Inquiry 1061.

CarrierNET has RAM-resident communications software called ExcellNet. The basic version supports peripheral sharing only and costs $219 per workstation. The version I tested ($298 per workstation) included drive- or subdirectory-level password security, E-mail and file transfer capabilities, and some DOS functions, like the ability to view directories on other PCs.

The prerelease device I received was limited to 19,200 bps, and the preliminary software and documentation were a little rough around the edges. Nevertheless, I was able to get my office AT clone and two 80386 portables up and running quickly. The E-mail and DOS functions worked without a hitch. It took about 1 minute to transfer a 100K-byte file between computers (1600 bps). When I sent more than one file, however, the network bogged down. Two 100K-byte files sent simultaneously to my AT clone arrived error-free, but they took over twice as long to transmit. Fortunately, you can set ExcellNet to operate in background mode.

But the real problems began when I moved one computer from BYTE's third-floor editorial offices to other floors. CarrierNET claims a range of up to 1 mile, but I couldn't establish any communications from the fifth floor. From the first and fourth floors, I could reach only one of the two workstations on the third floor. Further, transmissions became unacceptably slow: Calling up a one-screen directory on a remote PC took over 2 minutes.

CarrierNET won't work if your building has more than one transformer or has any crossed neutral and ground connections. It also won't work with surge suppressors that support common mode filtering. Unfortunately, I didn't have time to track down the problem.

When CarrierNET works, it works well. Sharing a printer attached to your PC is easy and quick, thanks to ExcellNet's spooling capability. Once you've configured ExcellNet, files transfer automatically to the remote printer. Transfers are consistently error-free, if not always fast. Also, the menu-driven E-mail system is easy to use. And the DOS commands let you copy, delete, and rename files, as well as construct and remove subdirectories on remote PCs.

CarrierNET seems best suited for small groups of users who share printers and transfer files occasionally. Before buying, however, check with an electrician to make sure that CarrierNET will work in your building.

—*Rob Mitchell*

Almost-Magic EMS Emulation

More and more of today's sophisticated applications have the built-in capability of using memory above MS-DOS's 640K-byte limitation, as long as that memory complies with the LIM/EMS. The result is much-improved performance. But there are a few roadblocks on the highway to that nirvana.

continued

The RAM above 640K bytes in today's systems is *extended* memory, and MS-DOS has no built-in way of managing it. You need some way of converting it to EMS. The easiest way is to buy an add-in board specifically designed for EMS. But with memory prices sky-high, that's not a viable alternative unless you have a bottomless wallet.

Turbo EMS is a software package that neatly handles these difficulties. It's an expanded-memory emulator that simulates the working of an expanded-memory board running EMS 4.0. It will neatly turn the extended memory in your system into what your applications will see as EMS memory.

Expanded-memory emulators aren't new, but their reliability has improved of late. And Turbo EMS has an additional unique feature. If your system doesn't have extended memory, it will turn your hard disk drive into pseudo-EMS memory. Instead of swapping EMS memory segments to and from RAM, it swaps them to your hard disk drive.

I quickly found that, with a few exceptions, Turbo EMS isn't the type of program you take out of the package, load, and run with nary a thought. But I did find the extensive installation utility well designed and helpful.

Turbo EMS does an extensive check of your system during installation, but it can be fooled. It was unable to detect that I was using my 2 megabytes of extended memory as a disk cache. The documentation told me I had to turn off the cache, but this took some digging. It also warned me that failure to uninstall memory-resident programs that use extended memory could result in "data corruption."

There are other areas where you can get into trouble. For example, most programs that use EMS don't care where in memory the 64K-byte *page frames* used for data swapping reside. But some programs do. Applications like DESQview, Paradox, and Windows require specific page-frame alignments. Turbo EMS's documentation was helpful, but it took some research.

After you've filled in all the options, Turbo EMS installs a device driver call in your CONFIG.SYS file. Then you reboot your system and go—or so I thought. After I rebooted, applications kept telling me that they couldn't detect any EMS memory in my system. I eventually found out why. About halfway through the manual, you're told you have to use a utility to turn on the EMS emulation. Problem solved. But there's a lesson here: With Turbo EMS, it's absolutely essential to read the documentation carefully and plan your installation.

THE FACTS

Turbo EMS
$99.95

Requirements:
IBM PC, XT, AT, PS/2, or compatible with at least 256K bytes of RAM and MS-DOS 2.1 or higher.

Lantana Technology, Inc.
4393 Viewridge Ave.
Suite A
San Diego, CA 92123
(619) 565-6400
Inquiry 1062.

Once I got Turbo EMS running, I ran Paradox 2.0 and several other applications with my "new" 2 megabytes of expanded memory. The results were impressive. I could access large databases more quickly, and common commands worked noticeably faster.

Then I tried the program on a system without any extended memory, using the hard disk drive instead. I wasn't impressed. Turbo EMS's swapping of data to and from the hard disk drive doesn't make much performance difference over the normal swapping that any sophisticated application does anyway. It's especially true with a slow 65-millisecond drive. Using a fast 25-ms drive, or, even better, a caching disk controller, does speed things up a bit.

Turbo EMS does an excellent job of converting your extended memory to EMS, opening up a whole new world of performance with applications designed to take advantage of expanded memory. But don't expect its hard disk drive EMS emulation to make a big difference in performance. There is, however, a definite niche for it. Some applications, like the latest version of Ventura Publisher, are beginning to require EMS to use certain features.

—*Stan Miastkowski*

PC-Write Gets Serious

In 1983, Quicksoft entered the word processor market with PC-Write, a shareware alternative to much more expensive programs. Because of its low price and good technical support, PC-Write did well: Here was a word processor that could do most of what its users wanted and at a fraction of what the others cost. However, the early versions lacked features that made many potential buyers pause. It could handle files of up to only 60K bytes of RAM, it didn't support columns, and the spelling checker was somewhat too cumbersome.

With **PC-Write 3.0**, Quicksoft has fixed the major drawbacks of previous versions. Not only will its longtime fans appreciate the improvements (after all, they suggested many of them), but first-time buyers or compulsive switchers would also do well to consider it.

The first thing I noticed is the command line, which tells you everything that you ever wanted to know about your file, such as what line you're on, how many lines are in the file, percentage of memory the file occupies, filename, and basic function key commands. At first, I found all this information distracting. But when displaying error messages or performing a search-and-replace operation, or if you're about to overwrite something, the program blocks out the command menu unless it pertains to your current operation.

Version 3.0 can handle any file up to the size of your system's available memory, but I didn't notice any speed loss in

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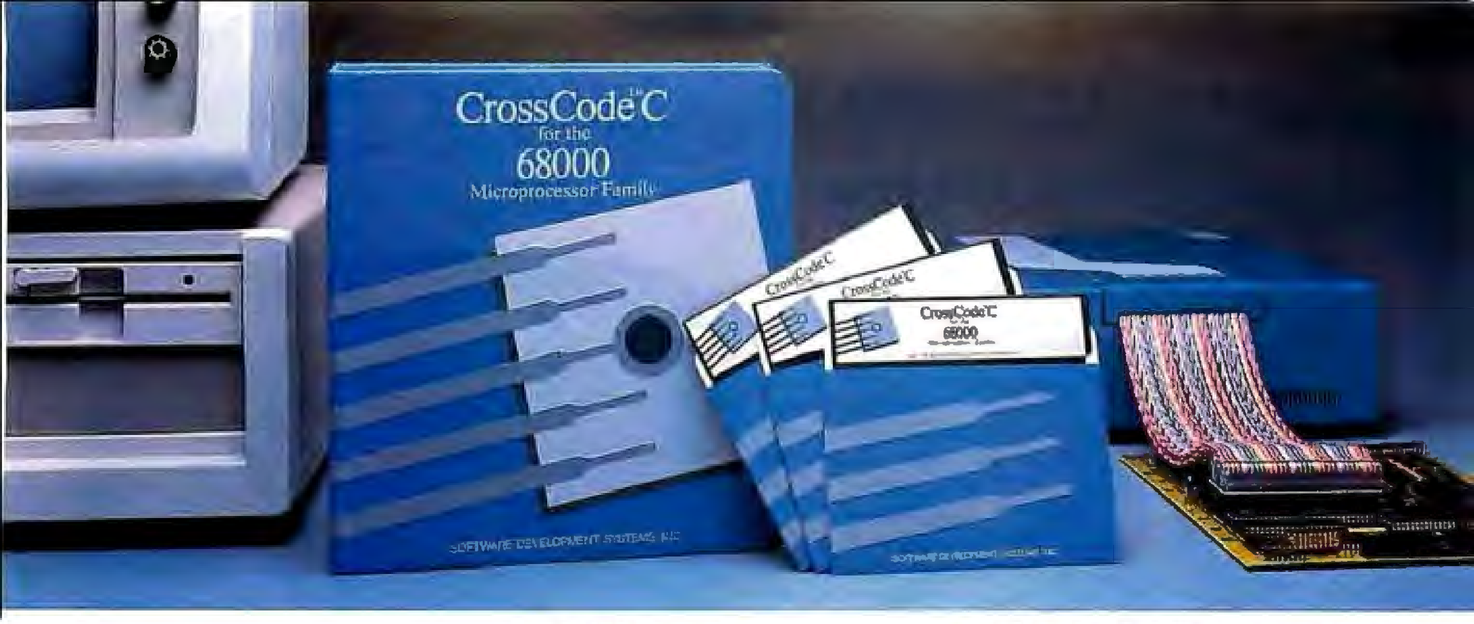

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- You can easily write assembly language routines that call C functions and vice versa, because the compiler uses simple, well documented parameter passing conventions.

2. ASSEMBLER: CrossCode C comes with a Motorola-style assembler that has all the features that assembly language programmers require. In fact, you could write your whole application with it:

- The assembler features an advanced macro language, conditional assembly, "include" files, and an unlimited size symbol table.
- Detailed cross references show you where you've defined and referenced your symbols.
- After a link, you can actually convert your "relocatable" assembler listings into "absolute" listings that contain absolute addresses and fully linked object code.

3. LINKER: The **CrossCode C** linker is designed to handle truly huge loads. There are no limits on the number of symbols in your load or on the size of your output file. And you can always count on full 32 bit target addressability, because the linker operates comfortably in the highest ranges of the 68020's address space.

4. DOWNLOADER: CrossCode C comes with a *downloader* that puts you in touch with all EPROM programmers and emulators. It can convert your load into Motorola S-Records, Intel Hex, Tek Hex, Extended Tek Hex, and Data I/O ASCII Hex. You can also produce a binary image and convert that image into any format you might want. In all formats, bytes can be split into EPROMs for an 8, 16, or 32 bit data bus.

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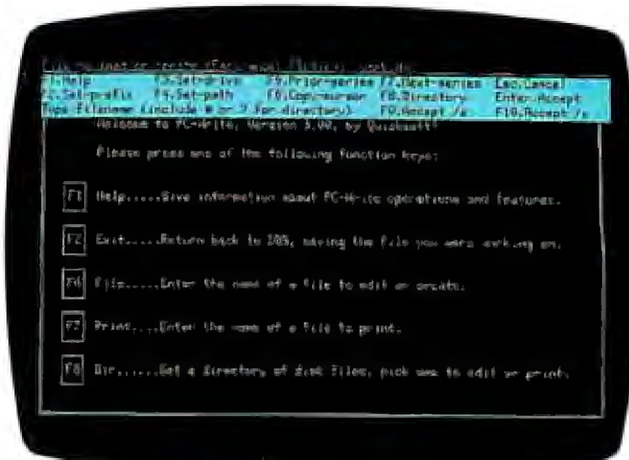

THE FACTS

PC-Write 3.0
$89

Requirements:
IBM PC, XT, AT, PS/2, or compatible with 448K bytes of RAM (320K bytes without the spelling checker) and DOS 2.0 or higher.

Quicksoft
219 First Ave. N
Suite 224
Seattle, WA 98109
(206) 282-0452
Inquiry 1063.

cursor response. It went from top to bottom of a 50K-byte file in less than a second, and the program found and replaced 34 occurrences of a word in 6 seconds on my IBM PC XT compatible. On BYTE's keystroke count benchmark test for word processors, PC-Write scored a respectable 228, compared to WordStar's 234 (see table 2 on page 110 in the May 1988 BYTE). You can also print from within the program, instead of using a separate print program, and with enough memory, you can buffer the print file for faster printing.

I found the spelling checker a bit quirky, although it is an improvement over the one in the previous version—but then, I've never met a spelling checker I liked. PC-Write's spelling checker looks for misspellings by checking if the word in question is in the master or user list. One- and two-letter words are ignored. Sometimes, the program flagged a plural of an offending word, only to offer its singular as a possible replacement. But if this happens to your favorite word too often, you can easily remedy it by adding the word to the 50,000-word dictionary. Version 3.0 lets you edit and execute most commands without leaving the spell search mode.

The program now finds duplicate words, and all guesses are displayed on the command line. You can also link and check related files. A nifty feature called shorthand mode lets you create macros, so you have to hit only a letter or two for commonly used words and phrases. You can toggle this feature on or off. Bob Wallace, president of Quicksoft, said the program's dictionary is constantly updated (registered users can call the company with suggestions).

Another feature is its ability to store columns as literal ASCII text, letting you import Lotus 1-2-3 print files into the program. You can also mark

continued

columns and move, copy, or delete them.

Each registered user of PC-Write receives two free upgrades. Instead of an upgrade, you can get a PageMaker import filter, DCA (Document Content Architecture) conversion package, LaserJet font manager, or the source code. Other goodies that cost extra (but most of which you can get through Quicksoft at a discount) include French and Hebrew capabilities (including voice support in Hebrew), Grammatik III, the *InSet* graphics capturer and extra fonts, and more.

With PC-Write 3.0, Quicksoft has dispelled any notion that it's not a "serious" product. The technical support folks are also friendly, knowledgeable, and patient. Even if the price were not under $100, this would still be a word processor most worthy of your consideration.

—Dave Andrews

A Real Deal: 2400-bps Modem for $95

When I first saw the ad from Compu Com Corp. for a $95 2400-bps modem, I was more than a little skeptical. I remembered how my father would say that things that appeared too good to be true usually weren't. Given that only recently have a few 1200-bps modems made their way to under $100, and that typical prices for 2400-bps modems range from $179 to about $350, the CCC ad promised a lot. So I gave the company a call.

The CCC Model 2400 modem is an internal short board designed for the IBM PC or compatibles. It is based on a Texas Instruments chip set that results in a sparsely populated—and therefore economical—board. The board includes two standard modular telephone jacks (a cable also comes with it) and a speaker with an external volume control.

Like most personal com-

continued

THE FACTS

CCC Model 2400
$95

Requirements:
IBM PC or compatible with at least one available bus slot.

Compu Com Corp.
1275 Palamos Ave.
Sunnyvale, CA 94089
(408) 732-4500
Inquiry 1065.

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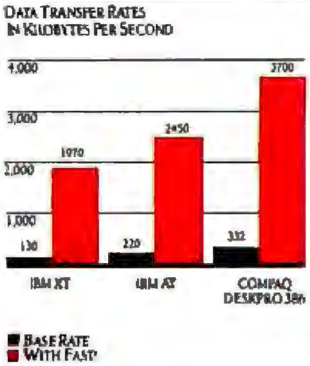

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FUTURE

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puter modems, the CCC unit uses the Hayes-compatible AT command set, and it has a 40-character command buffer. It also adjusts automatically to lower transmission speeds of 1200 bps or 300 bps.

I installed the modem in my Hyundai Super 286c with no problems. The board requires you to deal with only two jumpers. One jumper selects COM port 1, 2, 3, or 4; the other sets the default (on or off) for the auto-answer mode.

The package comes with a shareware communications program called Boyan (version D3), which has a license fee, should you decide to use it, of $35. Boyan is a fairly straightforward, no-frills program. It does have one significant drawback, as do many programs of this type: It supports only COM ports 1 and 2. This simply means that if you need to assign the modem to port 3 or 4, you cannot use Boyan.

I assigned the modem to my system's port 3 and used it with Procomm Plus. In addition to calling local access numbers, which provide relatively clean communications lines, I also sent and received ASCII files on a daily basis via standard long-distance service at 2400 bps and 1200 bps. And although my experience didn't constitute a scientific test, the number of occasional line-noise glitches was about the same as on a USRobotics Courier 2400.

I didn't do any exhaustive lab line-noise tests, but in real-world use, the CCC Model 2400 worked fine. This is the first 2400-bps modem I've seen for less than $100, and it's a bargain. It comes with a two-year warranty and a 30-day money-back policy. That's a very good deal.

—Dennis Allen

The Electronic Darkroom

Picture Publisher is an image editing software package billed as an "electronic darkroom." I used it to edit and manipulate a set of scanned gray-scale images to increase their clarity or remove flaws.

Once you have Microsoft Windows, Picture Publisher, and any Tag Image File Format (TIFF) picture files loaded and ready to go, a suite of useful tools is at your disposal. These tools include Greymap functions, which let you adjust or enhance gray-scale values; Mask functions, which let you create freehand or geometric shapes to either protect an area from global edits or mark an area for edits; Retouch, which you use to smooth, brighten, feather, or add texture to an image; Edit functions, which provide cut-and-paste features; and Process functions, which you use to view, crop, scale, or otherwise ready images for final placement on a page.

You use basic utilities like Undo, Apply, and Zoom to implement or delete your edits. You can access the tools and utilities via Windows' pull-down menus, the Astral Picture Window icons, or the function keys.

To actually edit an image, you move between the Windows interface and the Astral Picture Window. The Astral Picture Window is basically a full-screen window within the Windows environment. When you work in the Astral Picture Window, Picture Publisher paints to a full VGA screen so you can see 64 levels of gray and manipulate 256 levels of gray. I found it easy to move between the two interfaces.

It is also easy to create spe-

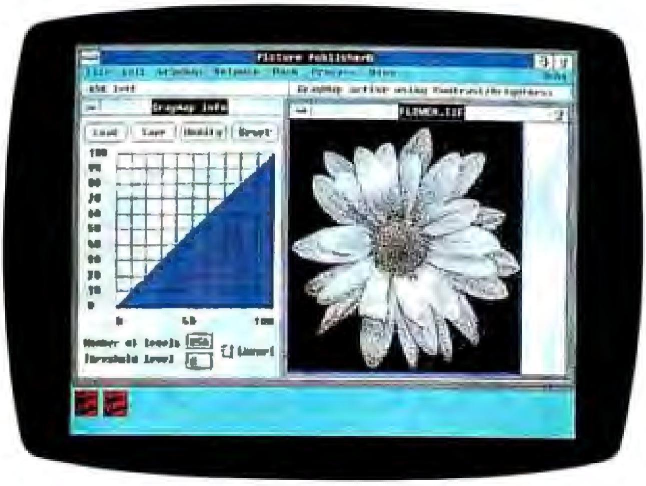
cial-effect images with Picture Publisher. For example, you can *posterize* a photo, which groups gray tones with ones of similar value, or you can change an image's *threshold*, which converts gray tones to either black or white to create line art.

The two functions that I found particularly fascinating were Retouch and Greymap. Retouch lets you adjust the gray values assigned to a pixel using a paintbrush. You can easily implement all kinds of changes, like sharpening the image via an edge-enhancing filter or painting over flaws on an image using a gray tone of your choice. I used the sharpen feature to give better definition to some of my fuzzy images.

The Greymap functions let you do complex adjustments or fairly quick adjustments in brightness or contrast.

I ran the product on a PS/2 Model 80 running Microsoft Windows 2.03. The documentation clearly explained basic image-preparation concepts and was easy to follow. While I found the product easy to use, anyone buying it should have some familiarity with both Windows and basic desktop publishing and darkroom concepts. Edited images can be ported to page layout, presentation graphics, or word processing software that accepts TIFF or the Encapsulated PostScript Font format. If you're a serious desktop publisher, Picture Publisher is worth a look.

—Jan Fiderio ■



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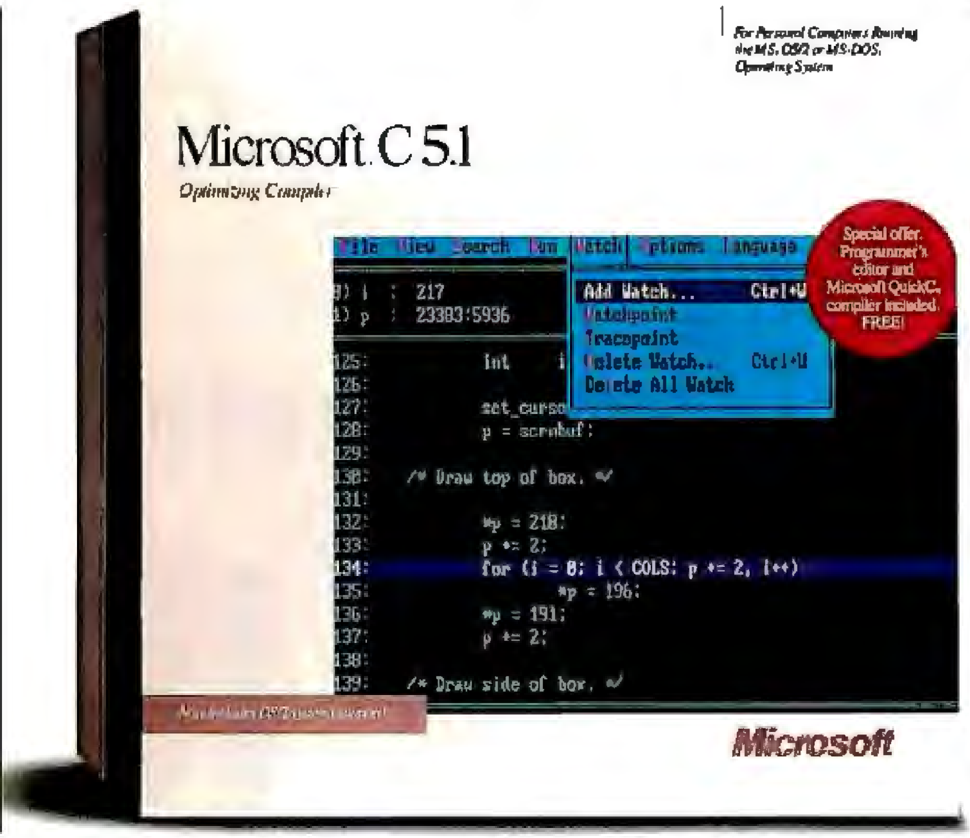

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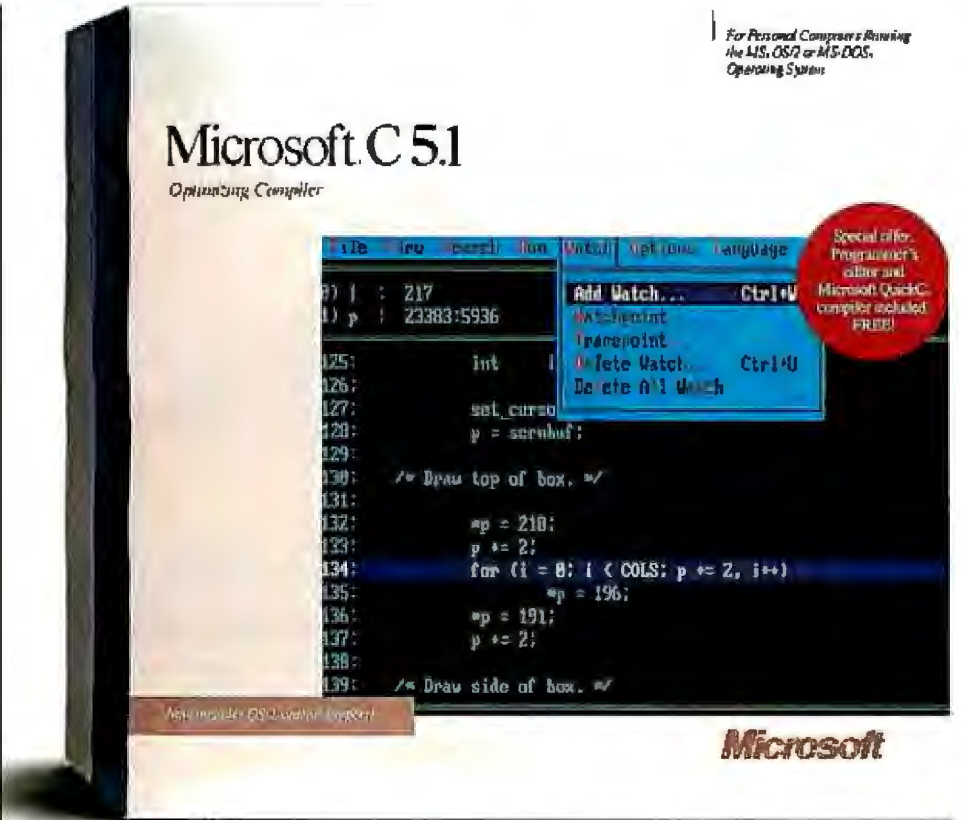

Microsoft C Optimizing Compiler 5.1 Techbox

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CHAOS MANOR AWARDS

Jerry hands out the kudos for the most distinguished products of 1988

I have got 8 million things to do. At dawn tomorrow I catch an airplane to New England, where I'm scheduled to do some briefings about the space program, as well as attend a BYTE Editorial Exposition. Meanwhile, Christmas is in a few days, and I've done no shopping at all. I found Larry Niven's present last spring, so that's set, and Mrs. Pournelle can handle the rest—except of course for her own, which, with luck, I'll pick up in New Hampshire. Surely they have interesting presents?

Meanwhile, this is the last column of the year, which means it's time for my annual Chaos Manor Awards. BYTE has recently instituted annual awards, and it's about time; I've nothing against the other magazines' awards, but I do think BYTE has unique expertise in this field. The BYTE awards are the result of a vote of the BYTE editors, and they are "official"; you saw them in the January issue.

The Chaos Manor Awards come under different rules. They aren't "official" from BYTE, just from me. There's no vote, although I may check with other BYTE editors to see if they have had problems I didn't notice. Eligibility is the year I got a product, not the year it came out. Finally, the usual Chaos Manor rules apply: unless otherwise noted, this is all stuff that I've personally used and beat the devil out of.

1988

This has been an interesting year. I began this column a few weeks ago by setting up a GrandView outline (I'll get back to GrandView later). Within a week, I had more than enough items to fill three columns. I've acquired a *lot* of useful stuff this year, and much of it first came out in 1988. Some of these products aren't earthshaking, but they're all darned useful. By me, 1988 was a *very* good year for computer users.

Most Useful Computer

The clear winner in this category is the Cheetah 386, which is built up from a Cheetah motherboard and memory installed in a "tower" configuration. Intel furnished the chip set (the 80386 and 80387). Big Cheetah runs at 25 MHz. It would run faster if I got Intel to send me faster-rated chips, and I just may do that; although I have to say that Big Cheetah already runs fast enough for anything I'm likely to do. The BIOS is by Award. So far it has been compatible with everything I've tried, including the new DESQview 3.0.

Just about everything I have said about Big Cheetah could be said about the Zenith Z-386 (although that runs at 16 MHz, still fast enough for nearly anything I do). It happens that I use Big Cheetah a bit more than I do the Zenith, but it could be the other way around. That is, I never experiment on my primary machine; and since I'm *always* mucking about with new software and boards and equipment, something has to be the experimental machine.

I keep a generic IBM PC AT clone that came from Larry Aldridge's Sterling Solutions (1824 South Starfire Ave., Corona, CA 91719) for stuff I'm really doubtful about. For a fair test, however, all the stuff—boards and software—should be run with an 80386 since, in my judgment, the 80386 is the wave of the future. The Z-386 serves as the 80386 test-bed, and it has never failed me. When Larry Niven needed a new computer, I had no hesitation in recommending the Z-386, which is what he bought. Still, Big Cheetah is faster, and I do use him a bit more; so that's the machine of the year, with the Z-386 as runner-up.

The 80286 chip, originally greeted with enthusiasm when the AT came out, has proven to be a dead end. For one thing, while it's easy to get from virtual mode (where the 80286 pretends that it's a fast 8086 like you have in your PC) to protected mode (which is genuine 16-bit operations that can directly access 16 megabytes of memory), getting back from protected mode to virtual mode requires a kludge you have to see before you'll believe it.

That's not the worst problem. If Intel had been able to make 80286s of consistent quality, the chip might still have a protected-mode future, but they didn't. Instead, we have a number of steps and revisions of the 80286, and they are not all alike. Programs running in virtual mode aren't likely to notice, but when you move into protected mode, it can make a real difference. Thus, anyone programming for the 80286 in protected mode must find a least common denominator of the chip to write to. That is possible, but since it's also difficult and expensive, it's generally confined to large programming outfits. Much of the driving force in this industry comes from small programming companies.

There is useful 80286 software, but in general, the future of the 80286 is to be used as a kind of fast 8086, while the 80386 has a great future. The 80286 won't be abandoned quickly because there are so many of them out there, but I see a definite trend toward software written just for the 80386. Most important, there will be compilers and code generators using the 80386's special features.

Disk Drive of the Year

Big Cheetah's disk drive is the Priam ESDI 330-megabyte hard disk drive, and that gets the award in this category.

I'm very happy with the trend to ever-larger hard disk drives. I didn't predict it; indeed, one of Pournelle's laws was "Silicon is cheap, but iron is expensive."

continued

The Amiga 2000 is the clear winner as most-improved computer.

This was formulated back in the days of the S-100 bus, and it was intended to warn users that it was a lot easier to upgrade a machine that used a bus and cards than the single-card computers that were the S-100's chief rivals, but I also applied it to disk drives. I was quite certain that spinning metal would soon give way to something without moving parts, like magnetic bubble memory.

I still think that eventually that has to happen—doggone it, it really is easier to fabricate complex silicon than to make high-precision spinning platters and heads—but it's also very clear that it won't happen soon. I'm seeing reliable gigabyte drives that fit into an AT chassis. Priam has a 700-megabyte drive that I suspect will be next year's drive of the year; in seven years of using Priam drives, from the original 20-megabyte drive to the 330-megabyte unit I use now, I've never lost any data.

Priam shares this award with itself: that is, I also have their 330-megabyte SCSI MacDisk for the Macintosh II. Of course, it uses the same hardware as Big Cheetah's disk drive, so this is really only one award. The MacDisk sure is handy: I've noticed that the Mac II hard disk seems to fill up even faster than PC hard disks do. It's probably the graphics and image files. Priam was kind enough to donate a 330-megabyte MacDisk to the Lowell Observatory, and it's about time I publicly thanked them. I'll report on using microcomputers at the Lowell Observatory soon.

Most Improved Computer

The Amiga 2000 is the clear winner here. It's not just the hardware upgrade to the 68020 chip and a new chip set with more video RAM (although those certainly helped). Commodore has also greatly improved the operating system. The Amiga 2000 will now boot from its hard disk; there's no more Kickstart with a floppy disk and then calling in the Workbench. The disk access times have been improved dramatically: it used to be that you could go get a sandwich while the Amiga read in a medium-length file.

The Amiga 2000 is now good enough for most things you'd like a computer for. For example, WordPerfect users will find their favorite editor works fine on the new Amiga. Indeed, the whole software base is expanding rapidly.

I was just up to the Stanford Linear Accelerator Center (SLAC), where they use Amiga 2000s as workstations for both secretarial and scientific staff. A great deal of the work is done locally, while the Amiga's multiprocessing capability keeps it connected to their big mainframe. SLAC has developed software to let the mainframe initiate an Amiga task while the Amiga is doing something else. They use Donald Knuth's TEX scientific text formatter; there's an excellent implementation for the Amiga. Incidentally, the *X* in TEX is a Greek chi, so it's pronounced "tek."

SLAC has developed a whole slew of software for the Amiga. I was quite frankly impressed with what the SLAC people can make the Amiga do. If Commodore could manage to get the SLAC software—most of it is public domain—and distribute it with the Amiga, it would go a long way toward making the Amiga a machine for the rest of us.

Most Useful Peripheral

Hands down, the most useful new peripheral I acquired this year is the Maximum Storage WORM (write once, read many times) drive. Runner-up is Information Storage's WORM drive. I find the Maximum Storage software a bit handier than Information Storage's WORM TOS. Both WORM drives work very well. Both have recently come out with high-density formats that get even more data on one WORM cartridge.

The main function of a WORM drive is to back up all my work: fiction, programs, data brought in by E-mail, *everything* of value. WORM storage disks cost about a dollar a megabyte; and unlike other backup media, the WORM *saves* everything. You can page back on the WORM and find every version you ever saved. This can be invaluable for programmers. It's no bad thing for fiction writers, either.

Since the computer sees the WORM as just another disk drive, you can use it to store compilers, word processors, and other software that is read and not written to, thus saving hard disk space.

The really neat thing about a WORM is that you don't mind using it to back things up, since it works with COPY or

continued


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XCOPY, just like any other disk drive. The WORM isn't a great deal slower than your regular hard disk drive (well, it's slower than mine, but my Priam disk drive goes at an amazing 14 milliseconds; the WORM is more like 75 ms); consequently, it takes not much longer to make backup copies than it did to save the files in the first place. Once saved, they're nearly eternal. My practice is to alternate WORM cartridges, with the one not in use at the moment residing in a safe-deposit box at American Vault; that way, even if Chaos Manor burned down, I'd have most of what I've been working on.

I've said it before, but I'll repeat it here: anyone doing serious software development should get a WORM drive. It's likely to be one of the best investments a software development firm can make.

LANtastic

I don't have fixed categories in the Chaos Manor Awards; I invent categories to fit products that have impressed me. That description certainly fits Artisoft's LANtastic, which I'll call the LAN of the year. LANtastic consists of an 8-bit board and peer network software. Installation of both hardware and software is simple, and once done, any station on the network can configure itself to make none, all, or part of its files available to other stations. Since it is a true peer network, nothing can be accessed without prior permission.

LANtastic allows network access to a CD-ROM drive; the DOS extensions need be installed only in the remote machines. Since LANtastic works through DOS, it's possible to access WORM drives and nearly everything else.

There are faster LANs, but so far I've found LANtastic to be more than adequate for every task I've given it. I was even able to use it to network the DOS side of the Amiga to my PC.

PowerPoint

By far the most useful Mac product of the year was Microsoft's PowerPoint. This program lets you make and organize briefing slides; I used it to prepare the SSX (Space Ship Experimental) briefing for the incoming Bush administration. PowerPoint typifies both the good and bad points about the Mac: once you understand the techniques, it's easy to use, but many of those techniques can be discovered only through learning computer folklore.

PowerPoint makes one-sheet briefing

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FH	ST4096	28ms	MFM	80MB	$599

286^{12} Computer

PERFORMANCE RATINGS

SYSTEM	NORTON SI Ver4.0	MIPS	PowerMeter
IBM Model 50Z	11.2	1.6	147.2
Compaq 386-16	15.6	2.8	319.9
Shamrock 286-12/0	15.3	2.5	253.3
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charts that the program documentation calls "slides." Slides can incorporate both text and graphics. If you have a briefing logo, it can be pasted onto the presentation master, and it will then appear on every chart. I scanned in the logo—a stylized SSX rocket superimposed over a globe—with the Apple Macintosh scanner, another of those products that are infuriatingly excellent: it works fine, but you really have to work to outsmart the software, which seems perpetually to offer you options you want but which are grayed out (and thus not available). On the other hand, when you do figure this stuff out, it works splendidly. The logo really looks great.

PowerPoint charts or slides can be shown on-screen, photographed with something like the Datacam computer screen camera to make actual slides, or printed on a LaserWriter. The LaserWriter will print on acetate for overhead projectors. However you do it, the final product looks very professional.

There is also a notes system: each chart is produced in miniature at the top of a page, after which you can add any notes you like. When you print the briefing charts, you can also, if you wish, print the notes files.

PowerPoint makes one-sheet briefing charts that are called slides.

If your company is much involved with giving briefings and presentations, it's probably worth buying a Mac and a LaserWriter just to have this program; the output is that good.

Getting there may drive you nuts.

For example: when you print your charts, PowerPoint offers the option of normal printing, one chart per page, or "handout" style, which puts up to six charts (in miniature) on each sheet. This is a great way to give out briefing summaries, and when we finished the SSX briefing, I wanted to make handouts. When I did, though, there at the top of each page in a nice shadowed box were the words "Presentation Title," and at the bottom it said "Presented by:" followed by blank space. Clearly not what I wanted. If there had to be a "Presentation Title" box, it ought to have a title I had given it. I didn't care to have "Presented by: blank" on every page, either.

The PowerPoint documents are clear, detailed, and very long. If I were a professional document manager, I'd read that book from beginning to end. Alas, I'm not, and indeed I was in a great hurry and had no time to read a few hundred pages; since what I wanted was to title the presentation, I looked up "title" in the index. There was nothing there. Nothing under "presentation" or "presented by," either.

Eventually I figured it out: just as there is a "Master Slide" onto which you paste your logo and all the other stuff you want on every briefing chart, there's a "Handout Master" that does the same thing. All it takes is editing that. It all makes sense, too, once you cotton onto the philosophy.

It still wasn't all that easy to do things. For reasons I have yet to understand, the Handout Master insists on showing the Presentation Title in color, and when I try to use the facilities to change the color scheme, I get a bomb, "Sorry, a system error has occurred," and error message 05; none of which makes life easy if you are trying to make charts to take to the transition team and your airplane leaves in 5 hours.

I managed a kludge that seems to have worked. The "color" scheme the system gives me is so dark I can't read it, but I just typed in the Presentation Title blind and trusted to luck that when it printed in black and white it would look all right; and Lo!, it did.

I had other problems like that and was able to work around them all. I think using a Mac is a bit like learning Lisp: if you fool around with it long enough, there's a kind of "Aha!," after which everything is simple. I sure hope so.

Meanwhile, despite all the problems, PowerPoint let me make up a complex and highly professional presentation in a couple of evenings; in my old aerospace days, it would have taken the presentation art group at least a week to do a job that good, and the cost would have been greater than the value of the Mac II.

The Mac II and PowerPoint are seriously good stuff.

Printing

The printer of the year is the big Kyocera F-3010 laser printer. As I've said before, I really have no business hanging onto this much printer, but I'm sure glad they don't want it back just yet. The F-3010 emulates nearly every printer known, and it prints an honest 15 pages a minute of double-spaced Times Roman text (complete with italics and boldface). I printed a novel in well under an hour. Like most modern laser printers, the F-3010 stacks the output upside down.

Meanwhile, Mrs. Pournelle reminds me that the Mannesmann Tally laser printer continues to work reliably in her end of the shop. It also happens to use the Kyocera print engine.

Laptops

Despite its weight—it really is giving me a permanent list to port—the laptop I carry is the Zenith SupersPort 286, which is a full AT-compatible machine with a 20-megabyte hard disk drive. The screen is readable, and I get an honest 3-plus hours on each charge. I've carried the SupersPort to a lot of places, and although I really wish it weighed less, I find that I'm not willing to swap it for one of the other laptops we have here at Chaos Manor.

I did discover that the Super'sPort isn't as easy to use in my Bronco II as was its predecessor, the Z-183. The SupersPort is both smaller and heavier than the Z-183, and when you have to balance the machine on your lap while being driven at freeway speeds, that difference is important. I did manage to work with the SupersPort: I got a bungee cord and used that to hold the machine up against the dash, with its battery pack resting on the shelf above the glove compartment. The cord held the machine in place despite bumps and curves, and I was able to write several hundred words an hour.

For writers, the difference between the SupersPort and the Z-183 isn't all that great; either will do the job nicely. The SupersPort is, of course, faster and

continued

more powerful. The screen can fold to a wide variety of angles, making the SupersPort easier to use on airplanes. The fact is that I have both machines, and I'm sitting on an airplane writing this on the SupersPort, which I suppose says it all.

GrandView

The software product of the year is Symantec's GrandView, which is an outline processor. That may not sound very important, but GrandView is, particularly when used in conjunction with DESQview. GrandView is generally the first DESQview window I open; that way, I can get the day's schedule, then, when I'm doing other things, jump back to one or another GrandView outline to add notes on stuff that has to be done or insert ideas for columns and stories.

GrandView might not be quite so valuable without DESQview; it's the instant availability that makes the program vital. Since it lets you have several GrandView windows open at the same time, GrandView under DESQview gives rapid access to a calendar, files on future columns, files on books in progress, and so on. I can be connected on-line to BIX, get an idea for a future column, jump over to GrandView, record it, and get back to BIX in seconds.

I have the notes for this column on GrandView, which is what makes it possible for me to be writing while on this airplane. I really wonder how I ever got along without GrandView.

ScanMan

The gadget of the year is Logitech's ScanMan. This consists of a PC board, software, and a hand-held scanner you drag across whatever it is you want to bring into your PC. ScanMan only scans images; it doesn't convert text into ASCII files. However, once you have an image file, you can sometimes use Flagstaff Engineering's Spot OCR (optical character reader) software to make the conversion. I say "sometimes" because, while Spot seems to be the current state of the art in OCR software, there's still a good way to go before you can scan in and read everything you might want to.

If you intend to do a lot of scanning, particularly of text and documents, you'll probably be better off with the Hewlett-Packard full-size scanner; but for occasional work, ScanMan is easy to use and affordable.

Languages

The language of the year is Microsoft's QuickBASIC 4.5. This release cleans up bugs in version 4.0, and it also makes a number of significant changes in the user interface. You can still get the old interface back if you want it.

When I began this column years ago, much of it was devoted to language debates: which was the best language for programming a microcomputer? Theorists agreed on one thing: BASIC was not the language of choice, either for teaching programming or for writing useful programs. On the other hand, most of the early programs were written in Microsoft BASIC, largely because there just weren't many other choices. For a while there, it was either BASIC or assembly language.

The main objections to BASIC were that it was not strongly typed and there weren't any control structures. BASIC code tended to be full of GOTO statements, and any large BASIC program resembled a basket of cooked spaghetti. The program logic was impossible to fol-

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low, if it existed at all; many of those early BASIC programs "just growed."

That's all changed now. QuickBASIC 4.5 has all the control structures you'll ever need. It has IF...THEN...ELSE, CASE, DO WHILE, DO UNTIL, and so forth, all of which have been in BASIC for some time. It also has subroutines that can be called by name, and they are nearly indistinguishable from Pascal procedures. QB 4.5 subroutine variables can be local, local and static (a static variable doesn't go away when you exit the subroutine), or global.

While QB 4.5 isn't as strongly typed as Pascal, there are variable types, including records that work pretty much the same way that records do in Pascal. In a word, all the necessary data structures are there. It's still possible to write spaghetti code, but it's just as easy to do things right.

The result is a language quite good enough for complicated programs, as well as for quick-and-dirty jobs. I don't doubt that you can do a great deal more with C and that the resulting program will run faster; on the other hand, if you don't do a lot of programming in C, you won't do any. C is a language that lets you do in one line what it takes several lines of Pascal or BASIC to achieve. The result is that it's much harder to read the program, and if you put a large C program aside for a few weeks and then go back to it, you are likely to find it's going to take a long time to figure out what you did. With BASIC, you can usually just pick up the work and start adding to it.

I can make about as good a case for Borland's Turbo Pascal as I can for QB 4.5; but the fact remains that the major programming work I've done this year was on Mrs. Pournelle's reading program, and that has been done in QB 4.5. Also, when I have a quick job to do—file format conversions, for example—I find that I tend to use QB 4.5 because it's so simple to do.

I suspect that the future belongs to object-oriented languages, like Smalltalk or Actor; but at the moment, the language I actually use is QB 4.5.

Software Trendsetter

There are hardware differences between PC and Mac computers, but they're less important every year. For most users, the essential difference is the general philosophy of their operating systems. The Mac has always been visual and graphics-oriented, and Mac software in general has been developed to take advantage of that. Some of that software was so good that many of us thought it was worth buying a Mac to get it. Of course, much of this software was concerned with desktop publishing and document preparation, typified by packages like PowerPoint.

There were also programs like Microsoft's Excel and Softview's MacInTax.

Many analysts said the most important computer event of 1988 was the introduction of OS/2 and Presentation Manager. That may be true, but I have my doubts; even Microsoft says the installed base of OS/2 won't be very large for another couple of years. In my judgment, the 1988 improvements in Windows were considerably more important. Provided that you have a good EGA video system, you can now get both Excel and MacInTax for your AT. You don't even need Windows; both programs come with runtime packages that take care of the job.

That trend will continue. Windows, and in particular Hewlett-Packard's

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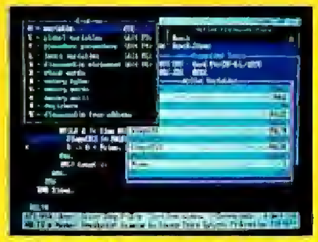

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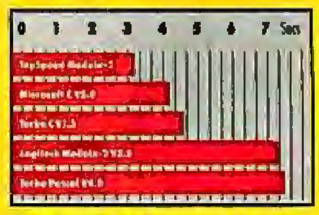

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NewWave Windows implementation, will go far to erase the differences between the PC and the Mac. Add object-oriented languages like Actor, and it may not be long before just about everything that runs on the Mac can about as easily be run on a PC. Apple's lawsuit against Microsoft and Hewlett-Packard was ill-advised, and I suspect that Apple already regrets it; both Apple and Hewlett-Packard would be better off if those resources had been invested in new technology rather than paid to lawyers. So would we all. Still, it's not hard to understand why Apple is afraid of what Windows portends.

Software Tool of the Year

Hands down, the software tool of the year is Borland's Turbo Debugger. I first saw this as a demonstration at Philippe Kahn's house a year or so ago, and I've been waiting for it ever since. If you use any Turbo products, you'll find the Turbo Debugger pretty simple; the interface is pretty much the standard Borland Turbo menu system. There's a good manual, but you won't often need it.

One of Turbo Debugger's neatest features is the ability to run on a remote machine, so that if your program crashes, the Debugger isn't dead and may be able to find out what some of the problems were.

Borland continues to make excellent software tools, and by its existence, it forces other major software publishers to improve their products to stay competitive. We all benefit.

Most Significant Hardware

The most significant hardware development last year was Intel's Connection CoProcessor board. That may be a bit stronger statement than I meant, but I won't withdraw it.

Another Pournelle law states, "One user, at least one CPU"; the Intel CoProcessor carries this further to "one task, one CPU." The CoProcessor has an on-board 80186, software in ROM, and its own memory. There's also provision for a modem. The result is a small communications computer hosted by your AT. It can call another CoProcessor, inquire for messages, send and receive messages (including fax images), and in general manage most of your communications activities, and do it while the host computer does other things.

There are things about the Intel CoProcessor that I'd change, but in my judgment, this pacesetter was the most significant hardware development I got

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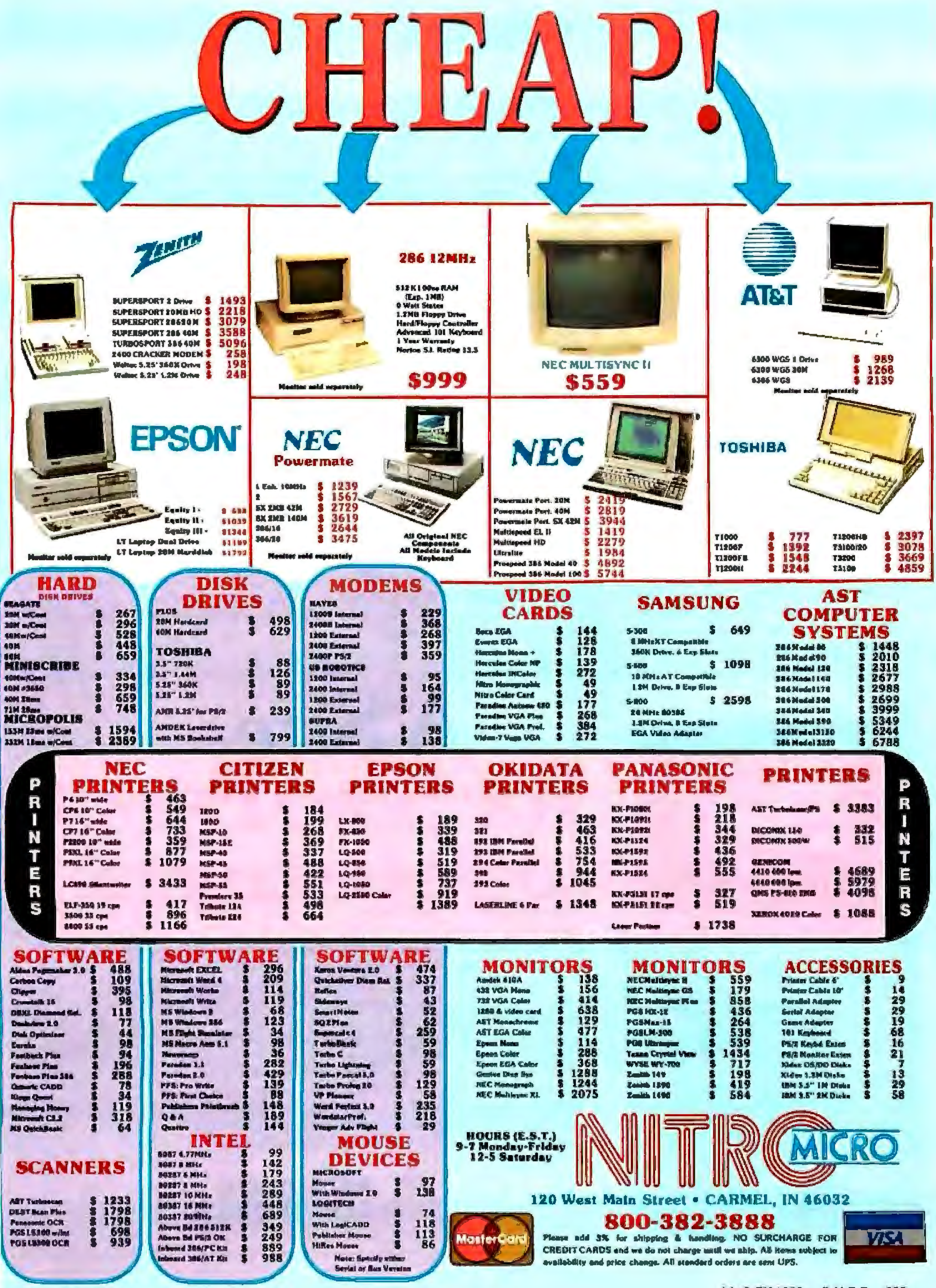

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this year. I hope to see a lot more coprocessors in the next few years.

Good Stuff

In addition to my awards, I like to commend other significant products that don't quite fit into the award system. Some, for example, set or exemplify trends. Others are just good stuff that someone ought to say good things about. Call this the Chaos Manor honorable mention list.

Item: Traveling Software. This company pioneered communications between laptop computers and the rest of the computer world, and they've been putting out good products ever since. This year, their trendsetters included a program to link the Macintosh to the PC and another to link up the new Sharp Wizard pocket computer to the PC world. If you don't have the Traveling Software catalog, get it. It's likely you'll find they sell something you need.

Item: DESQview, especially when combined with the Phar Lap DOS extensions. Between them, these two programs can do just about everything that OS/2 can, while letting you run all your old software at the same time. In my judgment, the main reason DESQview and Phar Lap haven't really taken off in sales—and they're doing quite well now—is the high price of memory, and of course that hurts OS/2 quite as much as it does DESQview.

Item: PC-Write 3.0. This shareware program improves every year, and it has become quite good enough for nearly anything you'd ever want a text editor for. Being shareware, you can get a copy and try it before you pay anything. I don't know what will be the future of shareware, but I do know that if it has a future, that will be in large part due to the efforts of Bob and Meagan Wallace.

Item: Flagstaff Engineering's Spot OCR software. I find in general it's still cheaper to send one of my old paperbacks overseas to one of those shops that key in text than it is to scan it in; but for short jobs, those that have to be done quickly, and jobs involving typescript or clean, well-set type, Spot is more than good enough. Someday we'll have hardware and software capable of reading in just about everything ever printed. Spot isn't there yet, but it's getting us closer.

Item: Tandon's removable Disk Pacs. Tandon pioneered removable hard disk drive technology. This year, it matured to usefulness. We used a pair of Tandon computers in two locations, with Disk Pacs to transfer programs and data. You can't throw these hard disks around—Tandon recommends that you treat them as you would an expensive camera—but they do withstand daily transportation. Tandon machines come both with and without floppy disk drives; a system without a floppy disk drive can be kept quite secure, since it's easier to keep track of Disk Pacs than floppy disks. If the Disk Pacs are locked into a safe, the computer data is as secure as your documents are.

We've had good results with Tandon's AT machines.

Item: Mace Software. Paul Mace was the first person to realize that you could recover data from an accidentally formatted hard disk. Since that time, the Mace utilities have been expanded to include a whole bunch of useful stuff.

This year's major Mace product is GRASP, a PC screen-management sys-

continued

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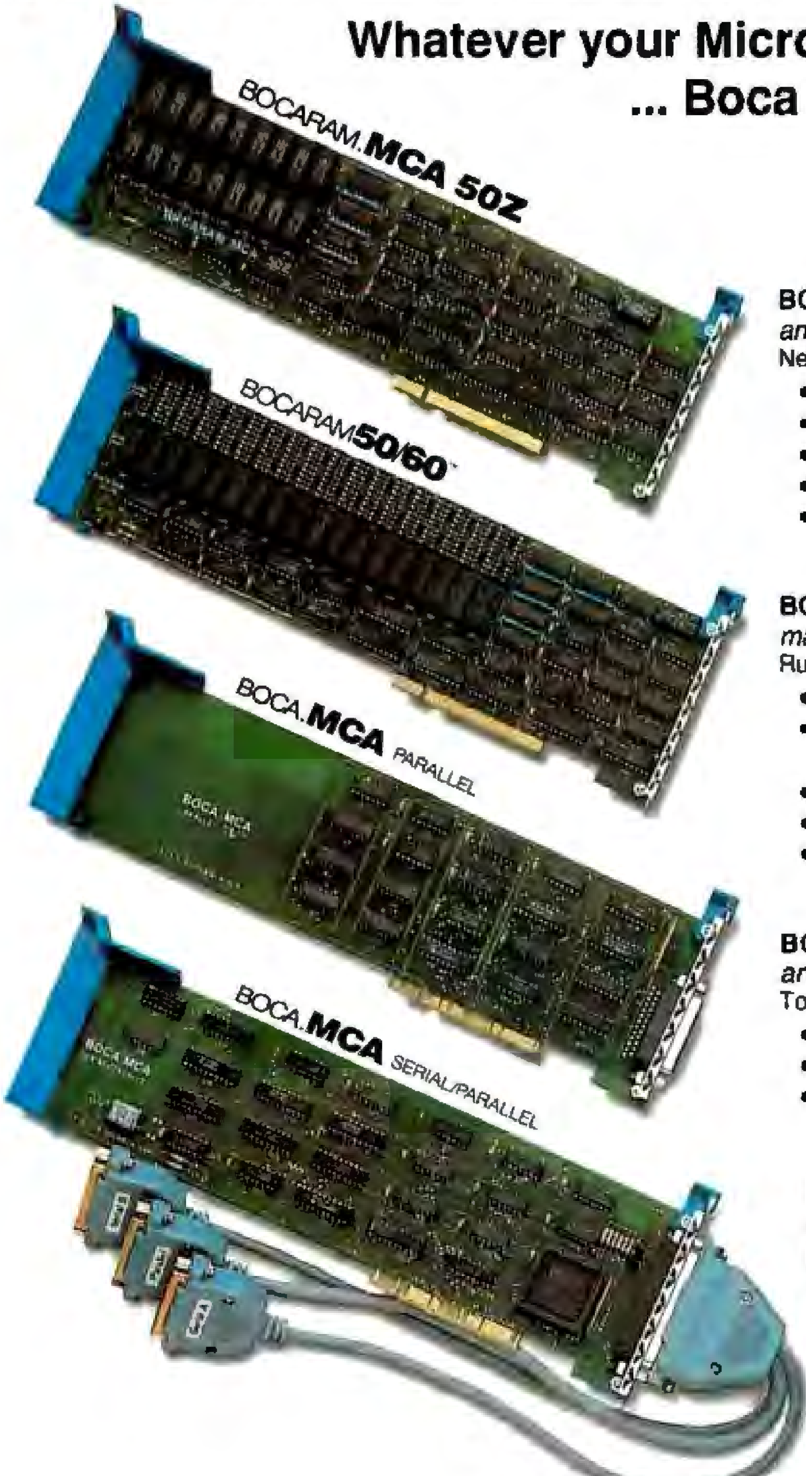

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tem that makes it simple to build up animated displays and otherwise do spectacular visuals by calling GRASP routines from BASIC, C, or Pascal programs. This is another of those companies that keep coming out with excellent stuff; you ought to get the Mace catalog.

Item: The Whitewater Group's Actor programming language. The real problem with Windows is that it's hard to learn how to write programs for it. Actor, an object-oriented language, makes Windows programming enormously easier, and it is a giant step in the right direction.

Logic Gem

I mentioned this last month. Now I have a copy. The only reason I don't make Logic Gem the Software Tool of the Year is that I just haven't had enough time to work with it; but I've seen enough to know I like it, and I'm pretty sure it will be on next year's honors list.

The blurb on the back of the Logic Gem document says, "Logic Gem does for program logic what spreadsheets do for numbers." That's a pretty good description. Logic Gem lets you make large truth tables, check for logic conflicts, and then automatically generate code that can be incorporated into your programs. It has already saved me several hours, and I haven't had it a week.

Highly recommended.

Game of the Year

This one's a tie: Dungeon Master, for either the Atari ST or the Amiga, is spectacular. The visuals are stunning, and the game can really get you involved. Exploring the 14-level dungeon took me about a month, and I found myself playing it a great deal more than I should have.

The other game of the year is Empire, for the Atari ST, the Amiga, or an EGA-equipped PC. I get a lot of computer games, and I try a lot of them, but find myself coming back to this one again and again.

Winding Down

There's a tie for book of the year, too: Charles Murray's *In Pursuit of Happiness: And Good Government* (Simon and Schuster, 1988) and John Keegan's *The Mask of Command* (Penguin, 1988). They're both important books, and I don't use that phrase lightly.

It's late at night, and I'm late with this column, which I'm finishing on the SupersPort in a room in the Jack Daniels Motor Inn in Peterborough, five days before Christmas. Since I started this column, I have flown to Boston, then driven up here to New Hampshire. I've also attended the first BYTE Editorial Exposition and gone to a birthday dinner for my BYTE technical editor, Stan Wszola.

I'd better get some sleep. I sure hope 1989 is as good a year as 1988 has been. ■

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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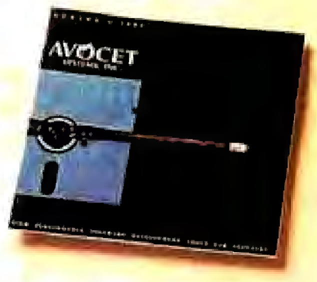

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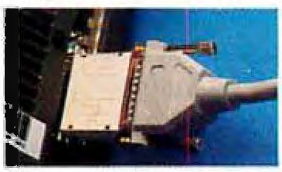
In 1988, $3.5 billion in microcomputer software will be sold worldwide. During that same time, another

$3.0 billion in sales will be lost to free distribution — better known as software piracy. And right now, Rainbow Technologies' Software Sentinel™ is protecting close to $1.0 billion in software for developers who never wanted to be part of the free software distribution network in the first place. The Software Sentinel hardware key is "execution control" software protection. It ships with the software and simply plugs into the PC's parallel port to be one hundred percent invisible to both user and the software. Users can make as many copies as they want. Make working submasters. Use a hard disk. Virtually anything that can be done with unprotected software. Except start freely distributing that software to other users. The Rainbow family of Software Sentinel products. Selected by the very big to the not-so-big developers of DOS, OS/2 and Xenix software in worldwide markets. To the cool tune of close to a billion dollars. So far.



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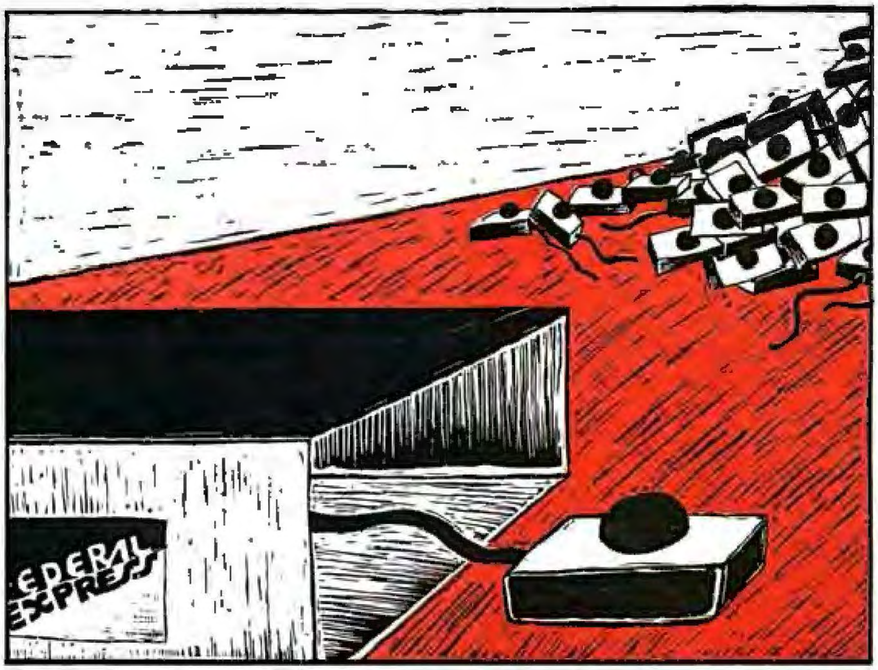
TRACKBALL MADNESS

Mice aren't as nice, but they may live a lot longer



Every time I have to deal with a hardware malfunction, I begin to wonder why I own computers. When my Abaton ProPoint trackball started acting up, I once again entered that nightmare zone that all users dread. Before it ended (that's assuming it *has* ended), things got pretty bizarre. The story is a good example of the kind of convoluted logic that drives the computer industry.

Let me begin by stating that I'm addicted to trackballs; since switching to these devices for use with my PC AT clone and my Macintosh, I've eliminated the sharp arthritis-like pains in my elbow that came with constant mouse use.

And ProPoint for the Mac seems to be a nifty product, nicely styled and ergonomically superior to many other trackballs I've seen. The position of the two buttons to the lower left of the ball is better suited to righties than to lefties, but since I'm right-handed, the design is ideal for me. I've become absolutely dependent on ProPoint, so when it stopped responding to left-right motion, I was panic-stricken.

I blew away whatever dirt I could see within the device, but that didn't help. Then I prodded and banged for a while, to no avail. I sighed and wrote the trackball off as dead.

As I hadn't bothered to send in my registration card, the following morning I called the mail-order desk at Computerware to buy a new one. When I explained my problem, a pleasant man told me to hold off and to try a call to Everex, of which Abaton is now a division.

"Don't be silly," he said. "They guarantee these things, and you might be able to save yourself a lot of money."

Wow, a helpful retailer! Duly impressed, I phoned Everex. Sure enough, the fact that I still had the original invoice was good enough, and the company issued a return authorization on the spot. I was told that the repair would take about a week from when Everex received the unit, and it would be returned to me by whatever shipping method I used to get it there. So I packed up the trackball and sent it off by Federal Express, next-day delivery.

Two weeks later, on a Tuesday, I called to find out why I hadn't received my repaired trackball, and I was told that it was scheduled to be shipped Thursday at the latest.

"So I'll have it for the weekend?"

"Definitely," came the reply.

By late Friday, with no trackball in sight, I called again.

"There's a backlog," I was told. "Your unit will be shipped at the beginning of next week."

Fine. Tuesday rolled around, and nothing happened. Wednesday, I called Everex again. "What's the problem?" I inquired.

"I don't know," said the customer service representative. "There's a backlog. I'll see what I can do."

"Why is there a backlog?" I asked. "What's going on?"

The customer service person sighed. "Nobody will tell me."

"You mean you've talked to the engineers and the technicians, and no one can offer an explanation?"

"That's about it."

At this point, I decided it was time to do a little poking. I called a friend of mine with an engineering background, who has worked with trackballs, and described the situation. "Everex will rue the day they stuck a guarantee on that puppy," he chuckled. "It's a design flaw, not a malfunction. Building a trackball suspension that won't deterio-

continued

ILLUSTRATION: CLAUDIA TANTILLO © 1989

rate quickly is not a trivial matter; it can be done, but they haven't done it. I'll bet you anything you don't get the same unit back."

I also telephoned the press relations person at Everex to find out whether there was some major problem with the ProPoint. No, I was told, the delay was more likely to be due to getting parts from suppliers than to any design flaw; the ProPoint's failure rate was in line with those of other trackballs. With completely opposite explanations, I had no choice but to wait.

Finally, 3½ weeks after the process had started, a Federal Express delivery arrived from Everex containing a brand-new ProPoint with a different serial number. I called my engineer friend again.

"How long had you been using the trackball, and how long is the guarantee?" he asked.

"Four months," I replied. "And the guarantee is five years."

"That's three a year," he said. "I predict that the new trackball will fail in four months, and you'll go through this again. Unless they change the design, you'll have to do it 15 times to get past the guarantee."

Ouch. I'm not sure what to make of all this. The facts are these: The guarantee is for real. The trackball certainly failed, and it was replaced with a new unit. Everyone at Everex was friendly and polite. I'd buy products from Everex again, and I recommend the company to friends.

But would I recommend the trackball? I guess I'll have my answer in another four months or so.

One final thought from my friend. "Everex acquired Abaton to get into the Mac market, but they're primarily a PC company. Now that IBM has endorsed mice, the market for third-party pointing devices is heating up fast. If the ProPoint is really a solid design, then why hasn't Everex brought out a PC version of it?"

Stay tuned.

Microsoft at Work

Microsoft's upgrade to Works for the Mac (2.0) is a truly curious thing. The company has managed to take an enormously flexible integrated software package, add a tremendous array of substantial features and improvements, yet make the product only slightly more useful than it was to begin with. This is no mean feat; I find myself simultaneously awed and irritated, a very strange feeling indeed. I still recommend the product highly—it can easily handle 80 percent to 90 percent of most routine application tasks—yet I'm not sure I'd recommend the upgrade to anyone who already owns the program.

I find that I am simultaneously awed and irritated about Works 2.0.

The three most grandiose additions to Works—a spelling checker, a macro recorder, and powerful drawing facilities—all fail to measure up to what I would have expected from Microsoft. The spelling checker is unacceptably slow, and it does not let you check as you type. The macro recorder offers no capabilities for editing, branching, or modifying the speed of playback; it merely spits back recorded keystrokes as fast as it can. Thus, it's useless for anything but the simplest of functions, like inserting boilerplate phrases into text.

You access the drawing tools as a mode within the word processor or the spreadsheet, rather than firing up a separate new module. This is handy if you want to add little pictures to an existing document, but once you scratch the surface of this feature, it's downright odd. You get the basic palette for drawing lines, rectangles, polygons, ovals, and so on, with patterns and fills, and you can even draw lines that end with arrowheads. However, every time you create an object, the program changes back to the selection pointer, in direct violation of Apple's guidelines for software design. Very annoying.

You get a customizable snap grid, but you can't see it on the screen; there's also no vertical ruler bar, so positioning of objects is haphazard at best. The text tool will let you form blocks of text, a rudimentary sort of page layout, but you have to either type the text right there or paste from the Clipboard, and the spelling checker won't work on objects created in draw mode.

The communications module, always the program's weakest link, has not been improved as far as I could tell. There's still no way to automate log-on procedures, unless you count the macro recorder, which is a sorry solution at best. This was one of my biggest gripes with earlier versions of Works; I wish it had been fixed.

The spreadsheet allows nearly double the number of rows as Works 1.1 (from 9999 to 16,832), but remember you're limited by RAM, so this may be moot. Microsoft has added new functions for date and time, and you can attach notes to individual cells. There's no way to link worksheets, but you can play games with the Clipboard and the macro recorder. Both the spreadsheet and the database now offer the ability to choose one font/size/style per document, but you can't mix attributes.

The Works 2.0 database will accept spreadsheet calculation functions within records, and the report generator now has scroll bars and margin control. The package is still lacking a logical field type (e.g., Yes/No or True/False), which would have been a simple but utilitarian improvement.

The word processor has gained a few niceties, like the ability to print labels two and three across, search and replace on tab and carriage-return characters, and decimal tabs. Forget enhancements like multiple-line headers, indexes,

continued

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Flowcharting II Plus	229	207
Interactive Easyflow	150	135
OPT-TECH SORT/MERGE	149	99
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Windows for Data	295	259
LOTUS ADD-ONS		
4Views	150	119
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@bASE	195	121
Allways	150	117
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Graph-in-the-Box	140	109
Inword	100	80
Look & Link	100	64
Note-It Plus	80	68
Noteworthy	80	59
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See More	80	68
Sideways	70	45
Smartnotes	80	59
Spellin!	80	68
Sqz! Plus	100	CALL
PLANNING		
Harvard Total Project II	595	515
Project 4.0	495	340
Super Project Expert	695	515
Time Line 3.0	595	345
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SCIENCE AND ENGINEERING		
Asystant Plus	895	549
DADiSP	795	719
Eureka: The Solver	167	119
Gauss Math + Stat Package	395	359
HIWIRE-Plus	895	805
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Vopt	60	55
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C Tools Programmer's Library	90	69
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dBASE IV Developer's Edition	1295	899
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Diagram Master Prem Pack	365	206
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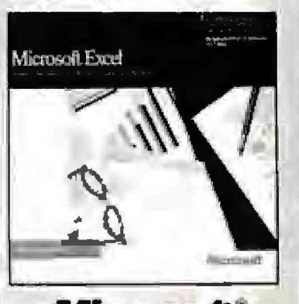

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Reflex Data Base Systems	150	109
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Norton Editor	75	50
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PFS: First Choice v. 2.0	159	104
PFS: First Publisher v. 2.0	129	75
PFS: Graph	140	91
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tables of contents, and such; they haven't been implemented.

New overall features include a simple page preview much like that in Word, the capability to save and name a "Works Desktop" file that will launch a given set of documents, and a "Stationery" file format—as close as you can get to a style sheet in Works, though the trick works only if you open a Stationery document and resave it as something else.

On the whole, Works 2.0 is a better program, but Microsoft seems to have opted for slickness rather than raw power. I keep saying that Works could be an excellent tool for experienced users; meanwhile, Microsoft keeps adding frills for novices. In spite of constant denials, I can't shake the feeling that Microsoft is trying desperately to hold back Works so it doesn't cannibalize the market for its other software products. Oh, well.

In the meantime, I've been playing with a nearly bulletproof beta version of Tim Lundeen's WorksPlus Spell 2.0, and it is still an excellent companion for Works. Why would you need a spelling checker for a program that already has one? Simple. WorksPlus Spell offers greater speed, checking as you type, hyphenation, word lookup, and a glossary command that lets you store and expand abbreviations. None of this is available in the Works spelling checker. Whatever version of Works you own, WorksPlus Spell is a requirement.

Annual Confession

Every March since I began this column, I take a little time to list the hardware and software that I use personally. As I've written quite a bit about these programs in the past year, I'll just reduce the exercise to a few short lists:

- *Primary hardware:* Mac SE with a 16-MHz Radius 68020 accelerator and a Jasmine Direct Drive 160. *Software:* Microsoft Works with WorksPlus Spell, PageMaker, Canvas, Microsoft Word, Excel, Reflex Plus, More, Prototyper, Course Builder, Microphone II, DeskTop Express, Suitcase II, DiskTop, QuicKeys, QuickDEX, FontSizer, SuperGlue, LetraStudio, Fontographer, FreeHand, TOPS, and various Adobe typefaces.
- *Secondary hardware:* Tandon PCA-40 (AT clone) with a MicroSpeed FastTrap and a Logitech Bus Mouse. *Software:* WordStar 5.0, Framework III, Lotus 1-2-3 with Funk's Worksheet Utilities, Mirror II, Procomm, PC-Write, Xy-Write, Professional Write 2.0, Memory-Mate, Reflex, Ready!, Cruise Control, Pop Drop, Ventura Publisher, PageMaker, TOPS, and various Bitstream typefaces.
- *Portables:* Cambridge Z88 and NEC PC-8500.
- *Favorite nonclassifiable computer:* Canon Cat with the Cat 180 printer.
- *Favorite device:* Apple LaserWriter IINT (solid, clean, and fast enough for anyone but the truly demented).
- *Next purchase:* A flatbed scanner. ■

Ezra Shapiro is a consulting editor for BYTE. You can contact him on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

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

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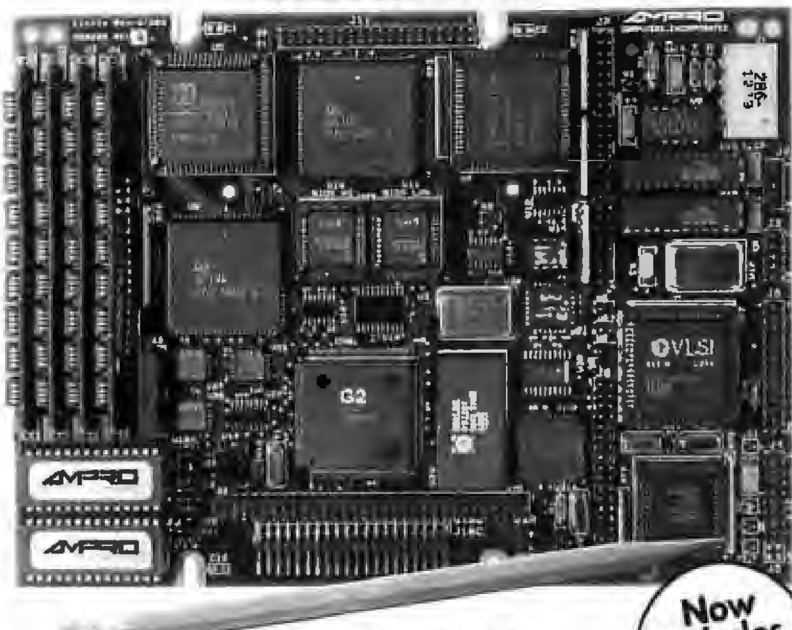

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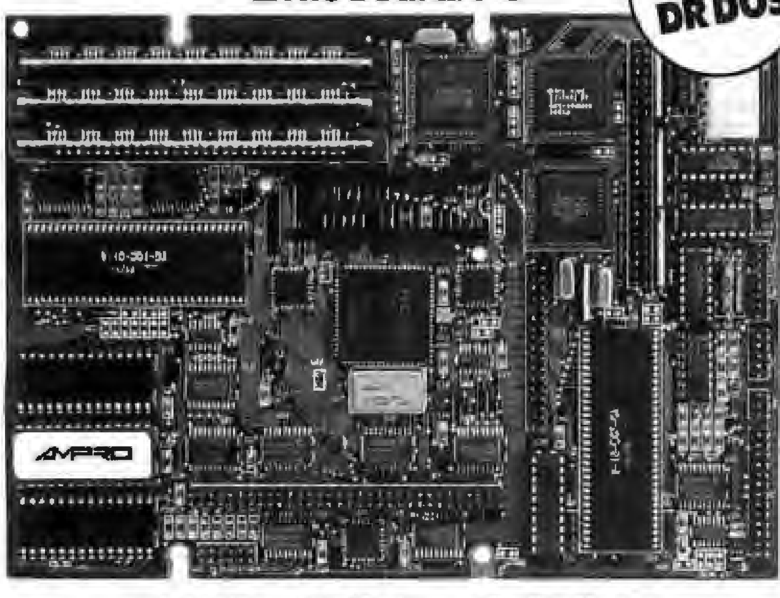

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WHAT HATH COMDEX WROUGHT?

Wayne roams the halls of COMDEX and discovers the ubiquitous "COMDEX fact"

Once there was a time when you could depend on COMDEX to provide a couple of stunning industry developments. No more. COMDEX has become an immense project filled with hype and wonder, where the first fact you discover is that even the best walking shoes made by L.L. Bean may not be equal to the task.

This fact, of course, leads to further "COMDEX facts." In his book *A Colder Eye*, noted author and critic Hugh Kenner (a member of the BIX writers conference) describes Irish facts as "anything they tell you in Ireland." A COMDEX fact, then, is "anything they tell you at COMDEX."

COMDEX Facts

The first COMDEX fact I encountered concerned the existence of a 33-MHz 80386-based IBM PC AT clone. I classify this rumor as a COMDEX fact because Intel has yet to ship a 33-MHz version of the 80386 processor. A couple of companies exhibited what they claimed to be such machines, but they were actually using processors designed for slower operation.

Then there is WingZ by Informix, a COMDEX fact for such a long time that it is nearly a COMDEX legend. WingZ is supposed to be a superspreadsheet for the Macintosh. But to date, this unseen product is serving only as a vehicle for the distribution of thousands of gym bags, because most users are more familiar with the orange and yellow bags with the WingZ logo than they are with Informix. Perhaps one day the promise will become a product that will deprive hundreds of bag-seekers of their just spoils.

Fortunately, there was more to COMDEX this year than COMDEX facts. One of the advantages of this conference's having grown so large is that, with some careful observation, you can now spot trends. This year's trends hold some promise for business computer users.

Three of the most important trends involve databases aimed at corporations, local-area networking, and OS/2. I think it's incorrect to call this the year of the database, or the LAN, but this is a year in which you will see some important elements begin to come together. These are evolutionary changes, of course, but the result of this process is a solid trend toward change.

Databases

Structured Query Language is finally coming to small computers in a useful fashion. Several vendors exhibited versions of SQL database packages designed for the corporate environment. Some of these suppliers are already shipping products—Oracle and XDB among them. Other software should be shipping by the time you read this, including SQL server software from Oracle, Novell, and Ashton-Tate. WordTech and Borland also exhibited SQL front-end software.

WordTech Systems currently sells dBXL and Quicksilver, a dBASE clone and a dBASE compiler, respectively. The company has reached agreements with Oracle, Novell, and Gupta Technologies to convert dBXL and Quicksilver into dBASE language front ends for SQL database software. The results of these conversions will provide firms with various ways to upgrade existing dBASE language applications to the point where they can access the company mainframe.

Not to be outdone, Ashton-Tate was busy showing dBASE IV, which has embedded SQL. By this spring, there should also be a dBASE SQL server. In the meantime, the embedded SQL means

continued

ILLUSTRATION: RANDY LYHUS © 1989

you can develop applications containing SQL and put them into production as soon as the server software becomes available.

Finally, XDB Systems announced it also would offer a dBASE language front end for the SQL server product. XDB, though, did not announce where it plans to obtain its dBASE front end.

An interesting aside came to light when Ashton-Tate announced it was taking legal action against Fox Software and the Santa Cruz Operation for their sales of FoxBASE. Very likely, the winner in this fray will be WordTech Systems, the company that had previously contracted with Ashton-Tate for the use of the dBASE language. While Ashton-Tate is fighting off clones, it looks as if WordTech will be signing up new SQL vendors.

While Ashton-Tate is fighting off clones, it looks as if WordTech will be signing up new SQL vendors.

LANs

For several years now, columnists have been predicting the "Year of the LAN." I won't add to the noise. There probably won't be a Year of the LAN for the simple reason that LANs arrived quietly and established themselves while we were distracted by other issues. In other words, the Year of the LAN has probably already happened.

Instead, we are seeing a year of considerable growth and maturation. LANs are becoming more a part of the business world, and, for some applications, SQL database servers are becoming more integrated into the applications. LAN manufacturers are working on ways to enhance their interoperability and utility.

Novell, the leader in LAN operating software according to a recent BYTE poll, is introducing Macintosh connectivity with its NetWare 2.15. This product will allow a Macintosh II or SE with an Ethernet interface card to work on a Novell network. Novell has also introduced its OS/2 Requester—software that lets you use OS/2 on the same networks with non-OS/2 systems.

Meanwhile, other LAN software continues to evolve. WordPerfect Corp. showed WordPerfect Office, a package the company refers to as group productivity software. Office works with Novell or NetBIOS networks. It provides E-mail and group scheduling, along with such functions as a calculator and notepad. WordPerfect's idea is to provide a consistent feel to the software, so that users familiar with its other products will feel right at home with the new additions.

OS/2

At COMDEX, I saw some evidence that actual software will exist for OS/2. Borland International has begun shipping a

continued

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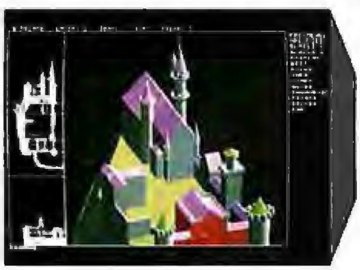

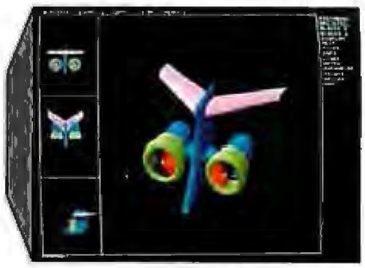

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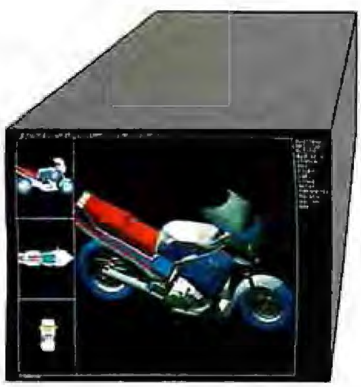
DR. STEVENS, NASA Space Scientist/Engineer



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At the COMDEX show, I saw some evidence that actual software will exist for OS/2.

version of Paradox for that operating system. Borland has said that it will begin shipping a version of SideKick for OS/2 with Presentation Manager by the first quarter of this year.

Lotus was showing Lotus 1-2-3 version 3, which will use OS/2. It still isn't clear when the company will start shipping that long-overdue upgrade. OS/2 software vendors generally agree that memory prices will have to moderate before this operating system will become widely accepted.

Business Impact

What does all this mean to you? As usual, COMDEX contained both good and bad news. The good news is that with the current state of LANs and SQL software, microcomputer-minicomputer-mainframe connectivity may finally become seamless. The bad news is that moving out of the current state of the art will be expensive.

The good news was demonstrated at COMDEX through the use of the (as-yet-unreleased) SQL version of Paradox, which was shown accessing SQL databases from three other database management systems. Paradox SQL was able to select information from any of the tables and from a combination of tables. The tables have also been from Oracle and located on a VAX or from DB2 and located on an IBM mainframe.

Software such as Paradox SQL will lead to seamless distributed processing, probably in the near future. Nearly all the required components are in place now. Still missing is a product that provides an easy way to use the Oracle server. Now the Oracle server must re-

continued

Items Discussed

dBXL $199
Quicksilver $599
WordTech Systems, Inc.
21 Altrinda Rd.
Orinda, CA 94563
(415) 254-0900
Inquiry 986.

dBASE IV $795
Developers' version $1295
Ashton-Tate
20101 Hamilton Ave.
Torrance, CA 90502
(213) 329-8000
Inquiry 981.

Novell NetWare 2.15
(Price not yet available)
Novell, Inc.
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Provo, UT 84601
(801) 379-5900
Inquiry 984.

Oracle SQL Server $2495
Oracle Corp.
20 Davis Dr.
Belmont, CA 94002
(415) 598-8000
Inquiry 983.

Paradox (single user) $725
Borland International
1800 Green Hills Rd.
Scotts Valley, CA 95066
(408) 439-1060
Inquiry 982.

WingZ
(Price not yet available)
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WordPerfect Office
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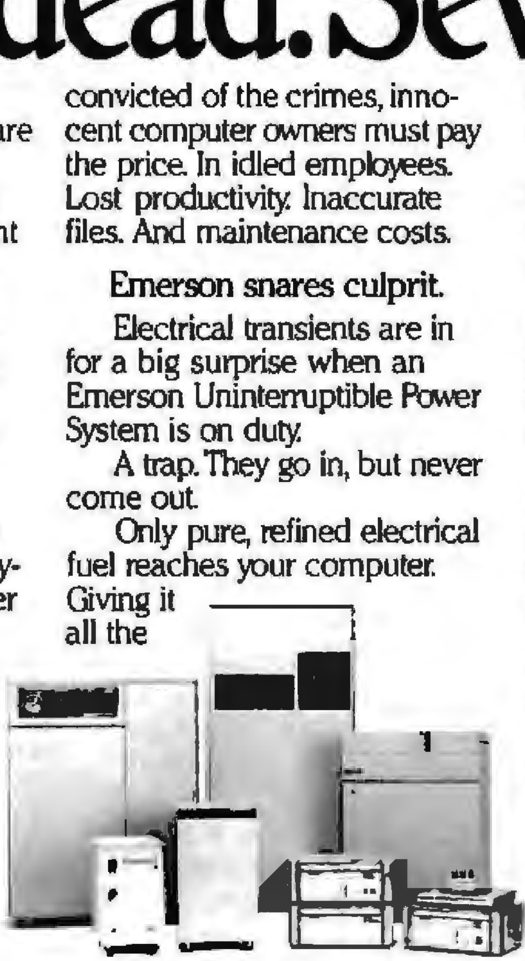

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side on a database server that runs Xenix, an environment many users find difficult to manage. Fortunately, at COMDEX, Oracle announced an OS/2 version of the server. It should be available by the time you read this.

Nothing at COMDEX held much hope for an early change to OS/2. If anything, reasons to stay with MS-DOS or the Mac continue to grow. Now that Presentation Manager is shipping, OS/2's memory requirement has grown to about 5 megabytes, depending on what you want to run in addition to the operating system. You could easily spend more on memory than you did on your computer. As yet, there is no software that offers a compelling reason to move to OS/2.

The lack of OS/2 software, plus increased performance and reduced prices on some systems, will affect the purchasing strategy for many businesses. Currently, 80286 versions of AT clones are readily available at prices significantly lower than for an 80386, either in its SX version or in the full 32-bit version. Meanwhile, there is virtually no widely used software that requires the 80386. With 20-MHz versions of the 80286 now being shipped, there is not even much of a speed difference.

What's a business to do? Unless a specific application actually requires the processing ability of an 80386, it may not pay to buy one. It's a reasonably safe bet, given a three-year economic lifetime, that there will be relatively little additional software actually requiring the 80386 during the time you will have the 80286 machine. After all, even though the 80286 has been around for several years, virtually all software is still written for the 8088.

The time will eventually come when the software for the 80386 or its successors starts to become a factor. Then you will start buying those machines. They will cost less, and you won't have lost anything in the meantime. Admittedly, I am offering a low-tech approach to computing, but nothing I saw at COMDEX contradicts this conservative strategy. ■

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

A MACINTOSH RETROSPECTIVE

Looking back at the first five years of a revolution

By the time you read this, the idea of a five-year retrospective for the Macintosh will probably seem pretty lame; I missed the anniversary date by a couple of months. But since I'm writing this in early December of 1988, please indulge me.

I was cleaning out the office in my home today (always a thrill), going through a closet to toss out some of the oldest computer flotsam (most of it software that runs on computers that don't exist anymore).

I came to the old Macintosh software heap. There I found the original cartons, manuals, and disks for software that amazed us all in 1984: the original System kit, MacPaint, MacWrite, MacTerminal, Microsoft Multiplan, and Microsoft BASIC Interpreter.

I remember thinking at the time that the Mac was pretty hot stuff and that it was going to revolutionize the way we think of and use personal computers. It's been five years since the Macintosh was released, so I asked myself whether it really revolutionized anything.

Consider the evidence from the Mac's point of view. The Mac, though bigger, faster, and more expensive, is still the Mac. Its interface is still the same. Pull-down menus. A mouse. Icons. Windows with scroll bars. Decent sound. Nice graphics that work with any application. Good built-in system support for standardized functions as part of the operating system.

Color has been added, and so has background processing with the MultiFinder. But if a Mac 128K user of 1984 could have been placed in a hermetically sealed room that very year, and released now to try out an 8-megabyte Mac IIx, he or she would have little trouble using it. The Macintosh has evolved since its 1984 introduction, but it's still the same kind of machine. In fact, the Mac has become a second standard after the IBM PC.

Now consider the evidence from the DOS point of view. In 1984, DOS was somewhere around version 2.xx. Its interface consisted of a helpful A:> or C:> prompt, and dandy error messages like "File allocation tab bad." Menus were for ordering food at a restaurant, not commanding your PC. A mouse was something you had exterminated; you certainly wouldn't tolerate one on your desktop. Icons were found in Greek Orthodox churches, not on your screen. Windows were on your house, not your computer display. Sound consisted of some wonderfully annoying buzzes and beeps. Graphics were CGA at worst, Hercules at best (but then compatibility was an issue). System support for standardized functions was weak and required major-league driver hacking.

By 1988, DOS was giving way to OS/2 with its Presentation Manager graphics, windows, icons, and mice. Sound was being improved. System support for database, networking, and other functions was being added. In short, the transmutation of the DOS interface to look like the Mac interface was in full swing. If you took a 1984 DOS user from that same hermetically sealed room and plopped that user down in front of a PS/2 Model 70 running OS/2 and the Presentation Manager, the reaction would be unequivocal: "How do I get the A:> prompt?"

By any measure, the Macintosh has indeed revolutionized the way personal computers interact with people. Mostly for the better, I think. When the largest computer manufacturer in the world (IBM) gets together with the largest PC software vendor (Microsoft) to put together a PC user interface that mimics

continued

the Macintosh's interface, I think we have evidence of a bonafide revolution.

It's a Taxing Time of the Year: MacInTax TaxView

Nobody likes to fill out federal income tax forms. Fortunately, however, it's one of those repetitive, numerically intensive tasks that can be simplified with the right program on the right computer. The right computer is, of course, the Macintosh, and I think the right program is MacInTax. I've been using MacInTax since it first appeared in time for the 1985 tax year. It's simply wonderful. I can't imagine how I ever kept my business depreciation calculations straight without it.

Over the past four years I've used and tested many of the tax-preparation programs that run on the PC and the Mac. Of the personal or professional tax-preparation programs on the market, MacInTax is by a large measure the easiest to learn and use. And at $119, it's also a bargain, especially since you can get yearly updates (which include new manuals) for only $55. MacInTax is so easy to use because its interface is simple and straightforward, yet still surprisingly sophisticated.

While many tax-preparation programs mimic the structure of those dreaded IRS forms, MacInTax takes that strategy to its limit: its on-screen display duplicates the IRS forms exactly (to the extent that 72 pixels per inch allows). So you just fill out the on-screen forms the same way you filled out the old paper forms. This method means that if you've ever filled out a tax form before, you already know how to use MacInTax.

Items Discussed

MacInTax 1988 .... $119
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SoftView, Inc.
4820 Adohr Lane, Suite F
Camarillo, CA 93010
(805) 388-2626
Inquiry 1101.

MasterJuggler 1.00 .... $69.95
ALSoft, Inc.
P.O. Box 927
Spring, TX 77383
(713) 353-4090
Inquiry 1102.

Need to fill out some of the other forms and schedules? No problem with MacInTax. They're all in the pull-down menu. You can have as many forms open as you need, although you can run out of memory, especially under MultiFinder on a 1-megabyte Mac.

If you hit a rough spot and need some help or want to see the IRS instructions for a particular entry, just double-click on the block in question. If the entry amount is calculated using an on-screen worksheet or is transferred from another form or schedule, double-clicking will pop up that worksheet, form, or schedule onto the screen and link it with the others and the 1040 form automatically. What could be simpler? I've never been able to figure out why other tax-preparation programs don't work this way. It seems so natural.

Printing has always been a strong suit of MacInTax, and it remains so. MacInTax will print *all* IRS forms, including the signature Form 1040, onto plain paper, using either a LaserWriter or an Imagewriter.

I tested MacInTax by turning it loose on my taxes, then my wife's, and finally on some test returns I cooked up that use just about every schedule the IRS has ever conceived. MacInTax was accurate, fast, and flawless in all my tests. I never ran into any of the weird problems that seem to plague some of the other tax-preparation programs I've used.

When I did have a question that the online help couldn't answer, the manual did the job nicely. MacInTax supplies more than 30 different forms and schedules, along with nine calculation worksheets that are handy as scratchpads; they are saved with the forms, but they don't get printed for the IRS's scrutiny.

MacInTax can also convert your previous year's tax return to work with the current version of the program (once you've saved the old forms under new names). This could save you some typing on your 1988 tax return if a lot of last year's data hasn't changed for this year's return.

MacInTax also integrates with the most popular financial-management programs on the Mac, including Andrew Tobias's Managing Your Money, MacMoney, Quicken, and Dollars and Sense. You can import information from any of these systems directly into MacInTax with just a few keystrokes. This means you can have a fully integrated management, financial-planning, and tax-reporting system if you use MacInTax with one of these systems.

continued

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Easy as Apple Pie

For PC users who have wandered into this column, there is good MacInTax news for you, too. Last year, SoftView produced a Microsoft Windows version of the program, and it continues this year. The Windows version is markedly slower than the Mac, though, even on a fast 80286 machine. To get performance akin to the Mac version, you'll need an 80386.

Although I've said it before, it bears repeating: MacInTax is the best personal computer tax-preparation program around. If you do your own taxes and don't have MacInTax, make your life a whole lot easier and get it soon.

Font/DA Juggler to the Max: MasterJuggler

I never used to worry much about how many fonts or desk accessories I needed or used. I had gotten to be pretty good at hacking the system using FEdit Plus, so I could always change the maximum number of desk accessories allowed each time a new system was released. But after you've done that little trick a couple of times, it loses its appeal. Because of this, I began to cast about for a better solution.

The answer, of course, was either Suitcase or Font/DA Juggler. For a variety of reasons too boring to list, I settled on Font/DA Juggler Plus as having just the right stuff for me. Well, I've become addicted. No more system hacking of desk-accessory limits for me.

With this in mind, I was pleased when ALSoft released the latest version of Juggler a few months back. They called it, appropriately enough, MasterJuggler. This baby does what it says: It allows you to juggle a bundle of fonts, sounds, Fkeys, and desk accessories with your Mac. It keeps them open and available whenever you need them, without choking the system. The desk accessories will appear in the regular Open Apple Menu in a scrollable list, with MasterJuggler always listed first, so you can get to it easily.

MasterJuggler works as a start-up document (INIT) that you drag into your System folder. Once open, MasterJuggler gives you access to all the features of Font/DA Juggler Plus, as well as a bunch more that I find useful. There are pop-up menus for MasterJuggler, and for any application and its windows; and a utility that detects any resource conflicts among all your desk accessories, Fkeys, or sounds.

It also has an application list that allows program selection from running and predefined programs. This is a handy adjunct to MultiFinder, since you can also hide windows each time you change an application (so your screen doesn't get too cluttered).

MasterJuggler is one of those Mac utilities that you wonder how you ever got along without. ALSoft just sent me another item from its growing list of utilities, MultiDisk, a jazzy disk partitioner that I'll report on next time. ALSoft is definitely a company to watch when it comes to providing clever, inexpensive, but nicely executed Macintosh utility programs. ■

Don Crabb is the director of laboratories and a senior lecturer for the computer science department at the University of Chicago. 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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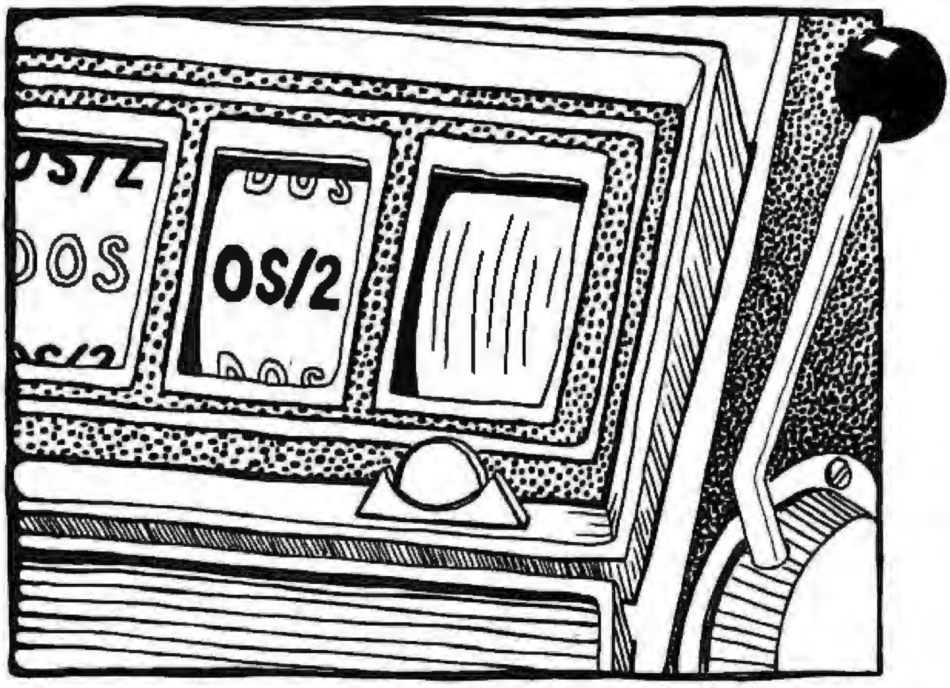
NOT QUITE COMDEX/2 YET

The jury is still out on whether OS/2 will be a hit or a miss



I have just returned from COMDEX. There are four basic post-COMDEX columns: the "COMDEX is really dying, and it says something about the industry" column, the "Boy, I didn't get any sleep, and my feet hurt a lot" column, the "COMDEX is mismanaged" column, and the "Gee, there was a lot of neat stuff" column. I'll give you all four for the price of one.

I brought a pair of Rockport shoes—the most comfortable almost-dressy shoe in the land—so my feet weren't too bad. And yeah, it was a pain waiting in the lines, but you get to meet people and hear things while waiting. There were also some noteworthy items vis-à-vis OS/2.

The OS/2 LANscape

The LAN Manager really makes OS/2 shine. It has good performance, well-documented interfaces, and, most important, support from many vendors. 3Com showed its LAN Manager–based 3+Open software. With 3+Open (as with Microsoft's own LAN Manager), DOS and OS/2 workstations can share a LAN. That's important because a *lot* of DOS machines will never run OS/2.

Since the two operating systems share a common file system, DOS and OS/2 workstations will work together comfortably, and the upgrade from DOS applications to OS/2 applications can be leisurely. Of course, at some point you'll want to switch from, say, the DOS Lotus 1-2-3 to the larger (and, I hope, faster) OS/2 Lotus 1-2-3, but you won't have to switch right away.

3Com also showed a graphical network traffic monitor—a tool you use to gauge network activity. It's not in a league with mainframe network managers, but I expect that will be remedied.

Torus Systems showed a LAN Manager product, too. Torus makes a graphical front end for NetBIOS-oriented LANs; it's called Tapestry, and it has been in the DOS world for several years now. It offers the usual E-mail and file and print services, but with an icon-based user interface. Tapestry I supported small LANs, but Tapestry II can connect to remote sites using X.25 and, the company claims, can support hundreds of workstations.

Unfortunately, the Moulton, Minasi & Company Charles Babbage Memorial Computation Center is a mite short of hundreds of workstations, so I can't test the claim, but I'll keep my ear to the ground. Like most LAN Manager–derived products, it can talk to both DOS and OS/2 servers and workstations, though in its current configuration, Tapestry's graphical enhancements work only on DOS machines.

The startling thing about talking with LAN Manager vendors was their enthusiasm. Everyone that I talked to who had used the LAN Manager's application programming interface agreed that it greatly simplifies the construction of LAN applications. The Torus folks said the support that LAN Manager provides is "straightforward, allowing us to spend time adding value to our product." Another LAN Manager supporter, Information Builders, said the same thing with respect to the port of its multiuser database, Focus, from DOS to OS/2.

OS/Too Many Promises

COMDEX offered an easy way to spot OS/2 products: They had an "OS/2" sign hanging off the ceiling. Some were disappointing—either an 80286 or 80386 machine demonstrating that it *could* run OS/2, or a Windows application that looked "just like what the Presentation Manager version will look like in Q1,"

continued

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that is, by March 31, 1989.

I stumbled across an application that showed quite a bit of promise but didn't get much attention: Micrografx's Mirrors program. Micrografx is mainly in the graphics business, and it makes a number of excellent object-oriented drawing programs for Windows, like In a Vision, Windows Draw, and Designer. The company has now ported Designer over to the Presentation Manager and was demonstrating it in living color—not the Windows version, the PM version. It ships, again, sometime in this quarter, and I'm looking forward to its release.

Mirrors came from the process of converting Designer from Windows to PM. The Micrografx folks wrote a Windows-to-PM conversion utility to simplify the matter. Figuring that others could use the utility, they decided to offer it to the outside world as Mirrors. Any OS/2 developer should look at it. The example of Mirrors conversion I saw—Designer—looked pretty good, and Micrografx is to be commended for offering a product to make PM development easier.

What we really need, however, is a Windows/PM fourth-generation language—something that is a simplified Windows application generator. Too many people roll their eyes when I suggest that they port their applications to Windows/PM. "Do you know how difficult that is?" they respond.

As I've said before, Windows/PM programming is very different from what most programmers are used to. Not *bad* different, just *different* different. A language designed from scratch for Windows would be of help here, something simpler than the usual PM code—C programs consisting largely of strung-together Windows procedure calls. Some attempts have been made to produce such a language for Windows, but thus far I haven't seen anything compelling.

NewWave

You've heard the hype. "NewWave makes Windows useful." "A whole new way of using the computer." And so on.

It's all true.

I was skeptical when I strode up to the Hewlett-Packard booth. But I soon saw the light. Don't get me wrong—NewWave isn't ready yet. The demonstration crashed a lot, and it suffered from the fact that it's built atop an already resource-intensive platform, namely, Windows 286. But it made me *want* to work with Windows.

NewWave starts out with a Macintosh-like screen showing file folders. Each folder is an associated group of files—a subdirectory, perhaps, that contains spreadsheets, graphs, and text relating to a particular project. You can open a folder and click on any of the files. This is slightly different from Windows, which starts you out looking at the MS-DOS Executive, basically just a disorganized directory of your files. Of course, NewWave, like Windows, knows that when you click on, say, a .WK1 file, it should activate Lotus 1-2-3 and feed the WK1 file to it.

The real fun begins, however, when you use a NewWave application. When you take a graph created by NewWave's graphics program and paste it into a document created by NewWave's word processor, the word processor invokes the graphics program to handle the ugly printing details, so the word processor needn't include redundant code.

This goes beyond the usual Windows clipboard: When the numbers change in

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> (214) 234-1769
> **Inquiry 1024.**
>
> **Tapestry II** $2995
> Torus Systems, Inc.
> 240 "B" Twin Dolphin Dr.
> Redwood City, CA 94065
> (415) 594-9336
> **Inquiry 1025.**
>
> **3+Open 1.0** $295
> 3Com Corp.
> 3165 Kifer Rd.
> Santa Clara, CA 95052
> (408) 562-6400
> **Inquiry 1026.**

the graph, the graph changes in the text, as with the "hot link" that the ill-fated Lotus Jazz used on the Mac. Unfortunately, for NewWave to become truly useful, we'd have to hope that a lot of folks would write NewWave applications. I just complained about writing Windows applications—NewWave applications are just Windows applications with more code added.

NewWave links to voice mail and LANs. Hewlett-Packard intends to support X Windows and OS/2's PM with it.

Finally, NewWave answers what is, to me, one of the most important arguments against WIMP (windows/icons/mice/pointers) interfaces—lack of a batch capability. NewWave has something called the NewWave Agent, which is basically a macro or batch file capability. There's the usual batch language that looks like a DOS .BAT file. Agent can also record and play back things that you do interactively. All in all, it's very nice. Take this with a grain of salt, though—I had only 45 minutes to play with the product. I'll report more as I learn more.

Dark Hints and Drivers

Time for a few things before I go. Iomega—the company that brings you the Bernoulli Box—will be shipping OS/2 Bernoulli drivers soon. That's good news for me since the Bernoulli Box is my favorite backup device.

Advanced Micro Devices, the company that makes its living producing faster and faster 80286 chips, had a display room where it basically said "386SX: Just Say No." AMD is annoyed about the feeling in the industry that the 80286 is not the chip of choice. The company makes 80286 chips because it used to get Intel's chip designs through a technology transfer agreement. Intel decided not to share the plans for the 80386, however, so AMD is seeking legal recourse to *get* the 80386 plans and is pushing the 80286 as hard as it can.

AMD ably demonstrated that, head to head, a 16-MHz 80286 is faster than a 16-MHz 80386SX, assuming you're running only real-mode programs (DOS) or 80286 protected-mode programs (OS/2). The 80286, of course, lacks several crucial 80386 features, but AMD argues that these features are of interest only to power users. A good argument, which was articulately defended by its engineering staff—AMD sent well-informed people to its COMDEX booth.

I had a few quibbles, however. When I countered, "Couldn't *everyone* use the ability to do DOS multitasking" and pointed to the fragility of OS/2's compatibility box, the AMD people dropped dark hints about an external memory management unit for the 80286 in the offing.

"You mean something that could make the compatibility box more bulletproof?" I asked.

"You're on the right track," they replied. Who knows? Maybe we needn't sell our 80286 machines yet. Then again, if a judge tells Intel to hand over the 80386 plans tomorrow, we may never hear of this mystery chip.

Finally, while at COMDEX, I tried to listen to everyone who'd answer the question, "Is OS/2 going to be a success?" For most, this is unfortunately a religious question—no middle ground. The answer was either "Yes, of course, and you're a fool to even ask the question," or "No, of course not, and only a fool would even be interested." There seemed to be about a 50/50 split on whether OS/2 will make it or not. What do you think?

Next month, I'll continue building the inexpensive OS/2 workstation. ■

Mark Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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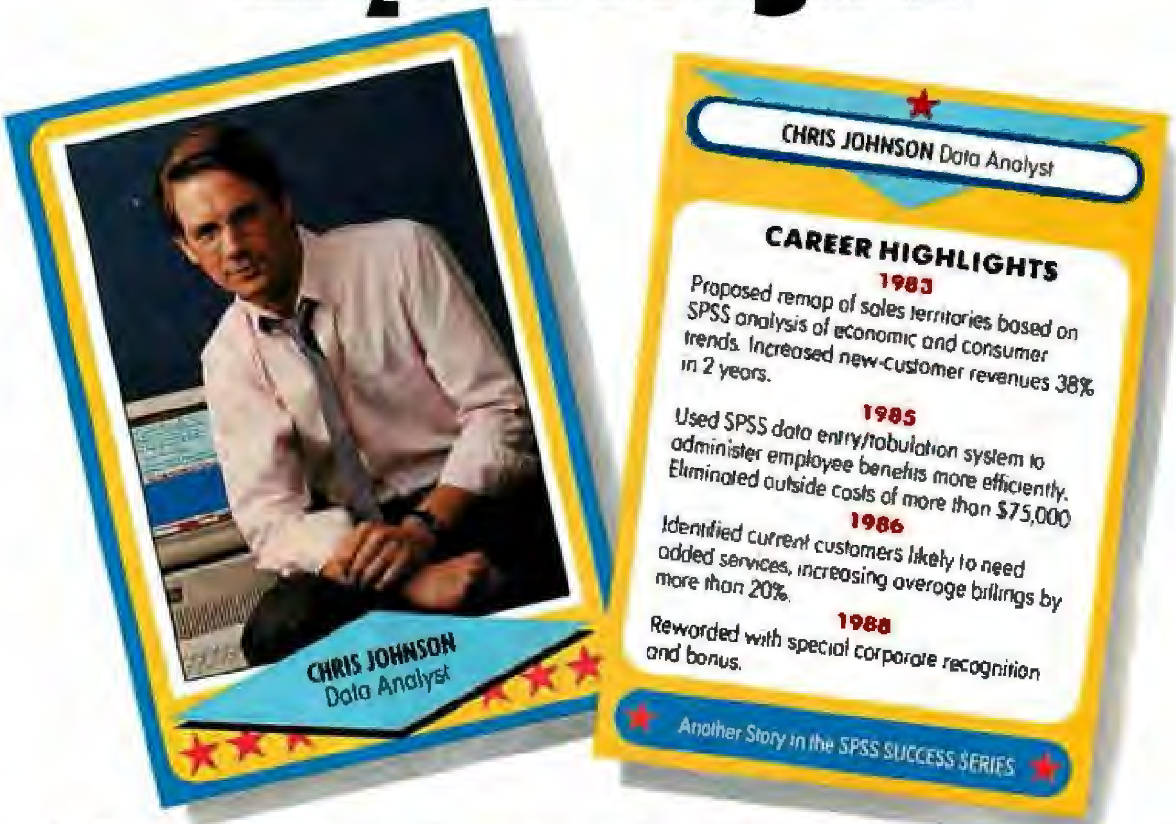

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THE PROTOCOL PACK

Putting XMODEM and its file transfer heirs through their paces

Protocol, as we saw last month, is an accepted way of doing things. For diplomats, protocol means ritual; for communications software, it's a mixed bag of connections, characters, and signals that can be understood at both ends of the connection. Once you've solved this communications equation, you've only just begun.

The proliferation of file transfer protocols provides you with an arsenal for attacking any file transfer situation and application. As we saw last month, the venerable XMODEM has evolved into a more robust protocol—larger block length, better error checking—and has spawned hybrid offspring, such as YMODEM (which offers batch file transfer, time- and date-stamped files, and 1K-byte blocks) and ZMODEM (which offers streaming protocol, a very efficient error-correction scheme).

However, with all these file transfer variants, many people have still never ventured beyond XMODEM for file transfers. The prevailing attitude seems to be, "If it ain't broke, don't fix it." That philosophy will get you by, but only if you're uploading or downloading an occasional file. For anyone transferring files on a regular basis, there are more efficient protocols than XMODEM.

I ran the file transfer protocols I discussed last month through their paces under a variety of common conditions. Before I get to the results, I want to introduce another protocol into the mix: Windowed XMODEM, or W/XMODEM.

Through the Windows

Windowed protocols, such as W/XMODEM, are an attempt to improve throughput by avoiding the start-stop approach implemented in the ACK/NAK send and receive scheme of XMODEM. Windowed protocols assume that the blocks, or "packets," are received without error, a kind of "expect the best" approach. Such protocols do not wait for the ACK before sending the next packet.

The receiving systems *do* send ACK signals; the sending systems just don't rely on receiving that ACK before sending the next packet. If an error occurs, the receiver sends a NAK to the transmitting computer; if the transmitting computer still has the failed packet in its memory, it resends it and proceeds. And there's the catch.

The failed packet must still be in the transmit buffer, and that buffer has a finite length. All windowing protocols set a maximum window size; W/XMODEM uses a four-packet window. This means that the transmitting computer can send a maximum of four packets without getting a reply from the host. If this weren't the case, error recovery wouldn't be possible.

Now let's take a look at the tests.

Basic Bits

The basic criterion for judging the efficiency of a protocol is to measure its throughput. Throughput, as defined here, is the amount of information being transferred from one system to another in the form of bits per second (bps).

Each character transferred consists of 8 bits. In addition, computer communications requires that the system send a start and stop bit, as well. The start bit lets the receiving computer know that the next 7 or 8 bits contain information. The stop bit tells the receiving computer that the whole character has been transmitted and to prepare for the next character. (These start/stops are also called *framing bits* because they frame the data bits.)

All this means that each character (8 bits) sent actually "costs" 10 bits. Thus,

continued

ILLUSTRATION: JAMES YANG © 1989

Table 1: *Results of tests using Procomm Plus and a 2400-bps modem to upload and download a 45K-byte file across the country over regular telephone lines. The straight ASCII transfer, included for comparison, was riddled with errors. The ZMODEM transfer was the winner, while XMODEM fared miserably.*

Protocol	Speed	Throughput	Efficiency (%)
ASCII (upload)	1200	880	73
ASCII (upload)	2400	1720	71
ASCII (download)	1200	1170	97
ASCII (download)	2400	2325	96
XMODEM (upload)	1200	647	54
XMODEM (upload)	2400	1534	64
XMODEM (download)	1200	663	55
XMODEM (download)	2400	1600	66
YMODEM (upload)	1200	1045	87
YMODEM (upload)	2400	2200	91.6
YMODEM (download)	1200	1090	91
YMODEM (download)	2400	2035	84
YMODEM-g (upload)	1200	Failed	N/A
YMODEM-g (upload)	2400	Failed	N/A
YMODEM-g (download)	1200	Failed	N/A
YMODEM-g (download)	2400	Failed	N/A
ZMODEM (upload)	1200	1120	93
ZMODEM (upload)	2400	2268	94.5
ZMODEM (download)	1200	1158	96
ZMODEM (download)	2400	2305	96
W/XMODEM (upload)	1200	940	78
W/XMODEM (upload)	2400	1700	70
W/XMODEM (download)	1200	690	57
W/XMODEM (download)	2400	2100	87.5

N/A = not applicable

under optimum conditions, a 2400-bps modem would send 240 characters per second (cps), since 2400/10 = 240. In reality, this rarely happens. Why? File transfer overhead, or artificial delays, are imposed on each data transfer by any of several factors. These delays are incurred in your file transfers by network flow controls (XON/XOFF), satellite relays, noisy telephone lines, and the sending and receiving of ACK/NAK signals.

To figure out the efficiency of a protocol, you divide the throughput by the rated speed of the modem. First, determine the number of characters per second transferred; you divide the file size by the total number of seconds needed to transfer it. To figure the throughput in bps, you multiply the cps by 10. To figure the efficiency, you divide the speed in bps by the rated speed of the modem. Here's an example of a 26,624-byte file (26K bytes) that took 126 seconds to send via a 2400-bps modem:

26,624/126 = 211.30 cps
211.30 × 10 = 2113 bps
2113/2400 = 88 percent efficiency

In the Field

Using Procomm Plus and a 2400-bps modem on an XT-class PC, I uploaded and downloaded a 45K-byte file from my home in San Francisco to a bulletin board in Washington, DC, over a regular telephone line. For comparison's sake, I also performed an ASCII (straight text, no protocol) upload and download. The results are shown in table 1.

At first glance, the straight ASCII file transfer looks pretty good, but statistics lie. The upload was done with flow control (XON/XOFF) enabled. The download had no such flow control; as fast as the text scrolled across the screen, I captured it to disk.

What these figures don't show is that, even with flow control, the text took several hits, and several large passages of the text were garbled and therefore unusable. The same thing happened with the download. I was receiving text very fast, but noise on the line introduced long strings of garbage characters. The resulting file increased in size because of the extra garbage characters, and the text was unusable. And, of course, straight ASCII text is useless for transferring executable files.

As expected, XMODEM transfers were terminally slow due to the turnaround time needed to send the ACK/NAK signals after every 128-bit block. Over voice-grade lines, the file transfer had to resend several failed blocks.

ZMODEM was the overall best performer. The streaming aspect of ZMODEM is responsible for this; the protocol doesn't depend on any ACK signals from the host computer. It simply keeps sending unless it receives a NAK, at which time it falls back to the failed block and starts to retransmit from that point.

YMODEM performed well because of the 1K-byte packet size that reduces the interaction of ACK/NAK signals between the computers.

YMODEM-g failed all the tests. With no error correction in the protocol and no use of error-correcting modems, failed blocks went undetected and uncorrected. The file transfers attempted just wouldn't work.

W/XMODEM performance was surprisingly poor, in part owing to its small window size (four packets); however, its efficiency was still better than that of XMODEM. The windowing aspect of W/XMODEM allows it to send four times the data of a regular XMODEM transfer before it has to check to see if any failed packets were sent. This decreases the turnaround sufficiently.

For XMODEM, regardless of file transfer rate, the protocol must receive an ACK/NAK for every packet sent, and when transferring packets in 128-bit blocks, that means a lot of time wasted on turnaround. These tests suggest that windowing improves efficiency somewhat, but not as much as going to YMODEM or ZMODEM with their larger block length.

I then performed the same tests, using the same setup, over Telenet's packet-switched network. (See table 2.)

Telenet introduces its own flow controls, and when combined with the host's flow control, uploads and downloads tended to suffer.

continued

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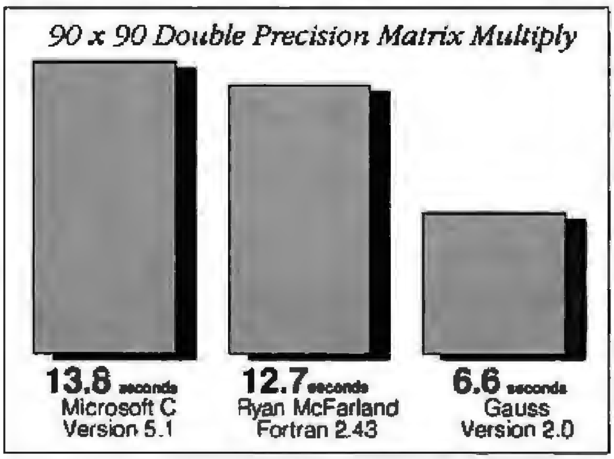

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Table 2: *Results of the same tests as in table 1, performed over Telenet's packet-switched network. Note that the efficiency of all the file transfer protocols was decreased. XMODEM suffered the worst, probably because of the combination of its short block length and Telenet's flow controls.*

Protocol	Speed (bps)	Throughput (bps)	Efficiency (%)
ASCII (upload)	1200	745	61
ASCII (upload)	2400	1688	71
ASCII (download)	1200	1096	91
ASCII (download)	2400	2160	90
XMODEM (upload)	1200	545	45
XMODEM (upload)	2400	1058	44
XMODEM (download)	1200	417	35
XMODEM (download)	2400	700	30
YMODEM (upload)	1200	956	79
YMODEM (upload)	2400	1995	83
YMODEM (download)	1200	1058	88
YMODEM (download)	2400	2024	84
YMODEM-g (upload)	1200	Failed	N/A
YMODEM-g (upload)	2400	Failed	N/A
YMODEM-g (download)	1200	Failed	N/A
YMODEM-g (download)	2400	Failed	N/A
ZMODEM (upload)	1200	1069	89
ZMODEM (upload)	2400	2200	92
ZMODEM (download)	1200	1089	90
ZMODEM (download)	2400	2289	95
W/XMODEM (upload)	1200	786	65
W/XMODEM (upload)	2400	1985	82
W/XMODEM (download)	1200	587	48
W/XMODEM (download)	2400	1865	77

N/A = not applicable

XMODEM performed miserably. The long turnaround time after each 128-bit block, combined with the delays of Telenet, wreaked havoc on download time.

ZMODEM again won out as the best performer. This is no surprise, since ZMODEM was specifically designed to operate over packet-switched networks. Telenet's network operates over satellite links, and there are inherent delays in the network. These delays slow up the ACK/NAK signals between computers. Because ZMODEM doesn't expect any ACK signals, it overcomes this pitfall.

YMODEM performance placed second; again, because of the 1K-byte packet size, the delays in turnaround are diminished.

YMODEM-g failed over Telenet, as it did over voice-grade lines. Use of error-correcting modems would help solve this problem, but to get full performance out of this protocol, you really need error-correcting modems *and* leased lines.

W/XMODEM had fewer errors over Telenet than voice grade lines. That's because the packet-switched network is designed to carry data and, therefore, is less susceptible to noise than ordinary phone lines. But W/XMODEM's efficiency over Telenet showed a decrease in all tests, except for the 2400-bps upload. Why the discrepancy? Perhaps there was less traffic on the network during the 2400-bps tests; my notes show that these tests were done around midnight, while the others were done during early evening. As traffic increases on a network like Telenet, the network must perform many more "housekeeping" functions. Housekeeping involves everything from addressing each packet to figuring out the packet's correct routing. At any one time, thousands of packets are traveling over Telenet, and when traffic increases it's possible to run into a kind of information gridlock. Conversely, when you're using the network during off-peak times (usually late at night), there's less traffic and, therefore, less housekeeping needed.

The Envelope, Please

ZMODEM is the overall winner, so why are people still using XMODEM? Habits are hard to break. Clearly, you can save time and money by switching to a different protocol. The trouble is, not all systems support ZMODEM.

If you find yourself facing extensive file transfers, and ZMODEM isn't available, try YMODEM. Most systems, including BIX, now support YMODEM. The popular TBBS bulletin board software program also supports YMODEM. The 1K-byte packet size of YMODEM makes this an efficient protocol, as the tests show. Using YMODEM is no great technical leap for the user, and XMODEM fans will have no trouble switching to this more efficient protocol.

On Your Own

Several factors come into play when running tests like these. I used real-world examples, so your mileage may vary. Tests under lab conditions would be much different, but nobody transfers files under laboratory conditions.

Your choice of a long-distance phone company plays into the equation, too. I've found US Sprint to be more reliable than MCI, perhaps due to its fiber-optic network. AT&T is still the best route for its consistently clean lines, but it's also more expensive than US Sprint. (Note than the rate difference in long distance carriers is much smaller than it was a few years ago. The difference between US Sprint and AT&T long distance charges is often only a few cents per minute.)

The bottom line is to run your own tests; there are several other protocols not covered here—I'll save those for another column. In the meantime, don't be afraid to experiment with new protocols. At worst, you'll waste some time but satisfy your curiosity. At best, you'll increase your on-line productivity and decrease those monthly telecommunications bills. For my money, that's a good reason to take a chance on change. ■

Brock N. Meeks is a San Francisco-based freelance writer who specializes in high technology. You can reach him on BIX as "brock."

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Upscale Monitors

Large-screen monitors add a new dimension of clarity to graphics applications

Steve Apiki
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Bigness has an aesthetic attraction all its own. From ancient monuments to cars of the fifties, people have always been fascinated by sheer size. But when you're selecting a monitor, bigness is more than a matter of aesthetics—it actually adds utility to the system.

Dedicated CAD workstations usually include large displays, but the benefits of a big monitor go beyond CAD. Enlarging the display size enhances virtually every graphical application, from desktop publishing to the myriad software products designed for windowing environments.

Extra screen size translates to an additional level of magnification. For CAD, more display space allows the designer to see fine detail and, at the same time, gauge the relationship of individual components to the overall drawing. Desktop publishing page displays attain true WYSIWYG only if the screen is large enough to accommodate an entire page layout.

It's also true that graphical user interfaces (e.g., Macintosh, Windows, Presentation Manager, and DESQview) are made more efficient with larger desktops. The trend toward graphical interfaces for general applications makes investing in a large-screen monitor an attractive proposal.

We looked at 10 monitors that are representative of the types of large-screen color displays available (see table 1). Pricing and features vary, but all the units have 19- or 20-inch screens. They vary in resolution from an EGA-compatible 640- by 480-pixel display to a 1280- by 1024-pixel display. While our primary focus was on the 10 color monitors, Rick Grehan also evaluated two popular monochrome models that are commonly used for desktop publishing (see the text box "The Monochrome Option" on page 170).

We divided our tests into two categories: low-level objective tests using industry-standard test equipment, and subjective evaluations. For the low-level tests, we used a Microvision analyzer to determine common performance measurements, such as spot size and misconvergence.

To test compatibility and to get a feel for how the monitors work in real-world situations, we ran subjective tests using graphics adapters appropriate for each monitor. Our pool of graphics boards included a Paradise EGA card, an IBM VGA controller, an NEC MultiSync board, and a Control Systems Artist 12 card. Test software was made up of AutoCAD Release 10 and a palette-shifting display program developed by the BYTE Lab. Photos of each monitor's display of text are provided on page 168.

Setting the Background

Color monitors operate by activating red, green, and blue phosphor dots arranged in combinations on the inside face of the CRT. Each dot can be turned on by any of three electron guns that generate the three primary colors. The two monitor components that contribute to performance are the electron beam drive circuitry and the glass bottle, with its phosphorescent dots, that makes up the CRT itself.

Fabricating a bottle with uniform phosphor distribution over an area as large as 19 inches is a difficult process that adds significantly to the high cost of large-screen displays. The bottle's contribution to the monitor's appearance, however, is limited to determining the fineness of the dot spacing and the curvature of the screen. The distance separating each dot in an RGB trio is called the monitor's dot pitch. While dot pitch represents an absolute resolution limit, obtainable resolution is more dependent on the driver circuitry than it is on the pitch of the monitor.

The monitor's internal circuitry converts input signals from the graphics controller into electron gun drive signals. The guns scan across the face of the CRT at a rate determined by the horizontal scan frequency. As the beams scan each line, the guns switch on and off to light individual pixel groups. The frequency with which the guns can be switched is determined by the video bandwidth specification. The scan continues line by line, top to bottom; a monitor's vertical frequency measures the time required to retrace all the lines that make up a screen.

Bandwidth and horizontal frequency together determine a monitor's resolution. The total number of dots that a monitor can display is determined by the bandwidth (number of dots per second) divided by the vertical frequency (1/seconds per screen). Since the vertical frequency must be at least 50 Hz to avoid flicker, high resolution depends on high bandwidth.

The greater the horizontal frequency, the more lines that can be retraced in a given vertical scan interval. Higher horizontal frequency therefore translates to greater vertical resolution. Higher vertical scan rates let displays react more quickly and are thus better suited for applications involving animation.

A technique known as interlacing lets the monitor trade reaction time for greater vertical resolution. Interlacing involves scanning only every other scan line with each vertical pass. An interlaced monitor has increased vertical resolution, but the two passes required for each screen refresh make reaction time longer, and some flicker may become noticeable.

Video standards like EGA and VGA include specifications for bandwidth and horizontal frequencies, so these ratings play an important part in determining a monitor's compatibility with a given standard (see table 2). Multiscan monitors—those with variable horizontal frequencies—automatically synchronize with adapter outputs that are within their range. Monitors that are capable of greater than 640- by 480-pixel resolution require nonstandard graphics cards to drive them beyond the realm of VGA. Nonstandard adapters will not run all graphics applications at high resolution; vendors must include drivers for each software product.

Monitor inputs can be TTL, analog, or both. Graphics adapters that can display many different colors (VGA and higher) or that have very high bandwidths are commonly analog; adapters with capabilities equal to or below EGA usually require TTL monitors.

User controls, once limited to contrast and brightness, now often include sophisticated adjustments for display position and alignment. Many monitors also feature a degaussing button to eliminate stray magnetic fields that can cause interference.

Behind the Screens

Our Microvision Superspot 100 system performs a variety of objective tests on CRTs, returning hard data on key specifications like spot size, misconvergence, time variance, blooming, and voltage regulation. Each parameter measures the accuracy and consistency of the monitor's display: Spot size determines screen resolution, while the other measurements reflect the severity of image errors introduced by the monitor.

continued

Table 1: *A roundup of large-screen color monitors shows a wide range of features and prices.*

	Price	Size	Display area (H x V)	Maximum resolution	Horizontal dot pitch	Bandwidth
Chugai Cadvision CPD-2040	$3495	19"	14.2" × 10.3"	1280 × 1024	0.31 mm	120 MHz
Colorgraphic Communications EG2040	$2200	19"	13" × 10"	640 × 480	0.31 mm	65 MHz
Electrohome ECM 1911	$2995	19"	15" × 11.5"	1230 × 960	0.31 mm	35 MHz
Hewlett-Packard D1187A	[1]	20"	14.2" × 10.8"	1280 × 1024	0.31 mm	100 MHz
Intecolor MegaTrend/2 E01923	$2395	20"	13.75" × 10.31"	640 × 480	0.31 mm	45 MHz
Microvitec Definition 1019/SP	$2395	19"	15.3" × 11.2"	800 × 600	0.31 mm	40 MHz
Mitsubishi HA3905K	$2720	20"	13.8" × 10.4"	1024 × 800	0.31 mm	50 MHz
Mitsubishi HL6905TK	$3650	20"	13.8" × 10.6"	1280 × 1024	0.31 mm	100 MHz
Nanao FlexScan Model 9500	$3999	20"	14.2" × 10.6"	1280 × 1024	0.31 mm	120 MHz
NEC MultiSync XL	$3195	19"	13.8" × 10.2"	1024 × 768	0.31 mm	65 MHz

[1] Evaluation unit is a production prototype; price not available at press time
N/A = Information not available from manufacturer

The Superspot 100 employs a linear photodiode array composed of 512 photosensitive scan elements. Housed within an optic module, the array derives a profile of an external light source by sampling the response from each photodiode element over a specified time interval. This grants us a glimpse of the monitor's true performance that goes beyond subjective evaluations and vendor-provided specifications. Unfortunately, we were unable to test the Chugai Cadvision monitor because our pattern generator was incompatible with the Cadvision's requirements.

Before setting up our tests, we had to take into consideration the intensity range of each monitor, so as not to penalize monitors with a wide range (see figure 1). Intensity, most often measured in footlamberts, or ft-L (a common unit of luminance), reflects the actual screen brightness. Although we have adjusted those tests that are affected directly by intensity range, you should still keep figure 1 in mind as you evaluate the results of these tests.

A wide intensity range offers greater control and flexibility. The Intecolor MegaTrend/2 sports an impressive intensity range from 10 ft-L to 30 ft-L; the Electrohome ECM 1911, on the other hand, ranges from approximately 6 ft-L

Scan frequency	Vertical scan frequency	Interlaced	Video input	Connectors	Dimensions (inches)	Weight (lbs.)
58-70 kHz	60 Hz	No	Analog	BNC	20 × 20 × 20	68.2
20.0-32.0 kHz	40-100 Hz	No	TTL	9-pin d-sub	17 × 18 × 19.5	66
15-36 kHz	45-86 Hz	Yes	Analog, TTL	9-pin d-sub	17.2 × 19 × 20.8	72.8
30-64 kHz	50-90 Hz	No	Analog	BNC	17.7 × 19.6 × 21.0	69.7
31.5 kHz	N/A	No	Analog	15-pin d-sub	18.6 × 18.9 × 20.5	62
15-36.5 kHz	45-100 Hz	No	Analog, TTL	9-pin d-sub	17.6 × 18.5 × 19.4	59
15.7-35.5 kHz	45-80 Hz	No	Analog, TTL	BNC, 15-pin d-sub	17.7 × 19.6 × 21.0	66
30-64 kHz	50-90 Hz	No	Analog	BNC	17.7 × 19.6 × 21.0	64
31.5 kHz, 48-50 kHz, 64-78 kHz	55-75 Hz	No	Analog	BNC	18.5 × 19.5 × 22.1	83.6
21.8-50 kHz	56-80 Hz	No	Analog, TTL	BNC, 9-pin d-sub	18.8 × 18.9 × 21.5	59.4

to 8 ft-L. For misconvergence, time variance, and voltage regulation tests, we set the monitors to a medium intensity level of 11 ft-L, except for the ECM 1911, which could reach an intensity of only 8 ft-L.

The Superspot 100 measures both horizontal and vertical widths of a scan line. By deriving the vector sum of these two measurements, you can determine

continued

Table 2: *A summary of video standards; compatible monitors must conform to these specifications.*

Graphics adapter	Maximum resolution	Video bandwidth	Horizontal scan rate	Vertical scan rate	Total colors
CGA	640 × 200	14.3 MHz	15.8 kHz	60 Hz	16
EGA	640 × 350	16.3 MHz	21.9 kHz	60 Hz	64
VGA	640 × 480	25.2 MHz	31.5 kHz	60 Hz	256k

the diameter of a single spot. This represents the beam's *spot size*. While the dot-pitch specification sets the resolution limit, the spot size gives a more practical measure of the monitor's fineness. We measured the spot size at center screen (see figure 2).

We also took readings at four different brightness levels, representing the full intensity range of each monitor. We did not adjust these results for brightness level because the absolute spot size is important for many applications. Therefore, you should use the graph in conjunction with figure 1. For example, the MegaTrend/2 and the NEC MultiSync XL have similar spot sizes at low intensity, but the MegaTrend/2 achieves this result at more than double the intensity. Each bar in the graph represents the cumulative result of spot sizes at all four brightness levels. For all the graphs (except figure 1), a smaller bar indicates better performance.

In a perfectly designed monitor, spot size will remain constant from the center of the screen (best case) to the corner of the screen (worst case). Figure 3 charts the change in spot size from center to corner. The Nanao FlexScan Model 9500 registered the smallest amount of change. The Mitsubishi monitors returned contrasting results: the Diamond Scan HL6905TK varied little, while the HA3905K fluctuated widely at each brightness level.

As intensity increases, the spot size tends to enlarge, adversely affecting the monitor's resolution. Figure 4 tracks the extent of this *blooming*. We adjusted the results so that the data reflects the actual bloom and not the monitor's intensity

Figure 1: *A map of the intensity range for each monitor. The Intecolor MegaTrend/2 sports an impressive range of 20 footlamberts.*

Figure 2: *Beam spot size at center screen. The stacked bars are cumulative results for four different brightness levels.*

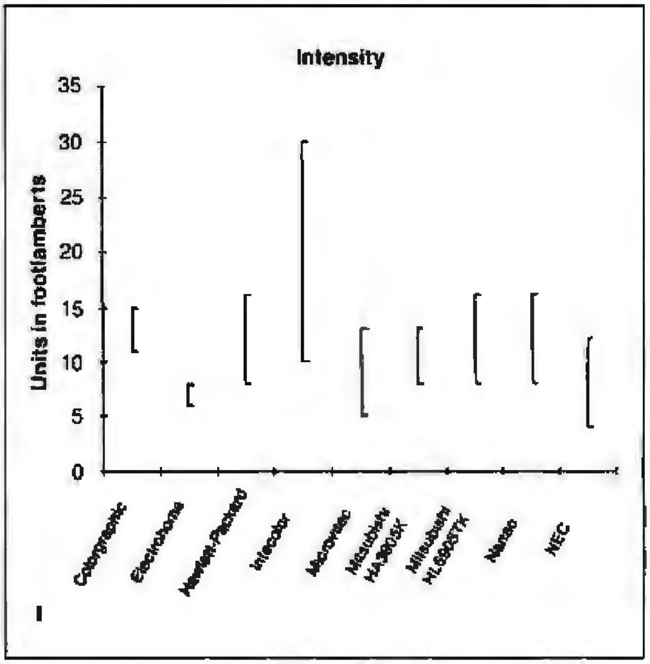
Figure 3: *This test tracked the change in spot size from center screen to the corner. Ideally, spot size should remain constant.*

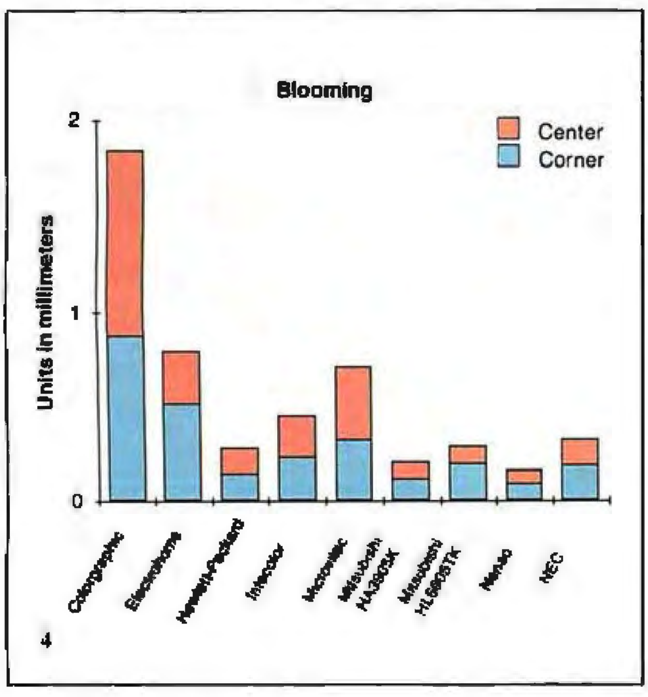
Figure 4: *A graphical illustration of how much a spot will enlarge, or "bloom," as intensity increases. Results were adjusted for intensity range.*

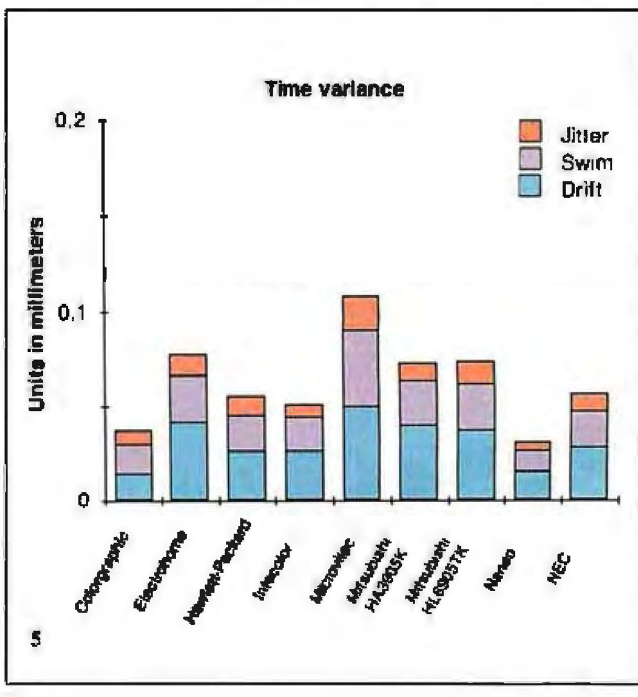
Figure 5: *Each bar in the stack represents time variances at different frequencies—high-frequency jitter, moderate-frequency swim, and low-frequency drift. Low values are desirable.*

Figure 6: *These results show how well the red, blue, and green electron beams are aligned. The lower the error, the better.*

Figure 7: *We examined change induced by energy variances (a reflection on the quality of voltage regulation) at the top and at the side of the screen. The stacked bars show cumulative results. Monitors with the shortest bars fared the best.*







range. The FlexScan and the Mitsubishi HA3905K bloomed little; the Colorgraphic Communications EG2040 suffered from excessive blooming.

The three types of time variations—high-frequency jitter, moderate-frequency swim, and low-frequency drift—can all be annoying and can contribute to eyestrain. The Superspot 100 measures time variance by sampling the shift of the beam position at three different frequency intervals (see figure 5). Measuring jitter involves sampling the beam's position every half second; similar samples are taken at 10-second intervals for swim and every 60 seconds for drift.

Four different tests registered time-dependent horizontal variance at center screen, horizontal variance at the corner, vertical variance at center screen, and vertical variance at the corner. Each bar in the stack represents an average of the four figures. Microvitec's Definition 1019/SP performed poorly on all three variance measurements, while, once again, the FlexScan scored well.

Misconvergence defines the alignment error of the red, blue, and green electron guns. Displays with high misconvergence can display color inaccurately. We tested both horizontal and vertical misconvergence (see figure 6). The tests track red-to-green, blue-to-green, and red-to-blue error; these three values are averaged to determine overall horizontal or vertical error. The best monitors will return results close to the zero line, reflecting low error and precise alignment.

Both Mitsubishi monitors displayed low error on the horizontal misconvergence tests, along with the Hewlett-Pack-

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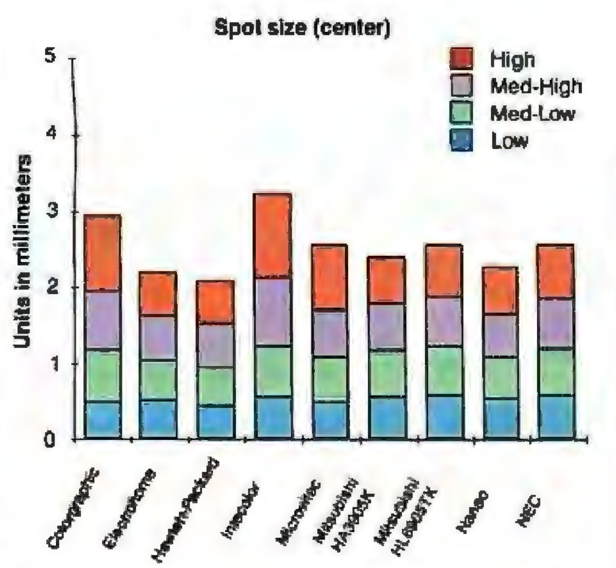

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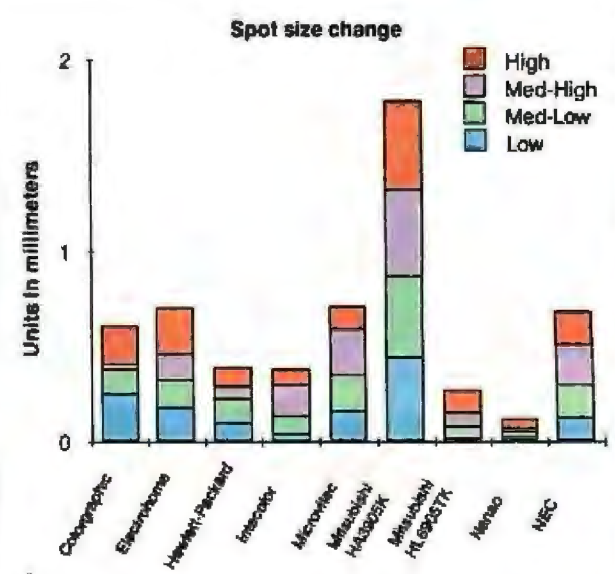

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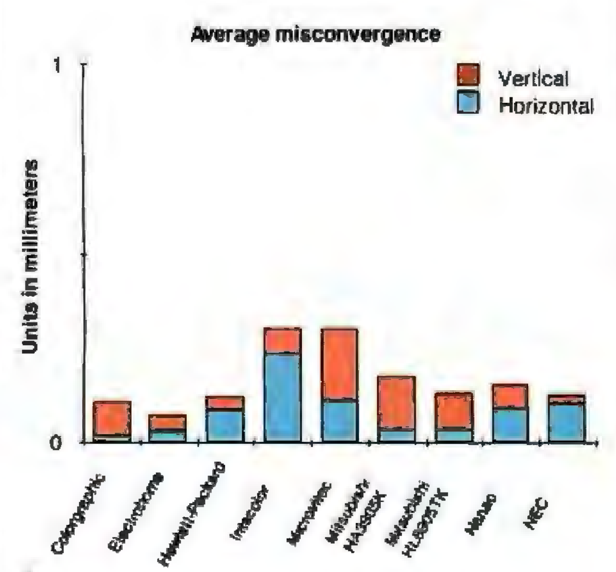

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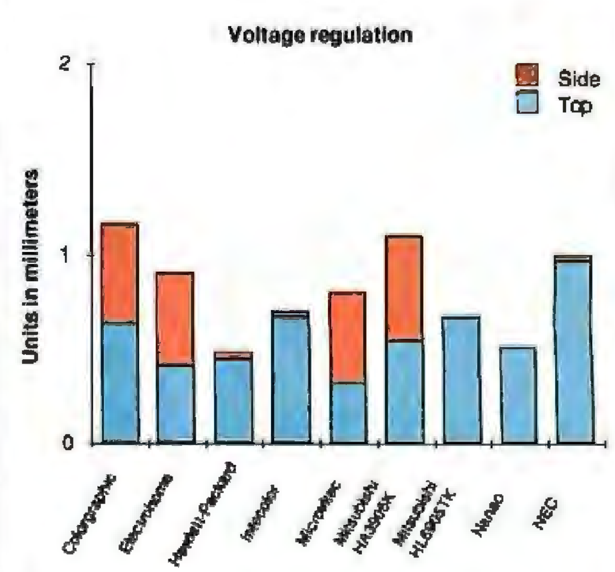

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Photo 1: *Sample text displays for each monitor. Varying levels of contrast, clarity, and resolution (in the relative density of each character) are evident. Monitors shown with other than standard IBM characters do not support standard graphics adapters.*

ard D1187A and the Electrohome ECM 1911. The latter two also scored well on the vertical misconvergence tests. Keep in mind, however, that we tested the ECM 1911 at a lower intensity level.

Another factor that can contribute to a lack of consistency is poor voltage regulation. A good monitor should keep the beam in the same position at both low energy levels (with most of the screen dark) and high energy levels (mostly bright). To measure the quality of a unit's voltage regulation (see figure 7), we marked the position of a horizontal line at the top of a black screen and measured the change in position of that line when all bits were turned on. We then tracked the movement of a vertical line at the side of the screen in the same way. The FlexScan and the D1187A displayed the best voltage regulation. The FlexScan and the HL6905TK had perfect voltage regulation at the side of the screen.

The Big Picture

The results of our subjective evaluations are described below. For each monitor, we tested compatibility with the graphics boards described earlier. We also evaluated overall display quality (see photo 1) and examined the color output using a VGA and EGA palette-display program, where applicable.

Chugai Cadvision CPD-2040: The Cadvision sits in a class by itself—it's the only large-screen monitor we reviewed that doesn't maintain compatibility with any PC graphics standard (see photo 2). This monitor, which is available for $3495, requires a high-resolution board like the Control Systems Artist 12, and so it could not be run through our EGA/VGA test equipment.

The display is best suited for CAD or other detailed work, and not for use as a primary monitor. Its most common use is as the second monitor in a two-monitor command/display system. The Cadvision does, however, show some flicker when it's placed close to another monitor; we tested it alongside a Compaq VGA display and found disturbances when the tubes were less than 2 feet apart.

Though we couldn't do objective testing, the Cadvision's display is clear and sharp. There were no problems with bright spots near the edges of the screen and no noticeable misconvergence. Setup is simple, with a front-panel power switch and four rear-panel BNC connectors for video input. The monitor rests easily on the standard tilt/swivel stand.

If you require 1280- by 1024-pixel resolution but don't need compatibility with standard cards, the Cadvision may be an option worth considering.

Colorgraphic Communications EG2040: At the low end in both resolution and price, the EG2040 offers large-screen EGA performance for a relatively modest $2200. While the maximum resolution, 640 by 480, is high enough for VGA, the monitor supports TTL inputs only.

The rear panel features two 9-pin d-sub connectors, one for TTL in and one for TTL out, so you can daisy chain similar monitors. There's a rear-panel degaussing button. The 2-foot-long cable supplied with the EG2040 is much too short, but it's a standard EGA cable, and replacements are easy to come by.

The display itself had a few problems when we tested it with the Paradise EGA card: noticeable overscan lines near the top and left side, and visible horizontal bars across the screen. Color contrast was quite good, lessening the washed-out look of most large-screen monitors.

Electrohome ECM 1911: Although most monitors with the kind of resolution specifications the ECM 1911 sports (1230 by 960) have horizontal scan rates in the 60-kHz range, this interlaced monitor has scan frequencies compatible with all IBM video standards (15 kHz to 36 kHz), and it worked flawlessly when connected to the IBM VGA controller.

The tinted CRT surface mutes reflections but contributes to lower contrast and decreased brightness. We noted white overscan lines near the edges of the screen, but a rear-panel overscan switch can increase the display size and push the lines out of view.

Our monitor came with no manual, which made determining the function of the unusual rear-panel switches difficult. There is an auto-position switch and four screw knobs for each vertical and horizontal size and position. Master positioning knobs override the position of the other screw knobs.

The $2995 ECM 1911 handles both TTL and analog inputs through separate rear-panel connectors.

Hewlett-Packard D1187A: We evaluated a production prototype D1187A, as

continued

Photo 2: *The Chugai Cadvision offered good resolution but was not multisyncing. It's best suited for CAD applications.*

The Monochrome Option

Rick Grehan

High-resolution monochrome monitors are currently the darlings of desktop publishers. These users need the elbowroom to work with full pages of text on-screen, but they can't always justify the cost of high-resolution color displays. Although these displays are also suitable for some CAD operations, it's often difficult to represent different elevations or an object's components using black and white only. Consequently, these displays are aimed primarily at people involved in the publishing industry.

Photo A: *The Cornerstone Technology DualPage was the better of the monochrome units.*

DualPage

The Cornerstone Technology DualPage derives its name from its ability to display two full pages of text on a vast 19-inch diagonal screen (see photo A). Although it's a monochrome display system, you can purchase the DualPage's controller board outfitted with additional memory in increments to provide two, four, or 16 levels of gray. Its ability to display gray scales is combined with a maximum resolution of 1600 by 1280 pixels.

You can install the DualPage's custom controller board in either an IBM PC XT or AT (or compatible) as either the primary or secondary display. The DualPage will be content to coexist with a Monochrome Display Adapter (MDA) or Hercules adapter already in your machine (a table in the manual shows jumper and switch settings, as well as the addresses to the DualPage's display memory maps).

On boot-up, the DualPage appears to the system as a Hercules color graphics adapter. DualPage comes with a packet of disks that include programs that let you switch between 40-row and 80-row DOS display formats. Both modes provide 96 columns, resulting in a "flattened" look in the 80-row mode. The remainder of the programs on the disks are drivers for applications like Ventura Publisher, AutoCAD, Lotus 1-2-3, and others.

While installing the drivers for Lotus 1-2-3, I uncovered the only real problems I had with the DualPage, and most of these had to do with the manual. First, when I tried to adjust the brightness, I found only a single knobless plastic stem in the back of the monitor. I consulted the manual's index, which referred me to page 3-9. There was no page 3-9. When I determined that the adjustment on the back was indeed for brightness, I discovered that the DualPage is so big (it measures 15½ inches high by 18 inches wide by 16½ inches deep) that I couldn't adjust the brightness *and* watch the screen.

Then I found—by trial and error—that the manual had left out a critical step in installing the Lotus 1-2-3 graphics drivers. This was easy to fix, and the results were worth it: a whopping 75 rows by 96 columns of spreadsheet.

I tested the DualPage using BYTE's low-level graphics benchmarks. The display was running in Hercules-emulation mode, and it turned in a performance of about 5.2 seconds on the text benchmark and 1.6 seconds on the graphics benchmark.

The DualPage includes a monitor, an adapter, and driver software. It also includes a one-year limited warranty. The adapter will run in the IBM XT, AT, PS/2 Model 30, and compatibles. The unit is available in three configurations: black and white ($2395), with four levels of gray ($2550), and with 16 levels of gray ($2995).

Elite Designview 19

Elite's Designview is a hefty 19-inch monitor that touts itself as a WYSIWYG display with 1280 by 1024 resolution, 96 dots per inch, and a 1-to-1 aspect ratio. This makes it particularly well-suited to desktop publishing—circles on-screen will show up as circles on your newsletter.

The Designview comes with its own controller board and—on boot-up—emulates either an MDA or a CGA monitor. Unlike the DualPage system, whose controller is built on custom hardware from the ground up, the Designview's controller is based on the Intel 82786 graphics coprocessor (see "Inside the 82786 Graphics Chip" by Bill Nicholls, August 1987 BYTE). On-board, the Designview adapter carries its own 512K bytes of video memory.

The Designview's 38-page manual leads you through the procedure of installing drivers for your favorite application. On the supplied disks, you'll find drivers for AutoCAD, PageMaker, Gem, Lotus 1-2-3, and many other applications. As an added bonus, the Designview's engineers sneaked a Microsoft InPort device connector onto the controller board. This means you can attach a mouse to the controller. In an era when the mouse is becoming indigenous to the computer desk, it's nice to see someone tying it so closely to the display system.

The Designview turned in poor figures on the low-level text benchmarks, but it produced more acceptable times on the graphics benchmarks. Specifically, for the 40-column text benchmark, the Designview averaged 40.4 seconds; for the 80-column text, it turned in an average time of 48.1 seconds; and for the graphics benchmark (modes 4, 5, and 6) the Designview's times averaged out to 1.7 seconds.

I don't find the poor text benchmark times bothersome, however. I can't imagine anyone purchasing a large display, only to run it under DOS in CGA text-emulation modes. This display is in its element when working with large-area graphics applications, and the graphics benchmarks look quite reasonable. Still, if you do decide to use your own word processor with the Designview, you'd have to be a mole not to be able to read the display's large, 16- by 32-pixel text.

The cursor-positioning portion of the text benchmarks showed up a quirk in the Designview's controller. While the cursor was being positioned rapid-fire all over the screen, the display tended to jump and flicker. I contacted the engineers at Elite, who attributed the problem to an interaction between the technique used to refresh the screen and the controller's 8-bit bus width. Elite's engineers stated that the screen flicker occured in only a limited number of applications (indeed, I observed the flicker only during the text benchmark) and that when the 16-bit bus version of the board was released, the effect would disappear.

At $1695, the Designview includes all hardware and software: monitor, board, cabling, and disks with drivers—plus a three-year parts and labor warranty. The board is compatible with the IBM XT, AT, and clones. (The documentation mentions no specific DOS dependency—this probably depends more on the application programs than on their drivers.) At press time, Elite said that a 16-bit version of the board should be available for the same price by the time this article reaches print. Elite plans to offer an upgrade to owners of 8-bit boards: For $150, you can send the company your 8-bit board, and Elite will swap it for a 16-bit board.

Rick Grehan is director of the BYTE Lab. He can be reached on BIX as "rick_g."

Hewlett-Packard was still preparing an initial production run when this article went to press. The company assured us that the model we reviewed would be identical to the production model, which is scheduled for release early this spring. Price had not yet been determined for the unit.

At first glance, the D1187A seems to be akin to Mitsubishi's large-screen HL6905TK, with the same cabinet design and similar specifications. Like the HL6905TK, this monitor has a wide range of horizontal frequencies that made it compatible with all the analog graphics cards we tried. Input connections are via five BNC connectors, for red, green, blue, and separate or composite syncs.

Position and size adjustments are made through controls located behind a panel cover on the right side of the monitor. There are two multiple-selection switches: one for channel selection and one for parameter selection. Each channel represents a different input frequency. Screen parameters like horizontal and vertical position can be adjusted and saved for each channel, so switching between graphics adapters requires only one initial adjustment.

There are 10 channels. You can set seven of these for any valid input frequency; two are reserved and preset with appropriate VGA and Macintosh II settings. Channel 0, the "auto" channel, accepts up to 11 settings separated by at least 3 kHz; it automatically locks itself to the input frequency and uses the correct presets. Channel 0 comes with three common frequencies preset from the factory.

The picture display itself is bright, and the screen shows virtually no reflections. The monitor exhibited no noticeable jitter when we ran it close to the Compaq 13-inch tube.

Intecolor MegaTrend/2 E01923: The Megatrend/2, like the Cadvision, is a single-input-frequency monitor. Its 31.5-kHz horizontal scan rate and 640 by 480 resolution make it best-suited for VGA and Mac II operation. It sells for $2395.

The monitor has an excellent ergonomic design, with a small-footprint tilt-and-swivel stand coupled with front-panel power and degaussing switches. The antiglare screen reduces reflections to some extent.

We ran the MegaTrend/2 from an IBM PS/2 VGA board. As with many of the units we tested, it showed some overscan brightness near the perimeter of the screen. It also displayed some irregularity in color: There were two faint red vertical lines on one side of the screen that remained even after degaussing.

Microvitec Definition 1019/SP: Microvitec's large-screen monitor features compatibility with all IBM graphics standards and sells for $2395. Resolution goes to 800 by 600 pixels; the display is noninterlaced.

The unit has separate 9-pin d-sub connectors for TTL and analog inputs, located at the back of the monitor. There is also a switch for manually selecting the number of colors in TTL mode, or for setting the monitor to automatically follow the colors generated by the graphics controller. Unfortunately, the power switch is also on the rear panel—hard to reach behind the 19.4-inch-deep unit. Front-panel switches enable input selection (TTL/analog), position and size adjustment, and the usual brightness and contrast control.

We tested the display with IBM's VGA controller. While the 1019/SP delivered excellent color quality, crisp contrast, and good brightness levels, it also had a few problems. The most important of these was the tendency for the image to bow at each side, making for curved lines and noticeable misconvergence in the corners. There were also some overscan lines on the screen, as was the case with many of the monitors.

Mitsubishi HA3905K: The HA3905K provides compatibility with all the IBM graphics standards and offers 1024 by 800 resolution. The $2720 unit scans from CGA frequencies to just beyond VGA, and it also supports the Mac II and Apple IIGS boards. It proved compatible with the IBM VGA board.

The rear of the monitor has five BNC connectors and a 15-pin d-sub connector socket. You can choose TTL or analog inputs. While in TTL mode, you can set text-only mode with white, green, or amber text, or graphics mode with 8, 16, or 64 colors. The selection switches are poorly labeled and arranged in a diagram that's not related to their function.

But the difficult configuration is only one of the unit's problems. The screen shows uneven brightness patterns, resulting in a splotchy look at low light levels, and some overscan lines are noticeable.

Mitsubishi Diamond Scan HL6905TK: Virtually identical to the Hewlett-Packard D1187A in external design, the HL6905TK features 1280 by 1024 resolution and 30- to 64-kHz scanning for $3650.

The HL6905TK monitor has the same channel setup as the D1187A. You can set viewing parameters for seven channels, and the monitor also has preset

continued

channels for Mac II and VGA operation. Its broad scan-frequency range made it compatible with all the analog graphics controllers we used in our tests.

The HL6905TK has a clear screen that provides excellent brightness but generated sharp reflections and was hard to use in bright light. Unlike the D1187A, it has an additional switch for selecting internal (sync on green) or external sync signals.

While the display showed excellent contrast and was generally a good performer, we noticed some nonuniform horizontal lines that round toward the edges of the display. The disturbance was visible only at low light levels, however.

Nanao FlexScan Model 9500: The FlexScan's wide-ranging input frequencies and top-of-the-line 1280 by 1024 resolution make it suitable for almost any PC application. Handy front-panel controls and a tilt-and-swivel base contribute to a simple setup and make adjustments easy (see photo 3). But premium performance carries a premium price—the FlexScan sells for $3999.

Choosing the right monitor depends heavily on your application.

Input frequencies range from 31.5 kHz to 78 kHz, with a few gaps between the three multiscanning channels. There are no channel presets, as with the HL6905TK and the D1187A, but front-panel knobs for position and size provide quick picture adjustments. The front panel also includes degaussing and power switches. For fine-tuning, there are signal attenuation and convergence adjustment knobs on the back. Input is through five BNC connectors; there are also corresponding output BNC jacks for the red, green, and blue analog signals.

Photo 3: *The Nanao FlexScan gave the best overall performance in the color monitor category.*

The antireflection CRT produced almost no glare, even in bright light. Contrast was excellent—almost as good as the 13-inch Compaq monitor we used for comparison. While the monitor worked fine with all our analog controllers, it showed one compatibility problem when using AutoCAD and the Artist 12 board: The display had a high background green level, giving the picture a strong green tint. Disconnecting the external sync input fixed the problem. The problem didn't show up with any other combination of application and adapter that we tried.

NEC MultiSync XL: As the extra-large version of the original multiscanning monitor, NEC's $3195 MultiSync XL comes from a line with an outstanding reputation. This unit deserves the praise: It's easy to configure and easy to use. Also, it provides excellent color contrast.

There are two types of input connector, BNC and d-sub. The 9-pin d-sub socket limits the bandwidth to 65 MHz, but it can be used for TTL or analog inputs. When in TTL mode, you can select monochrome text or color graphics and set the colors, much as you can on the HL6905TK. Positioning switches are hidden behind a panel on the front of the monitor, and a degaussing button is positioned underneath the unit. The package includes a tilt/swivel base.

Colors are on par with the 13-inch Compaq VGA. Contrast is also better than average: It gives the MultiSync XL less of a washed-out image than most of the other large-screen devices. The monitor works with EGA, VGA, and NEC MultiSync adapters. The one problem we had came when we used the MultiSync XL close to the Compaq monitor—the MultiSync XL's screen showed unacceptable flicker when the displays were less than 2 feet apart.

The Best of the Biggest

Choosing the right large-screen monitor depends heavily on your application. For pure desktop publishing work, the monochrome monitors deliver impressive resolution and full-page displays for less money. For dedicated CAD work, the Chugai Cadvision CPD-2040 offers some impressive specifications. The NEC MultiSync XL still sets the standard for flexibility and ease of use. Three of these monitors, though, stand out on both our subjective and objective tests: the Hewlett-Packard D1187A, the Mitsubishi Diamond Scan HL6905TK, and the Nanao FlexScan Model 9500.

The HL6905TK offers 1280 by 1024

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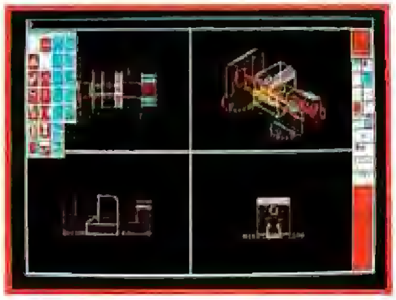

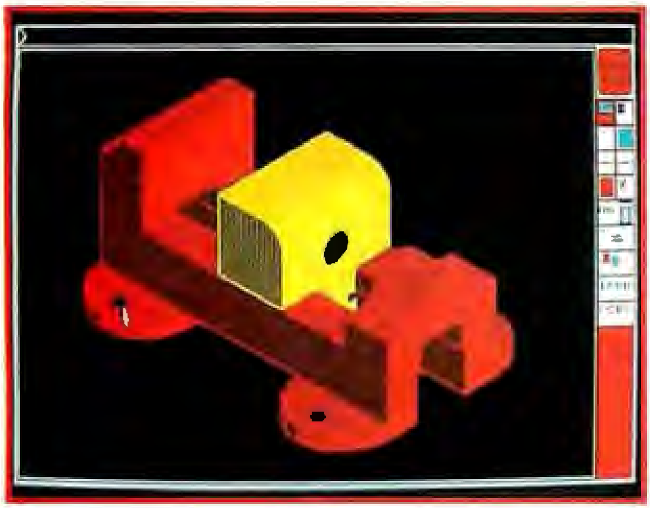

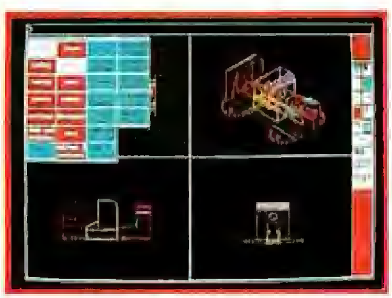

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23510 Telo St., Suite 5
Torrance, CA 90505
(213) 325-5202
Inquiry 1036.

NEC Home Electronics (U.S.A.), Inc.
Personal Computer
Products Division
1255 Michael Dr.
Wood Dale, IL 60191
(312) 860-9500
Inquiry 1037.

resolution, low blooming, consistent spot size from center to corner, and adequate voltage regulation. A broad scan range provides excellent compatibility. Only excessive variance and a hefty price tag hold it back.

The D1187A hangs near the top of the pack on almost every test we performed. It boasts the lowest spot size at center screen, and only the FlexScan posts a better corner spot size. Furthermore, its impressive spot size is not degraded at high intensity or when moving from center to corner. Variance measurements are within acceptable limits, and it scores well on both convergence tests. Round this off with 1280 by 1024 resolution and the best voltage regulation of the group, and you have a monitor that's hard to beat. Depending on how Hewlett-Packard prices this model, it may deserve a close look.

At $3999, the FlexScan was the most expensive monitor we tested. Not surprisingly, it was also among the best, attaining top-of-the-line status for every specification and every test. It boasts 1280 by 1024 resolution, extremely versatile scanning frequencies, fine spot size, the lowest blooming of the bunch, the least amount of change from center to corner, the best marks on all three variance tests, consistently low misconvergence error, and excellent voltage regulation. If you want the best, pay the price; because without a doubt, this is it. ■

Steve Apiki and Stanford Diehl are BYTE Lab testing editors. They can be reached on BIX as "apiki" and "sdiehl."

WE PUT THIS AD SIDEWAYS TO MAKE A POINT

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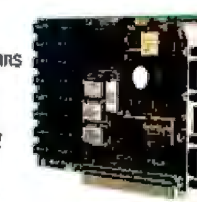

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Circle 207 on Reader Service Card

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The FLEXSCAN 9070 provides a 16-inch screen, large enough for CAD/CAE and 3-D projections, yet small enough to fit comfortably into your home work space.

1024 dots × 768 lines Graphics (Non-interlace)
AutoCAD

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Laptop Dilemma

The Compaq SLT/286 (left) and the Ogivar 286.

Choosing between the Compaq SLT/286 and the Ogivar 286 means defining your needs

Jeff Holtzman

Laptop computers appear to be diverging into two groups. The first group, typified by the Compaq SLT/286, offers battery power for computing wherever you are. The second group, including the Ogivar 286, is constrained by the need for AC power but usually offers an improved display using a plasma or electroluminescent screen.

Compaq's new SLT/286 combines a VGA-compatible backlit supertwist LCD screen, a 12-MHz 80C286, a decent keyboard, a fast hard disk drive, expandability, ease of servicing, and intelligent energy management. It's all packed into a diminutive case that occupies about as much space as two IBM *Technical Reference* manuals and weighs about as much as three bricks. Its only flaw is its cost, which approaches the five-digit mark for a fully expanded configuration.

Ogivar's 286 is a more traditional entry. From a distance, the machine bears a strong resemblance to Toshiba's T3100 and T5100 series. It's an AC-power-only machine with an EGA-compatible plasma display, a 12.5-MHz 80286, and an unusual keyboard that supports a French character set.

The Basics

The SLT/286 comes in two configurations: the Model 20 ($5399) and the Model 40 ($5999). The two machines are identical except for the hard disk drives—20-megabyte and 40-megabyte, respectively. Both drives have average access times under 30 milliseconds and 1-to-1 interleaving. You can upgrade a Model 20 to the larger drive, but it'll cost you $1399, more than twice the difference in price between the Models 20 and 40.

Both Compaq models include as standard equipment a 1.44-megabyte floppy disk drive; 640K bytes of memory; a serial port; a parallel port; ports for an external VGA monitor, external floppy disk drive or tape backup unit, external keyboard, and external numeric keypad; and a special port that allows the SLT/286 to dock with a desktop expansion chassis. The machine runs at either 8 or 12 MHz, keyboard-selectable.

Compaq says that the expansion chassis provides two standard 16-bit slots, as well as connectors for a standard VGA monitor, an Enhanced keyboard, and a printer. Unfortunately, the expansion chassis was not available for this review.

Compaq also offers several internal expansion options: a second serial port or a 2400-bps Hayes-compatible modem; up to 3 megabytes of memory, which can be configured as either extended or expanded (EMS 3.2) memory; and a math coprocessor, either an 8-MHz 80287 or a 12-MHz 80C287. Compaq has adapted its version of OS/2 1.0 Standard Edition for the SLT/286.

The 1-megabyte memory boards measure about 3½ by 1¼ inches and are populated on both sides with surface-mount chips. The boards plug into a small edge connector that provides the sole mechan-

continued

Compaq SLT/286

Company
Compaq Computer Corp.
20555 FM 149
P.O. Box 692000
Houston, TX 77269
(713) 370-0670

Components
Processor: 12-MHz 80C286; socket for 12-MHz 80C287 or 8-MHz 80287
Memory: 640K bytes, expandable to 3.6 megabytes
Mass storage: 1.44-megabyte floppy disk drive; 20-megabyte (Model 20) or 40-megabyte (Model 40) hard disk drive
Display: 10-inch diagonal VGA-compatible backlit supertwist LCD
Keyboard: 82 keys
I/O interfaces: DB-9 RS-232C port; DB-25 parallel port; VGA port; DB-37 external disk or tape port, expansion chassis port; external keypad connector

Size
4⅛ × 8½ × 13½ inches; 14 pounds

Software
Includes setup, disk cache, and expanded memory driver

Documentation
Getting Started; System Overview; Keyboard User's Reference; User Programs Reference; 12-MHz 80C287 Coprocessor Installation Guide; External Storage Module User's Guide; Asynchronous Communications Board Installation Guide; Mass Storage Device Installation Guide; Quick Reference Guide

Price
Model 20: $5399
Model 40: $5999
System as reviewed: $8316

Inquiry 852.

Ogivar 286

Company
Ogivar Technologies, Inc.
7200 Route Transcanadienne
Ville Saint-Laurent
Quebec, Canada H4T 1A3
(514) 737-3340

Components
Processor: 12.5-MHz 80286; socket for 80287 coprocessor
Memory: 640K bytes, expandable to 4.6 megabytes
Mass storage: 720K-byte 3½-inch floppy disk drive; 40-megabyte hard disk drive
Display: 10-inch diagonal EGA-compatible plasma
Keyboard: 84 keys
I/O interfaces: DB-9 RS-232C port; DB-25 parallel port; EGA port; external disk port; one expansion slot

Size
4 × 14 × 13 inches; 14 pounds

Software
MS-DOS 3.3; Fastwire II

Documentation
User's Guide, MS-DOS User's Guide

Price
System as reviewed: $4995

Inquiry 853.

ical support. With the cover in place, it's impossible for a module to pop out of a slot.

My review machine (valued at slightly more than $8000) was a Model 40 with the internal modem, 2 megabytes of expansion memory, and no math coprocessor. Compaq also supplied a copy of MS-DOS 3.31.

During the course of testing, the original machine developed problems with the display memory, so Compaq sent a replacement Model 20. I disassembled both machines, swapped hard disk drives, and transferred the modem and memory boards over to the new machine. In that way I found out that servicing the SLT/286 is a snap.

The standard configuration of the Ogivar 286 ($4995) includes a 40-megabyte hard disk drive, a 720K-byte 3½-inch floppy disk drive, 640K bytes of RAM, MS-DOS 3.3, and a copy of Fastwire II, a file transfer utility. Options include an expansion chassis, an external floppy disk drive, modems, a battery pack/auto power adapter, and expansion memory. The motherboard can hold as much as 2.6 megabytes of memory; an expansion slot can hold an additional 2 megabytes.

Compaq Features

The SLT/286 is innovative. It has a modified clamshell design, and the display screen tilts up from the rear to reveal the detachable keyboard. You can use the machine without removing the keyboard, but its height above the desk makes this uncomfortable. The rechargeable battery, which weighs about 2 pounds, is located beneath the keyboard; two latches allow you to change batteries quickly.

The floppy disk drive is on the left, the carrying handle is in the middle, and a second drive bay is on the right. The power switch and power input jack are located on the left side of the machine; the modem (or second serial) port is located on the right. All six external ports are located on the rear; unlike some laptops, the SLT/286 has a flip-down cover that protects the ports from the elements.

Unlike many laptops, the SLT's carrying handle is positioned so that the machine does not hang awkwardly to one side when you're carrying it. Beneath the handle is a standby-power push button and several LEDs: a power indicator, separate hard disk and floppy disk drive activity indicators, and a low-power indicator. The floppy drive indicator turns orange when a 720K-byte disk is being accessed, and green for a 1.44-megabyte disk. The power and low-battery indicators flash at various rates and in various combinations when the SLT/286 is in standby mode or when the battery starts to run down.

The SLT/286 weighs 14 pounds; the rechargeable battery accounts for 2 pounds. The external AC adapter adds another 2 pounds. In contrast, a Tandy Model 100 with power pack and spare batteries weighs less than 3 pounds. Using the SLT/286 on your lap or carrying it for long distances will try you physically.

Ogivar Features

On the outside, the Ogivar 286 bears a strong resemblance to Toshiba's AC-powered machines. The case features a clamshell design in black plastic. The floppy disk drive is mounted on the right side, the hard disk drive is mounted on the left within the case, and a small fan located at the rear cools the internal components.

The machine comes standard with 640K bytes of memory, serial and parallel ports, and a port for an external disk drive. In addition, the machine has one proprietary expansion slot; currently, Ogivar sells a 2400-bps modem, 1-megabyte and 2-megabyte memory cards, and an interface to an external expansion chassis. The expansion chassis can accept one standard 16-bit expansion card. Ogivar also sells an external battery pack

continued

Compaq SLT/286, Ogivar 286

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	Compaq	Ogivar
XyWrite III + 3.52	**Med./Large**	**Med./Large**
Load (large)	:15	:13
Word count	:05/:36	:05/:34
Search/replace	:08/:31	:08/:31
End of document	:03/:19	:02/:19
Block move	:12/:12	:12/:12
Spelling check	:15/1:55	:15/1:49
Microsoft Word 4.0		
Forward delete	:23	:23
Aldus PageMaker 1.0a		
Load document	:10	:20
Change/bold	:40	:41
Align right	:29	:31
Cut 10 pages	:25	:26
Place graphic	:07	:07
Print to file	2:42	2:48
Index:	**1.77**	**1.75**

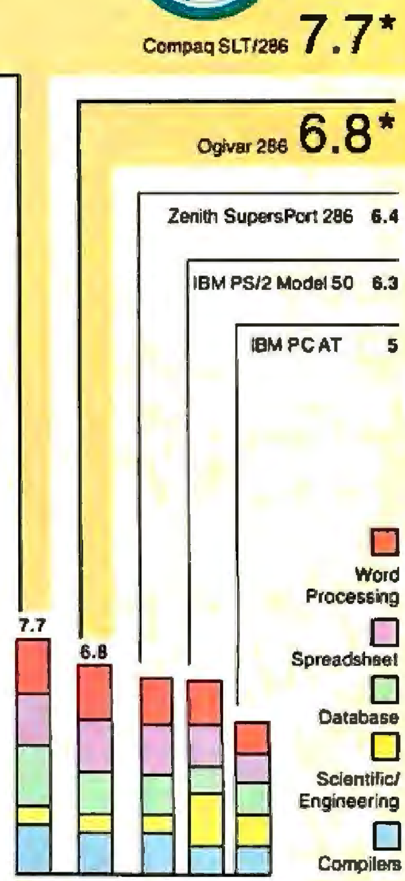
SPREADSHEET	Compaq	Ogivar
Lotus 1-2-3 2.01		
Block copy	:06	:05
Recalc	:03	:02
Load Monte Carlo	:23	:24
Recalc Monte Carlo	:12	:11
Load rlarge3	:06	:06
Recalc rlarge3	:02	:02
Recalc Goal-seek	:06	:05
Microsoft Excel 2.0		
Fill right	:09	:09
Undo fill	3:27	3:14
Recalc	:01	:03
Load rlarge3	:38	:38
Recalc rlarge3	:02	:02
Index:	**1.67**	**1.63**

DATABASE	Compaq	Ogivar
dBASE III+ 1.1		
Copy	1:09	:55
Index	:08	:21
List	1:07	1:53
Append	2:16	1:57
Delete	:02	:03
Pack	1:47	1:38
Count	:05	:18
Sort	1:04	1:24
Index:	**1.95**	**1.34**

SCIENTIFIC/ENGINEERING	Compaq	Ogivar
AutoCAD 2.52		
Load SoftWest	3:41	3:40
Regen SoftWest	3:26	3:25
Load StPauls	1:03	1:01
Regen StPauls	:58	:54
Hide/redraw	49:19	46:07
STATA 1.5		
Graphics	1:38	1:57
ANOVA	:59	:57
MathCAD 2.0		
IFS 800 pts	2:02	1:54
FFT/IFFT 1024 pts.	2:26	2:16
Index:	**0.61**	**0.62**

COMPILERS	Compaq	Ogivar
Microsoft C 5.0		
XLisp compile	6:08	7:03
Turbo Pascal 4.0		
Pascal S compile	:06	:07
Index:	**1.69**	**1.45**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT=1.



*Cumulative application index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

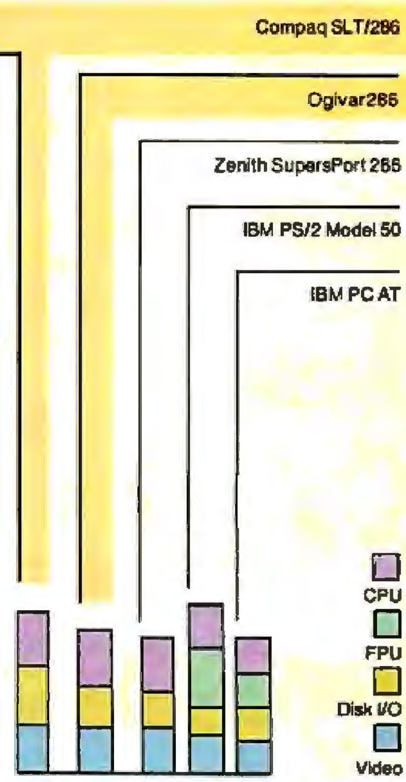
CPU	Compaq	Ogivar
Matrix	7.74	7.27
String Move		
Byte-wide	53.88	50.22
Word-wide:		
Odd-bnd.	53.88	50.24
Even-bnd.	26.97	25.12
Sieve	49.27	46.12
Sort	38.94	36.29
Index:	**1.59**	**1.70**

FLOATING POINT	Compaq	Ogivar
Math	N/A	N/A
Error[2]		
Sine(x)	N/A	N/A
Error		
e^x	N/A	N/A
Error		
Index:	**N/A**	**N/A**

DISK I/O	Compaq	Ogivar
Hard Seek[3]		
Outer track	3.33	3.31
Inner track	3.35	3.33
Half platter	9.05	9.98
Full platter	10.10	16.65
Average	6.46	8.32
DOS Seek		
1-sector	13.30	15.05
32-sector	19.99	61.09
File I/O[4]		
Seek	0.21	0.21
Read	0.61	0.80
Write	1.06	1.06
1-megabyte		
Write	4.14	7.96
Read	3.48	7.42
Index:	**1.77**	**1.19**

VIDEO	Compaq	Ogivar
Text		
Mode 0	5.97	7.21
Mode 1	5.93	7.20
Mode 2	5.87	6.98
Mode 3	5.88	6.96
Mode 7	N/A	N/A
Graphics		
CGA:		
Mode 4	3.46	3.29
Mode 5	3.46	3.29
Mode 6	3.68	3.50
EGA:		
Mode 13	5.73	5.05
Mode 14	6.28	5.60
Mode 15	N/A	N/A
Mode 16	6.30	5.57
VGA:		
Mode 18	6.61	N/A
Mode 19	3.79	N/A
Hercules	N/A	N/A
Index:	**1.43**	**1.38**

CONVENTIONAL BENCHMARKS	Compaq	Ogivar
LINPACK	4111.12	3835.61
Livermore Loops[5] (MFLOPS)	N/A	0.01
Dhrystone (MS C 5.0) (Dhry/sec)	2557	2750



N/A=Not applicable.

[1] All times are in seconds. Figures were generated using the 8088/8086 versions (1.1) of Small-C.

[2] The errors for Floating Point indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

[4] Read and write times for File I/O are in seconds per 64K bytes.

[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

that can power the unit for about 50 minutes.

The motherboard can hold as much as 2.6 megabytes of memory. Machines sold with less than the maximum are not field-upgradable; you must return the machine to the factory. Alternatively, you can install a 1-megabyte or 2-megabyte expansion card, but this means you give up use of the expansion slot.

The carrying handle runs the full length of the machine and is comfortable if you don't have to carry the computer for an extended length of time. An optional carrying case is available. Like the SLT/286, the Ogivar 286 weighs in at 14 pounds.

LCD versus Plasma

The SLT/286 display measures 10 inches diagonally and has the standard contrast and brightness controls. Attaining a suitable display angle is easy because the hinge rotates smoothly through a full 180 degrees. The surface of the display is highly reflective, so glare could be a problem; however, its smooth rotation makes it easy to compensate.

You can set the SLT/286 up to display dark characters on a light background or light characters on a dark background. The default is light on dark; unfortunately, there is no simple way to alter the default values without going through the setup program and rebooting. The machine does not provide any warning if you close the display without turning off the power.

The color of the display resembles tie-dyed denim; intensity varies in different portions of the screen. You can compensate for (but not eliminate) those variations using the contrast and intensity controls. Although noticeable, the problem is not hard on the eyes.

Compaq supplies a utility for mapping colors to intensities; the program can be used from the command line or loaded as a TSR program. Although no commercial software presently supports it, the SLT/286 can display 16 shades in a CGA-style 320- by 200-pixel mode. However, only eight shades are available in the high-resolution VGA modes.

The SLT/286 has an external analog VGA port that drove an NEC MultiSync monitor without problems. A pair of hot-key combinations let you switch between the LCD and the external monitor.

The Ogivar plasma display measures 10 inches diagonally and is quite legible, with a resolution of 640 by 400 pixels. Basically, it provides EGA compatibility; the 50 extra scan lines (standard

continued

EGA has 350 lines) provide greater vertical character separation, which enhances readability. The extra lines also allow for underlined text (standard EGAs do not provide the underline attribute). The Ogivar 286 has an external EGA port; unfortunately, the underline attribute does not show up on an external monitor, contrary to what the user's guide states.

On-screen text can appear "normal" (with low and high intensity, as used by an application), low intensity only, high intensity only, or swapped (low is high, and vice versa). You control those attributes from the keyboard and define default values using the setup program.

The plasma display has no gray scaling, so applications that run in color must map colors to pixels that are either on or off. Ogivar supplies two programs that allow palette mapping. Both of these programs can be loaded as TSRs; you can pop up one at any time—even over graphics programs—to map colors interactively. With the other, you specify the color mapping on the command line, and when you press a hot key, the display hardware is reprogrammed to force that mapping. This capability is useful after loading an application that sets its own colors.

Two other utilities let you vary the number of screen lines. One limits the screen to 350 scan lines. That's useful, because when all 400 lines are used in graphics modes, images designed for 350-line EGA resolution are stretched vertically. A circle, for example, looks like an ellipse standing on end. A corresponding utility restores full 400-line resolution.

A push button in the display lets you blank the screen at any time, but the button's value is questionable: The screen remains blank only as long as the button is pressed. The machine does not automatically shut off when you close the cover with the power on.

Removable Keyboard

The SLT/286's 82-key removable keyboard is about three-fourths of an inch thick and quite light (1½ pounds). It has rubber nonskid feet and levers for propping the keyboard up. However, the levers have only a single latch position that raises the keyboard to a steeper than usual angle. Hence, keys in the rows farthest from the palms are higher than usual. As with the display, the problem is not severe. However, in the propped position, the keyboard blocks the floppy disk drive when the keyboard abuts the system unit.

All keys have a satisfying feel and an

continued

Advantages are enhanced by Tatung
VGA provides significantly higher resolution. In fact, image clarity is 37% higher than EGA. And while EGA gives you 16 on-screen colors, VGA puts 256 colors (from a palette of 262,144 colors) on a monitor's screen at a time. Distortion, ghosting, and even eye fatigue is sharply reduced. In text modes, characters (even those with descenders like y, p and g) are more clearly defined thanks to a 9 x 16 dot matrix. But, while the monitor is a vital part of a VGA system, we think the real key is the VGA card that goes with it.

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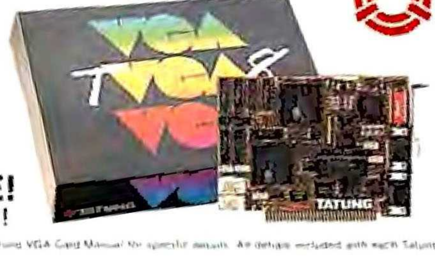

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electronic click. The Num Lock, Caps Lock, and Scroll Lock keys each have an LED. The keys themselves are full-size, except for the Fn key and the arrow keys. Although the keys' spatial arrangement is intuitive, their small size makes them hard to use. In addition, I occasionally bumped the left arrow key with the right side of my right hand.

Unfortunately, the Control key was moved from its normal position (on Enhanced keyboards) beneath the Caps Lock key to a point below the *A* key. The result is that you must curve the little finger of your left hand inward, beneath the palm, rather than outward. It's not impossible to adapt, but there's no excuse for moving a frequently used key to yet another position.

The keyboard also provides an embedded number pad beneath the 7, 8, and 9 keys. You access the embedded functions using the Fn key. The arrangement is a little confusing, because some keys have four functions. For example, the 7 key normally generates 7 and &, depending on whether a Shift key is pressed. When you press Fn, the 7 key generates 7 or Home, depending on the state of the Num Lock key and the Shift keys. For basic cursor movement, I found that using Fn (with Num Lock off) and the embedded keys is more efficient than using the miniature cursor keys.

Another flaw is that, like the Control key, the Fn key is much too small, and its location is terrible. There's room for it next to the Control key; since the Control key is undersized anyway, why not put the Fn key where you can reach it?

Bilingual Keyboard

Although the Ogivar 286 performs at roughly the same level as the Compaq, using it is difficult because of the keyboard's poor layout. For example, the Insert and Delete keys are inexplicably located to the left of the space bar. The cursor keys are arranged in a nonintuitive shape that makes them nearly impossible to use. An extra key (backslash/vertical bar) is located between Enter and the quote key. PageUp and PageDown are located right by Enter, but End and Home are in the function-key row. The function keys themselves are offset one position to the left from where they're normally located.

There is an embedded numeric keypad beneath the 7, 8, and 9 keys; the indicators for Num Lock, Caps Lock, and Scroll Lock are in a row beneath the tilt-up display. Other indicators show the status of power, hard and floppy disk drive access, and the "non-ASCII" key. The latter indicates that the French character set is active; a similarly labeled key just to the right of the space bar activates the French mode. In this mode, pressing the ? key produces an ASCII character 130 and, with the Shift key, an ASCII 135.

You can create other accented characters with two keystrokes by pressing an accent key followed by the desired vowel. This feature is very handy if you work in French; if you never do, and you don't want to go into non-ASCII mode accidentally (a likely possibility due to the location of the non-ASCII key), you can disable the key using the ROM-based setup program.

Disk Drives

The SLT/286 uses a Citizen floppy disk drive and a Conner 40-megabyte hard disk drive. Compaq rates the SLT/286's hard disk drive as having a 29-millisecond average access time; the Coretest re-

continued

ported a value of 24.4 ms, a 6-ms track-to-track seek time, and a data transfer rate of 640K bytes per second. All three figures would be better than average for a desktop AT compatible; in a portable, they're outstanding.

A rear-panel port lets you add an external floppy disk drive or a tape backup. However, the drives are expensive ($275 for a 5¼-inch drive) and require a special external storage module—a $299 option. The 40-megabyte tape drive is somewhat more reasonable at $799, but the module is also required with it. In addition, the module accepts only one device—either the floppy disk drive or the tape backup. Optionally, you can boot from an external floppy disk drive.

The Ogivar's floppy disk drive is a Toshiba, and the hard disk drive is by Matsushita. The hard drive has a fast average seek time—about 33 ms, according to the Coretest. However, its overall throughput is a disappointing 166K bytes per second, not much better than an 8-bit XT controller.

A rear-panel floppy disk drive port lets you add an external 360K-byte 5¼-inch floppy disk drive ($530). Unlike the Compaq, the Ogivar 286 doesn't require an external storage module.

Power Concerns

Compaq provides a number of features to help you manage the SLT/286's energy store. You can press the front-panel standby button to cut off power to the SLT/286's major subsystems: CPU/memory, screen, hard disk drive, and modem. In standby mode, the power LED blinks; you can restore normal operation at any time by pressing the standby button again.

The SLT/286 also provides several automatic energy-saving features. One will place the machine in standby mode if the system has been inactive (i.e., no use of disk drives, I/O ports, keyboard, or modem) for a preset period of time. Another turns off the hard disk drive if it hasn't been accessed recently. Another blanks the screen. The time-out values for all three energy-saving features are defined using the setup program. You can also change the values temporarily by using a utility program (PWRCON); rebooting restores the default values.

The setup program also allows you to determine whether the optional modem is to be powered when you boot. The PWRCON program lets you turn modem power on and off as desired.

When battery power does start to run down, the SLT/286 provides two stages of warnings, Low Battery I and II. Stage I is initiated when approximately 10 percent of battery power remains; Stage II, when 5 percent is left.

You can connect the AC adapter while the SLT/286 is running, but to switch battery packs, you must power down. The SLT/286 handles connecting and disconnecting the adapter while in operation without a hitch.

Another innovative feature of the SLT/286 is the battery charger/AC adapter. It switches automatically between 110- and 220-volt systems, and it can "quick-charge" a battery in 1½ to 3 hours. In addition, you can charge the nickel-cadmium battery while you're working on the machine.

The adapter's connector is polarized, so there is no danger of inserting it into the SLT/286 backward. The adapter has two LEDs; one indicates when it is connected to AC power, and the other indicates when it is quick-charging.

continued

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As for battery life, Compaq claims the SLT/286 can run for about 3 hours without needing a charge. To test that claim, I set up GrandView to save to disk automatically every 5 minutes, and I set the disk time-out to 1 minute (the minimum). I was able to use the machine for about 2½ hours continuously. With the modem turned on, battery life decreased to about 1½ hours.

The Ogivar 286 is essentially an AC-power-only machine. The power demands of a plasma display prohibit the use of a reasonable-size internal battery. An external battery pack is available, but the price is a daunting $655.

Beneath the Keyboard

The Compaq is built like a Swiss watch. All subassemblies fit well and are logically integrated into the main chassis. A modular design makes servicing (i.e., module swapping) fast and easy.

The chassis is actually composed of several modules, each of which consists of a printed circuit board encased in a lightweight aluminum box. The base is a ½-inch-thick box that contains the motherboard; the disk drives, modem, power module, and memory-slot cover all plug into various card-edge and dual-row header connectors.

The motherboard measures about 12 by 7½ inches and occupies most of the base surface. It is built almost entirely from surface-mount devices; the exceptions are the BIOS EPROMs and the math coprocessor socket, which are standard DIPs. The CPU is an 80C286, and it is socketed. Most of the LSI ICs other than the RAM and CPU bear Compaq logos.

The motherboard in the review machine was labeled Rev. G; even so, there were three engineering-change jumpers and two ¼-watt resistors hand-soldered to the rear side of the board.

Although the Ogivar electronic subassemblies are well made, mechanical integration is only fair, making this machine difficult to disassemble for servicing. The Chips & Technologies system-support ICs provide memory and I/O interfacing; the BIOS (3.02J) is by Award Software.

On the Bench

The two machines are roughly comparable in speed; the Zenith SupersPort 286, the Mitsubishi 286, and even the 12.5-MHz 80386-based GRiDCase 1530 have similar performance ratings.

The Ogivar's raw CPU performance exceeds the SLT/286's by about 7 percent. However, Compaq's high-performance subsystems help balance overall system performance. The SLT/286's hard disk drive is faster than the Ogivar's by almost 50 percent, and that allows it to surpass the Ogivar 286 in almost all application categories. The disk-intensive database tests, for example, really reflect the low-level disk benchmarks in that the SLT/286 is about 45 percent faster than the Ogivar 286. In the other application-level benchmarks, the two machines were nearly identical, but because of the SLT/286's better disk drive performance, its overall application index was about 13 percent better than the Ogivar 286's.

Compatibility Testing

I successfully ran the following software packages on both machines: SideKick 1.56b, PCED 1.01a, AutoSketch 1.01, Fastwire II, WordPerfect 5.0, WordStar 5.0, Lotus 2.01, VP-Planner 1.0, Turbo

Pascal 4.0, Procomm Plus 1.1A, and Ken Skier's No-Squint Laptop Cursor 1.09. I also ran Windows 286 version 2.1, with PageMaker 3.0 and Designer 1.2, without problems on the Compaq.

I was able to successfully install and run IBM's OS/2 1.1 (Presentation Manager) on the Compaq; of the four AT compatibles that I happened to have in the office at the time, it was the only one that would run PM. I got an error message about the COM1: serial port not installing, but a Microsoft Serial Mouse worked fine from that port. There was not enough memory on the Ogivar to run PM or Windows.

User's Perspective

The Compaq SLT/286 comes closer to my idea of perfection than any other battery-powered portable on the market. Although the display doesn't have as much contrast as a real CRT, it's good enough to work on all day without eyestrain. The screen is legible in bright sunlight and in a dark room. The eight-level gray scaling allows you to run software set up for a color monitor without fiddling with a mapping utility, and that's a real plus.

However, the Compaq's LCD screen has long-persistence imaging, so scrolling text and moving graphics images leave a trail. That can be bothersome—for example, if you're used to reading information coming by modem from an on-line service.

The plasma display on the Ogivar is readable in almost any light, but you are limited to monochrome EGA operation, although you can experiment with color-mapping utility software.

The Compaq's keyboard has a few flaws, but they're tolerable. The Ogivar keyboard has major flaws that are really a pain. However, the Ogivar does make working in French painless.

The SLT/286's automatic drive time-out saves battery power, but it can be frustrating to wait for the disk to come up to speed every time you save your work.

Compaq's documentation is typically well done, with lots of illustrations and clear explanations. Ogivar's documentation is not as extensive or as polished as Compaq's. It covers only the basics, and it lacks an index.

The base price for an SLT/286 with a 40-megabyte hard disk drive is $5999; a similarly equipped Ogivar 286 costs $4995. By contrast, the comparable Zenith SupersPort 286 costs $5599. The SLT/286 outperforms both machines, and it has the advantage of battery power and a much better screen (the Zenith provides only CGA compatibility).

A fully expanded SLT/286 with a modem, a math coprocessor, maximum memory (3.6 megabytes), and an expansion chassis costs more than $10,000. However, the machine could do double duty on the desktop and in the field.

Both machines have comparable performance. In terms of overall quality, the Compaq SLT/286 holds the edge over the Ogivar 286. In terms of price, the Ogivar 286 takes the lead. Deciding between the Ogivar and the Compaq comes down to whether you prefer an umbilical cord to AC power or if you want your computing on the go. ■

Jeff Holtzman owns Publishing Concepts, a firm that specializes in evaluation, verification, and documentation of high-technology products. He lives in Ann Arbor, Michigan, and can be reached on BIX c/o "editors."

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Advanced Floppy Disk Drive Controllers

From left to right: Omni-Bridge, Mux Card, and CompatiCard I.

Extend the versatility of your computer

Jeff Holtzman

How do you share information stored on incompatible disk formats? For occasional use, transferring files via an RS-232C hookup suffices, but for everyday use, you'll want to install in your PC a floppy disk drive for each desired disk format. Doing so with a modern 80286- or 80386-based IBM PC AT compatible may be as simple as installing a new disk drive and running your machine's setup utility. It's not so simple, however, with older PCs, XTs, or compatibles based on the 8088. One solution is to install an advanced floppy disk drive controller card.

For this review, I looked at the Sysgen Omni-Bridge, the MicroSolutions CompatiCard I, and the Manzana Mux Card. All these cards offer increased versatility for the older PC. Each board has certain advantages and disadvantages. Their features are summarized in table 1.

Upgrade Path

To add a new drive type to an older XT compatible, you must add the new or secondary controller, select nonconflicting I/O port addresses, install a device driver, and upgrade the DOS version for your system.

I installed the Sysgen Omni-Bridge and the MicroSolutions CompatiCard I as secondary controllers and connected both 1.2-megabyte (Fujitsu) and 1.44-megabyte (Manzana) drives to each. As part of the testing procedure, I installed and ran all the cards in both an AST Premium/286 and an IBM PC XT, both running PC-DOS 3.3.

Unlike the others, the Manzana Mux Card is not a disk drive controller, but a bus multiplexer with simple logic (gates and latches) that allows you to connect more than two drives to a single floppy disk drive controller. It has limitations: It cannot control 1.2-megabyte drives, and it can control only 720K-byte drives on XT machines.

In both machines, I connected the Mux Card to the pre-existing controllers: a Western Digital combined hard disk/floppy disk drive controller in the Premium/286, and a generic multi-I/O card in the XT.

I had no trouble formatting and using bootable high-density 3½-inch and 5¼-inch system disks using DOS's native FORMAT/S command with both the Omni-Bridge and the CompatiCard. After some initial setup difficulties, I got the same results with 720K-byte disks on the XT and 1.44-megabyte disks on the Premium/286 using the Mux Card.

All three boards are half-length and fit into either an 8-bit or a 16-bit bus slot. Each is built using traditional DIP technology; all three exhibit high-quality components and workmanship. The Sysgen card had one engineering-change jumper soldered to two pins of an IC on top of the board.

MicroSolutions CompatiCard I

The CompatiCard I is the most versatile floppy disk drive controller on the market. At $175, it's also rather expensive,

continued

	CompatiCard I	Omni-Bridge	Mux Card
Type	Advanced floppy disk drive controller	Advanced floppy disk drive controller	Floppy disk drive multiplexer
Company	MicroSolutions Computer Products 132 West Lincoln Hwy. DeKalb, IL 60115 (815) 756-3411	Sysgen, Inc 556 Gibraltar Dr. Milpitas, CA 95035 (408) 263-4411	Manzana MicroSystems P.O. Box 2117 Goleta, CA 93118 (805) 968-1387
Features	As many as four internal drives in 360K-byte, 1.2-megabyte, 720K-byte, and 1.44-megabyte formats	Allows you to add one or two drives in any format internally, and one or two externally	Runs one or two 1.44-megabyte drives off an existing AT controller
Size	Half-length	Half-length	Half-length
Hardware Needed	8-bit or 16-bit slot and cables	8-bit or 16-bit slot and cables	8-bit or 16-bit slot and floppy disk drive controller
Software Needed	DOS 3.3 or higher for best performance	DOS 3.3 or higher for best performance	DOS 3.3 or higher for best performance
Options	CompatiCard II: $125 MatchMaker: $149 Macintosh external drive: $239	Internal 1.44-megabyte drive: $250 Bridge-Tape: $695	3rd Internal (720K-byte) drive: $299 3rd Internal Plus (1.44-megabyte) drive: $340 3FIVE.SYS software: $75
Documentation	36-page booklet	44-page booklet	60-page booklet
Price	Adapter card with software: $175 (cables extra)	Adapter card with software: $95 (cables extra)	Adapter card with cables and software: $70
	Inquiry 855.	**Inquiry 856.**	**Inquiry 857.**

Table 1: *Each advanced floppy disk drive controller or multiplexer can handle a specific number and variety of floppy disk drives.*

	5¼-inch		3½-inch		Max no. of drives			RAM (bytes)
	360K-byte	1.2-Mb	720K-byte	1.44-Mb	Int.	Ext.	Total used	
Mux Card	Yes	No	Yes	*	2	2	2	7K
CompatiCard I	Yes	Yes	Yes	Yes	4	2	4	12K
Omni-Bridge	Yes	Yes	Yes	Yes	2	2	4	9K

* Only in AT or with high density controller in XT.

but you get what you pay for. The CompatiCard accepts eight types of drives—four types of 5¼-inch drives, three types of 3½-inch drives, and 8-inch drives. All standard IBM formats are supported, as are several proprietary formats.

The CompatiCard lets you install up to four drives, each of which can be of any supported type. Appropriate connectors are supplied so that up to four drives can be installed internally; a standard 37-pin D connector provides for one or two external drives.

You can install the CompatiCard as your primary floppy disk drive controller or as a secondary controller. In fact, you could install as many as four CompatiCards in a single PC, providing a total of 16 disk drives.

To install the CompatiCard, you set two jumpers that determine its I/O port addresses, and then connect cables from your drives. The card provides both an edge-card connector and a 34-pin dual-row header strip to connect drives 0 and 1. Another header strip allows connection to drives 2 and 3; that strip is wired in parallel with the external D connector. Last, you insert the card into a vacant slot.

If the CompatiCard is the primary controller, and if your BIOS supports the format of your new disk, installation is complete. Otherwise, you'll have to alter your CONFIG.SYS file so that DOS will load a device driver.

You use CCDRIVER.SYS to specify the address (0 to 15), the type (0 to 7), and, optionally, the step rate (1 to 32) of each drive attached to the CompatiCard. So, to add 1.2-megabyte (type 2) and 1.44-megabyte (type 7) drives, I used DEVICE=CCDRIVER.SYS/6,2/7,7.

If you use DOS 3.2 or higher, and if DOS's DRIVER.SYS and CCDRIVER.SYS are located in the same directory, CCDRIVER.SYS will load DRIVER.SYS and use it to process requests from the DOS disk-manipulation programs (e.g., FORMAT). Otherwise, you'll have to format disks with CCFORMAT.COM, and the other DOS programs (e.g., COPYDISK) may not work. The two drivers together occupy just under 12K bytes of RAM.

The CompatiCard's documentation is brief but logical. If you comprehend the basic issues, the documentation is suffi-

Floppy Disk Drive Problems

Four types of floppy disks and four corresponding disk formats are commonly used in the IBM world: the 360K-byte and 1.2-megabyte 5¼-inch formats, and the 720K-byte and 1.44-megabyte 3½-inch formats. For either disk size, it is impossible to read the high-density disks in the low-density drives. In the other direction, although it's possible to read from and write to a 360K-byte floppy disk in a 1.2-megabyte drive, the results are unreliable; you can, however, reliably read from and write to a 720K-byte disk in a 1.44-megabyte drive.

So, to read all four types of disks, you really need three disk drives: 360K-byte and 1.2-megabyte in the 5¼-inch size, and 1.44-megabyte in the 3½-inch size. But, depending on the type of PC you have, adding disk drives may not be simple.

As you might expect, there are two types of problems: software and hardware. You can resolve software problems by adding a new BIOS, a new version of DOS, a device driver, or some combination thereof. Hardware problems can be resolved by substituting a new floppy disk drive controller for your present one, or by adding a secondary controller.

Software Limits

Because of the way disk formats evolved over time, most PC and XT compatibles have built-in BIOS support for only the 360K-byte and lesser (e.g., 160K-, 180K-, and 320K-byte) formats. Most AT compatibles have built-in support for both the 360K-byte and the 1.2-megabyte formats; newer ATs also support one or both of the 3½-inch formats. You can determine which formats your AT supports by running its setup program.

Even without built-in BIOS support, you can install a new-format floppy disk drive in an old machine by adding a software device driver. DOS versions 3.2 and higher include a device driver called DRIVER.SYS, which supports newer disk formats, depending on the version of DOS. Most drive vendors sell similar drivers.

There are several disadvantages to the device-driver approach, however. First, the machine will be unable to boot from the drive because it will not know how to read the drive until after it has loaded the device driver. Therefore, a drive without built-in BIOS support cannot be installed as drive A. Further, the driver eats up precious RAM, typically about 10K bytes. On the other hand, a software driver can be upgraded more easily than a driver in ROM or EPROM.

You may also have to upgrade your version of DOS to take advantage of all the features of the newly added drive. DOS versions under 3.0 support the 360K-byte and lesser formats; DOS 3.0 and 3.1 support the 1.2-megabyte format; DOS 3.2 adds the 720K-byte format; and DOS 3.3 adds the 1.44-megabyte format.

To use DOS's FORMAT, DISKCOPY, DISKCOMP, and, in some cases, BACKUP and RESTORE programs, you have to use a version of DOS that directly supports the desired format. Generally, however, even without a higher version of DOS, you'll be able to format disks with a special utility supplied by the disk vendor, the controller card vendor, or a third party. Creating bootable system disks may take several steps, however.

Hardware Limits

Even with the right software, you must also have the right hardware. Standard PC and XT floppy disk drive controllers are limited to a data transfer rate of 250K bits per second; this is not high enough for the high-density (1.2-megabyte and 1.44-megabyte) formats, which require either a 300- or 500-Kbps rate, depending on drive speed. The situation is somewhat better with AT-compatible disk drive controllers, which are designed for all three data transfer rates.

Another variable is the number of drives a controller can support. You can connect as many as four drives to IBM's standard PC/XT floppy disk drive controller, but only two can be mounted internally. Many clone controllers support two internal drives and no external drives.

Most controllers (floppy disk drive-only and combination hard disk/floppy disk drive) for ATs support only two drives. You can add a secondary controller that uses different I/O ports, but a device driver will be necessary to communicate with the CPU.

Cabling may also be a problem. Adding a secondary or specialty controller may require an extra-long data cable, and the cables that come with some machines won't reach. You may also need a Y adapter to supply power to a new drive. To avoid disappointment and unnecessary delays, make sure you acquire the appropriate cables when ordering the other components.

cient. Novices, however, may need help. I found the company's technical-support staff knowledgeable, polite, and easy to reach.

A stripped-down version of the card (CompatiCard II) is also available for $125; it supports only two internal drives, but they can be any standard type. The CompatiCard II can function as a primary or secondary controller.

Sysgen Omni-Bridge

The Omni-Bridge is a semi-intelligent disk drive controller that can function as a primary or secondary controller. It can control as many as four drives in all standard formats; however, only two drives can be mounted internally.

Like the CompatiCard, The Omni-Bridge includes its own on-board LSI disk drive–controller IC. In addition, the board has an EPROM with part of the driver code. The value of this 8K bytes of firmware is questionable, however, because, even with it, you still have to load a device driver that occupies about 10K bytes of RAM. If the EPROM contained the entire device driver, you could boot from a drive not supported by your BIOS and save the RAM as well.

To install the board, you run a setup program that shows you how to set the on-board DIP switches (eight positions in two DIPs); the switches specify drive types, BIOS and I/O port addresses, and so on. Then you insert the card in your PC and run a cable to your drive(s). Both edge-card and header strips are provided for the internal drives.

An Install program will modify your CONFIG.SYS file, or you can do so manually, using information in the manual. After rebooting, the new drives are available for use.

continued

Macintosh Disks

Not only are there four types of DOS disks, now there are also Macintosh disks to contend with. With care, it's possible to transfer PageMaker, Excel, and even some text files between the two environments without losing any essential information. But what do you do if you're creating PageMaker files on a PC and want to print them at a service bureau that accepts only Mac-format disks?

MatchMaker

One solution is to add an external Mac drive to your PC. MicroSolutions sells a half-length card called the MatchMaker ($149) that lets you do just that. MatchMaker uses its own I/O ports and has no connection whatsoever with the PC's disk drive controller. The card goes into an empty 8-bit or 16-bit expansion slot; the drive plugs into a 19-pin D connector through which it obtains power and exchanges data. You also need an external Macintosh drive, of course.

MatchMaker uses a TSR program called MAC.COM that occupies about 35K bytes of RAM. MAC.COM provides a set of DOS-like commands (e.g., MCOPY, MDEL, and MRD) for manipulating Macintosh disks—those with both the flat (Macintosh File System) and the hierarchical (Hierarchical File System) directory structures. The Macintosh drive is designated as drive M. So, for example, to copy MYPCFILE to a Mac disk, you'd type: C>MCOPY MYPCFILE M:. Wild cards are acceptable in filename specifications (e.g., MYPCFILE.*). Because Macintosh filenames can be longer than eight characters and can also include illegal DOS characters, the program truncates long filenames and generally translates illegal characters to an underline character.

Because the M drive is simulated, it's not available to normal DOS commands or other programs. So you couldn't do this: XCOPY M:*.* C:\MACFILES. MatchMaker would be much more useful if the M drive were accessible at the DOS level.

Deluxe Option Board

Central Point Software (15220 Northwest Greenbrier Pkwy., Suite 200, Beaverton, OR 97006, (503) 690-8090) has been selling the Copy II PC Deluxe Option Board ($159) for several years as a means of backing up copy-protected software. The Deluxe version lets you use Macintosh disks in an IBM-type 720K-byte or 1.44-megabyte 3½-inch disk drive.

You install the Deluxe Option Board between your current controller and your disk drive(s). Central Point specifically warns that some Alps and Mitsubishi drives cannot read and write Macintosh disks reliably. If you're in the market for a drive, and you're considering using it to trade files with a Macintosh, the company recommends using Citizen, TEAC, and Toshiba drives, in either the 720K-byte or 1.44-megabyte format.

Next, you load a memory-resident program called MCP.EXE that occupies less than 1K byte of memory. It provides a set of commands similar to those provided by MatchMaker (MCD, and so on). However, with MCP.EXE, you refer to a device by its DOS designation. For example, MCP MFORMAT A: would format a disk in physical drive A.

Neither product can rename a file or a directory on a Mac disk. More significantly, neither deals with the problems of data translation. You'll need a third-party program to convert WordStar files to MacWrite, for example.

I used both products over a period of several months with varying degrees of success. I had occasional problems with MatchMaker; it seems that the external drive is not well shielded, so it sometimes picked up stray electromagnetic interference from my NEC MultiSync monitor (a veritable "radio station"); the effects depended on whether the drive was located on top of the Premium/286 or beside it (i.e., further from the monitor).

The Option Board also failed occasionally, especially when accessing the inner tracks.

As with the CompatiCard, the OmniBridge lets you use DOS's disk-manipulation programs if you are running DOS 3.2 or higher. Otherwise, you must use OFORMAT.COM. In the latter case, other DOS programs (e.g., DISKCOPY) may not work correctly.

The documentation is rather confusing on a number of points. For example, the manual refers to any drive after the first two logical drives (A and B) as external drives, whether they're actually installed in the chassis or in an external case. This can be confusing.

Manzana Mux Card

Manzana sells a number of disk drive products, separately and bundled in various combinations. The core of the line is the Mux Card, which lets you add a third (and a fourth) drive to an existing floppy disk drive controller with support for only two.

Because the Mux Card works off the existing controller, it relies on simple, inexpensive circuitry, keeping the cost of the board (with cables and software) to $70. However, the simplicity of the board precludes adding any high-density drive to an XT-type controller with the 250K-bit-per-second data transfer rate. That means you can't use this board to format 1.44-megabyte disks in an XT with a standard floppy disk drive controller. (But you can format 720K-byte disks in a 1.44-megabyte drive with a standard controller.)

In addition, you can add a 1.44-megabyte drive to an AT with a standard controller, but the Manzana hardware and software doesn't support 1.2-megabyte 5¼-inch drives at all.

For this review, Manzana supplied a bundled product known as the 3rd Internal Plus. It consists of a Mux Card, a 1.44-megabyte drive, and a software driver called 3FIVE.SYS. (A 720K-byte version of the 3rd Internal is also available.) Each product is sold separately; even though the three are bundled, the documentation for each is contained in a separate booklet, and it's up to you to integrate the three. The type in the booklets is small, dense, and hard to read, and the information is poorly organized and poorly written.

Installing the disk drive was simple enough, but I had a great deal of trouble configuring the card and getting the software to access the drive, and I had to get help from the company's technical-support line. Fortunately, the technician got me up and running quickly.

To install this card, you must disconnect your current disk-to-controller cable and rewire things so that the Mux Card appears between the controller and the disk drives (as with Central Point Software's Deluxe Option Board; see the text box "Macintosh Disks" at left). The problem is that the written description in the manual is unclear about which connector goes where. You must also set a number of jumpers on the card, depending on the port address it uses, type of cable (straight or "inch-twisted"), and so on.

Then you install the device driver. 3FIVE.SYS is available separately; a copy of it is also included with each disk drive and Mux Card sold by Manzana. The driver can function without the Mux Card; it would be useful if you were trying to install a 3½-inch drive in a system running an early version of DOS—one without DRIVER.SYS.

Although I had trouble installing the Mux Card, in operation it performed flawlessly.

Formats Galore

The CompatiCard I is well documented and extremely versatile but expensive. On the other hand, the Mux Card is quite inexpensive, but it has limitations and is poorly documented. The Omni-Bridge is in the middle in terms of price, versatility, and documentation.

If you're upgrading an XT-class machine, the Mux Card is not a good buy because of its limitations. For this purpose, one of the CompatiCards or the Omni-Bridge would be a more appropriate choice.

If you can tolerate the documentation, the Mux is a good buy for upgrading an AT. Manzana's bundled price for the 3rd Internal is high, but if you're willing to do a little shopping around, you can buy the Mux Card from Manzana and a quality drive elsewhere and save more than $100.

If you're building a system from scratch, want it to be able to read from and write to all IBM disk formats, and want more than two internal drives, the CompatiCard is the way to go.

On an XT, the Omni-Bridge has one advantage over the other cards: You can connect one of Sysgen's tape backup units to the external DB-37 connector and operate it at twice the speed possible with a standard controller.

Cost aside, my personal favorite is the CompatiCard. The documentation is clear, the card is well designed, and it's suitable for use in both XT and AT machines. If you've got an XT lying around your office unused, you could install a CompatiCard in it, along with a drive of each type, and then use the machine to transfer files among the different disk formats. ■

Jeff Holtzman owns Publishing Concepts, a firm that specializes in evaluation, verification, and documentation of high-technology products. He lives in Ann Arbor, Michigan, and he can be reached on BIX c/o "editors."

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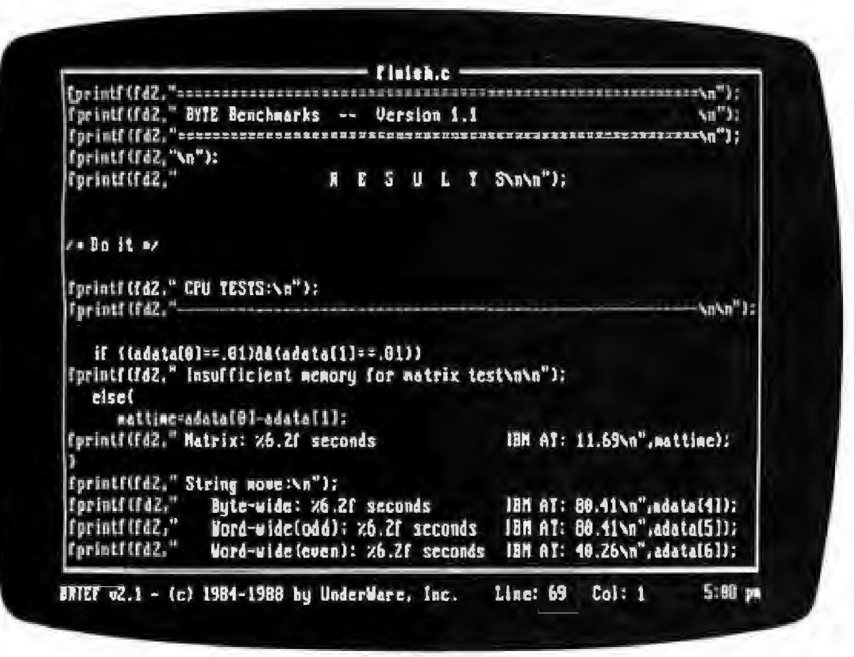

Powerful embedded languages offer ultimate flexibility

Jon Udell

As software gets more complex, it gets harder to create programs that will satisfy a diverse group of users. That's why so many application programs have programmable features. But when an application caters to one particularly demanding group of users—programmers—it must offer more than just a few programmable features.

I looked at four popular text editors that do just that—BRIEF 2.1 ($195, Solution Systems), EMACS 1.2 ($325, UniPress), Epsilon 3.2 ($195, Lugaru), and ME 2.1 ($89, Magma). These editors are specialized for programmers editing source code, and that means they're line, not paragraph, oriented. They all run on a standard IBM PC or compatible; EMACS needs at least 384K bytes of RAM, and Epsilon, ME, and BRIEF will run in 256K bytes. And these text editors let you customize them in nearly limitless ways.

Each of them manages the complexity of customization by dividing itself into the *kernel* and *user* layers. The kernel is the executable file you run from the DOS command line. It manages machine resources, implements basic operations involving files, buffers, and windows, and supports the user layer. The user layer is a set of files containing code written in the editor's extension language and executed by the kernel. It implements key bindings, search-and-replace protocols, and language-sensitive modes.

This layered architecture has two benefits. You're not stuck with the default user interface, and to the extent that it's implemented in the user layer, you can change it. You can also add powerful new features to the editor.

Of course, you can't change everything. For example, a kernel might not support virtual memory or limit lines to a certain length. Table 1 lists some kernel-level characteristics of the four editors. One major difference is the way each editor implements an edit buffer. An editor that follows the EMACS tradition—like UniPress EMACS and Epsilon—views a buffer as a one-dimensional array of characters. Other editors, including BRIEF and ME, represent a buffer as a two-dimensional array.

That distinction has several ramifications. With the one-dimensional scheme, row and column coordinates aren't readily available, so EMACS and Epsilon report the current position in a buffer as a percentage of the buffer's total size. It's the reverse with the two-dimensional approach. The absolute index into the buffer isn't at hand, but row and column coordinates are, so BRIEF and ME report these.

On balance, I prefer the latter approach, because two-dimensional representation is useful for operations on rectangular regions. BRIEF and ME support rectangular cut and paste, for example, while EMACS and Epsilon don't. The one-dimensional method has advan-

continued

Table 1: *Kernel characteristics.*

	BRIEF	EMACS	Epsilon	ME
Virtual memory	Yes	No	Yes	Yes
Line length	144 to 512	Unlimited	Unlimited	512
Maximum file size	64,000 lines	Free memory	Free disk space	Free disk space
OS/2 version	No*	No	Yes	Yes
Horizontal windows	Yes	Yes	Yes	Yes
Vertical windows	Yes	No	No	Yes
Highlight marked region	Yes	No	No	Yes
Multiple marked regions	Yes	No	No	No
DOS shell	Yes	Yes	Yes	No
DOS buffer	No	No	Yes	No
Rectangular cut and paste	Yes	No	No	Yes
Regular expressions	Yes	Yes	Yes	Yes
Undo	Yes	Yes	No	No

*The manufacturer says it is currently working on an OS/2 version of BRIEF

Table 2: *Performance characteristics, working with a 100K-byte file.*

	BRIEF	EMACS	Epsilon	ME
Read file	4	13	4	9
Jump to end of file	1	0	0	0
Scroll to end of file	17	49	25	19
Search to end of file	3	9	1	2
Write file	4	7	2	5
Execute tag command	19	—*	25	45

*Ran out of memory using a 100K byte file

Note: Tests were conducted on a MicroServe ProPlus AT with 640K bytes of RAM and a 40-megabyte hard disk drive.

tages, too. Since buffers and disk files are similar—they're both streams of bytes—you can use EMACS and Epsilon to edit binary files (e.g., executables, databases, and so forth) in situations that would otherwise require a debugger.

A BRIEF Look

BRIEF dazzled me with its speed. Though it didn't win all my benchmark tests (see table 2), it turned in the best overall performance. But what really sets BRIEF apart from the others is the rapidity with which you can move the cursor around in a buffer. The program can speed up the rate at which keys repeat; when you hold the key bound to the `next_char` function, the cursor flies across the screen. It's so fast that I never had to resort to `next_word`.

The program also has a great undo facility. BRIEF's undo stack stores 30 commands by default, and you can increase that number to 300. That means you can literally run the editor backward, undoing the effects of previous commands. BRIEF restricts the undoable commands to those that change the position in or contents of a buffer. It can't undo operations that change the size or location of a window, or switch from one buffer to another, but it does maintain separate undo stacks for each active buffer. (BRIEF divides the total number of undoable commands among the active buffers.)

If you haven't used a feature like this, it'll take some getting used to, but you'll soon be hooked. It's more than a way to recover from mistakes. As the manual points out, the undo stack makes every buffer location you visit an implicit bookmark. So when you scroll from one part of a buffer to another, you use undo to get back to your starting location.

Like all the editors in this review, BRIEF keeps a circular list of buffers. The command `edit_next_buffer` cycles through the list, presenting each successive buffer in the current window. The command `buf_list` presents the whole list. You can select and then edit, write, or delete any of the buffers in the list. Both functions are located in the user layer and rely on primitive kernel functions, such as `next_buffer`, to communicate with BRIEF's internal data structures.

About a third of BRIEF's commands are implemented that way—as user-layer code that calls primitive kernel functions. The rest of the commands hook directly into the kernel. For example, the `next_word` command resides in the user layer and uses the kernel function `next_char` to do its work. But `next_char` is a command, too. You call it by pressing the key to which it's bound (by default, the right arrow) or by naming it at the BRIEF command prompt. From the user's perspective, there is no difference between commands implemented in the user layer and those implemented in the kernel.

Fetching files into buffers is something you do often enough to have an efficient scheme for doing it. BRIEF cuts down considerably on the keystrokes required to fetch a file. When it prompts you for a filename, you type the first few characters of a name and then press the tab key. If the partial name is enough to uniquely identify a file in the current directory, BRIEF automatically completes it. Otherwise, BRIEF displays a menu of files whose names begin with the characters you've typed, so you just point and shoot.

Because BRIEF keeps a record of the responses to all its prompts, you can recall a previous response to the filename prompt without having to retype it. This is useful if you need to retrieve a file that you've already viewed before. The code that supports this behavior resides in the user layer. It's a well-developed package called the Dialog Manager, used most prominently by BRIEF's help facility. BRIEF's authors recommend that anyone writing a user-interactive extension to BRIEF should use the Dialog Manager, to save time and to maintain the look and feel of the core program.

EMACS from UniPress

EMACS was the slowest of the four editors. Because UniPress EMACS began life as a Unix program running on large machines, it hasn't had the kind of extensive Intel CPU-specific performance

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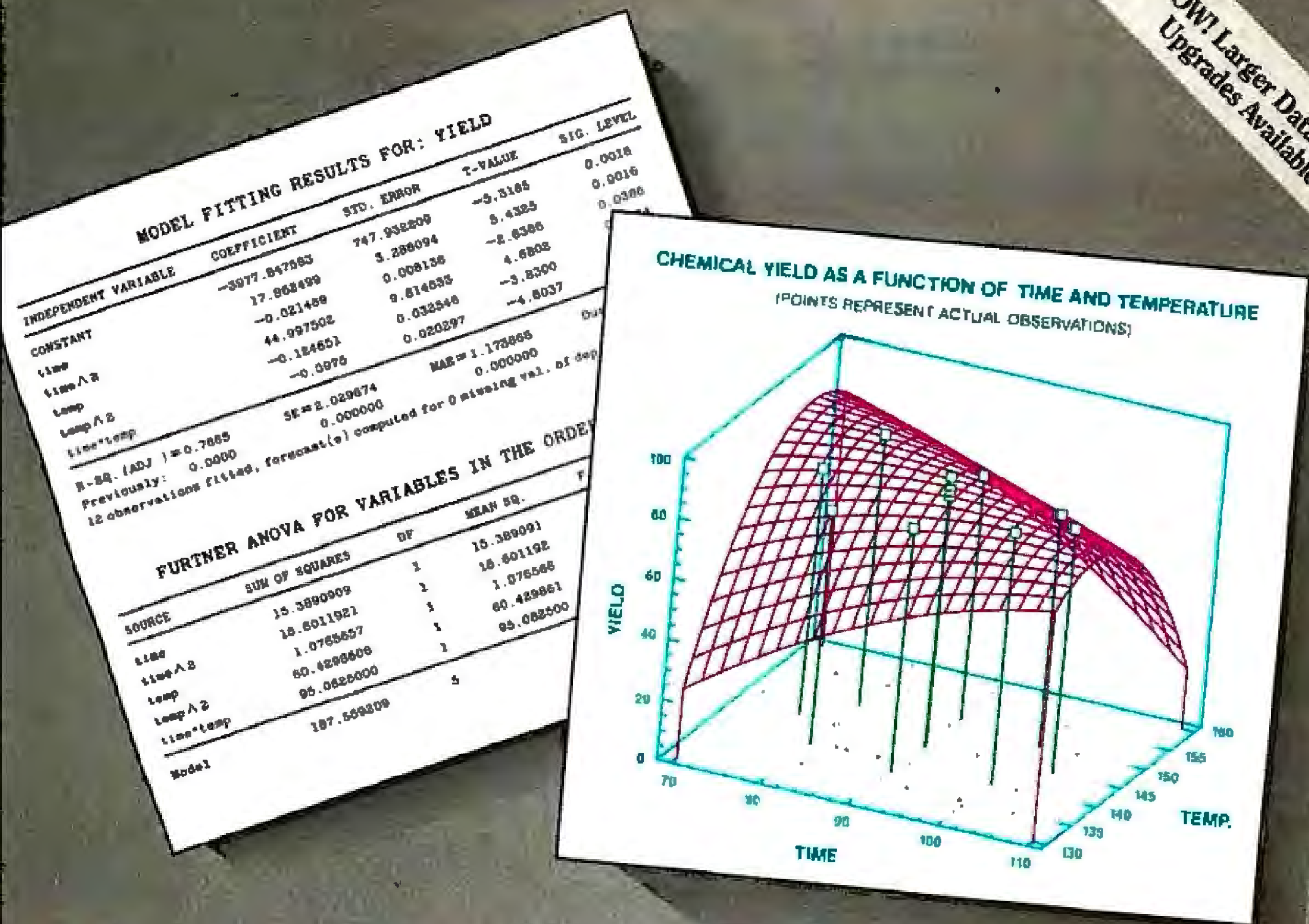

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Company	Solution Systems 541 Main St., Suite 410 South Weymouth, MA 02190 (617) 337-6963 (800) 821-2492	UniPress Software 2025 Lincoln Hwy Edison, NJ 08817 (201) 985-8000	Lugaru Software Ltd 5843 Forbes Ave. Pittsburgh, PA 15217 (412) 421-5911
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Software Needed	MS-DOS 2.0 or higher	MS-DOS 2.0 or higher	MS-DOS 2.0 or higher
Language	C, Assembly, BRIEF Macro	C	C
Documentation	186-page user's guide, 215-page macro language reference, quick reference	134-page generic user's guide, 100-page PC-specific user's guide	198-page reference manual
Price	$195	$325	$195
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tuning that programs born on the PC get. It's also the only one that doesn't implement virtual memory (though its Unix incarnation does), so buffer space is limited to about 100K bytes. On the other hand, it's the most widely available program: It runs on dozens of machines under a variety of operating systems, including DOS, VMS, and many flavors of Unix.

While no speed demon, the program is a faithful implementation of EMACS as it was originally conceived by Richard Stallman at MIT. That means you get a set of default key bindings that you may be tempted to change but probably shouldn't. In an EMACS editor, you can do almost everything you need without moving either hand away from the home row. For example, the commands `forward-character` and `backward-character` are bound to Ctrl-F and Ctrl-B, respectively.

All the EMACS commands flow from the Ctrl (or Alt) keys, often in multiple combinations (e.g., `visit-file` is bound to Ctrl-X/Ctrl-V). That seems bizarre at first, but once you get used to it—particularly if you're a touch typist—you'll be amazed at what an efficient scheme it is. And since you use the QWERTY keys in conjunction with only one or two special control keys, your editing skills don't depend on any particular keyboard layout; that's helpful in a heterogeneous computing environment.

You can, of course, reconfigure any of the editors reviewed here to behave that way. Since I favor the EMACS key bindings, I did just that with BRIEF and ME (Epsilon already had the EMACS bindings). What really makes EMACS special is its help system. It stores the names of all its commands, along with their key bindings, in a table that you access by way of the apropos command. The apropos command prompts for a string, then pops up a buffer containing all the commands whose names contain the string. It's a quick way to locate commands that work on windows, buffers, words, lines, or files.

What is particularly nice about apropos is that EMACS records new commands—ones you add to the editor by way of the extension language—in the name table. So the help system automatically tracks extensions to the editor, and you don't have to remember to update anything. Other useful help commands include `describe-key`, which prompts for a key and tells you what command is bound to it, and `describe-bindings`, which produces a complete list of commands and key bindings. Unfortunately, UniPress didn't implement a related command, `describe-command`, which retrieves short descriptions of commands. According to UniPress, DOS users can't afford the space to store the text database. (Epsilon, however, does implement both apropos and `describe-command`.)

UniPress EMACS completes partial names in a variety of contexts (as does Epsilon). As with BRIEF, you can type a partial name and view a list of matching names. In EMACS editors, the list appears as a buffer rather than a menu; you keep adding characters to the partial name until it's unique. The completion facility works not only with filenames, but also with commands and system variables. However, UniPress EMACS doesn't complete buffer names.

Epsilon: Another Implementation of EMACS

Of the four editors reviewed here, Epsilon most cleanly separates the user and kernel layers. All the Epsilon commands reside in the user layer; that's a compelling demonstration of the speed and power of EEL, Epsilon's extension language. And Epsilon's implementation of EMACS outdoes UniPress's in many respects: it's faster, offers more features, and has greater capacity.

Only Epsilon supports a DOS process

ME 2.1

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buffer. It not only shells to a spawned DOS process—something many programs and all the editors reviewed here do—but it also creates a captive DOS process within an editing buffer. The transcript of your DOS session that accumulates in the process buffer is a handy document; it also simplifies program compilation from within the editor.

Like the others, Epsilon supports language-sensitive modes. When you fetch a file whose name ends with .c, for example, Epsilon switches to a mode appropriate to C programming (i.e., it indents text as you enter it according to one of several popular styles). Epsilon doesn't provide more ambitious template-oriented features. For example, BRIEF and UniPress EMACS can expand an "f" into the template of a for construct. I find such features intrusive and don't use them, but if you feel differently, you could easily extend Epsilon to provide such behavior.

Epsilon completes names in every conceivable context, and when doing so it requires fewer keystrokes than does UniPress EMACS. But it doesn't attach a history stack to each prompt, as BRIEF does, and it doesn't provide an undo command as BRIEF and, to a lesser degree, UniPress EMACS and ME do. Something that compensates for the lack of an undo feature is the kill ring. The kill ring is a set of buffers used in a cyclical manner by successive operations that delete text. The buffers in the kill ring aren't invisible system-only buffers. Epsilon displays them when you list available buffers, and you can visit them and retrieve text from them.

Like the other editors, Epsilon supports keystroke macros: sets of keystrokes that you record, assign to a key, and then play back. It's a handy way to automate little tasks that aren't worth implementing in the extension language. Unlike the others, Epsilon permits you to save these recorded sequences directly so you can reuse them. (UniPress EMACS and ME do this indirectly, by converting keystrokes into extension-language code.) Epsilon accomplishes that by storing keystroke macros in its state file, a single file that contains the entire user layer along with extensions that you add to it.

One useful command that none of the others have is `sort-buffer`, which, as its name suggests, sorts the lines in a buffer and puts the result in a new, sorted buffer. Another, shared with UniPress EMACS, lets you repeat any command a specified number of times. Called `argument`, this command prompts for a count of repetitions and then feeds that count to the next command you execute.

Magma Software Systems' ME

ME has good performance and does everything a text editor should. Still, I liked it the least. ME has a weak help system and very poor documentation—I spent a lot more time getting up to speed with ME than with the others. I also didn't like the way ME organized its kernel and user layers.

The extension-language packages that come with ME aren't integral to the product, as they are with the other editors. They demonstrate that you can use the extension language to add features, but the product itself doesn't rely on the extension language. And the add-in packages have a haphazard feel to them. Some the program's author wrote, others ME users donated, and many were buggy. For example, ME's undo command, written in the extension language, broke when I remapped the default key bindings, since it records keys rather than command names.

Another example illustrates why it's important to implement user-interactive behavior in the user layer. In ME, when you mark a region, it prompts for an action: You can delete, write, or copy the region. But because that behavior inheres in the kernel, you can't change it, so I wasn't able to rework the cut-and-paste facility to my liking. Primitive, atomic operations belong in the kernel; complex, user-interactive operations belong in the user layer. Finally, ME doesn't support file-, buffer-, or command-name completion, so I had to do a lot of typing to get things done.

Setting these caveats aside, ME has lots of useful features. Like BRIEF, it supports multiple resizable windows that can split the screen horizontally and vertically (Epsilon and UniPress EMACS support only horizontal windows), and it permits rectangular cut-and-paste operations. It's got a good virtual memory manager, so you can edit extremely large files.

Like the other editors, it supports regular expressions; thus, in search operations, you can specify not just a literal string, but a wild-card-like pattern. For example, the pattern `^[0-9]+` finds a string of digits of any length at the beginning of a line. Regular expressions are slightly less powerful in ME and EMACS than in BRIEF and Epsilon. You can't form a compound expression like `[a-z]([0-9]|[A-Z])+`, which specifies a single lowercase letter followed by either a string of digits or a string of uppercase letters. ME supports the "|" (or) symbol but doesn't let you use parentheses to specify its precedence. BRIEF and Epsilon do support this method of grouping expressions.

ME shares with BRIEF the ability to associate extension-language functions with program events. These event hooks can activate user-written functions when you insert a character into a buffer, press Ctrl-Break, or exit ME.

ME is unique in making available the source code for its kernel; that costs an additional $100. So in principle, ME is the most extensible of all these editors—though modifying the kernel is more work than you may want to undertake. If you're interested, though, you could link in large-model C functions that, when added to a table of functions, appear as new primitives in ME's extension language. To be compatible with ME, such functions can take only two types of arguments: integers and strings.

Using the Extension Languages

BRIEF and UniPress EMACS base their extension languages on Lisp (see table 3). They're quite similar to one another, though only superficially Lisp-like. The languages use Lisp syntax: parenthesized prefix expressions of the form (op-

continued

Table 3: *Extension language characteristics.*

	BRIEF	EMACS	Epsilon	ME
Derivation	Lisp	Lisp	C	C
Data types	String, int	String, int	All C types	String, int
Recursion	Yes	Partial	Yes	No
State file	No	No	Yes	No
Debugger	No	Yes	Yes	No

erator operand operand ...), and a defun (in BRIEF's case, macro) operator to define new functions. But there aren't any lists; the only data types are strings and integers. You must declare variables before using them, and when a function wants to receive arguments, it has to call a special function to pull them off the stack.

Both languages support recursion, but when I wrote a version of the Fibonacci function for each, I found that only BRIEF ran it correctly. The UniPress EMACS extension language, called MLisp, failed to evaluate the function's arguments properly when it recursed—though it didn't detect a problem—so the function returned the wrong answer. UniPress acknowledges the existence of this bug. Of course, I wouldn't know just where it went wrong if it weren't for the superb MLisp debugger, a true source-level debugger that traces the execution of an MLisp function, shows its effects on the current buffer, and prints the values of variables. Epsilon has a debugger also, though one not quite so fancy; neither BRIEF nor ME provides one.

Epsilon and ME use C as the model for their extension languages, but there's a big difference between the two. Epsilon's EEL is so close to K&R C that the manual sums up the differences in less than a page. It supports strings, integers, arrays, structures, and pointers. You can even use pointers to functions, as the implementation of completion in EEL nicely illustrates. The functions that complete on commands, filenames, and buffer names call the same central function, passing pointers to functions that explore appropriate name spaces.

The ME extension language, by contrast, looks like C, but it isn't C. There are just two data types: strings and integers. Functions aren't required to declare the arguments they receive. The #include statement fails when you supply a quoted string as you normally do in C; ME requires an unquoted string instead. And the Fibonacci function, which Epsilon ran correctly, failed in ME; as with UniPress EMACS, it returned the wrong answer without any indication of error. As it turned out, ME doesn't support recursion—though I had to call Magma to discover that, since I found no mention of the subject in the documentation.

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The four editors use four different methods of compiling, loading, and accessing extension-language code. BRIEF, Epsilon, and ME use standalone compilers. The EMACS compiler is part of the editor's kernel; the load function, when first run on a file containing MLisp code, both compiles the source code and loads the resulting object code into memory. On subsequent loads, so long as the source code hasn't changed, the program skips the compile and just loads the object code.

BRIEF's auto_load command opens a file containing compiled macros but doesn't immediately load them; the macros in that file can then load if and when they're called. Epsilon's state file contains the compiled aggregation of all the source files that make up the user layer and loads the whole thing at startup. ME and EMACS load compiled code on a per-file basis.

To test the extension languages, I created a new command, tag, for each of the editors. Intended for use from within a buffer containing C source code, tag searches for all lines containing either a #define statement or a function declaration, puts those lines in a buffer, and displays the buffer. I got all four programs to work, and the programs are quite similar to one another.

Writing a regular expression that would match all lines with function declarations—and only those—was the hardest part. What finally worked was a pattern that specifies a letter, digit, or underscore, followed by a string of letters, digits, underscores, spaces, and asterisks (for functions that return pointers), followed by a left parenthesis, a string of zero or more arbitrary characters, and a right parenthesis. I anchored the whole pattern to both the beginning and the end of the line on which it occurs. That pattern appears in each of the programs, with minor variations having to do with the representation of the beginning of a line, the end of a line, the any-character wild card, and a literal use of a character, such as the asterisk, that otherwise has special meaning.

Putting It All into Perspective

Text editors, like programming languages, stir up a religious frenzy among their adherents. That's even more true now that text editors include programming languages.

My goal here hasn't been to choose winners and losers, but rather to investigate a representative sampling of a class of products—extensible editors—and to give you a feel for what's meant by extensibility and how you can make use of it. The tag command is quite useful, and it is easy to create. Think about doing the same thing from scratch in a standard language like C—without all the built-in support for windows, buffers, and regular expressions—and you'll begin to appreciate the power of an extensible editor.

Nevertheless, of the editors reviewed, both BRIEF and Epsilon emerge as superior products. They're useful right out of the shrink wrapper—you don't have to extend them to get needed features. And as table 2 shows, they're very fast. But when you do want to add a feature, they make the job about as easy as it can be.

Editor's note: *Listings of the four programs are available in a variety of formats.* *See page 3 for details.* ■

Jon Udell is a BYTE technical editor. He can be reached on BIX as "judell."

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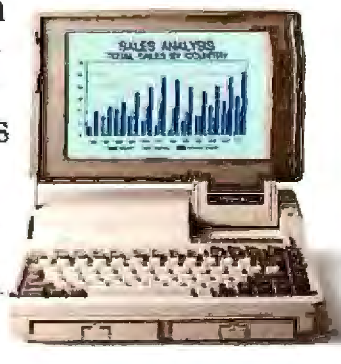

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A Virtual Toolkit for Windows and the Mac

XVT's libraries guarantee Mac-to-PC and PC-to-Mac portability

Ray Valdés

In this era of competing graphical environments, developers face tough choices. Should they commit to a particular system—Microsoft Windows, Presentation Manager, the Macintosh—or try to construct a portable application that abstracts the properties that these systems share? The single-system approach is perilous; the multisystem approach is safer but terribly arduous. XVT (Extensible Virtual Toolkit) 1.1 from the Advanced Programming Institute (API) simplifies the safer course of action.

This $995 product implements a library of functions that provide a common programming interface across windowing environments. Initially, XVT spans the Macintosh and Windows environments. XVT's author, Marc Rochkind, intends to port this virtual toolkit to other present and future industry-standard environments—notably X-Windows and Presentation Manager.

Some graphical environments, like X-Windows and ParcPlace Systems' Smalltalk-80, are designed to be portable to different hardware platforms. However, XVT is different. It is a thin intermediate layer of software that lies between the application program and the native environment. Because this intermediate layer relies on the services of the native environment for presenting menus, tracking the mouse, and framing windows, applications created with XVT have the look and feel of applications written from scratch for the native environment. API provides a sample MacDraw-like application, called XVT-Draw, that illustrates the approach and validates it through proof-by-existence.

XVT provides functions similar to the ones provided by the native Mac and Windows environments. There are functions to create and manipulate windows, draw graphics objects on the screen, allocate relocatable memory blocks, deal with events and messages, put up dialog boxes and alert boxes, read and write files and directories, transfer data to and from the clipboard, and print the contents of a window.

In addition to these functions, XVT provides applications developers with a built-in help subsystem that users access through the system menu, and also with some facilities for debugging through a trace transcript. Other higher-level extensions beyond what the Mac and Windows environments offer include a font-selection menu and support for file directories. Table 1 lists representative XVT functions along with their Windows and Mac counterparts.

The XVT package comes with two disks and documentation. One disk is an 800K-byte 3½-inch Mac disk, the other a 360K-byte 5¼-inch MS-DOS floppy

continued

XVT Draw runs on the Macintosh (above) and on the PC (below).

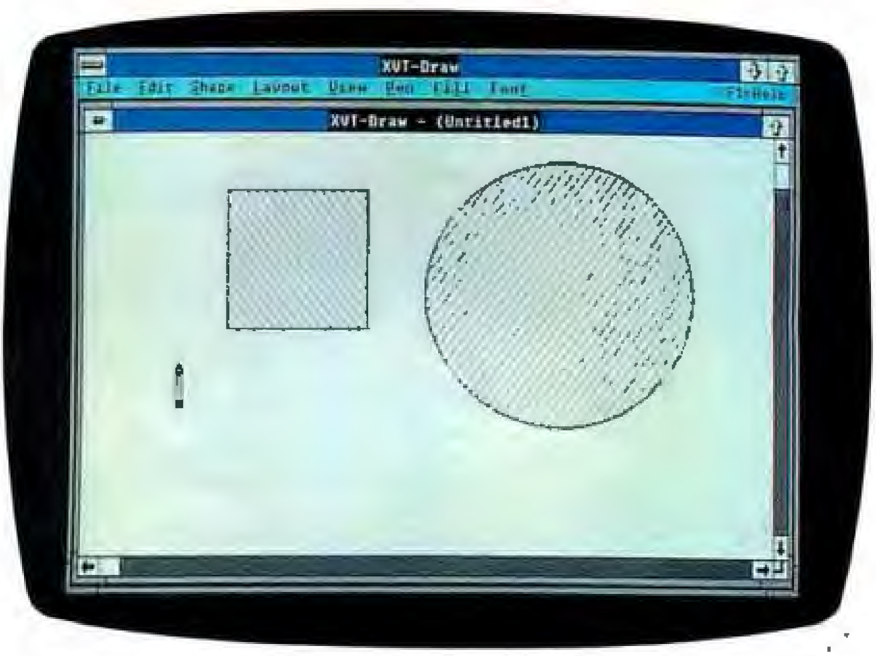

Table 1: *Representative XVT functions, along with their Mac and Windows counterparts.*

	XVT	Mac Toolbox	Windows
Window management	new_window	NewWindow	CreateWindow
	close_window	CloseWindow	DestroyWindow
	show_window	ShowWindow	ShowWindow
	show_window	HideWindow	ShowWindow
	set_front_window	BringToFront	SetWindowPos
	get_client_rect	GrafPort data struct	GetClientRect
	local_global	LocalToGlobal	ClientToScreen
	—	GlobalToLocal	ScreenToClient
	set_title	SetWTitle	SetWindowText
	invalidate_rect	InvalRect	InvalidateRect
	—	BeginUpdate	BeginPaint
	—	EndUpdate	EndPaint
Memory management	galloc	NewHandle	GlobalAlloc
	gfree	DisposHandle	GlobalFree
	glock	HLock, handle data struc	GlobalLock
	gunlock	HUnlock	GlobalUnLock
	grealloc*	SetHandleSize	GlobalReAlloc
	gsize	GetHandleSize	GlobalSize
Events	main_event	app event loop	app Window Procedure
	xvt internal	FindWindow	DispatchMessage
Drawing	set_cur_window	SetPort	GetDC, hDC data struct
	get_cur_window	GetPort	hDC data struct
	move_to	MoveTo	MoveTo
	draw_line	LineTo	LineTo
	draw_arc	FrameArc,PaintArc	Arc
	draw_oval	FrameOval,PaintOval	Ellipse
	draw_rect	FrameRect,PaintRect	Rectangle
	draw_pie	PaintArc,FillArc	Pie
	draw_polygon	FramePoly,PaintPoly	Polygon
	draw_roundrect	FrameRoundRect, PaintRound	Rect RoundRect
Pictures	picture_make	OpenPicture	CreateBitmapIndirect
	picture_open	OpenPicture	SelectObject
	picture_close	ClosePicture	DeleteObject
	picture_draw	DrawPicture	StretchBlt
	picture_free	KillPicture	DeleteObject
	picture_lock	HLock	GetBitmapBits
	picture_unlock	HUnlock	—
Files	open_file_dlg	SFGetFile	OpenFile
	—	FSOpen	OpenFile
	—	FSClose	close
	gread	FSRead	read
	gwrite	FSWrite	write
Misc.	caret_off	—	ShowCaret
	caret_on	—	HideCaret
	obscure_cursor	ObscureCursor	ShowCursor
	pt_in_rect	PtInRect	PtInRect
	set_rect	SetRect	SetRect
	needs_update	SectRect	IntersectRect
	offset_rect	OffsetRect	OffsetRect
	is_rect_empty	EmptyRect	—
	set_rect_empty	SetRect	SetRectEmpty

*Not available in XVT 1.1 but will be available in version 1.2

disk. For version 1.1 of XVT, the Mac disk contains files totaling 464K bytes, in four folders: lib, include, examples, and bin. The MS-DOS disk has a similar structure, except that there are no directories and the files are compressed to fit on the smaller-capacity floppy disk.

The MS-DOS disk includes a batch-installation file and a small decompression program that create a directory structure on your hard disk similar to the one shipped on the Mac disk. The installation process is simple enough that you can ignore the batch file and do the installation manually from the command line. That's my procedure with new programs so that I know exactly what goes where. If you have the Windows development environment installed and know how to use it (a prerequisite for XVT), none of this will present any problem.

When installed, the lib directory contains the XVT library for your C compiler. On MS-DOS, there is one file, XVT.LIB, that is an 87K-byte medium-model library file for the Microsoft C Compiler. On the Mac, there are two files: a Lightspeed C file and an MPW C file (both about 56K bytes in size). You link these libraries, along with your regular Windows and Macintosh libraries, to the XVT applications you write.

The include directory contains header files for your C compiler. There are two, and they are identical for the Mac and MS-DOS. The principal file is XVT.H, which is about 500 lines long and declares the data structures and type definitions used by the XVT virtual environment. In addition, XVT.H has function prototypes for all the XVT functions. That's relatively modest compared to the 2400 lines of the Windows header and the roughly 2000 lines for the Mac header files in Lightspeed. Like these equivalents, XVT.H must be included in all program files that interact with the environment. The second file, called XVT-MENU.H, contains environment-independent menu definitions. Under MS-DOS, the include directory also contains header files for the resource compiler.

The third directory contains small example programs, in source code form, illustrating how to use XVT to accomplish typical tasks. The source files are named for the function they illustrate: scrolling, tracking the mouse, displaying multiple windows, selecting fonts, listing a directory, and using a clipping region. Each cookbook-type example does its job, but I wish API had provided more of them. Much more helpful would have been the source code to a medium-size application

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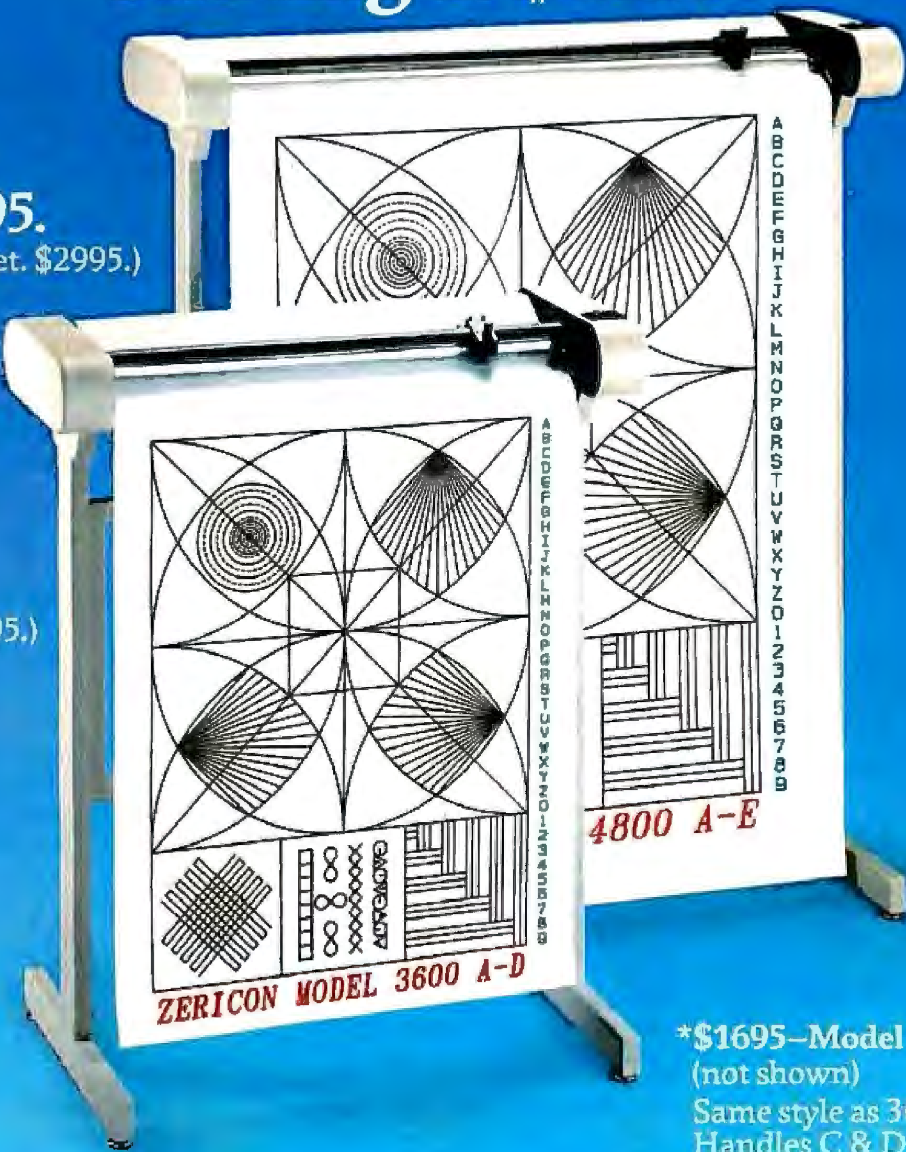

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XVT (Extensible Virtual Toolkit) 1.1

Type
Portable software development tool for Macintosh and Windows graphical environments

Company
Advanced Programming Institute, Ltd.
P.O. Box 17665
Boulder, CO 80308
(303) 443-4223

Format
One 360K-byte 5¼-inch floppy disk (for IBM PCs and compatibles) and one 800K-byte 3½-inch floppy disk (for Macs)

Hardware Needed
IBM PC or compatible capable of running Microsoft Windows, and/or a Macintosh 512KE or higher

Software Needed
For IBM PCs and compatibles: Windows 2.03 or higher; Microsoft C 5.1 or higher; and Microsoft Windows Software Development Kit 2.10 or higher
For the Mac: Macintosh System 5.0 or higher, Lightspeed C 3.0 or higher

Language
C

Documentation
60-page Technical Overview

Price
$995 (complete package includes both Mac and PC versions)
Programmer's Reference Manual. $25

Inquiry 1064.

that combines the functions into a whole program. API offers nothing like that, although it says it plans to distribute the source code to the XVT-Draw sample.

The bin directory, the fourth and last directory, contains two executable files: the XVT-Draw example application and the Help File compiler utility. On MS-DOS, XVT-Draw is 134K bytes in size; on the Mac, it is 104K bytes. The Help File compiler is of similar size on both machines—about 30K bytes.

Setting Up an XVT Environment

Installing XVT was a breeze on the Mac, and easy on the PC, too—once I had installed the basic development tools that this product requires.

For this review, I used a Compaq 386 with 2 megabytes of memory, a 70-megabyte hard disk drive, and a Micro Display Systems Genius full-page display. My Mac system is a Mac SE with 4 megabytes of memory, a Radius 68020 accelerator, a Radius full-page display, and a 40-megabyte hard disk drive. These hardware configurations represent what many consider the minimum needed for doing serious development work on PCs and Macs. Gone forever are the days when you could fit a C compiler, text editor, linker, debugger, libraries, *and* your source code on a dual-floppy machine with 512K bytes of memory. The XVT package imposes no additional hardware requirements beyond what you need to run the native toolkits.

XVT assumes you have the standard development tools for your particular environment. On the Mac, this means either Lightspeed C 3.0 or MPW C. I use Lightspeed C, and I was up and running with no problems. On my MS-DOS system, I used Microsoft C 5.1 and the Microsoft Windows Software Development Kit (SDK) 2.03. Installing the XVT library and compiling and running the sample programs were fairly simple.

For Mac programmers used to the purity of one type of screen display, one size of memory pointer, one floating-point option, and one user interface, it is a jarring experience to encounter the strange world of MS-DOS and Windows. There's a gauntlet of irritating and unpleasant experiences to run through as you ascend the learning curve. Some novice programmers might unfairly associate the XVT product with these negative experiences, but I want to emphasize that none of this has to do with the quality or ease of use of the XVT product, which is commendable.

Using XVT

Writing an application using XVT is much like writing it for the native environment, except that you use the above-mentioned header files in place of the native headers and you use the XVT library *in addition to* the native libraries. All other development tools operate in the same way. The only caveat is that, with MS-DOS, you have to use the medium-model compiler option.

Native Mac and Windows applications are built around a top-level event loop that invokes appropriate event handlers. XVT works similarly, but the event loop is buried in the XVT library. Applications programmers need only supply the handlers, a process that's like what you do under Windows when you specify a `WndProc` for each class of window. According to API, the upcoming version 1.2 of XVT will make the buried internal event loop accessible to the application through an event-hook procedure.

I compiled and ran all the sample applications on both my PC and my Mac. Then I combined several of the examples—one that featured mouse tracking and another that manipulated multiple windows—into a single program. Finally, I took a toy drawing application that I've written for both the PC and the Mac and ported it to XVT. Everything went smoothly. I should emphasize, though, that I'd originally written my drawing program in a portable way so I could create both PC and Mac versions. A program written specifically for either environment would, naturally, be more difficult to port to XVT.

XVT Subsystems

The services provided by the XVT environment are a blend of those supported on the Mac and in Windows. XVT contains subsystems for event processing, memory management, window creation, graphics drawing, menu handling, file reading and writing, printing, and clipboard management. Some of these are closer to the Mac in spirit, and others are closer to Windows.

The memory management subsystem is philosophically closer to Windows than to the Mac because there is no double-indirection of handles as on the Mac. Also, as in Windows, you have to lock an object in memory to obtain a pointer to it. The memory functions include the following: allocate a relocatable memory block, free it, lock it (and return a pointer to the locked block), unlock it, and return its size. In version 1.1, there's no function to resize a memory block, so you'll have to do that yourself. The company says this was an oversight and it will add the function to version 1.2.

In the area of event processing, the 15 event types in XVT represent a conceptual middle ground between the 11 Mac events and the 96 message types defined in Windows. The mouse events are mouse up, mouse down, move, and double-click. Window events are update, activate, close, destroy, resize, vertical scroll, and horizontal scroll. The remaining events are keyboard character, menu command, font selection, and application termination. XVT excludes the Mac network event from this set because Windows does not support it. Likewise, it excludes all Windows intertask communication events. A new feature not found in either Mac or Windows is the

continued

font-selection event, the foundation of XVT's higher-level support for menu display of font styles and sizes.

The window management subsystem includes functions to create a new window, return the size of its content area, close the window, invalidate its content (i.e., invoke repainting), query the system for the frontmost window, set the clipping rectangle, set the window title, get and set the cursor, convert from window coordinates to screen coordinates, and set the scroll position and scroll range. These routines are closer to the Mac than to Windows. You don't need to register different window types, and you don't have to specify a separate event handler for each window class.

The graphical functions are philosophically closer to Windows than to the Mac. XVT supports the concept of a pen tool (for drawing lines and outlines of shapes) as well as a brush tool (for filling in hollow areas like the interior of a rectangle). Pens come in different colors (white, black, and transparent), styles (currently only a solid style—no dashed styles), and draw modes (e.g., XOR, OR, COPY). There are 12 brush styles (for filling areas, including white, light gray, dark gray, diagonal, and vertical).

There are routines to make a window available for drawing, set the pen and brush tools, draw shapes (line, polyline, polygon, rectangle, oval, roundrect, arc, pie, and text), set text-font attributes (size, family, style), and perform queries.

There's an asymmetry in XVT's implementation of stored pictures, which contain the cumulative result of a series of drawing commands. On the Mac, an XVT picture is stored as a PICT file; this preserves object structure and simplifies redisplay, scaling, and interapplication transfer. Although Windows supports a PICT analogue—the Metafile—XVT, for some reason, doesn't use it. Instead, XVT implements stored pictures as bitmap objects, although the manual hints that this may change. There are routines to create a picture, open it for the accumulation of drawing commands, close it, play it back within a scaled rectangle, lock it for reading and writing to a file, and dispose of it.

Menu-bar support includes routines to add check marks to menu items, enable and disable items, draw the menu bar, set menu text, and support the font-selection menu. File-system support implements an abstract object called a directory, which represents native directories on local file systems. There are built-in functions that return the start-up directory or obtain a directory selection from the user by means of a dialog box.

Printing is another messy device-dependent topic that causes problems even for programmers writing in a single native environment. XVT supports the necessary operations: begin printing, start a new page, end a page, and end printing.

Dialog support in XVT is straightforward. Some simple dialogs are built in (e.g., an about box, an alert box, and a prompt box) along with the more elaborate file-directory dialog mentioned earlier. Custom user dialogs are supported through XVT functions (e.g., `check_radio_button`, `enable item`, `get item text`, `check box`) in conjunction with resource files in the native environment.

You can try out XVT-Draw for nothing and see how it feels.

Is There a Performance Penalty?

With interactive graphical applications, performance is often a subjective matter that doesn't lend itself to quantitative measurement. For some applications, a twentieth-of-a-second lag can make a difference. For others, differences of whole seconds may not matter much. For example, on my high-end Compaq 386 running any Windows application, the mouse tracking always feels clunky and sluggish when compared to the feel of the mouse on my lowly Mac 512 (never mind my 68020 Mac). But when I look at published benchmarks of programs that run on both machines (e.g., Aldus PageMaker), the numbers don't bear that out.

With one exception, all the operations I tried out using the XVT library—tracking the mouse, dragging a window, typing in text, choosing menu items—felt like equivalent operations found in native applications. The single performance anomaly I observed relates to Windows. When I selected an occluded child window within an XVT application, the time required to uncover, highlight, and redraw the window seemed substantially longer than in a native Windows application. This was true even for a do-nothing example program that did no computation or redrawing within the window.

That's a small thing that many people might not even notice. Fortunately, you can see for yourself without investing $1000 to buy XVT. You can download XVT-Draw, the sample application, from many electronic bulletin boards and information utilities as shareware, in both Mac and Windows versions. Try out its functions and see how they feel. If the application you want to write is similar in size and structure, it should have equivalent performance.

It comes down to this: The XVT layer is about as thin as it can be while meeting the design goals of portability and real-world functionality. The level of abstraction seems appropriate. On a subsystem-by-subsystem or function-by-function basis, the decisions made by its author are reasonable. Although you or I might not make the same choice in every case, none stands out as horribly mistaken. It's very unlikely that an average programming shop will surpass this particular implementation in terms of efficiency, quality, and robustness.

Some innovative applications might require choices in function mapping that are different from those made in XVT. You can sidestep XVT, though, and use the native environment, although the resulting application will be nonportable.

What's Wrong with XVT?

XVT does have a weak point. The quality of its documentation is typical of that from a small, tool-oriented vendor with limited resources: It's OK, but it doesn't go far enough. The documentation consists of a 60-page Technical Overview, a 160-page Programmer's Reference Manual ($25 extra), and a smattering of technical notes and updates. Explanations are understandable and clear despite the dense nature of the topic at hand.

But the documentation lacks information. There's no index and no up-to-date list of the functions available in the system. I was able to find what I needed in the header files, with their function prototypes, but API should provide a separate list and group the functions by subsystem as well as alphabetically.

Assorted release memos, bug reports, and technical notes are confusing for the same reason: There's no catalog of functions to which you can relate them. The bug reports do serve one useful purpose, though. They indicate the health of the product. I was pleased to find evidence of benign incremental improvements (characteristic of a product beginning its journey to maturity), rather than mysterious

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items describing unexplained fatal errors. Still, this is no excuse for not having a better-organized, up-to-date reference manual.

In fairness to API, I should note that many of the above criticisms applied equally to the Mac Toolbox and the Windows SDK when they were introduced. As with those two systems, it is likely that XVT will continue to improve—particularly in documentation. The company promises that version 1.2 will be out by the time this review is printed and that it will have some (but not all) of the improvements suggested above.

Making the Decision

XVT is a tremendous bargain for developers who must have portability but don't want to commit time and resources to developing in two native environments. I'm convinced that, for these people, the savings in time, aggravation, and opportunity costs will easily exceed XVT's price by one or even two orders of magnitude. But the decision to commit to a development platform like XVT is a major one, comparable to choosing a programming language. The problem is the large gap between the $25 you can spend to peruse the XVT manual and the $995 you have to spend before you can actually try out the product. Perhaps API can come up with some intermediate arrangement to help prospective buyers familiarize themselves with XVT.

If you are interested in writing portable, graphically based applications software, you can't afford to ignore XVT. Get the Technical Overview, which is a free article reprint, and order the Programmer's Reference Manual for $25. Download and try out the sample shareware application, XVT-Draw. Become familiar with your target environments if you are not already familiar with them. Try writing some small native applications. Then consider purchasing XVT.

If you are part of an organization with a healthy R&D budget, order a copy of XVT and try it out. Even if your organization eventually decides not to use it, chances are you will have learned a number of useful concepts. If using XVT keeps you from including WINDOWS.H or the Mac Toolbox header files in every module of your application, it will have been worth at least its purchase price. ■

Ray Valdés is president and founder of Sapphire Software, a technology consulting firm in San Francisco, California, that specializes in the design and development of graphical software. He can be reached on BIX c/o "editors."


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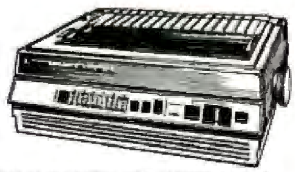

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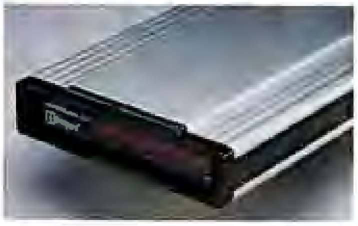
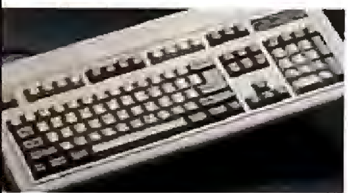


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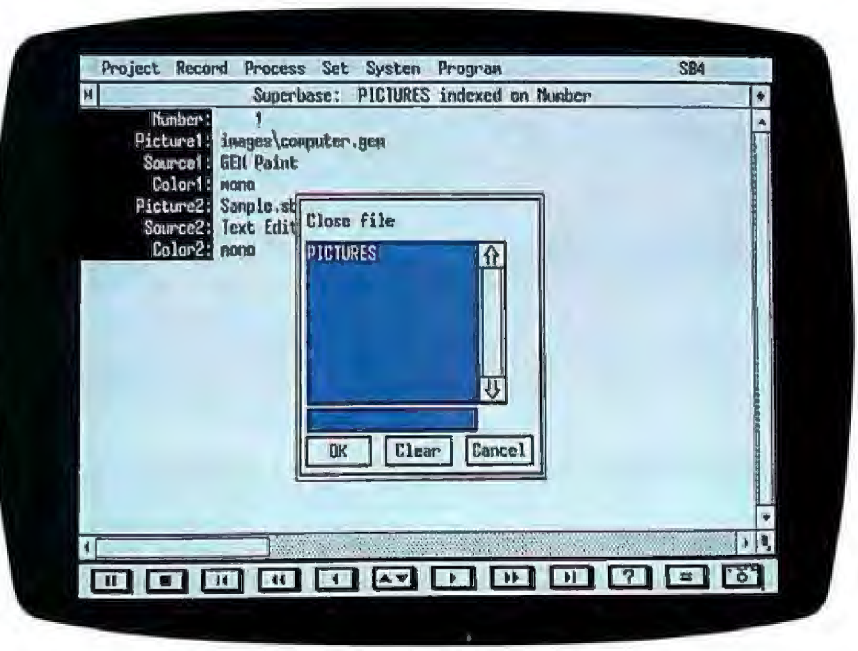
Superbase 4

A great concept whose design may not be so super

Nick Baran



At the very least, Superbase 4 is an intriguing program. It's part of a new breed of database managers for IBM PCs and compatibles that can include graphics images and external text files as fields in a database table. Superbase 4 is also a full-featured relational system. It has a large BASIC-like programming language and a query system modeled after Structured Query Language (SQL).

Of course, supporting all those different things—graphics images, text files, a programming language, and a query system—may be a great concept, but it's a lot to promise. And the version of the program I worked with, version 4.0, is not without its faults.

Based in the U.K., Precision Software, the developer and vendor of Superbase 4, currently offers the program for Digital Research's GEM windowing environment, which runs under MS-DOS. Superbase 4 is bundled with GEM 2.1, which is about two years old. According to a company spokesperson, there are no plans at present to bundle the program with GEM 3.0. However, customers can run Superbase 4 under version 3.0 if they purchase it separately. Precision Software says it plans to introduce a version of the program running under Microsoft Windows early this year.

Installation and Operation

The Superbase program comes on four 5¼-inch floppy disks plus an additional six floppy disks for the GEM windowing system. The installed program plus GEM requires about 1.5 megabytes of disk space. Superbase 4 requires 640K bytes of RAM and a graphics board and monitor supporting CGA, Hercules, or EGA. I tested Superbase 4 on an IBM PC XT with an Orchid 80286 TurboEGA board.

Installation is simple, although you must learn the basic workings of GEM, which is similar to Microsoft Windows in its operation but slower. Whether you like GEM or not, you'll have to get used to it if you want to run Superbase 4.

Superbase 4 depends on a graphics-based environment and therefore requires a mouse to operate effectively, although it is possible to run it entirely from the keyboard. You can access almost all operations from pull-down menus at the top of the screen or from a series of control buttons along the bottom of the screen. The control buttons act essentially like the buttons of a tape recorder, letting you "fast-forward" and "rewind" the records of a database, move sequentially from one record to the next, and perform ad hoc queries and searches of the open database file.

You can display records in Form view, Table view, or Record view. The Form view lets you enter or display data using a custom-designed form from the Superbase Forms Editor. Clicking on the fast-forward button in Table view lets you view a screenful of records at a time. Record view displays a single record at a time and is the default format for entering data. The control buttons include options for moving to the top and bottom of the file, moving forward or backward through the file, searching on a keyword in the file, or performing a query. However, there were some bugs in the control button functions. Occasionally, the system would report "end of file" without displaying any records moving either forward or backward through the file. The

continued

Superba e 4 version 4.0

Type
DBMS

Company
Precision, Inc
(subsidiary of Precision Software, Inc)
8404 Sterling St., Suite A
Irving, TX 75063
(214) 929-4888

Format
Four 5¼-inch floppy disks for Superbase; six 5¼-inch floppy disks for GEM

Hardware Needed
IBM PC, XT, AT, PS/2, or compatible with 640K bytes of memory; a hard disk drive with at least 1.5 megabytes of free space, a CGA, Hercules, or EGA graphics card; one floppy disk drive

Documentation
Two spiral-bound user's manuals (approximately 200 pages each); pocket reference guide

Price
$695 (includes GEM 2 1)

Inquiry 851.

only solution was to close the file and reopen it.

Relational Structure

Superbase 4 uses the standard relational table structure of rows and columns. It includes text, numeric, time, and date data types, as well as an external data type that can point to a graphics or text file. A nice feature is that text data types can have multiple response fields, allowing up to nine separate data entries for a single field, with a total of 500 characters. Each table is stored as a separate database file, and common fields can link the tables to other Superbase 4 database files. Superbase uses a linking system similar to SQL, in which the common field names are appended with the corresponding database filename (e.g., `lastname.ACCOUNTS = lastname.CUSTOMER`). You can therefore use fields from other open databases in any data-entry form or report. Superbase 4 allows the importing of dBASE, data-interchange format, and ASCII files, and also exporting to ASCII file format.

Superbase 4 can have multiple database files open, but you can access only one database at a time interactively. You can set up a form or report that accesses and displays data from multiple databases, however. Using the system's link facility, you can set up links between as many as 99 database files. Unfortunately, the use of multiple files is poorly documented in the Superbase user's manuals. Almost all the tutorials and examples focus on single-file operations.

Superbase 4 maintains separate index files for each indexed field in the database. Indexes are optional, but you must have at least one index per database. You can view your data sorted in the order of the open index. Only one index can be open at a time. Indexes are automatically updated as you enter data. Searches and queries are very fast if they are performed on the field of the currently open index. I tried a text search of a 700-record database and obtained the answer almost instantaneously. However, Superbase 4 took an additional 4 or 5 seconds to search through the rest of the file when there were no more matches.

As long as you stick to searches on the field of the open index, the performance is quite good. Since the indexes update automatically, your data is always in sorted order according to the open index. Thus, the performance of sorting is not really an issue, although you can slow down data entry considerably if you define too many indexes.

Two Programs in One

Superbase 4 actually consists of two programs. The primary program is the Superbase 4 application itself, which includes facilities for entering and displaying data, querying database files, and developing programs in the Superbase 4 programming language, called DML (for database management language). DML is modeled after the BASIC programming language. It includes over 200 commands and a complete set of math, date, time, string, and financial functions. You can generate programs using the Superbase 4 text editor or with any simple text editor.

The Superbase application includes a full-screen text editor and utilities for viewing the status of files, listing directories, and determining available system memory. The directory-listing function was erratic and would occasionally report a blank screen and return to the main menu, even though the directory contained files. A major drawback of the program is that there is no facility for temporarily exiting to MS-DOS. This is a major omission for any competitive application package on the market today.

The other component of the package is a separate Forms Editor, which you use to design data-entry forms and reports for Superbase databases. You must exit Superbase temporarily to use the Forms Editor. You can locate fields anywhere on the screen, specify calculated fields and fields from other databases, and design windows and boxes to enhance the appearance of the form. Forms can consist of multiple pages.

Unfortunately, forms design is not a trivial exercise for the uninitiated. The manual even warns that the technique of drawing patterns and outlines on forms "may be difficult to master." It was difficult, indeed. After laboriously designing a form, I lost the entire thing because of an error I made in specifying a box border. Most users are accustomed to more forgiving interfaces. Simply warning the user in the manual is not enough.

Reports are a subset of forms created in the Forms Editor. You can define groups, headers, footers, and the usual array of calculations and functions that you would expect in a full-featured relational database. However, the report generator has some serious design flaws. If you inadvertently select an option such as Group or Footer and then decide you don't need to use it, there seems to be no way to change your mind. For example, if you decide to add a footer and click on this menu option, you can't remove the footer area from your report without clearing the screen, thus losing the rest of your report. If you leave the footer area blank, the computer freezes when you attempt to print the report. Another odd quirk of the report generator is that you can run test reports only on the printer, not on the screen.

Reports are saved as Superbase DML programs, and, to run a report, you must execute it from the Superbase 4 Program menu option. Unfortunately, all Superbase 4 programs have the same file extension, so there is no way of telling which programs are reports and which are used for other purposes; you have to name your files so that you can remember which ones are reports. This is a major inconvenience.

A Few Problems

As I mentioned earlier, one of the big selling points of Superbase 4 is its ability to display graphics images and text files as fields in a database. Superbase does this by providing an `External file` data type, which is used as a pointer to the external text or graphics file. Any file containing ASCII text or graphics images in IMG, PCX, GEM, or PICT format can be included as a field in a database record. Thus, theoretically, you could have a database of addresses with a field

continued

that contains a bit-mapped image of the house at each address. Or you could have a database that catalogs a series of reports or text documents.

However, there's a big problem. GEM doesn't support enough memory to display graphics images in Superbase. Specifically, GEM does not support expanded memory—so Superbase 4 can use only 640K bytes. I found that bit-mapped graphics images could not be displayed because of memory limitations (I got an "insufficient memory" message even with a small, 10K-byte image produced with PC Paintbrush).

Superbase has a complete Query Definition facility for defining and storing complex queries.

Precision Software acknowledged this problem and told me that there is some improvement if you use GEM 3.0. However, this means that you must purchase GEM 3.0 separately, which is hardly a satisfactory solution. The Superbase manual suggests removing GEM desk accessories and disabling your RAM disk to free up more memory for graphics display. These are not satisfactory solutions, either. Presumably, a version of Superbase under Microsoft Windows would support expanded memory and get around the present memory limitations.

The use of external text files works somewhat better. Superbase displays external text files using its own text editor. You can either display the text file in a window on the screen or expand the window to the full screen. You can edit the external file from within Superbase using the text editor. Superbase 4 also lets you search external text files for text strings. However, it will not open the file and display the text string that it found; it simply lists the record containing the external file with the desired text string. You still have to find the string by scrolling through the flagged external file.

Another drawback is that Superbase matches lines to search for text strings; thus, it won't find a text string if it's on multiple lines. If you were storing a large library of documents, it would be almost impossible to ensure that text strings of interest were always located on one line.

Searches of text files are extremely slow. Searching for a string in a simple four-record database with one text file of about 500 words and another of about 40 words took close to 30 seconds. Text searches would be slow indeed with, say, 500 external files.

One of the more promising features of Superbase 4 is its query facility. While you can perform simple single-file queries using the control button at the bottom of the screen, Superbase 4 also includes a complete Query Definition facility for defining and storing complex queries. The Query Definition facility consists of a menu-driven dialog box in which you enter the desired fields, the filter or query criteria, and the appropriate format parameters for the output of the query. In fact, you can output fairly sophisticated reports using the Query Definition facility. You can specify field groups and, as I mentioned earlier, fields from other databases.

The problem is that the Query Definition facility is poorly documented and difficult to use. Virtually no examples are provided for developing a query using multiple files. I struggled for several hours with a simple query involving two database files and a common last name. There should be a more comprehensive, step-by-step tutorial for the query facility. While it may be powerful, it's not much good if it's too difficult to learn.

Superbase 4 also includes a communications function for dialing other computers using Superbase and exchanging files via the XMODEM protocol. As it stands in the current version, communications must be performed in auto-dial mode, and each machine must be set up to either answer or receive only. Communications commands can also be included in DML programs.

Superbase 4 has the potential to be a powerful and useful database program, but the 640K-byte memory restriction severely limits it. If Precision Software does indeed port the program to Windows and, better still, to Presentation Manager, it will be worth a second look. Still, the documentation and tutorial material should be greatly improved, and the bugs in the program eliminated.

While Superbase 4 has great promise, it's difficult to recommend in its current form. ■

Nick Baran is a BYTE senior technical editor based in San Francisco. He can be reached on BIX as "nickbaran."

Spring 1989

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BYTE

Macintosh Special Edition

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Information (Mis)management

Because of the wide proliferation of computer viruses, the free exchange of information may be in peril

Welcome to BYTE's third Macintosh Special Edition. One of the main functions of these supplements is to give you not merely good information on the Macintosh family of computers, but information you won't find anywhere else. You'll use any computer more effectively if you know more about it than simply how to turn it on and what application to run. The Mac is no exception.

Even if you don't need to write your own INIT (as Paul Mercer and Fred A. Huxham show us how to do in "Extending Your Macintosh"), you'll be better off *knowing* the meaning of all those icons marching along the bottom of the Mac's screen at boot time.

And as your use of the Mac becomes more sophisticated, the time may come when you do want to write an INIT. That information will be found here in BYTE. Advanced computer users are like that: They want to use their computers in ways that their designers never anticipated. Either way—as solid background information or practical how-to information—the BYTE Macintosh Special Editions fill the bill.

The Dark Side

For quite some time now, I've watched the outbreaks of various strains of Mac viruses come and go, but I had never encountered one myself. My interest in them was merely as a programming curiosity. However, three things occurred recently that changed my feelings on the matter.

First, an author unwittingly sent us a Mac disk infected with the SCORES virus. Curious or not, we scrupulously check submitted disks for virus infections, so we detected it right away. No Mac system at BYTE was ever infected. However, as you might expect, the author was not thrilled to find out that his computer was.

Second, during the first week of November, a worm worked its way through Internet, bogging down numerous networked Unix systems. This worm was "benign" in that it only made copies of itself and gobbled up processor time. However, if the worm had deleted or mangled data on the systems that it invaded, the damage could have been immense.

This incident disturbs me a great deal, since most of the Macs at BYTE are linked by AppleShare to a single server. As stated earlier, while we exercise caution in using new software that we receive, anyone on the network might slip up and infect the Mac he or she is working on. Under the right conditions, the infection could spread to every Mac on the network. This is not a very pleasant thought.

Third, I have hanging from a nail on my office wall one of the infamous green-banded Mega-ROM CD-ROMs from Quantum Leap Technologies. The notoriety of this particular CD-ROM is that some of the Mac applications on it are infected with an nVIR virus. Unlike an infected hard disk, which you can erase to wipe out an infection, the data on a CD-ROM is permanent.

The infection on this particular CD-ROM is there for all time—or at least until I retire it for use as a Frisbee. The release of an infected CD-ROM was absolutely unintentional on Quantum Leap's part, and the company has since redistributed new, uninfected copies of it. You can be certain that Quantum Leap is unhappy about the incident, both for the notoriety and because of the cost to make a new master disk and have new copies pressed.

The upshot of all this is that computer viruses are starting to cost us in terms of time to clean systems of infections, to replace corrupted files, or to redistribute software. But it can cost us more than that. Computing in the next decade will rely heavily on our ability to freely access and use vast amounts of information on computer systems across the country or across the globe. We will hurl ideas composed of text and images off satellites to other nations. Their citizens, as they get to know us, will really—and finally—become our neighbors.

But viruses threaten this capability, even as we put it into place. To safeguard ourselves from these viruses, we might have to isolate our networks and hamper the free exchange of information, which is the very soul of the Information Age. This loss is the one that will cost us dearly.

As one who helps spread information about computers in BYTE, I'd really hate to see this happen. But unless we convince every programmer that viruses foul the very environment in which thoughts are freely exchanged and great ideas grow, I don't see any other possible outcome.

Information exchange is important in nonelectronic media, too, of course. For example, we put the information that we think you want in these supplements. Now it's time for information to flow the other way.

Are these supplements meeting your needs? What helps you most? What would you like to see handled differently? Only if you pick up your keyboard and write us—via either conventional mail or BIX mail—can we find out. Only through the exchange of information can we find out if we're serving your interests. We welcome your input.

—Tom Thompson
Senior Technical Editor
(BIX name "tom_thompson")

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Circle M11 on Reader Service Card (DEALERS: M12)

Studio/8: The Best Paint Yet

THE FACTS

Studio/8
$495

Requirements:
Mac II with at least 1 megabyte of RAM (2 megabytes strongly recommended) and a hard disk drive with at least 6 megabytes open for Studio/8; for color painting, video board with 16- or 256-color support; System 5.1 or higher.

Electronic Arts
1820 Gateway Dr.
San Mateo, CA 94404
(415) 571-7171
Inquiry M225.

If **Studio/8** put on even one more ounce of features, it would bust the britches of the Macintosh. This color paint program from Electronic Arts is stuffed with more tools and capabilities than most people will know what to do with, including artists. It comes on five disks, and, like SuperPaint, it has all the things you'd expect in a great Mac paint program, plus things from slick programs like PixelPaint and Photon Paint.

But it also has some of the tools for drawing straight lines and smooth curves that made FreeHand and Illustrator famous. With so much to work and play with, it's an addictive program. The good news is that it's an expensive addiction, so if you can't afford color hardware and lots of memory, you're safe.

I had the luxury of using Studio/8 on a Mac II with a video card supporting the full 256 colors. It's in 256-color mode that Studio/8 really shines. It's where you can use its advanced paint techniques, like blending and smearing colors, mixing colors, painting with patterns (either the ones in the Toolkit or ones that you have done), and working with pseudowatercolors. There's also a color-sampling tool (it looks like an eyedropper) that essentially picks up a color from the canvas and puts it on the brush or in the airbrush—very helpful if you have to match a custom color. A masking feature lets you cover up any sections of a drawing you want shielded, just like masking up the chrome before spray-painting a car.

One of the program's fanciest provisions lets you easily make a paintbrush out of pretty much any pattern or drawing; you draw it, and then the brush loads up with it. This is really handy for doing complex but finely detailed background patterns. But even on a Mac with 2 megabytes of RAM, I couldn't always pull this off. When I tried to load some of the package's predone backgrounds to use them as brushes, I got "insufficient memory" messages.

Besides a complete set of painting and drawing tools, Studio/8 has a feature called Gallery, which lets you set up a virtual slide show of images. You can establish the sequence of pictures to appear on the screen and go from one picture to the next using things like dissolves and disassembling checkerboards. For some folks, this is total overkill, but if you're in a situation where you have to make presentations, this is a good alternative to buying another package specifically for that purpose.

The program can open images stored in the following formats: PICT, Tag Image File Format, and MacPaint; you can bring in Encapsulated PostScript files from Illustrator using the Clipboard. For output, you can send documents to a LaserWriter, a Tektronix Model 4693D printer, or a Mirus film printer. I checked only the laser-printer output, and after working with the glorious colors on the screen, the lasered images were downright depressing.

As a box of artist's tools, this is one of the best collections available. You can use it to draw anything from clean schematics to soft illustrations to wildly patterned designs. It's straightforward, but for the more advanced functions, you'll have to consult the manual, which is 300 pages long and looks like a high school geometry textbook.

This is the most versatile paint package I've used. Just listing what it can do would take lots of room. A program this meaty is for people who want a do-just-about-everything color paint/draw program and who also have ample memory—someone with a corporate art director's budget.

The bad side of Studio/8 is its capacious memory needs. I often couldn't save files, getting instead an "error: volume full" message. I had no trouble with simple images of only a few colors, though.

Besides lots of memory, the one other essential component for using Studio/8 is restraint. The temptation is to pig out and use everything in the Toolkit at least once. It's easy to be dazzled by all the tools and tricks and end up with screens that are the artistic equivalent of Las Vegas.

—*D. Barker*

Pascal on the Mac

Just Enough Pascal from Symantec's Think Technologies Division is an add-on module for the language that gets the novice user comfortable with working within the Lightspeed environment by building a game application called GridWalker.

A special desk accessory functions as a tutorial for all the program's operations. There are 20 segments in the

continued

assembly of GridWalker, and the desk accessory has different buttons for explanation, assembly, and tinkering. The advantages of handling a tutorial like this aren't totally obvious until it is used inside Lightspeed Pascal.

This desk accessory adds yet another window to the multiwindow Lightspeed Pascal environment that you can refer to at any time. Your attention remains on the screen, instead of having to manipulate a book. We found it novel and convenient to do things this way, especially since the Just Enough Pascal desk accessory is a small hypertext system. You can click on highlighted words, and the program jumps to relevant discussion of the word inside the message box. The user interface is well thought out.

Just Enough Pascal's approach to teaching is that you learn by doing. In the assembly section, the actual construction of the game occurs. You select text from the message box (a special mode allows complete selection of the relevant text in its entirety without requiring you to scroll) and paste it into the main program listing. No direct typing is necessary. The steps are clearly laid out and logical in progression. After you've assembled one part, the tinkering section gives instructive ways to change things within the program (while telling you how not to mess it up for the next section to build on), so that the important points of the construction are understood.

The tinkering area is probably the best innovation in this type of learning system. It lets the student self-test his or her understanding of learned concepts by extending them into areas where answers are not given by the program. The student is required to think, not simply to memorize, encouraging the type of thinking that a programmer is required to do in real life when solving programming problems. Of course, Just Enough Pascal also manages to teach the Pascal syntax that is necessary to use the language.

Definitions abound, and they are used by succeeding parts of the lesson in their normal context. This forces the student to master the definition or the assembly becomes problematic.

What happens if you make a mechanical error of some sort—say, failing to paste the correct text into the right place? A troubleshooting button offers helpful suggestions as to where things might go wrong. However, the correct program list (and unit changes) is provided for each step. Even if you terminally munge something, you can continue the lesson using the preceding building blocks that you know to be correct. This kind of error recovery shows the attention to detail that Just Enough Pascal has.

Just Enough Pascal is a learning experience that does not condescend to the novice, but teaches the language in a straightforward manner, using a tool (the desk accessory) that is well suited to the job. Whether you are new to the language or just want to brush up on it, this is a great learning tool.

—Anne Lent and Laurence H. Loeb

THE FACTS

Just Enough Pascal
$75

Requirements:
Mac Plus, SE, or II with 1 megabyte of RAM, Lightspeed Pascal 2.0, and System 5.0 or higher.

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Extending Your Macintosh

Paul Mercer and Fred A. Huxham

Some helpful rules for programming start-up routines on the Macintosh

With the latest System software, the Macintosh Plus has most of the software features of the Mac SE, such as the Script, Sound Managers, and hierarchical menus. It has these additional capabilities even though it was introduced in 1986 (more than a year before the Mac SE), with a completely different set of ROMs. New features like these are added to a Mac's repertoire when you drag a new version of the System software to the start-up volume.

How does the Mac System software accomplish this? It quietly patches the Macintosh Toolbox at start-up using special resources that are called INITs and PTCHes. An INIT is a small block of executable 68000 code with a single entry point at offset 0 that is used to initialize parts of the Mac operating system at boot time. INITs normally install resources like device drivers, and the PTCHes, which are similar to INITs, patch out known bugs in the Mac Toolbox. Other INITs modify or extend the behavior of the system. We'll focus on the latter function, and we'll give you guidelines about when to use an INIT and some sample code to help you write one.

In the original System software design, all INITs resided in the System File. When the Macintosh was started up, ROM boot code loaded the system INITs and executed them. But as Mac software became more sophisticated, third-party developers wanted to customize system behavior in other directions and wrote their own INITs. But this probably caused more problems than it solved, for two reasons. First, the number of INITs that could be installed was limited to 36, since the ROM boot code executed only those INITs numbered 0 through 35 in the System File. Second, there was no standard way to install INITs into the System File, so most third-party vendors wrote their own installer programs. Alas, many of these applications were quite limited, and some even had bugs that could corrupt the System File, rendering it useless.

Faced with these predicaments, Apple introduced the INIT 31 mechanism in January 1986. It's documented in detail in *Inside Macintosh* Volume IV.

The INIT 31 Mechanism

INIT 31 is a simple solution to the above problems. It makes dealing with INITs much simpler for both users and developers. First, no more installer programs are required. To install an INIT, you simply place it in the start-up volume's System Folder and reboot. To remove an INIT, you drag its icon from the System Folder.

One of the last system INITs to run, INIT 31 searches the System Folder, looking for certain files that contain other INIT resources, and executes each of them as if it were within the System File. The limit of 36 INITs is also gone.

INIT 31 is a System INIT, an INIT resource that resides in the System File. When the Mac boots, all the INIT resources in the System File are executed. When INIT 31 is executed, it does the following:

- Searches for files of type INIT, cdev, or RDEV within the boot volume's System Folder.
- Opens the resource fork of each file of the specified type.
- Checks to see if the file has a sysz resource ID = 0. The first long word of the sysz resource specifies the size of a contiguous block of memory that must be available in the system heap for this particular INIT to run. If this space isn't available, INIT 31 tries to resize the system heap to accommodate the sysz request. If a sysz 0 resource isn't included in the file, INIT 31 assumes a 16K-byte default space. A sysz resource doesn't assure that your INIT will get the memory requested. An INIT must still check for errors when allocating memory.
- Checks the file for INIT resources.

continued

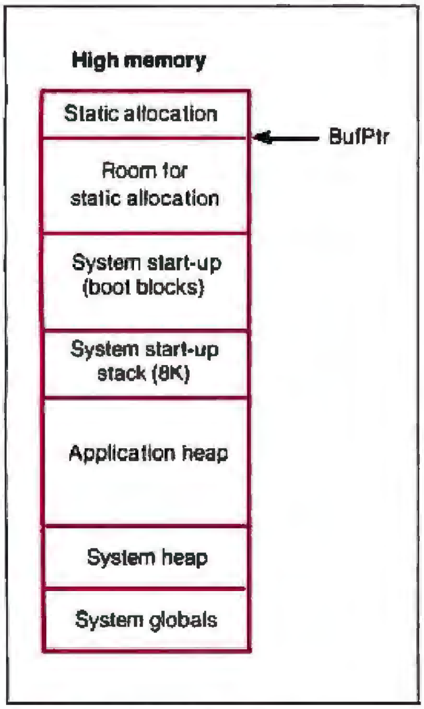

Figure 1: *Macintosh RAM at system start-up.*

Each INIT resource is loaded via a `GetIndResource` call, and MC68000 registers A0 through A6 and D0 through D7 are saved. A handle to the currently running INIT is placed in register A0. The running INIT can use this handle to call, for example, `SetHandleSize` or `DetachResource` on itself. INIT 31 does not actually lock down the INIT resource, so it must have its locked bit set.

After executing the last INIT resource of a particular file, the resource fork of the file is closed, and INIT 31 continues its file search.

Some Guidelines

Since INITs are run very early in the start-up process, it is important that you adhere to the Macintosh rules of defensive programming. It is completely unacceptable for an INIT to crash at boot time. It is just as unacceptable to not have an "abort" option in the beginning of the INIT, which, if invoked, causes it to simply exit. This is necessary because, despite your best efforts, an INIT can break or cause a system crash because of future System changes or through interaction with another INIT. Over time, most INIT developers have adopted a casual standard: Holding down the mouse button or the Shift key will abort an INIT's execution. Listing 1, `UserTestInstall` from the `ScrapSaver` source, shows one way to detect this condition.

It's generally a bad idea to require user interaction at INIT time. Since the only Toolbox manager initialized at INIT 31 time is QuickDraw, it is difficult to prompt the user for any input. Although you can initialize other Toolbox managers from the INIT itself, Apple designed the INIT 31 mechanism for installing device drivers and system patches. The user should not have to pay attention to the computer at boot time; filling in dialogues or answering questions in order to get the computer to run is not desirable. The `UserTestInstall` function does not completely violate this principle of no user interaction, since the standard behavior (i.e., your Macintosh boots and the INIT installs) requires no user input.

As a rule, it's also a bad idea to design anything major, in terms of size or execution time, as an INIT. If you have an

INIT that is larger than a few K bytes or requires more than a second or two to run, there's probably a better way to do what you want done. Think hard about your goals and see if you can do the same job by turning your INIT into an application. This approach makes even more sense now that MultiFinder is available.

Allocating Permanent Memory

When you're implementing an INIT that patches a system trap or installs a driver, you must allocate memory permanently. There are two main ways to do this. Figure 1 illustrates a simplified Macintosh memory map at initialization time.

The system heap is the best place for static memory allocation, since it is initialized only once at boot time. Before INIT 31, a number of obstacles stood in the path of increasing the system heap if your memory requirements were too great. At that time, most machines had only 512K bytes of RAM, and permanently reserving big blocks of memory hindered the functionality of the computer. Increasing the system heap even caused a number of popular applications to break due to their incorrect assumptions about the system memory layout.

Back in the early days of Macintosh programming, it was common practice for programmers to get their static memory by lowering the low-memory system global `BufPtr`. This global holds the default stack pointer value that the Macintosh System Segment Loader uses to launch applications. Initially, this global points close to the top of available RAM. Programmers lowered `BufPtr` by the number of bytes they required, and then they used the memory that was between the old and the new `BufPtr` as their permanent memory. Using this memory would appear to actually wipe out the stack used by the current INIT. To avoid this fatal situation, the stack is actually allocated much lower in memory at INIT time.

Lowering `BufPtr`, however, has its limitations. The most notable is that since subsequent INITs (and potentially, applications) might likewise lower `BufPtr` to get memory, it is impossible to free any of the previously allocated memory and return it to the heap for use by the system. An easy target for abuse here is the Macintosh file system cache. Despite the fact that you can use the Control Panel desk accessory to adjust the memory allocated for caching, unless the cache INIT was the last program to lower `BufPtr` (it usually is last, since it is numbered 35), it cannot increase or shrink the cache memory until the machine is restarted. Changing the cache to use system heap memory would be an improvement for many users.

Using INIT 31 with ScrapSaver

Macintosh users know the Clipboard as the place where objects are placed for subsequent pasting after a cut or copy command. This simple yet effective mechanism is the vehicle by which users interchange data between applications. The Clipboard (or "desk scrap" in *Inside Macintosh* terminology) is not maintained across reboots of the machine. `ScrapSaver` is an INIT that remedies the loss of desk scraps by writing the scrap file to disk. A breakdown of `ScrapSaver` looks like this:

• At boot-up, see if `ScrapSaver` is to be loaded. This includes checking the

continued

mouse button and Shift key, as well as the System version (4.0 or higher).
• Install a ShutDown procedure for writing the scrap file to disk.
• Determine the name of the scrap file by reading it from the boot blocks.
• Read the scrap file header to determine the current scrap size and data type, and store this information in the appropriate low-memory globals to initialize the scrap.
• Draw an appropriate icon on the desktop. The icon reflects the type of object in the scrap file.

The ScrapSaver INIT remedies the loss of desk scraps by writing the scrap file to disk.

Shutdown Procedures

As described above, ScrapSaver makes use of the Macintosh Shutdown Manager, which is documented in *Inside Macintosh* Volume V. It gives developers a formal interface for restarting or shutting down the Mac, as well as routines to install and remove procedures that will be called at shutdown and restart time. When a ShutDown procedure is installed, the programmer must specify when in the shutdown process it is to be called. There are five different possibilities:

• `sdOnPowerOff` calls procedure before power-off.
• `sdOnRestart` calls procedure before restart.
• `sdOnUnmount` calls procedure before unmounting the start-up volume.
• `sdOnDrivers` calls procedure before closing drivers.
• `sdRestartOrPower` calls procedure before either power off or restart.

Since a Toolbox trap—UnloadScrap—already exists for flushing the scrap file to disk, ScrapSaver simply has to install a ShutDown procedure to call it. Installing a ShutDown procedure involves allocating a nonrelocatable memory block in the system heap to hold the code. The block is allocated in the system heap, since it needs to be around when the Shutdown Manager calls it. The ShutDown procedure is then moved into this block with the BlockMove trap. The Shutdown Manager trap SDInstall is called to place a pointer to this code into the shutdown task queue. We pass sdOnUnmount as one of the arguments to SDInstall, since we want the scrap file flushed before volumes are unmounted whenever the machine is shut down or restarted. Listing 2 shows the code from ScrapSaver to install this procedure.

The INIT Code

It is a straightforward task to write an INIT that reads in the Clipboard file and fills in the necessary low-memory globals needed to get the system to recognize the scrap. Table 1 lists the Scrap Manager low-memory globals.

continued

Listing 1: `UserTestInstall`, *from the* `ScrapSaver` *source, is code that detects when the Shift key or mouse button is down to abort the execution of the INIT.*

```
;--------------------------------------------------------------------------
;       UserTestInstall tests the mouse button and
;       Shift key states and will return NE
;       if either is down
;--------------------------------------------------------------------------
UserTestInstall:
        moveq.l #-1,d7          ; d7 is the Boolean result
        clr.b   -(sp)           ; Boolean result for _Button
        _Button
        move.b  (sp)+,d0        ; get and test result
        bne.s   UserNoInstall
        pea     myKeys(a6)      ; my copy of the key map
        _GetKeys
        btst    #shiftBit,shiftByte+myKeys(a6)
                                ; check the Shift key
        bne.s   UserNoInstall
        moveq.l #0,d7           ; everything is wonderful
UserNoInstall:
        tst.w   d7              ; set the condition codes and
        rts                     ;   return
```

Listing 2: *The code that defines the custom* `ShutDown` *procedure and the code to install it. Note: The assembly language macro for* `UnloadScrap` *is actually spelled* `UnlodeScrap`.

```
;--------------------------------------------------------------------------
;       This ShutDown procedure simply flushes
;       the scrap file to disk
;--------------------------------------------------------------------------
MyShutDownProc:
    clr.l   -(sp)           ; function result
    _UnlodeScrap            ; write the scrap to disk
    addq.l  #4, sp          ; ignore result
    rts
MyProcEnd:
;--------------------------------------------------------------------------
;       Copy the ShutDown proc to the system
;       heap and install it into the ShutDown task queue
;--------------------------------------------------------------------------
InstallShutDownProc:
    moveq.l #-1,d7          ; error is initial function result
    move.l  #MyProcEnd-MyShutDownProc, d0
                            ; get length of ShutDown code
    _NewPtr sys             ; make space in system heap, result in a0
    bne.s   NoShutDown      ; error!

    move.l  a0,a1           ; put in a1 for _BlockMove
    lea     MyShutDownProc, a0 ; source
    move.l  #MyProcEnd-MyShutDownProc, d0
                            ; length again
    _BlockMove              ; copy the code
    move.l  a1,-(sp)        ; the ShutDown procedure pointer
    move.w  #sdOnUnmount, -(sp) ; call this procedure at ShutDown time
    _SDInstall              ; unmounting disks
    moveq.l #0, d7          ; no error
NoShutDown:
    tst.w   d7              ; error
    rts
```

At INIT 31 time, all these variables are uninitialized. In addition to these variables, we must understand the format of the scrap file (see figure 2).

To install a valid scrap object, the INIT needs to do the following:

- Store the name of the scrap file into the low-memory Scrap Manager global ScrapTag.
- Store the address of ScrapTag (970 hexadecimal) into the ScrapName variable.
- Read the data-size field of the scrap file and store it into the ScrapSize variable. We need to increase the size of this field to account for the size of the data-type and data-size header fields. The definition of ScrapSize includes them.
- Initialize the ScrapHandle variable to Nil, since we don't really read the scrap into memory.
- Initialize the ScrapCount variable to zero.
- Initialize the ScrapState variable to zero.

Performing the above steps is all that's required to initialize the Scrap Manager. When an application later needs to access the scrap, the scrap file contents will be read into memory. See listing 3 for the complete ScrapSaver assembly language code. Listing 4 contains the INIT resource information in Rez format. Listing 5 is the MPW make file.

The Start Manager chapter of *Inside Macintosh* Volume V states that the name of the scrap file is stored in the boot blocks of a Macintosh volume. Reading this requires the use of the Device Manager instead of the File Manager, since the boot blocks are not part of any file. They are actually logical blocks 0 and 1 (each block is 512 bytes, so the boot blocks are 1K byte in size) of every Macintosh volume that has a System Folder.

In addition to specifying the scrap filename, the boot blocks are used to store a number of other system parameters, including additional System File names and the size of the event queue. Page 351 of *Inside Macintosh* Volume V contains a chart of the boot block contents. You should note that using this very implementation-specific information unnecessarily will needlessly jeopardize your program's ability to remain compatible in future implementations of the Macintosh operating system. Even though all these low-memory system globals are listed in the SysEqu.a file distributed with Apple's MPW development system, the careful programmer will always be wary of direct accesses (writing in particular) to system globals. Generally, if a functional interface is provided to accomplish something, use it. But since there's no other way to achieve ScrapSaver functionality without writing to low memory, we have to run the risk of future incompatibility.

Hello, World

ScrapSaver's use of the Shutdown Manager contains an important lesson for all Macintosh programmers. The Shutdown Manager is available on all Macintosh computers using System 4.0 and higher. If you called a Shutdown Manager function without ascertaining the presence of System 4.0 or higher, you'd be greeted by system error ID = 12, unimplemented trap error. Fortunately, it's easy to check the System version with the use of the SysEnvirons function.

SysEnvirons wasn't available until System 4.1, so for our purposes, we'll check for a System 4.1 or higher. Once again, this seems like a catch-22 situation; however, the library code for SysEnvirons handles pre-System 4.1 situa-

continued

Table 1: *Scrap Manager low-memory globals.*

Name	Location (in hex.)	Purpose	Space allocated
ScrapSize	960	Scrap length	Long
ScrapHandle	964	Memory scrap	Handle
ScrapCount	968	Validation byte	Word
ScrapState	96A	Scrap state	Word
ScrapName	96C	Pointer to scrap name	Pointer
ScrapTag	970	Scrap filename	STRING[15]

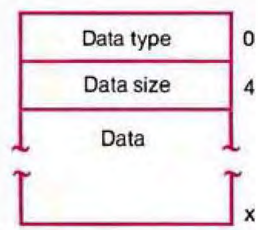

Figure 2: *The format of the scrap file.*

Listing 3: *The complete MPW assembly language source code for the* ScrapSaver *INIT.*

```
;  ScrapSaver is an INIT that reads the desk scrap at boot time.
;  It also installs a ShutDown procedure to flush the scrap file to
;   disk at Restart or ShutDown time.
;
;  Version 2.01     Changed SetScrapGlobals to skip scrap size adjust if size is 0
;
;  Copyright 1987, 1988 Paul Mercer.
;
;  Thanks to Darin Adler for many helpful comments and suggestions.
;
;------------------------------------------------------------------------------------------

              INCLUDE     'SysEqu.a'        ; get Macintosh system symbols
              INCLUDE     'Traps.a'         ; get Macintosh system trap macros
              INCLUDE     'ShutDownEqu.a'   ; get Shutdown Manager symbols
```

```
; symbols relating to boot blocks
BBSize          equ     1024            ; size of boot blocks
BBScrapName     equ     $6A             ; offset from start of boot blocks to scrap name
ScrapNameSize   equ     16              ; size of scrap filename (Pascal STR[15])

; system symbols
sysNeeded       equ     $0410           ; ShutDown Manager is only in System 4.1 and up
shiftByte       equ     7               ; byte and
shiftBit        equ     0               ;  bit offset in key map for Shift key

; icon resource id numbers
noScrap         equ     129             ; empty scrap file
blobScrap       equ     130             ; unknown scrap type
TEXTScrap       equ     131             ; TEXT scrap type
PICTScrap       equ     132             ; PICT scrap type
noInstallScrap  equ     133             ; aborted ScrapSaver install

; my globals allocated on the stack
myStackFrame    record  0,decrement     ; my stack frame
myKeys          ds.b    128/8           ; KeyMap structure for GetKeys in routine UserTestInstall
theWorld        ds.b    SysEnvRec       ;  for SysEnvirons in routine SysTestInstall
paramBlock      ds.b    ioHVQElSize     ;  for File System calls
bootBlocks      ds.b    BBSize          ;  buffer for loading boot blocks
smallBuffer     ds.l    1               ;  buffer for reading scrap variables
varsSize        equ     *
                endr

ScrapSaver:     main                    ; executable code entry point

        import  InitShowINIT,ShowINIT31   ; ShowINIT31 code
        import  SysEnvirons             ; SysEnvirons glue
        with    myStackFrame            ; use the stack frame

;-----------------------------------------------------------------------------------------------------------
;  This is the standard, but not required, header for executable resources
;-----------------------------------------------------------------------------------------------------------
        bra.s   CodeStart               ; skip header data
        dc.l    ('INIT'     )           ; resource type INIT
        dc.w    1                       ; id 1
        dc.w    2                       ; version 2

CodeStart:
        bsr     InitShowINIT            ; initialize the ShowINIT library right away
        link    a6,#varsSize            ; allocate my variables on the stack
        movem.l d3-d7/a2-a6,-(sp)       ; save the standard Toolbox registers

        bsr.s   UserTestInstall         ; test to see if user objects to installation
        bne.s   NoInstall               ;  and exit quickly
        bsr.s   SysTestInstall          ; ascertain system requirements
        bne.s   NoInstall               ;  and exit if not
        bsr.s   InstallShutDownProc     ; install the scrap file flushing ShutDown proc
        bne.s   NoInstall               ;  but exit if we fail
        bsr     ReadBootBlocks          ; read in the boot blocks into a buffer
        bne.s   NoInstall               ;  but exit if error
        bsr     ReadScrapFile           ; read the scrap size and type (d5, d6)
        bsr     SetScrapGlobals         ; and effect the scrap change
        bsr     GetIconNumber           ;  and pass these registers to GetIconNumber
                                        ;  which returns an ICN# resource id in d7
Exit:
        move.w  d7,-(sp)                ; push the ICN# id for ShowINIT31
        bsr     ShowINIT31              ; draw the icon
        movem.l (sp)+,d3-d7/a2-a6       ; restore the previously saved registers
        unlk    a6                      ; deallocate my variables
        rts                             ; return to INIT31
NoInstall:
        move.w  #noInstallScrap,d7      ; specify the 'X' icon
        bra.s   Exit                    ;  and fall through to common exit
```

continued

```
;------------------------------------------------------------------------------------------
;  UserTestInstall tests the mouse button and Shift key states
;   and will return NE if either is down
;------------------------------------------------------------------------------------------
UserTestInstall:
        moveq.l #-1,d7                  ; d7 is the Boolean result
        clr.b   -(sp)                   ; Boolean result for Button
         _Button
        move.b  (sp)+,d0                ; get and test result
        bne.s   UserNoInstall
        pea     myKeys(a6)              ; my copy of the key map
        _GetKeys
        btst    #shiftBit,shiftByte+myKeys(a6)  ; check the Shift key
        bne.s   UserNoInstall
        moveq.l #0,d7                   ; everything is wonderful
UserNoInstall:
        tst.w   d7                      ; set the condition codes
        rts                             ;  and return

;------------------------------------------------------------------------------------------
;  SysTestInstall returns NE if the System version is older than 4.1
;   to make sure we have the ShutDown Manager facilities
;------------------------------------------------------------------------------------------
SysTestInstall:
        moveq.l  #-1,d7                 ; d7 is the Boolean result
        clr.w    -(sp)                  ; OSErr function result
        move.w   #1,-(sp)               ; versionRequested is 1
        pea      theWorld(a6)           ; the environsRec argument
        bsr      SysEnvirons            ; call SysEnvirons
        move.w   (sp)+,d0               ; get and test OSErr result
        bmi.s    SysNoInstall           ;  and exit if real error (negative)
        cmp.w    #sysNeeded,theWorld.systemVersion(a6)  ; we need System 4.1
                                                        ;    for _ShutDown
        blt.s    SysNoInstall
        moveq.l  #0,d7                  ; everything is wonderful
SysNoInstall:
        tst.w    d7                     ; set the condition codes
        rts                             ;  and return

;------------------------------------------------------------------------------------------
;  A simple ShutDown procedure that flushes the scrap file to disk
;------------------------------------------------------------------------------------------
MyShutDownProc:
        clr.l    -(sp)                  ; function result
        _UnlodeScrap                    ; write the scrap to disk
        addq.l   #4,sp                  ; ignore result
        rts
MyProcEnd:

;------------------------------------------------------------------------------------------
;  Copy the ShutDown proc to the system heap and install it
;    into the ShutDown task queue
;------------------------------------------------------------------------------------------
InstallShutDownProc:
        moveq.l #-1,d7
        move.l  #MyProcEnd-MyShutDownProc,d0 ; get length of ShutDown code
        _NewPtr sys                    ; make space in system heap, result in a0
        bne.s   NoShutDown             ; error!

        move.l  a0,a1                  ; put in a1 for _BlockMove
        lea     MyShutDownProc,a0      ; source
        move.l  #MyProcEnd-MyShutDownProc,d0 ; length again
        _BlockMove                     ; copy the code

        move.l  a1,-(sp)               ; the ShutDown procedure pointer
        move.w  #sdOnUnmount,-(sp)     ; call this procedure at ShutDown time
        _SDInstall                     ;  unmounting disks
        moveq.l #0,d7                  ; no error
```

```
NoShutDown:
        tst.w   d7                  ; error
        rts

;-----------------------------------------------------------------------------------------------
; Read the boot blocks into the boot blocks buffer,
;  return NE if reading fails
;-----------------------------------------------------------------------------------------------
ReadBootBlocks:
        lea     paramBlock(a6),a0   ; point to parameter block with a0

        clr.l   ioFileName(a0)      ; no name for input
        clr.w   ioVRefNum(a0)       ; zero is the default volume
        clr.w   ioVolIndex(a0)      ; zero the volume index to use ioVRefNum
        _HGetVInfo                  ; get the default volume info
                                    ;  so we can use the Device Manager
                                    ;  to read the boot blocks
         bne.s  @Error              ; exit on error

         move.w ioVDrvInfo(a0),ioVRefNum(a0) ; get the default volume's drive
         move.w ioVDRefNum(a0),ioRefNum(a0)  ;  number and driver refnum
         lea    bootBlocks(a6),a1   ; load the boot blocks here
         move.l a1,ioBuffer(a0)
         move.l #BBSize,ioReqCount(a0)       ; load this many bytes
         move.w #fsFromStart,ioPosMode(a0)
         move.l #0,ioPosOffset(a0)  ; boot blocks are at beginning of volume
         _Read                      ; read the scrap filename (Device Manager call)
@Error:
         rts


;-----------------------------------------------------------------------------------------------
; Returns scrap type and scrap size in d5, d6,
;  these values are zero if the file is empty or doesn't exist
;-----------------------------------------------------------------------------------------------
ReadScrapFile:
        clr.l   d5                  ; initialize the output type and size
        clr.l   d6
        lea     paramBlock(a6),a0   ; point to parameter block with a0

        lea     bootBlocks+BBScrapName(a6),a1 ; a1 points to scrap name read
                                              ;  from the boot blocks
        move.l  a1,ioFileName(a0)   ; set up the filename
        move.w  theWorld.sysVRefNum(a6),ioVRefNum(a0) ; get the boot drive
                                                      ;  working directory
        clr.b   ioFileType(a0)      ; the Mac uses only file type zero
        move.b  #fsRdPerm,ioPermssn(a0)  ; we want only read permission
        clr.l   ioOwnBuf(a0)        ; no special access path buffer
        _Open
        bne.s   @Error

        lea     smallBuffer(a6),a1  ; load the scrap type and size here
        move.l  a1,ioBuffer(a0)
        move.l  #4,ioReqCount(a0)   ; it is a long word
        move.w  #fsFromStart,ioPosMode(a0)
        move.l  #0,ioPosOffset(a0)  ; size is at start of file
        _Read                       ; read in scrap type
        bne.s   @AfterOpenError
        move.l  (a1),d5             ; return scrap type here
        _Read                       ; read in scrap size
        bne.s   @AfterOpenError
        move.l  (a1),d6             ; return scrap size here

@AfterOpenError:
        _Close
@Error:
        rts
```

continued

```
;-----------------------------------------------------------------------------------------------
;  Take scrap size in d6
;   and set up the Scrap Manager low-memory globals:
;     ScrapSize
;     ScrapName
;     ScrapTag
;     ScrapHandle
;     ScrapCount
;  Note that this is the only routine that directly accesses low memory
;-----------------------------------------------------------------------------------------------
SetScrapGlobals:
        lea      bootBlocks+BBScrapName(a6),a0 ; a0 points to scrap name read
                                               ;  from the boot blocks
        lea      ScrapTag,a1                   ; ScrapTag holds the scrap name
        moveq.l  #ScrapNameSize,d0         ; this many bytes
        _BlockMove
        move.l   a1,ScrapName          ; set up ScrapName to point to ScrapTag
        move.l   d6,d0
        beq.s    ZeroSize
        addq.l   #8,d0                 ; adjust for type & size header
ZeroSize:
        move.l   d0,ScrapSize          ;  and store it for the Scrap Manager
        clr.l    ScrapHandle           ; initialize the rest of the Scrap Manager
        clr.w    ScrapCount            ; variables
        clr.w    ScrapState
        rts

;-----------------------------------------------------------------------------------------------
;  GetIconNumber takes the scrap type in d5 and the scrap size in d6
;   and returns the appropriate ICN# resource id in d7
;-----------------------------------------------------------------------------------------------
GetIconNumber:
        move.w   #noScrap,d7           ; start with this guy
        tst.l    d6                    ; any scrap?
        beq.s    GetDone               ;  nope, so fall through

        lea      TypeToIDTable,a0      ; point to the types table
NextType:
        move.w   (a0)+,d7              ; get the resource id
        move.l   (a0)+,d0              ;  and the corresponding type
        beq.s    GetDone               ; if at end of list then blob out
        cmp.l    d5,d0                 ;  else if we haven't matched the type then
        bne.s    NextType               ;  loop again

GetDone:
        rts

;-----------------------------------------------------------------------------------------------
;  This table consists of an icon resource id followed by a scrap type
;   and is terminated by a generic icon id followed by a zero type
;-----------------------------------------------------------------------------------------------
TypeToIDTable:
        dc.w       TEXTScrap
        dc.l       ('TEXT')

        dc.w       PICTScrap
        dc.l       ('PICT')

        dc.w       blobScrap
        dc.l       0                   ; end of list marker

;-----------------------------------------------------------------------------------------------
;  End the INIT with some more embedded version info
;-----------------------------------------------------------------------------------------------
        dc.b       'Version 2.0'
        dc.b       'Copyright 1987, 1988 Paul Mercer'

        end
```

Listing 4: *The* ScrapSaver *resources in Rez format.*

```
#include "Types.r"

type 'Paul' as 'STR ';

resource 'Paul' (0) {
    "ScrapSaver Version 2.0\r©1987, 1988 P. Mercer"
};

resource 'BNDL' (128) {
    'Paul',
    0,
    {
      'ICN#',
      {
         0, 128
      },
      'FREF',
      {
         0, 128
      }
    }
};

resource 'FREF' (128) {
    'INIT',
    0,
    " "
};

/* Finder Icon */
resource 'ICN#' (128) {
    {   /* array: 2 elements */
        /* [1] */
        $"00 00 00 00 00 00 00 00 07 E0 00 00 04 20 00"
        $"03 F8 1F C0 06 20 04 60 04 40 02 20 04 7F FE 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 02 20 04 00 00 60 04 00 10 20"
        $"04 00 01 20 04 00 88 20 04 00 01 E0 04 00 26 20"
        $"04 04 08 20 04 00 90 20 04 00 20 20 04 08 20 20"
        $"04 01 40 20 04 00 40 20 06 04 40 60 03 FF FF C0",
        /* [2] */
        $"00 00 00 00 00 00 00 00 07 E0 00 00 07 E0 00"
        $"03 FF FF C0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 03 FF FF C0"
    }
};

/* noScrap */
resource 'ICN#' (129) {
    {
        $"00 00 00 00 00 00 00 00 07 E0 00 00 04 20 00"
        $"03 F8 1F C0 06 20 04 60 04 40 02 20 04 7F FE 20"
        $"04 04 04 20 04 08 02 20 04 10 01 20 04 20 00 A0"
        $"04 40 01 20 04 80 02 20 05 00 04 20 04 80 08 20"
        $"04 40 10 20 04 20 20 20 04 10 40 20 04 08 80 20"
        $"04 05 00 20 04 02 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 06 00 00 60 03 FF FF C0",

        $"00 00 00 00 00 00 00 00 07 E0 00 00 07 E0 00"
        $"03 FF FF C0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 03 FF FF C0"
    }
};

/* blobScrap */
resource 'ICN#' (130) {
    {
        $"00 00 00 00 00 00 00 00 07 E0 00 00 04 20 00"
        $"03 F8 1F C0 06 20 04 60 04 40 02 20 04 7F FE 20"
        $"04 04 04 20 04 08 E2 20 04 11 31 20 04 20 10 A0"
        $"04 40 31 20 04 81 E2 20 05 02 04 20 04 80 08 20"
        $"04 48 10 20 04 20 20 20 04 10 40 20 04 08 80 20"
        $"04 05 00 20 04 02 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 06 00 00 60 03 FF FF C0",

        $"00 00 00 00 00 00 00 00 07 E0 00 00 07 E0 00"
        $"03 FF FF C0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 03 FF FF C0"
    }
};

/* TEXTScrap */
resource 'ICN#' (131) {
    {
        $"00 00 00 00 00 00 00 00 07 E0 00 00 04 20 00"
        $"03 F8 1F C0 06 20 04 60 04 40 02 20 04 7F FE 20"
        $"04 04 04 20 04 09 22 20 04 10 91 20 04 22 48 A0"
        $"04 49 21 20 04 84 82 20 05 12 44 20 04 88 08 20"
        $"04 44 10 20 04 22 20 20 04 10 40 20 04 08 80 20"
        $"04 05 00 20 04 02 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 06 00 00 60 03 FF FF C0",

        $"00 00 00 00 00 00 00 00 07 E0 00 00 07 E0 00"
        $"03 FF FF C0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 03 FF FF C0"
    }
};

/* PICTScrap */
resource 'ICN#' (132) {
    {
        $"00 00 00 00 00 00 00 00 07 E0 00 00 04 20 00"
        $"03 F8 1F C0 06 20 04 60 04 40 02 20 04 7F FE 20"
        $"04 04 04 20 04 08 02 20 04 10 21 20 04 21 94 A0"
        $"04 40 C9 20 04 82 72 20 05 21 24 20 04 92 C8 20"
        $"04 49 90 20 04 25 20 20 04 12 40 20 04 08 80 20"
        $"04 05 00 20 04 02 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 06 00 00 60 03 FF FF C0",

        $"00 00 00 00 00 00 00 00 07 E0 00 00 07 E0 00"
        $"03 FF FF C0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 03 FF FF C0"
    }
};
```

continued

```
/* noInstallScrap */
resource 'ICN#' (133) {
    {
        $"00 00 00 00 00 00 00 00 00 07 E0 00 00 04 20 00"
        $"03 F8 1F C0 06 20 04 60 04 40 02 20 04 7F FE 20"
        $"04 00 00 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 30 0C 20 04 78 1E 20 04 3C 3C 20 04 1E 78 20"
        $"04 0F F0 20 04 07 E0 20 04 03 C0 20 04 07 E0 20"
        $"04 0F F0 20 04 1E 78 20 04 3C 3C 20 04 78 1E 20"
        $"04 30 0C 20 04 00 00 20 04 00 00 20 04 00 00 20"
        $"04 00 00 20 04 00 00 20 06 00 00 60 03 FF FF C0",
        $"00 00 00 00 00 00 00 00 00 07 E0 00 00 07 E0 00"
        $"03 FF FF C0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 07 FF FF E0"
        $"07 FF FF E0 07 FF FF E0 07 FF FF E0 03 FF FF C0"
    }
};
```

tions. To check the System version number, you need to call the SysEnvirons function and then check the systemVersion field of the SysEnvRec. If this field is equal to 0401 or greater, the machine is running System 4.1 or higher.

Listing 6 gives the Pascal declarations for the SysEnvRec record and the SysEnvirons function.

Since SysEnvirons is so straightforward to use, there's no reason not to take advantage of its services.

Listing 5: *The MPW make file for the* ScrapSaver *INIT.*

```
# Simple MakeFile for ScrapSaver INIT

ScrapSaver ƒƒ ScrapSaver.r
  Rez ScrapSaver.r -o ScrapSaver

ScrapSaver ƒƒ ScrapSaver.a.o ShowINIT.a.o
  Link ScrapSaver.a.o ShowINIT.a.o ∂
    -o ScrapSaver ∂
    "{Libraries}"Interface.o ∂
    -rt INIT=0 -ra =16 ∂
    -sn Main='ScrapSaver'
  SetFile -a B ScrapSaver -t INIT -c Paul      # set the bundle bit
  Duplicate ScrapSaver "{SystemFolder}" -y  # copy finished file to System
                                              Folder
```

Listing 6: *The Pascal declarations for the* SysEnvRec *record and the* SysEnvirons *function.*

```
{ SysEnvirons data structure }

SysEnvRec = RECORD
                environsVersion:        INTEGER;
                machineType:            INTEGER;
                systemVersion:          INTEGER;
                processor:              INTEGER;
                hasFPU:                 BOOLEAN;
                hasColorQD:             BOOLEAN;
                keyBoardType:           INTEGER;
                atDrvrVersNum:          INTEGER;
                sysVRefNum:             INTEGER;
            END;

FUNCTION SysEnvirons(versionRequested: INTEGER; VAR theWorld: SysEnvRec):
                      OSErr;
```

ShowINIT

To inform you of its installation, ScrapSaver uses ShowINIT, a piece of public domain code written by Paul Mercer. This code is distributed in the form of an MPW object file and is available on BIX. ShowINIT lets an INIT draw an icon to the screen after loading, complete with a mask that visually indicates that the INIT has successfully installed itself. It takes care of all the nitty-gritty work involved in creating and displaying an icon's data structures. ShowINIT is attractive, since all the icons are drawn in a line at the bottom of the screen. Because ShowINIT decides where an INIT's icon is drawn, those INITs that use this resource avoid overlapping displays. Those INITs not using this resource unknowingly draw over icons previously displayed. This simple icon-drawing mechanism is powerful. For instance, to show that you have aborted the loading of an INIT, you can draw a special icon.

To use ShowINIT, you must call the routine InitShowINIT at the very beginning of the INIT code. Just before exiting from the INIT and returning to the caller (INIT 31), you will call ShowINIT31. ShowINIT31 expects a word-size argument on the stack specifying the ID number of the ICN# resource to draw.

Be Careful Out There

Even though INITs are relatively easy to write, you should apply careful thought before going headlong into the implementation process. Part of the fun in programming the Macintosh is changing system behavior with an INIT trap patch.

Try to temper your enthusiasm for hacking the system with a good dose of thought on compatibility and survival in an ever-changing world. ■

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Paul Mercer is a member of the Finder team at Apple Computer. Fred A. Huxham does software research at Farallon Computing. They can be reached on BIX c/o "editors."

Introducing the New Extended TextEdit

Michael Ogawa

Macintosh's basic text editor has been upgraded in several important ways

One reason for the success of the Macintosh is that Apple provided hundreds of routines in ROM and System software for realizing the human interface envisioned by its designers. Routines are available for drawing primitive graphics shapes, for varied character sets, for drawing and manipulating windows, and for user interaction with an application program. Among the facilities provided to developers is a text-editing system that supports proportionally spaced fonts and is capable of automatic word wrap and various text justifications.

Apple continually upgrades its System software, providing developers with stronger and more flexible routines to incorporate into their applications. Apple recently extended the capabilities of the supplied text-editing facilities.

About TextEdit

Apple's text-editing facilities are a part of the Macintosh Toolbox known as TextEdit, and they are built on other Toolbox routines for drawing and text measurement. TextEdit provides basic text-editing (i.e., backspace, cut, copy, and paste) and formatting capabilities within applications, handling both keyboard and mouse interaction from the user. It also provides automatic word wrap, left-, center-, or right-justification, and the use of any single font, size, and style variation within a block of text.

Most of TextEdit's limitations are understandable considering its design origins. TextEdit was designed to provide basic text-editing and formatting capabilities needed in applications, while following the Macintosh User Interface Guidelines. Its most prominent usage is in dialog boxes for displaying prompts and receiving user input. If you have previously programmed on Apple IIs, you may well have seen the genesis of TextEdit in Apple's guidelines for standard input routines, such as the "blinking underline cursor" routines. TextEdit can be seen as the maturation and fulfillment of these earlier concepts for providing common input routines for all applications.

TextEdit is limited to 32,768 characters within a block of text. This limit is reasonable considering that the text is managed as one large block. Performance slows down on large blocks, making a higher limit impractical. To keep performance up on longer blocks of text requires "banding," or breaking a document into more manageable pieces of text. This goes into the area of disk-based editing, well beyond the original intent of the RAM-based TextEdit.

Another 32,768 limit is that of the destination rectangle, which provides positioning information about the block of text. That is, no block of text can be wider or taller than 32,768 pixels. This pixel limit can be reached long before hitting the maximum character limit, especially if the text block is narrow and the font size is large.

TextEdit has other limitations: no support of fully justified text (i.e., text aligned on the left and right margins), no support for fixed tab positions (either at specified evenly spaced distances or individually specified horizontal offsets), and only one font, size, and style per text block. A text block could be in any single font, size, and font-style variation, but mixed fonts and variations are not available.

As far as input routines go, TextEdit is very nearly fully featured. Data input pushing the 32K-byte boundaries is unrealistic. At that point, it is no longer data entry. What you are talking about then is a full text editor or word processor. Full justification in data entry is rarely necessary, and most static text items in dialog boxes are so short that full justification doesn't read as easily as simply aligned prompts. Tabbed input is a reasonable request for many applications. If you only need to provide a few inputs per screen, the Dialog Manager provides this capability by using separate text-editing boxes for each data element. For anything bigger, you may be able to use the List Manager for display-only columnar formatting.

Varied fonts within data-input items are probably needed only on rare occasions. However, as users grow more accustomed to easily changing fonts using menus and then seeing the actual font style on the screen, they will want this ability more often. Varied fonts, once the domain of sophisticated word processing programs, will be demanded from all types of applications, not just from applications that are thought of as text processors.

The Macintosh has definitely raised user expectation levels. Features once considered advanced are now expected as part of baseline standard-features sets. For example, many word processing programs for other machines would be considered text editors on the Mac simply because they don't support WYSIWYG font variations.

Welcome to the New TextEdit

With the release of the Macintosh II and System 4.1 for all Macs with 128K bytes of ROM, TextEdit received a boost in capabilities. TextEdit now lets you mix fonts, font sizes, and font styles within a block of text. A newly supported font attribute is color. TextEdit can use the new Color QuickDraw RGB color information when drawing text.

The new font capabilities are provided

continued

An Alternate Means of Handling Mixed Faces

When the new TextEdit functionality was introduced with System 4.1, it was easy to implement a Style menu. It was very difficult to implement MacWrite's component manner of managing font faces, while managing a Word style menu was merely difficult.

To handle font menus in an aggregate fashion such as in Word, you determine if there is currently a null style record. If so, use it to determine the menu settings. Otherwise, you have to find all the styles over the selection range, and, for any attribute that was continuous over the selection range, check its menu item.

Listing A illustrates this with the routine DocStyleMenus( ) and support routines TEGetNullStyle( ), TEC2-Run( ), and TEGetNextStyle( ). Note that the menus are actually set by the routines DocFontMenu( ), DocSize-Menu( ), and DocFaceMenu( ), which are exactly the same as described in the main article.

Adjusting the menus for an insertion point, or a selection range with only one style run, is trivial. If the selection range contains more than one style run, then all the runs must be checked for each attribute to see if the attribute is consistent throughout.

The algorithm first gets the attribute of the initial run within the selection range. Then for all the other runs in the range, it checks to see if the attributes are the same. If an attribute doesn't match, an invalid attribute value is passed to the routine that actually ad-

Listing A: *Adjusting the font, font-size, and font-face menus.* DocFontMenu( ), DocSizeMenu( ), *and* DocFaceMenu( ) *are the same as in the main article listing.*

```
static Boolean TEGetNullStyle(VAR pTheStyle,
                    pLineHeight, pFontAscent, hTE)
TextStyle  *pTheStyle;
Integer  *pLineHeight, *pFontAscent;
TEHandle  hTE;
/*  The TEGetNullStyle() function returns the
style information, including line height and font
ascent, for a null selection, if there is a null
selection style. A null selection style exists
only if TESetStyle() has been called when
selStart and selEnd are equal. If there is a null
selection style, the function value returned is
TRUE. If there is no null selection style, or the
edit record is an old-style record, then the
function value returned is FALSE. */
/*  m_o 04.23.88 */
{
  Boolean  hasNullStyle = FALSE;

  if ((**hTE).txSize == -1) {
    StScrpHandle  hNullScrap;
    TEStyleHandle  hTEStyle;

    hTEStyle = GetStylHandle(hTE);
    hNullScrap = (*(**hTEStyle).nullStyle)
                       ->nullScrap;
    if (hasNullStyle =
          (**hNullScrap).scrpNStyles != 0) {
      ScrpSTElement  *pScrpSTElem;

      pScrpSTElem = (**hNullScrap).scrpStyleTab;
      BlockMove(&pScrpSTElem->scrpFont,
        pTheStyle, (long)sizeof(*pTheStyle));
      *pLineHeight = pScrpSTElem->scrpHeight;
      *pFontAscent = pScrpSTElem->scrpAscent;
    }
  }
  return(hasNullStyle);
}
```

```
static Integer TEC2Run(cOffset, hTE)
register Integer  cOffset;
TEHandle  hTE;
/*  Returns the run number of the character whose
offset is cOffset in the text belonging to the
edit record **hTE. The run number returned is a
0-based run offset index. */
/*  Uses a standard binary search algorithm,
making sure to always round downward if the
character offset cOffset does not match an offset
in the line-starts array. The use of the pointer
to the beginning of the line-starts array in the
relocatable text edit record is safe because
there are no calls made from within this routine.
*/
/*  m_o 04.15.88 */
{
  register Integer  rn, lo, hi, runStart;
  register StyleRun  *pRuns;
  TEStyleHandle  hTEStyle;

  hTEStyle = GetStylHandle(hTE);
  lo = 0;
  hi = (**hTEStyle).nRuns;
  pRuns = (**hTEStyle).runs;
  while (hi >= lo) {
    rn = (lo + hi) / 2;
    runStart = pRuns[rn].startChar;
    if (cOffset == runStart)
      break;
    else if (cOffset > runStart)
      lo = rn + 1;
    else
      hi = rn - 1;
  }
  return((cOffset < runStart) ? rn - 1 : rn);
}


static Boolean TEGetNextStyle(VAR pCOffset,
  VAR pTheStyle, pLineHeight, pFontAscent, hTE)
Integer  *pCOffset;
TextStyle  *pTheStyle;
Integer  *pLineHeight, *pFontAscent;
TEHandle  hTE;
```

justs the menu of the particular attribute. The invalid value never matches any menu item, so none is checkmarked.

The routine DocStyleMenus( ) calls two routines that were defined similar to the new TextEdit routine TEGetStyle( ). The example program never uses the line-height and font-ascent information they return. They were defined that way just so they "looked" like functional derivatives of TEGetStyle( ).

```
static Boolean
TEGetNullStyle(VAR
  pTheStyle, pLineHeight,
  pFontAscent, hTE)
TextStyle  *pTheStyle;
Integer    *pLineHeight,
           *pFontAscent;
TEHandle   hTE;
```

The TEGetNullStyle( ) function returns the style information, including line height and font ascent, for a null selection, if there is a null selection style.

A null selection style exists only if TESetStyle( ) has been called when selStart and selEnd are equal. If there is a null selection style, the function value returned is TRUE. If there is no null selection style, or the edit record is an old-style record, then the function value returned is FALSE.

```
static Boolean
TEGetNextStyle(VAR
  pCOffset, VAR pTheStyle,
```

continued

```
/* The TEGetNextStyle() function returns the
style information, including line height and font
ascent, of the next style after the style of the
character *pCOffset. The character offset of the
first character in the next style is returned
through *pCOffset, and the function value
returned is TRUE. If there is no next style, or
for an old-style edit record, the function value
returned is FALSE, *pCOffset is unchanged, and no
style information is returned. */
/* m_o 04.23.88 */
{
  Integer  curStylRun;
  Boolean  fndNxtStyl = FALSE;

  if ((**hTE).txSize == -1) {
    Integer  nxtStylRun;
    TEStyleHandle  hTEStyle;

    hTEStyle = GetStylHandle(hTE);
    nxtStylRun = TEC2Run(*pCOffset, hTE) + 1;
    if (fndNxtStyl = (nxtStylRun <
                      (**hTEStyle).nRuns)) {
      STElement  *pSTElem;

      *pCOffset =
        (**hTEStyle).runs[nxtStylRun].startChar;
      pSTElem = *(**hTEStyle).styleTab +
        (**hTEStyle).runs[nxtStylRun].styleIndex;
      BlockMove(&pSTElem->stFont, pTheStyle,
        (long)sizeof(*pTheStyle));
      *pLineHeight = pSTElem->stHeight;
      *pFontAscent = pSTElem->stAscent;
    }
  }
  return(fndNxtStyl);
}


static void DocStyleMenus(hTE)
TEHandle  hTE;
/* Updates the menus for fonts, font faces, and
font sizes. HTE is a handle to the edit record of
the currently active document window. The menus
are updated according to the style of the
character just before the insertion point, or of
the styles of the characters within the selection
range. */
/* m_o 04.24.88 */
{
  Integer  lHt, ascent;
  TextStyle  theStyle;
  Boolean  plainTx;

  if (!TEGetNullStyle(&theStyle, &lHt,
                      &ascent, hTE)) {
    Integer  cOffset;

    cOffset = (**hTE).selStart;
    if (cOffset && cOffset == (**hTE).selEnd)
      --cOffset;
    TEGetStyle(cOffset, &theStyle, &lHt,
                        &ascent, hTE);
  }
  plainTx = theStyle.tsFace == 0;

  if ((**hTE).selEnd != (**hTE).selStart) {
    Integer  cOffset, lHt2, ascent2;
    TextStyle  nxtStyle;

    cOffset = (**hTE).selStart;
    while (TEGetNextStyle(&cOffset, &nxtStyle,
      &lHt2, &ascent2, hTE) && cOffset <
      (**hTE).selEnd) {
      if (nxtStyle.tsFont != theStyle.tsFont)
        theStyle.tsFont = -1;
      if (nxtStyle.tsSize != theStyle.tsSize)
        theStyle.tsSize = -1;
      plainTx = plainTx && nxtStyle.tsFace == 0;
      if (nxtStyle.tsFace != theStyle.tsFace)
        theStyle.tsFace = 0;
    }
  }

  DocFontMenu(theStyle.tsFont);
  DocSizeMenu(theStyle.tsSize, theStyle.tsFont);
  DocFaceMenu(theStyle.tsFace, plainTx);
}
```

```
  pLineHeight, pFontAscent,
    hTE)
Integer     *pCOffset;
TextStyle   *pTheStyle;
Integer     *pLineHeight,
            *pFontAscent;
TEHandle    hTE;
```

The `TEGetNullStyle()` function returns the style information, including line height and font ascent, of the next style after the style of the character `*pCOffset`. The character offset of the first character in the next style is returned through `*pCOffset`, and the function value returned is TRUE. If there is no next style, or for an old-style edit record, the function value returned is FALSE, `*pCOffset` is unchanged, and no style information is returned.

Listing B illustrates changing a font face. Note that the algorithm used to change the font face relies on the font-face menu being correctly checkmarked. If the face being toggled isn't the Plain menu item and the item is currently unchecked, then the corresponding face is simply added to the face(s) of the selected text. But if the item is already checked, meaning also that there is one continuous style over the selection, then the face is subtracted from the face(s) of the selected text.

Listing B: *Changing the font face. Notice how* `DocFontFace()` *relies on the menu items being correctly checked. (The statements between the preprocessor commands are a bug workaround. This bug may be fixed in a future System release.)*

```
void DocFontFace(myFontFaceMItem, wptr, doUpdt)
Integer  myFontFaceMItem;
WindowPtr  wptr;
Boolean  doUpdt;
/* Changes the font face of the selected text in
the window wptr. MyFontFaceMItem is the menu item
number of the font face. If the item is the Plain
menu item, then the selected text is changed to
Plain.
  If the item isn't the Plain menu item and the
item is currently unchecked, then the
corresponding face is added to the face(s) of the
selected text. If the item is already checked,
then the face is subtracted from the face(s) of
the selected text (which must be continuous over
the selection range).
  The document is marked changed, and the global
MenusChanged is set. If doUpdt is TRUE, then the
text will be redrawn, and if necessary the
vertical scroll bar will be recalibrated and the
selection scrolled into view. (If you wish to
make several face changes, call DocFontFace()
once for each change, passing FALSE for doUpdt
for all except the last face change. This will
minimize the amount of recalculations done.) */
/* m_o 11.20.88 */
{
  Style  theFace;
  TextStyle  myStyle;
  MyDataHndl hMyData = (MyDataHndl)
                         GetWRefCon(wptr);
  TEHandle  hTE = (*hMyData)->teRecord;

#  ifdef BUNNY
    {Ptr  p = &myStyle.tsFace + 1;  *p = 0;}
#  endif
  if (theFace = (myFontFaceMItem == PLAIN_MITEM) ?
    0 : 1 << (myFontFaceMItem - BOLD_MITEM)) {
    char  markChar[2];

    GetItemMark(MyMenus[STYLE_MENU],
      myFontFaceMItem,
      markChar);
    if (markChar[1]) {
      Integer  lnHt, ascent;

      /* get style at beginning of selection */
      TEGetStyle((*hTE)->selStart, &myStyle,
      &lnHt, &ascent, hTE);
/* set face to existing faces except menu item */
      theFace = ~theFace;
      theFace &= myStyle.tsFace;
      /* set all to plain */
      myStyle.tsFace = 0;
      TESetStyle(doFace, &myStyle, FALSE, hTE);
    }
  }
  myStyle.tsFace = theFace;
  TESetStyle(doFace, &myStyle, doUpdt, hTE);
  if (doUpdt)
    SetScrollMax(wptr, TRUE);
  MenusChanged = (*hMyData)->changed = TRUE;
}
```

for within blocks of text and through the Macintosh Clipboard and desk scrap mechanism. As an added bonus, the new improved TextEdit uses the standard Scrap Manager's desk scrap rather than the private TextEdit scrap. This means the programmer needn't resort to using special Toolbox routines to move text to and from this private scrap if the intent is to share data among applications via the desk scrap.

Unfortunately, there is still no provision for fixed tab positions. To TextEdit, a tab is still just another character whose width is determined in the font's definition. Let's face it, anyone who has used a typewriter expects tabs to do more than act as a space character. Just doing an initial line indent or aligning a few columns in a memo or short piece of text are common needs for tabs. Many programmers have tried devising ways to patch tab support into TextEdit, but Apple has warned that such patches have a high probability of breaking in future releases of the System software. Hopefully, Apple will address this in future TextEdit improvements.

As for everyone who hoped to be able to write a text editor or word processor with a few hundred lines of code and an "About. . ." box, the news is that the old 32K-byte limits still exist. Nevertheless, the current improvements in TextEdit are significant and will make life a lot easier for programmers and users alike.

New TextEdit Data Structures

The TextEdit upgrade introduces the concept of *style runs* of characters, where *style* now refers to a composite descrip-

continued

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tion of font family, size, face, and color information. The term *font face*, rather than *font style*, is now used to refer to stylistic variations such as boldface or underline or a combination of these. If you've been developing on the Mac for some time, you should get used to using this new terminology, using the term *font face* for individual variations and *font style* for the composite descriptions.

There are several new TextEdit data structures, plus the new Color QuickDraw data structure to define color information. Also, the TextEdit record itself redefines two fields and sets three other fields to *sentinel values* to indicate that the record is a new-style record. The revised TextEdit record with the added structures is shown in figure 1.

Because a font is no longer constrained to a single size within a block of text, there can't be a single value that describes the block's line height. Therefore, the `txSize`, `lineHeight`, and `fontAscent` fields are useless. These fields are set to −1 to indicate that this is a new-style TextEdit record and the values for these attributes must be found elsewhere.

The `txFont` and `txFace` fields of the TextEdit record are also meaningless, since there is not necessarily one font or face for a text block anymore. Since these

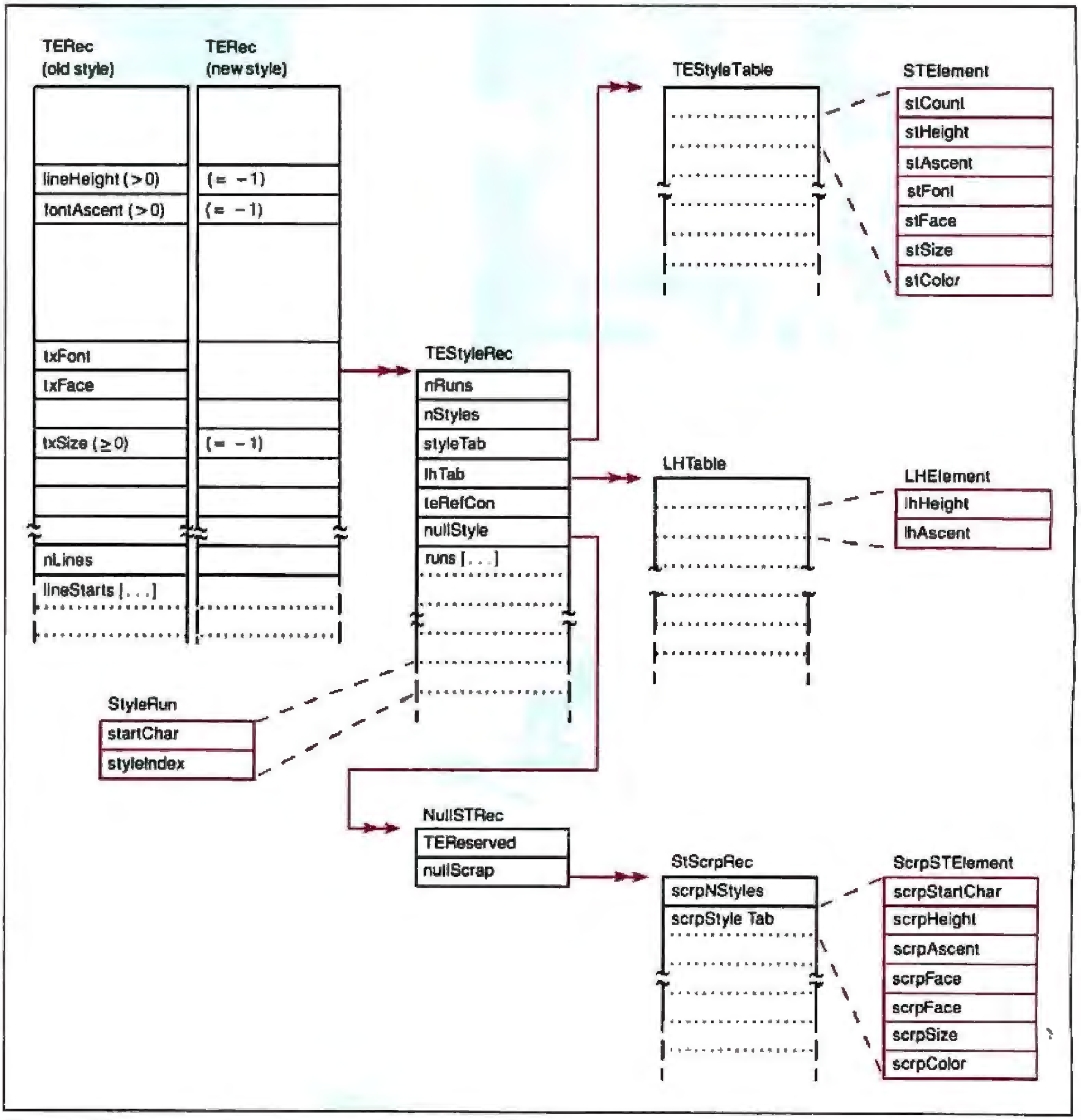

Figure 1: *The new text-edit record and auxiliary structures. The double-arrowed lines indicate handles to data.*

two 2-byte fields reside adjacent to each other in the TextEdit record, the new edit record redefines them as a single 4-byte field, storing a handle to the new text style information record. This style record, TEStyleRec, is the jumping-off place for all the other new data structures.

As mentioned earlier, any particular combination of font-variation attributes is referred to simply as a *style*. Text is kept track of as *runs* of characters that have the same style. Each unique style used within an edit record's text is stored in a style-table element, and all the styles are kept in a TEStyleTable style-table array. A handle to the style-table array is kept in the style record.

To specify which style applies to a character in the text, TextEdit maintains an array of StyleRun style-run records. A style-run record gives a starting character offset from the beginning of the text, and an index into the style table. The style-run records are stored at the end of the style record in ascending character offset order. All characters whose offset into the text is equal to or greater than the starting character of a style run, and less than the starting character of the next style run, use the style indicated by the style index of the style run. This is illustrated in figure 2.

There are two calls used to find out the style attributes at a given character offset and to set the style attributes of the current selection. They use the TEStyle text-style data structure to communicate the style-attribute information.

Until any text is entered in a new style, there is no way to store the pending style, because all style runs have to be at least one character long. The NullSTRec null-selection style record maintains the style information when an application sets style information at an insertion point.

Scrap Management

Previously, there was a separate, private scrap for TextEdit. When you wanted to move a cut or copied piece of text to other applications or desk accessories, you had to call TEToScrap( ) to move the text from this private scrap into the global desk scrap of the Scrap Manager. Likewise, to use text from an external source, you had to call TEFromScrap( ) to read the desk scrap into TextEdit's private scrap.

TextEdit now communicates directly with the Scrap Manager. The TECut( ) and TECopy( ) functions place the text in the Scrap Manager's desk scrap. For backward compatibility, these functions also place a copy of the scrap handle in TextEdit's private scrap global, TEScrpHandle, and for old-style TextEdit records, they use the private scrap only. TEPaste( ) and the new TEStylPaste( ) both use the Scrap Manager's scrap, except for old-style records, where they again use TextEdit's private scrap.

To communicate style information to the desk scrap, there is a style scrap record, stored in the desk scrap as type styl. The style scrap record is a variable-length structure. It begins with a count field scrpNStyles indicating how many scrap style-table elements follow. There is a table element ScrpSTElement for each style run within the scrap text. Each element contains information about the starting character offset within the scrap text, the height and ascent of the run, and the style information. Elements are in order of the starting offset, and there may be elements with duplicate style information. When cutting or copying text, TextEdit automatically writes this style information to the desk scrap along with the text. When pasting, if the desk scrap contains this style information, it is used along with the text.

The positive result is that you automatically write both the text and style information to the scrap when cutting or copying with the new text-edit records. If you then paste into the standard Scrapbook, you will see the text unformatted, but the scrap type information will show that

continued

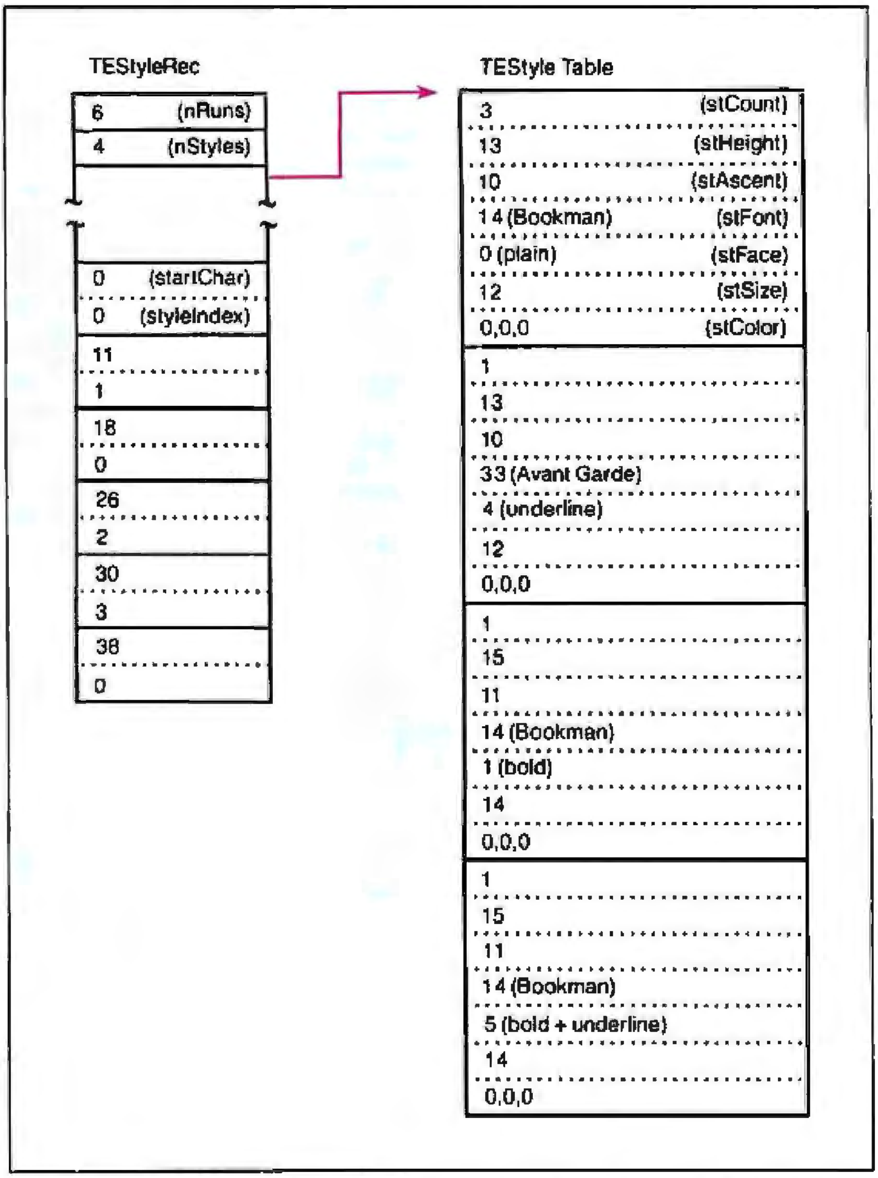

Figure 2: *Style-run record giving the starting character offset from the beginning of the text, and an index into the style table.*

both text and style information has been saved. Likewise, TextEdit also automatically pastes in any text from the desk scrap with its accompanying style information.

So if you are using TextEdit for all your text manipulation, it's as easy to maintain your styles as not. If you are using your own text-processing routines, you should consider writing out scrap data with style information in the new `styl` format, as well as any proprietary format. Apple strongly recommends that developers use the Scrap Manager to access the Scrapbook and the desk scrap. Using the Scrap Manager will ensure that applications can share the desk scrap in shared (i.e., MultiFinder) environments.

If you're going to store style information in the new `styl` format, or in a format similar to the style table and runs array, be aware that the font information is stored by number rather than name. The desk scrap and the Scrapbook aren't normally carried from machine to machine, so this should not be a problem. However, by storing style information in a data file simply as numbers, you could make your application susceptible to the "changing font problem": Other machines or different fonts in the System may cause a document to display differently from the way you intended if your font ID numbers are already in use. To minimize this problem, you should maintain a table of font IDs and names and automatically adjust the fonts.

Where's My Line?

One big "gotcha" with the new capabilities is that scrolling is harder to handle. This is because line heights are no longer fixed throughout the text. Since line heights can now vary, the number of text lines displayable in the view rectangle can vary throughout the text and, as the user changes fonts and sizes, through time.

The current improvements in TextEdit will make life a lot easier.

Because of this, control values must now be correlated to pixel offsets from the top of the destination rectangle to the top of the view rectangle, instead of corresponding to line offsets. Additional calculations are needed to ensure scrolling by full lines of text. The maximum control value is derived by determining the lines of text that can be completely shown on the last screen, taking the height of all lines above, and using this value for the maximum control value. Figure 3 illustrates this, along with the accompanying C source code for the function `SetScrollMax()` in listing 1.

When scrolling, you want to "pin" the control values and the pixel offsets so that the top visible line of text aligns with the top of the view rectangle. Listing 2 shows how to determine the amounts to scroll for the various parts of the scroll bar.

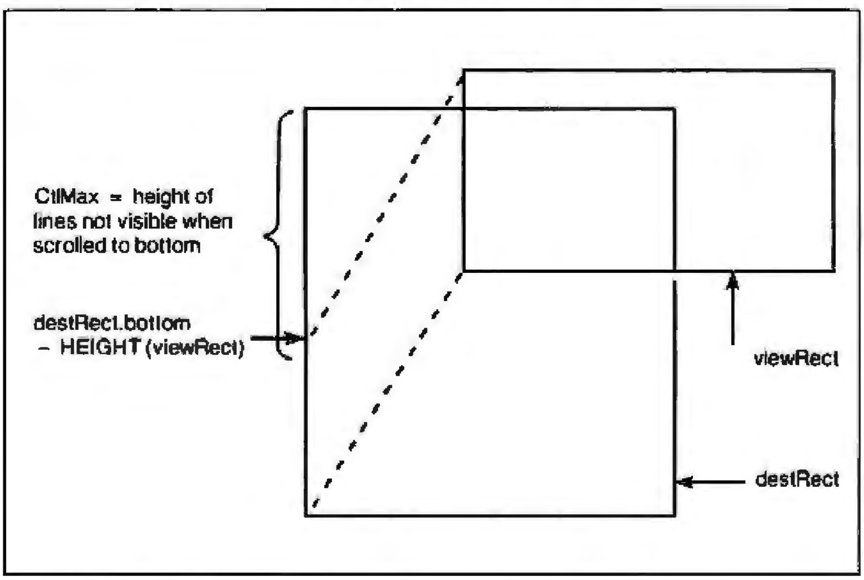

Figure 3: *Setting the maximum value of the vertical scroll bar.*

When scrolling up one line (mouse in down arrow), the distance to be scrolled is the height of the line currently at the top of the view rectangle. But for scrolling down one line (mouse in up arrow), the distance to be scrolled is the height of the line above the line currently at the top of the view rectangle. When scrolling up a window of text at a time, the distance to be scrolled is the height of all the lines of text currently visible in their entirety, less the last of those lines (i.e., the line of text at the window's bottom becomes the line at the window's top). When scrolling down by a windowful, you want to scroll the line currently at the top of the window down so that it is the last line visible in its entirety, and such that the new line at the top of the view rectangle is also completely visible.

Scrolling with the thumb involves getting the value of the scroll bar after the user has released the mouse button, then forcing the control value to the closest value that will align the top of the visible text to the top of the view rectangle. The following code fragment illustrates this, and listing 3 includes `TEPinLine()`.

```
/* hScrollerV == handle to
     vertical scroll bar */
/* mouseLoc == point (local
     coordinates) where mouse
     was initially pressed */
/* HScrollTE == handle
     (global) to TE record */

if (partCode == inThumb) {
     Integer v0, v1, v1pin;

    v0 = GetCtlValue
      (hScrollerV);
    TrackControl(hScrollerV,
      mouseLoc,
      NULL);
   v1 = GetCtlValue
      (hScrollerV);
   v1pin = TEPinLine(v1,
      HScrollTE);
   if (v1 != v1pin)
     SetCtlValue(hScrollerV,
      v1pin);
   if (v0 != v1pin)
     TEScroll(0, v0 - v1pin,
       HScrollTE);
}
```

Converting a character offset to a line offset is a commonly required function. The function `TEC2Line()` shown in listing 4 uses a binary search strategy to quickly return the line offset given a character offset. Note that the dereferencing of the line-starts array pLnStarts is safe because there are no Toolbox calls, or calls to functions in other segments that would cause memory to be moved.

Changing Fonts Is Easy

Changing the font over a selection range is easy to do, as is changing the font size. However, changing a font face can be harder. Because font faces can be combinational, design problems occur when the selection range does not have a consistent face setting. You also have to keep track of the menus for the font styles.

When the selection range includes mixed fonts, no font in the font menu should be checkmarked as the current font. Also, most applications will have none of the font sizes outlined. (Outlining a font size indicates that there is a bitmap font available in that size for the current font.) However, if the font size is consistent through the selection range, the size should be checkmarked in the menu. If the user then chooses a font, all characters within the selection range now use that font.

Neither the fonts nor font-face menus are dependent on font size(s) within the selection range. When the selection range includes mixed font sizes, no size in the menu should be checkmarked as the current font size. If the user chooses a font size, that font size is applied to all characters within the selection range.

The application designer must decide how to handle selection ranges with mixed font faces. Consider how MacWrite and Word deal with mixed selection ranges. MacWrite deals with font faces by viewing combinational faces in a component manner. That is, if over the selection range all characters are in bold, then the Bold menu item is checked, even though some characters within the selection may be bold-italic, others bold-underlined, and others merely bold.

Word, on the other hand, deals with font faces by viewing combinational faces in an aggregate manner. In Word, even if over the selection range all characters are in bold, the Bold menu item is not checked if some characters are bold-italic, while others are bold-underlined, and others merely bold.

The implication of all this is that with MacWrite you can toggle off a component face within a mixed run, whereas with Word you can't.

With the original extensions to TextEdit, you could more easily implement Word's method than MacWrite's. How-

continued

Listing 1: *This routine recalibrates the vertical scroll bar.*

```
void SetScrollMax(wptr, fShowSel)
WindowPtr  wptr;
Boolean  fShowSel;
/*  Adjusts the scroll bar maximum value so that the scroll bar range is
not allowed to exceed the end of the text. Wptr is a pointer to the window
of the text and scroll bar. If fShowSel is true, then the text is scrolled
if necessary so that the insertion point or the beginning of the selection
range is visible. */
/*  Note 1: The maximum control value is the pixel offset of the top of the
first line of text on the last screen. Or, you can think of it as the
height of all lines above the first line visible in the last screen full of
text.
  Note 2: If the last line is empty because the last character is a <<cr>>,
then we have to add the height for one extra line because it is not
actually included in the count of the number of lines.
  Note 3: TEGetHeight() expects 1-based line numbers. Our TEC2Line()
routine returns a 0-based line number. */
/*  mo 11.20.88 */
{
  Integer  vMax;     /* new maximum control value */
  Integer  d;     /* delta old/new control values */
  MyDataHndl  hMyData  = (MyDataHndl)GetWRefCon(wptr);
  TEHandle  hTE     = (*hMyData)->teRecord;
  ControlHandle  hScrollV  = (*hMyData)->hScrollV;
  Integer  nChars  = (**hTE).teLength;
  Integer  nLns    = (**hTE).nLines;
  Integer  viewHt  = HEIGHT((**hTE).viewRect);
  Integer  textHt  = TEGetHeight(nLns, 1, hTE);
  Integer  v0      = GetCtlValue(hScrollV);

  /* see Note 2, above */
  if (nChars > 0 && (*(**hTE).hText)[nChars - 1] == CR)
    textHt += TEGetHeight(nLns, nLns, hTE);
  /* text requires scrolling? */
  if (textHt > viewHt) {
    Point  scratchPt;  /* see Note 1, above */
    Integer  cOffset;  /* character offset @ scratchPt */
    Integer  lastHiddenLn;  /* line offset @ scratchPt */

    scratchPt.h = (**hTE).destRect.left;
    scratchPt.v = textHt - viewHt + (**hTE).destRect.top;
    cOffset = TEGetOffset(scratchPt, hTE);
    lastHiddenLn = TEC2Line(cOffset, hTE);
    vMax = TEGetHeight(lastHiddenLn + 1, 1, hTE);
  }
  else
    vMax = 0;
  SetCtlMax(hScrollV, vMax);
  /* did control value change? */
  if (d = v0 - GetCtlValue(hScrollV))
    TEScroll(0, d, hTE);
  if (fShowSel)
    ShowSel(wptr);
}
```

Listing 2: *Action procedure for the vertical scroll bar; it handles mousedowns in the scroll arrows and the page regions.*

```
static pascal void TrackVScroll(hScrollV, partCode)
ControlHandle  hScrollV;
Integer  partCode;
/*  Track control procedure used to adjust the vertical scroll bar hScrollV
and scroll the text. PartCode handles the portion of the scroll bar that
the mouse is down in (which may be simulated). The private global HScrollTE
```

continued

```
must be set on entry to contain the handle to the affected text's edit
record. */
/* Key principle when scrolling by page amounts: When scrolling up a page,
the last visible line becomes the first visible line, and vice versa when
scrolling down a page.
  Here, the last visible line means the last line visible in its entirety.
  It is assumed that the minimum control value is 0.
  An alternate strategy for passing the handle to the TextEdit record is to
store it in the control's refCon field. */
/* m_o 04.17.88 */
{
  Point  pt;
  Integer  v0, vMax, cOffset, curTopLn, d;

  if (!partCode)
    return;
  v0 = GetCtlValue(hScrollV);
  vMax = GetCtlMax(hScrollV);
  /* location of view rectangles top left corner */
  pt = (**HScrollTE).viewRect.topLeft;
  /* calculate current top line */
  cOffset = TEGetOffset(pt, HScrollTE);
  curTopLn = TEC2Line(cOffset, HScrollTE);
  switch (partCode) {
  case inUpButton:
    if (v0 == 0)
      return;
    /* calculate height of line above current view */
    d = -TEGetHeight(curTopLn - 1 + 1, curTopLn - 1 + 1,
          HScrollTE);
    break;
  case inDownButton:
    if (v0 == vMax)
      return;
    /* calculate height of line currently at top of view */
    d = TEGetHeight(curTopLn + 1, curTopLn + 1, HScrollTE);
    break;
  case inPageUp: {
    Integer  viewHt, newTopLn;

    if (v0 == 0)
      return;
    viewHt = HEIGHT((**HScrollTE).viewRect);
    /* calculate pixel offset to new top line: the current top
       line's bottom minus the view height; then convert to
       line offset */
    pt.v += TEGetHeight(curTopLn + 1, curTopLn + 1,
      HScrollTE) - viewHt;
    cOffset = TEGetOffset(pt, HScrollTE);
    newTopLn = TEC2Line(cOffset, HScrollTE);
    /* if height from current top line to new top line
       greater than view height, change new top line to
       scroll one less line */
    if (TEGetHeight(curTopLn + 1, newTopLn + 1, HScrollTE) >
          viewHt)
      ++newTopLn;
    d = -TEGetHeight(curTopLn - 1 + 1, newTopLn + 1,
      HScrollTE);
    break;
  }
  case inPageDown: {
    Integer  curBtmLn;

    if (v0 == vMax)
      return;
```

ever, since the release of System 6.0, MacWrite's method is easier. System 6.0 added the routine TEContinuousStyle(), which makes it simple to determine the font attributes over a selection range. Listing 5 illustrates adjusting the font menus. TextEdit handles the Style menu in a component fashion similar to MacWrite. For an example of how to handle the Style menu in an aggregate manner similar to Word, see the text box "An Alternate Means of Handling Mixed Faces" on page 22.

It's very easy to "add" a face over a range with a single call to TESetStyle(). But prior to System 6.0, subtracting a face from a range required you to individually modify each run throughout the selection range. This meant that for each run within the selection range, you had to get the style of the run using TEGetStyle(), then call TESetStyle() with the original aggregate face less the component face being removed. The addition of the doToggle mode has made changing font faces much simpler.

Listing 6 illustrates changing a font versus changing a font face. Note that the algorithm used to change the font face relies on the font-face menu being correctly checkmarked. Not only is proper menu maintenance important to the user interface, but it can also simplify a program's internal design. Part of the Apple Human Interface Guidelines is that, as much as possible, users shouldn't be presented with choices that really can't be made. If an option or command isn't currently available, it should be dimmed or disabled so users don't waste time trying to do something that can't be done.

Note also the usage of the toggleFace flag in DocFontFace(). This is necessary for a most peculiar reason. If you call TESetStyle() with a mode of doFace+doToggle and a style of bold for a selection range that includes plain and bold text, the faces will swap—the plain text becoming bold and vice versa. Therefore, use the doToggle mode only when you wish to toggle a face off.

The example code ignores the issue of making style changes undoable. Undoing a style change over a selection range with multiple styles is not simply a matter of reapplying or "negating" a font-face change over the entire selection range. If the font was changed and the selection included runs of different fonts, each run must have its original font set back individually. The same applies to a font-size change. With font faces, if some runs originally used the newly applied face,

continued

```
    /* calculate current bottom line of view */
    pt.v = (*HScrollTE)->viewRect.bottom;
    cOffset = TEGetOffset(pt, HScrollTE);
    curBtmLn = TEC2Line(cOffset, HScrollTE);
    /* if height from current top line to new top line
       (i.e., the old bottom line) greater than view height,
       change new top line to scroll one less line */
    if (TEGetHeight(curBtmLn + 1, curTopLn + 1, HScrollTE) >
      HEIGHT((*HScrollTE)->viewRect))
      --curBtmLn;
    d = TEGetHeight(curBtmLn - 1 + 1, curTopLn + 1,
      HScrollTE);
    break;
  }
  } /* switch */
  SetCtlValue(hScrollV, v0 + d);
  TEScroll(0, v0 - GetCtlValue(hScrollV), HScrollTE);
}
```

Listing 3: `TEPinLine()`. *This procedure "pins" control values so that a line of text is aligned with the top of a view rectangle.*

```
Integer TEPinLine(pixFromTop, hTE)
Integer  pixFromTop;
TEHandle  hTE;
/*  Given a vertical pixel offset pixFromTop from the top of the text
belonging to the edit record **hTE, TEPinLine() returns a vertical pixel
offset pinned to the top of the line that the original offset fell in. */
/*  m_o 04.17.88 */
{
  Point  myPt;
  Integer  cOffset, theLine;

  myPt.h = (*hTE)->destRect.left;
  myPt.v = (*hTE)->destRect.top + pixFromTop;
  cOffset = TEGetOffset(myPt, hTE);
  theLine = TEC2Line(cOffset, hTE);
  return((theLine) ?
    TEGetHeight(theLine - 1 + 1, 1, hTE) : 0);

}
```

Listing 4: `TEC2Line()` *is a commonly used routine. It converts character offsets into line offsets.*

```
Integer TEC2Line(cOffset, hTE)
register Integer  cOffset;
TEHandle  hTE;
/*  Returns the line number of the character whose offset is cOffset in the
text belonging to the edit record **hTE. The line number returned is a 0-
based line offset index. */
/*  Uses a standard binary search algorithm, making sure to always round
downward if the character offset cOffset does not match an offset in the
line-starts array. The use of the pointer to the beginning of the line-
starts array in the relocatable text edit record is safe because there are
no calls made from within this routine. */
/*  m_o 04.15.88 */
{
  register Integer  ln, lo, hi, *pLnStarts, lnStart;

  lo = 0;
  hi = (*hTE)->nLines;
```

continued

```
  pLnStarts = (*hTE)->lineStarts;
  while (hi >= lo) {
    ln = (lo + hi) / 2;
    lnStart = pLnStarts[ln];
    if (cOffset == lnStart)
      break;
    else if (cOffset > lnStart)
      lo = ln + 1;
    else
      hi = ln - 1;
  }
  return((cOffset < lnStart) ? ln - 1 : ln);
}
```

Listing 5: *Adjusting the font, font-size, and font-face menus. There is no invalid value for the font-face information, so an extra Boolean is used to indicate if the font face is actually Plain; the plain value for the font-face value passed to the menu-adjusting routine indicates that no face (other than possibly Plain) is consistent throughout the selection range.*

```
static void DocFontMenu(theFontID)
Integer  theFontID;
/*  Checks the font in the font menu whose ID is equal to theFontID and un-
checks all other fonts. If no font is to be checked, then a value that
won't match any font ID, such as -1, should be passed in for theFontID. */
/*  m_o 11.20.88 */
{
  Integer  item, nItems;
  MenuHandle  hMenu;

  hMenu = MyMenus[FONT_MENU];
  for (item = 1, nItems = CountMItems(hMenu);
    item <= nItems; item++) {
    Str255  fontName;
    Integer  fontNum;

    GetItem(hMenu, item, fontName);
    GetFNum(fontName, &fontNum);
    CheckItem(hMenu, item, fontNum == theFontID);
  }
}


static void DocSizeMenu(theFontSz, theFontID)
Integer  theFontSz, theFontID;
/*  Checks the size in the font size equal to theFontSz, and unchecks all
other sizes. If no size is to be checked, then a value that won't match any
size, such as -1 or 0, should be passed in for theFontSz.
  Also sets the item style to be outlined for each font size that is
available as a bit-map font in the font specified by theFontID. If there is
no font to check for available bit-map fonts, then -1 should be passed in
for theFontID. */
/*  m_o 11.20.88 */
{
  Integer  item, nItems;
  MenuHandle  hMenu;

  hMenu = MyMenus[STYLE_MENU];
  for (item = SIZE1_MITEM, nItems = CountMItems(hMenu);
    item < nItems; item++) {
    Integer  sz;

    sz = (Integer)MItem2Num(hMenu, item);
    SetItemStyle(hMenu, item,
      (theFontID != -1 && RealFont(theFontID, sz)) ?
```

continued

then undoing the face change would leave those runs alone. Only those runs that did not originally include the applied face would have the face removed.

You will need a copy of *Macintosh Technical Note* #207 for documentation on the routines added with System 6.0. And because these routines are implemented with selectors through the same `_TEDispatch` trap that was added with System 4.1, you must check for their existence by using the `SysEnvirons()` call and checking specifically for a System version greater than or equal to 0600 hexidecimal. Testing whether or not the `_TEDispatch` trap is implemented is not sufficient all by itself.

Support of non-Roman script systems will be a big design point.

Other Font Issues

When setting a font, don't use font ID #1, the application font. The application font is not an actual font. It is a reference to the default font that most applications use. This default is usually Geneva, but it's different for languages that don't use roman character sets.

If there is any text in the application font, it will appear as Geneva (assuming that is what the application font maps to). But your comparison routines will not recognize the text as being in Geneva. For that to happen, you have to write code to specifically test whether text is in the application font; if so, you have to map to the actual font, which isn't necessarily Geneva.

The same is true for font size 0, which tells the System to use the System font size. The System font size is usually, but not always, 12 points. Additionally, many large-screen monitors now come with software to specify a System font size larger than 12 points.

It isn't quite enough to never explicitly set a style using the application font or the System font size. When you call `TEStylNew()` to create a new-style edit record, it initializes the style-element table from the `txFont`, `txFace`, and `tx-`

continued

```
        outline : 0);
      CheckItem(hMenu, item, sz == theFontSz);
    }
  }


static void DocFaceMenu(theFontFace, plainTx)
Style  theFontFace;
Boolean  plainTx;
/*  Checks all font faces in the Style menu whose corresponding bit is set
in the theFontFace parameter. Any font face whose corresponding bit is
clear is unchecked in the Style menu. If plainTx is TRUE, then the Plain
menu item is checked, otherwise it is unchecked. */
/*  m_o 11.20.88 */
{
  Integer  item;
  MenuHandle  hMenu;

  hMenu = MyMenus[STYLE_MENU];
  CheckItem(hMenu, PLAIN_MITEM, plainTx);
  for (item = BOLD_MITEM - BOLD_MITEM;
    item <= EXTEND_MITEM - BOLD_MITEM; ++item)
    CheckItem(hMenu, BOLD_MITEM + item,
      theFontFace & (1 << item));
}


static void DocStyleMenus(hTE)
TEHandle  hTE;
/*  Updates the menus for fonts, font faces, and font sizes. HTE is a
handle to the edit record of the currently active document window. The
menus are updated according to the style of the character just before the
insertion point, or of the styles of the characters within the selection
range. */
/*  m_o 11.20.88 */
{
  Integer  mode;
  Boolean  continuous;
  TextStyle  theStyle;

  mode = doFont;
  if (!TEContinuousStyle(&mode, &theStyle, hTE))
    theStyle.tsFont = -1;
  DocFontMenu(theStyle.tsFont);

  mode = doSize;
  if (!TEContinuousStyle(&mode, &theStyle, hTE))
    theStyle.tsSize = -1;
  DocSizeMenu(theStyle.tsSize, theStyle.tsFont);

  mode = doFace;
  if (!(continuous = TEContinuousStyle(&mode, &theStyle, hTE)))
    theStyle.tsFace = 0;
  DocFaceMenu(theStyle.tsFace,
    continuous && theStyle.tsFace == 0);
}
```

Size fields of the grafPort. So before creating a new edit record, call the QuickDraw routines `TextFont()` and `TextSize()` to set the font and font-size fields to appropriate values.

All This and Colors II?

TextEdit was extended not only to include multiple fonts, font sizes, and font faces, but also to support color. Color output devices are still pretty expensive, but the capability is there. To take advantage of it, all you need to do is allocate a `CGrafPort` (a new color grafport).

If you do decide to support colored text within your application, you should allow the user to set up color "presets." Making the user choose a color from the Color Picker Package is less than ideal, but so is a fixed color palette.

Ready for International Fame

The new TextEdit is also compatible with the Script Manager. This means that

TextEdit can handle languages that write from right to left, have large extended character sets well past 256 characters, have special word-break rules, or use characters whose appearance is context sensitive (i.e., it changes depending on the preceding or following characters). Examples of such writing systems are Japanese, Chinese, and Arabic, which are known as non-Roman scripts, as opposed to writing systems that evolved from Latin.

The Script Manager, using writing-system-specific *Script Interface Systems*, intercepts and modifies many system calls to measure, draw, sort, and convert text. For developers who must write their own text-editing engine, support of non-Roman script systems will be a big design point.

Saving a Document

Probably the simplest way to save a document with text and styles is to save the text in the file's data fork and all the style information in the file's resource fork. The file should be of type TEXT.

Using this scheme, you need to save the styles table and the runs array. You might also want to save the modification time of the file as a resource. When you are reading the document back in, if the modification date resource doesn't exist, or if it isn't the same as the actual current value of the file's modification date, then you know that the file was edited by some other application and you should ignore any style data in the resource fork.

After reading in and setting up the saved text, you read in the saved style table and replace the data in the existing style table with the saved style-table data, then reset the `nStyles` field of the style record. Next, read in the saved runs array and replace the existing runs array with it, and reset the `nRuns` field of the style record. Finally, call the old `TECalText()` routine to recalculate the line-heights table along with the line-starts array. You may also want to save and restore the selection range, the document's window size and placement, and the visible portion of the document within the window. The following pseudocode illustrates the procedure:

```
Read in text.
Set text-edit record to use
      read-in text (directly or
      by using TESetText()).
Read in modification date
      resource.
If modification date resource
      exists & equals file's
```

continued

Listing 6: *Changing the font and changing the font size are similar and relatively simple operations. Changing the font face is more involved. Notice how* DocFontFace( ) *relies on the menu items being correctly checked. (The statements between the preprocessor commands are a bug workaround. This bug may be fixed in the next System release.) All three operations are much more involved when implemented so that the style change is undoable.*

```
void DocFont(myFontName, wptr)
Str255  myFontName;
WindowPtr  wptr;
/*  Changes the font of the selected text in the window wptr to the font
named myFontName. The document is marked changed, and the global
MenusChanged is set. If necessary, the vertical scroll bar is recalibrated
and the selection range is scrolled into view. */
/*  m_o 04.24.88 */
{
  TextStyle  myStyle;
  MyDataHndl  hMyData;

  hMyData = (MyDataHndl)GetWRefCon(wptr);
  GetFNum(myFontName, &myStyle.tsFont);
  TESetStyle(doFont, &myStyle, TRUE,
    (*hMyData)->teRecord);
  SetScrollMax(wptr, TRUE);
  MenusChanged = (*hMyData)->changed = TRUE;
}


void DocFontFace(myFontFaceMItem, wptr, doUpdt)
Integer  myFontFaceMItem;
WindowPtr  wptr;
Boolean  doUpdt;
/*  Changes the font face of the selected text in the window wptr.
MyFontFaceMItem is the menu item number of the font face. If the item is
the Plain menu item, then the selected text is changed to Plain.
  If the item isn't the Plain menu item, then the font face is toggled.
That is, if the specified face is continuous over the current selection
range, it is toggled off, otherwise that face is set continuous over the
selection range.
  The document is marked changed, and the global MenusChanged is set. If
doUpdt is TRUE, then the text will be redrawn, and if necessary the
vertical scroll bar will be recalibrated and the selection scrolled into
view. (If you wish to make several face changes, call DocFontFace() once
for each change, passing FALSE for doUpdt for all except the last face
change. This will minimize the amount of recalculations done.) */
/*  m_o 11.20.88 */
{
  Boolean  toggleFace;
  TextStyle  myStyle;
  MyDataHndl  hMyData = (MyDataHndl)GetWRefCon(wptr);
  TEHandle  hTE = (*hMyData)->teRecord;

  myStyle.tsFace = (myFontFaceMItem == PLAIN_MITEM) ?
    0 : 1 << (myFontFaceMItem - BOLD_MITEM);
  if (!myStyle.tsFace)
    toggleFace = FALSE;
  else {
    char  markChar[2];

    GetItemMark(MyMenus[STYLE_MENU], myFontFaceMItem, markChar);
    toggleFace = markChar[1] != 0;
  }
  TESetStyle(doFace + ((toggleFace) ? doToggle : 0), &myStyle,
    doUpdt, hTE);
  if (doUpdt)
    SetScrollMax(wptr, TRUE);
  MenusChanged = (*hMyData)->changed = TRUE;
}
```

```
 actual mod.date {
 Read in the styles table.
   Replace existing style
     table using
     PtrToXHand().
   Set number of entries in
     nStyles field of style
     record.
   (Calculate number of
      entries in styles table
      by dividing table size
      by element size.)
   Read in runs array.
   Set size of style record to
     size of style record
     (exclusive of any run
     elements) plus size of
     read-in runs array.
   Use BlockMove() to copy
     runs array to style
     record.
   Set number of runs in nRuns
     field of style record.
   (Calculate number of
     entries in runs array by
     dividing array size by
     element size and
     subtracting one element.
     The subtraction of an
     element is because there
     is a dummy element at the
     end of the array that is
     not included in the nRuns
     count.)
}
Call TECalText() to readjust
  the line-heights array.
```

The advantage to this method is that any application that can read a TEXT file will be able to access the text. The drawback to this strategy is that, due to limitations in the Resource Manager, the document cannot be accessed simultaneously by multiple users except as read-only.

Keep Your Eyes Open

In addition to *Inside Macintosh*, volume V, every developer who wants to use the new TextEdit routines should read *Macintosh Technical Note* #131 (revised March 1, 1988) and #207 from Macintosh Developer Technical Support.

Note #131 covers known TextEdit bugs and workarounds, while Note #207 covers the changes to TextEdit introduced with System 6.0. ■

Michael Ogawa is a software designer for Palomar Software (Oceanside, CA). Since 1985 he has been involved with designing, programming, and managing projects for commercially marketed Macintosh business productivity software. He can be reached on BIX c/o "editors."

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BYTE

Exploring the Mystery

Laurence H. Loeb

Understanding ResEdit's use opens more than windows for the Macintosh programmer

Since 1985, the resource editor has been one of the Macintosh's major utilities. Before then, a disparate collection of editing utilities was available, but ResEdit's object was to bring all these resource-modifying programs under one roof to share a common, extensible interface. It has been successful in doing just that, but it has also been one of the most misunderstood utilities because, to date, it comes without a manual.

The operation of ResEdit is one of the mysteries that aspiring Mac programmers must solve because it does things for developers that no other program will. It lays bare the innards of a Mac program for inspection. It gives powers of creation to those familiar with its workings. (So does RMaker, for that matter, but ResEdit shows the graphical content of the resource, which gives better feedback on how something will look.) In the best Mac tradition, ResEdit removes a layer of abstraction (the specification list) that programs like RMaker interpose between worker and work.

A Caveat for the Unwary

Before you do anything with ResEdit, though, please heed some hard-gotten advice. Always work with a backup of your program when using ResEdit, *never* with the original. ResEdit has a way of crashing once in a while. It's lots better than it used to be, but you may ask it to dive into the ground at Mach 3 without realizing it. Also, if you make a mistake and later save that mistake to your original, you may have no way of tracing what went wrong without a known good copy of the program. Before you go exploring, make sure you have a known good backup, preferably on a disk not connected to the machine. Really. It *will* happen to you one day. It does to everyone.

Some Bare-Handed Bit Grabbing

An exploratory walk through ResEdit country with me as your guide can teach you some vital things. One item that will amaze your technoid friends is the power to create an icon that goes with an application and sticks with it even when it's copied to another disk. The following instructions may seem tedious to the more adventurous, but this trick won't work unless all the individual tasks are done. The Finder is very bull-headed about wanting certain information. That's what you have to learn to give it.

I'll start with an application I wrote (see "Program Extenders" in the December 1988 BYTE, page M52) that has the "generic" icon attached. This is the icon the Finder assigns when no other is specified. Opening ResEdit (I used version 1.2b2) gives the main window listing the applications ResEdit recognizes. Successive selecting and clicking get you to a window that lists the resources present in my application, a Mac-to-Wang terminal program. You are now ready to start slogging through the terrain.

Under the FILE menu, select New (or press Command-N). The select box comes up, to let you name what type of resource to create. You're going to tell the Finder about desktop information. This is stored in the Bundle (BNDL) resource, so that's what you select from the box on the left of the dialogue. Having clicked the OK button, you see a BNDL resource showing in the program's type list window. But you're not done yet. Opening the BNDL type will give you an empty list window. You have to create another BNDL (by Command-N or menu choosing) before you can do anything.

A quick review is in order here because this step is important, and it's the single thing most new users goof up on. A New selection must be done twice. The first creates the BNDL shown in the program's list. The second New creates a BNDL inside the list window of the previous BNDL. Got that? This has to be done correctly before ResEdit will let you proceed. If the menu choices described later will not "un-gray" at any

continued

point, this may be the cause.

Now, double-click on the secondary BNDL. A window will appear. It will have an ID number that has been randomly selected by ResEdit. This is where you set the actual BNDL information. Set the owner ID to 0 first. (You could do this later, but I recommend doing it now.) After setting it, close the window. The secondary BNDL will show as selected. Command-I (or Get Info from the menu) will bring up the information window. Set its ID to 132 and close the window. The ID should change in the BNDL-type window as well. Open the secondary BNDL again. Where it says OwnerName, put in a 4-character string that you want to use to identify your newly created icon to the Finder. This string must be unique to your application. (As a matter of fact, Developer Services at Apple should really approve whatever string you use here to make sure that it isn't used by another application. Apple has reserved for its own use strings composed entirely of lowercase letters.) Insert the string by typing it in.

Next, click on the row of asterisks in the BNDL window under numTypes. A box will appear around them. Double-clicking produces a type box with a line of dashes beneath it. Type ICN# (which means "icon list") into the type box and double-click on the row of dashes. Two more boxes will appear. Putting 0 into localID and 128 into rsrcID will do the trick here. Double-clicking on the asterisks now produces another type box, which you fill in with FREF (for "file reference"). In the same manner as before, double-click on the dashed line and get localID and rsrcID boxes. (Do you see a pattern emerging? Asterisks get you a new type, while the dashes get a secondary specifier.) Insert 1 and 129 into them, respectively. You can now close the entire BNDL window.

You should then be at the application's type window. Create a new ICN# type from the menu or keyboard. A window will appear when you do. (Because it's an ICN# resource, you don't have to do the two New operations. ResEdit is smart enough to give you the window based on the type you have requested.) A square indicates what icon you will be working on. Do a Command-I at this point and set the ID of the selected ICN to 128. Double-clicking in the square will put you in the graphical icon editor. This is where you'll design the icon you want to affix to the application.

ResEdit's icon editor functions in much the same way that MacPaint's Fat-

continued

Figure 1: *A list of resource types.*

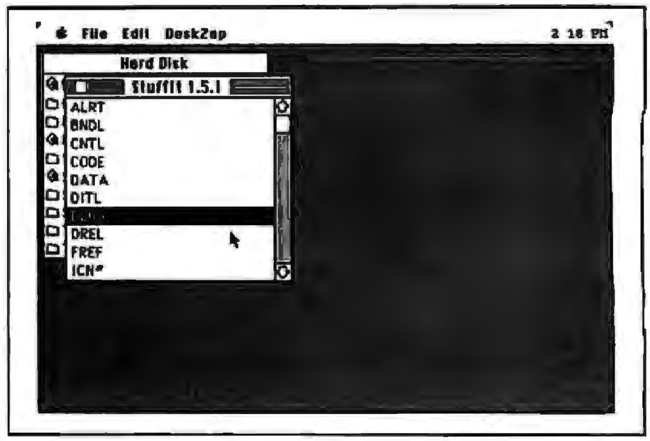


Figure 2: *A list of the DLOGs present.*

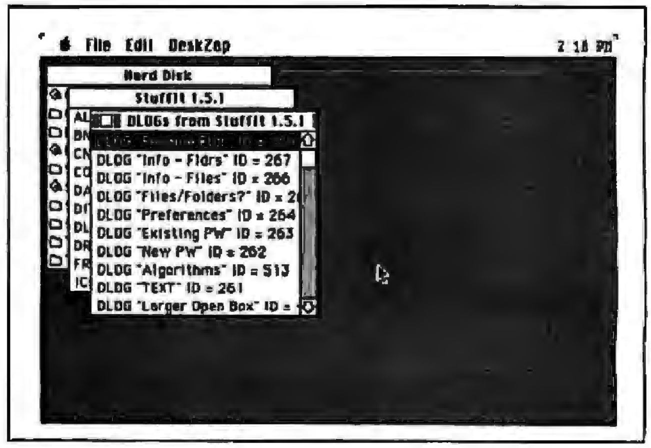


Figure 3: *A graphical representation of the dialogue in small format.*

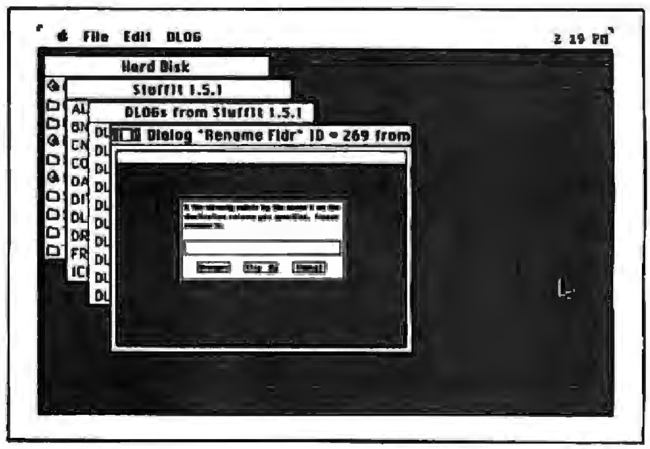
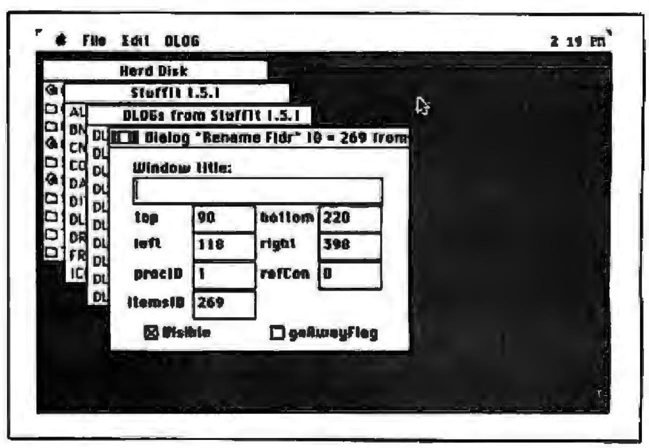


Figure 4: *Dialogue displayed as text.*



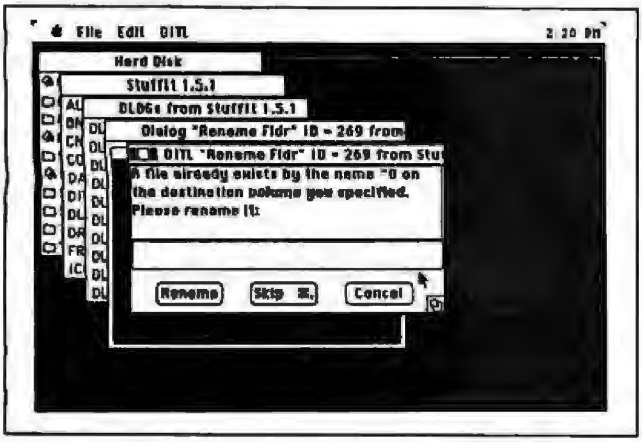


Figure 5: *An Edit window for the DLOG.*

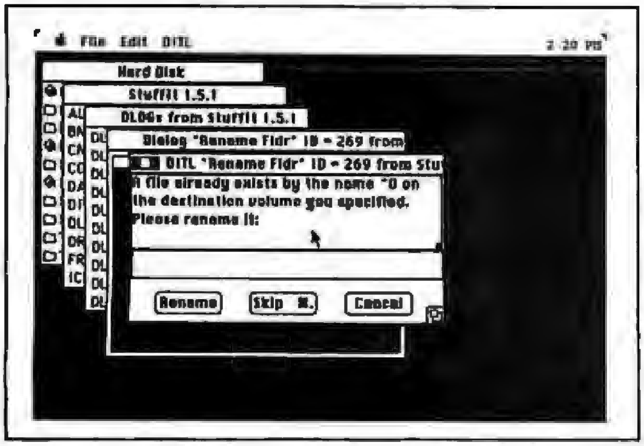


Figure 6: *An Edit box for an individual dialogue item.*

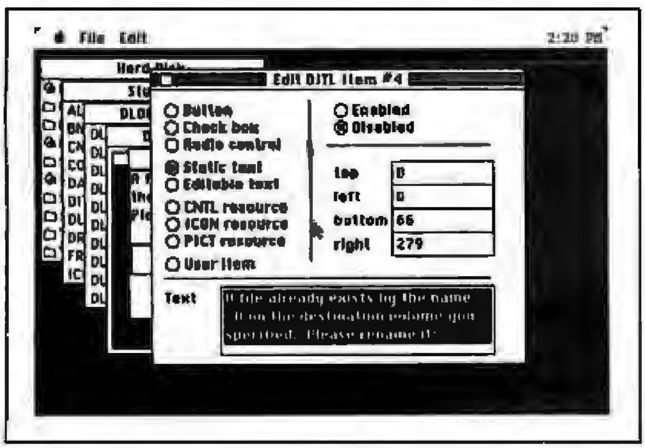
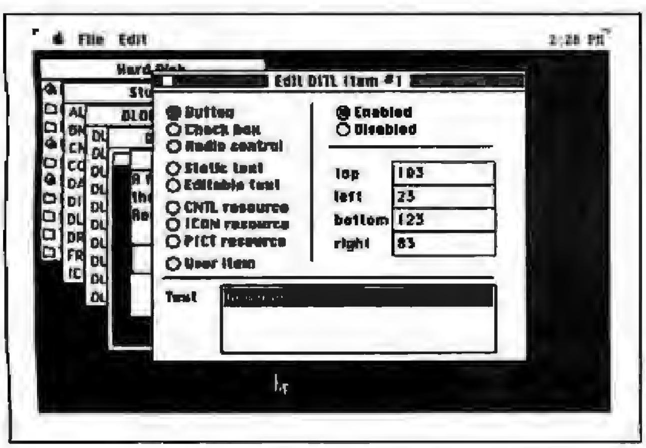


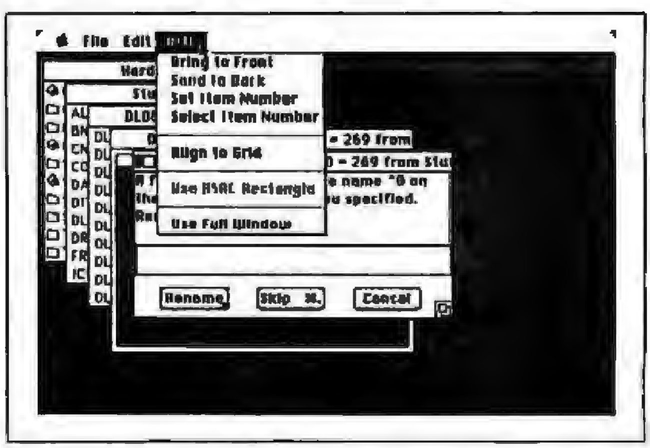
Figure 7: *A new message can be added.*

Figure 8: (bottom left) *An Edit box to change the button name.*

Figure 9: (bottom right) *The DITL type list.*

With ResEdit at your side, you'll have fun exploring the inside of an already-created program, such as StuffIt, and learn a lot in the process.





Bits mode does. The left side of ResEdit's icon-editor screen is where the bits are set to make the "data" part of the icon (what you see on the desktop when the icon is not selected). The left part of this screen is where the "mask" is made (for when the icon is selected). The bottom of the screen shows the icon under various conditions (selected, unselected, small, and so on) to give you an idea of what things will look like when you're done. The ICN# menu that appears with the editor allows the data part to be copied to the mask part so that misalignment doesn't occur. After making the icon and the mask, close both the editor and the ICN# windows.

When you specified the BNDL resource, I mentioned an FREF resource that you had not yet created. Now's the time. As you did for BNDL, select New twice (once for the application type list and once inside the FREF window). A Command-I on the secondary window lets you set the ID of this resource to 129 as you did for the BNDL resource. Once that is done, you can double-click on the secondary window to open a new window. The file type is set to APPL for application, the icon local ID to 0, and the filename to the 4-character string you used before. Close the window.

The last major step is coming up. You have to create a resource with the same name as the 4-character string. As before, you'll use the "double New" way to make the resource. A Get Info on the secondary window allows you to set its ID to 0. Then close all the resource windows. Nothing further needs to be done with it. (Advanced note: If you open the ID=0 resource as an STR [a string], you can put information into it that will show in the application's information window when a Get Info is done from the desktop as version information. It's not mandatory to do this, however.)

You can then close the application's resource type list. As you close it, ResEdit will ask if you want to save the changes. Click yes. After it is closed (and highlighted), do a Get Info on the application. Set the type to APPL and the creator to the 4-character string you have used. Close the window, and you are done!

A Real-Life Example

Now that you have one trick down pat, you're ready to go on and see what the inside of an already-created program looks like with ResEdit on your side. StuffIt 1.5.1 is a great utility from Ray Lau that has widespread distribution within the Mac community (and if you haven't sent your shareware to him yet, please do so right away!).

Figure 1 shows what you find when you open StuffIt, namely the resource types that are present. Select the DLOG (dialogue) resource. Figure 2 is a list of the DLOGs present; select the first one and double-click. Figure 3 is the image that then shows. It's a graphical representation of the dialogue in a small format. Note the DLOG menu that has appeared in the menu bar. It allows the choice of a graphical or text representation of the dialogue. Figure 4 shows the same dialogue displayed as "text" information.

Going back to the graphical representation is very interesting, but how does any editing get done? You simply double-click on the graphic. The result is shown in figure 5. Newer versions of ResEdit are smart enough to realize that DITLs (dialogue item lists) are linked to DLOGs. They call up the appropriate linked DITL to the DLOG automatically. Older ResEdits made this a manual operation. In any case, you can see each of the individual dialogue items. Select one (figure 6). A bordered box is drawn around it with a gray "handle" in the lower right-hand corner. Double-click on that, and the edit box (figure 7) appears. The editable text is selected at the bottom. You can now change it to your heart's content with whatever message you want. (The ^0 in the text is a placeholder for a `paramtext` Toolbox call. To actually use the dialogue, you would call `paramtext` from the code, specifying the name that would go into the dialogue as one of the parameters.) When you close the edit box, you see the effect of your change. If a change in the size of the edited item is required, this is where you would make it.

Double-click once more with the button selected. Figure 8 is the edit box that appears, similar to the previous one. Again, this is where you would make any text changes (i.e., the name of the button). One way to confirm for yourself the linking that ResEdit does is to select DITLs individually. Figure 9 shows the DITL in the type list. Selecting the one corresponding to the DLOG you just did would show it with the new wording in effect. You can always access the DITLs this way without the DLOG if that is faster for the purpose you have in mind. ALRT (alert) resources also exhibit this kind of linked behavior. You can open an ALRT to see what it looks like and call up the individual DITL items from it, in

Figure 10: *ALRT menu choice.*

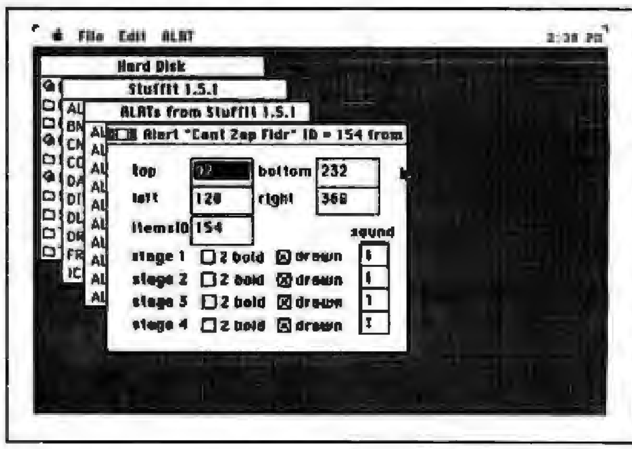
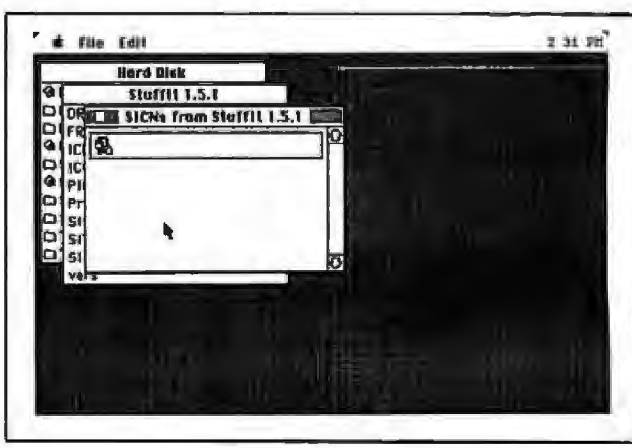


Figure 11: *A StuffIt small icon listing box.*



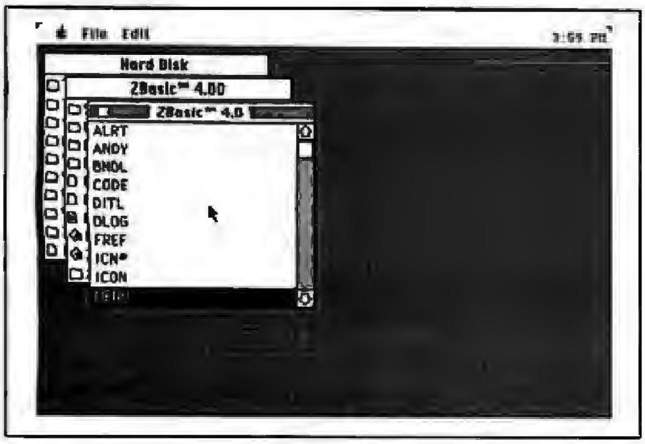


Figure 12: *ZBasic 4.0 menu resource.*

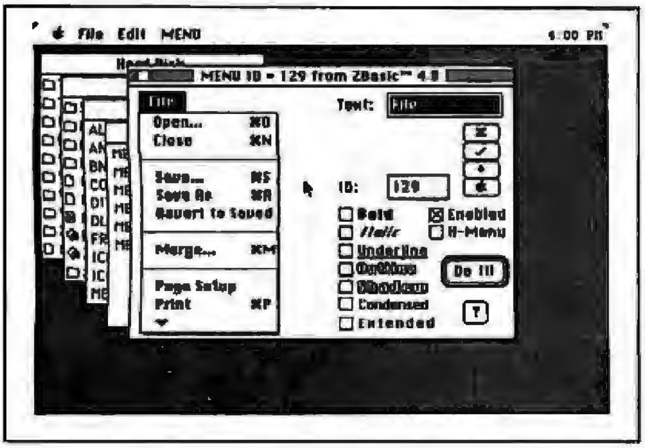


Figure 13: *Main file menu.*

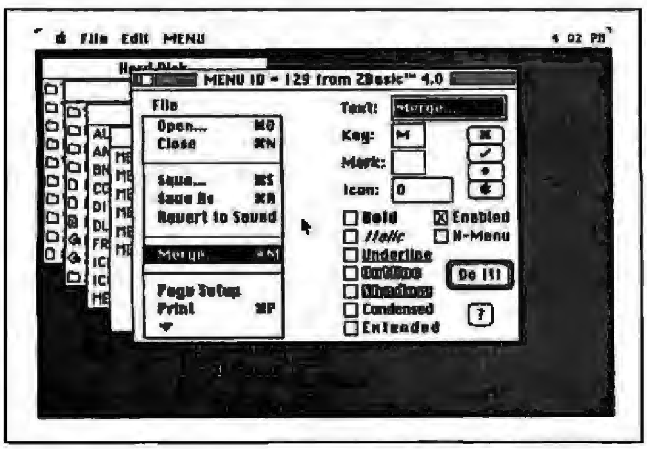


Figure 14: *Items can be selected and edited.*

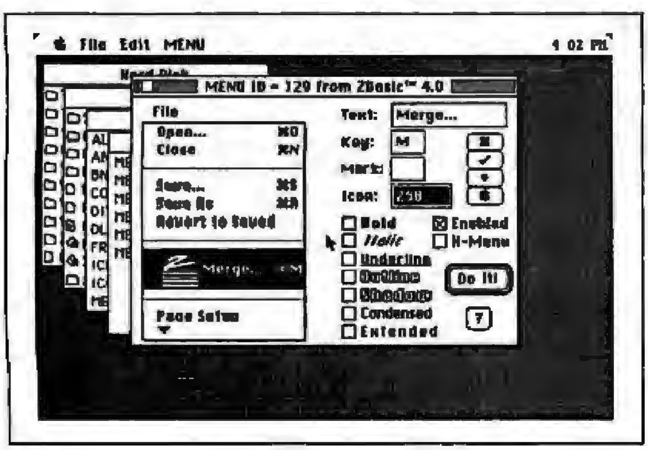


Figure 15: *Type a ZBasic icon number, hit Do It!, and the icon appears.*

the same manner as from a DLOG. However, the text displayed by choosing it from the ALRT menu choice (figure 10) is specific for what is needed for an alert.

One of the resource types StuffIt has listed is SICN (small icon). Opening this up in the standard manner shows an interesting listing box (figure 11). The small icon is shown about the same size as it would appear in the program. Double-clicking on the small icon brings up the editing box. This editor works the same way as the icon editor you saw before. Bits are set and cleared to produce a small icon.

Something Completely Different

One resource that StuffIt lacks is a menu. I grabbed ZBasic 4.0 and opened it up to show a menu resource (figure 12). Since I know that ID = 129 is almost always the File menu, I picked that one and opened it. What appears (figure 13) will be a surprise to anyone using the Apple-issue ResEdit. Alan Goates of Otherware (310 South 13th East, #3, Salt Lake City, UT 84102) has created a very nice menu editor for ResEdit that I use in preference to Apple's. When I spoke earlier of ResEdit being extensible, this is one of the things I had in mind. (MenuEditor 1.2 is available in the listings section of the macintosh conference on BIX.)

Figure 13 shows what the screen looks like when the main menu is selected. Any individual item can be selected (figure 14) and edited as far as text or marked state. To demonstrate how easy it is to edit with this tool, I simply typed in the number of one of ZBasic's icons, hit the Do It! button, and got the results in figure 15. The respacing necessary in the menu to reflect the icon's presence was done automatically. Adding the menu editor to a standard ResEdit is very simple, nothing more than a copy and paste. I recommend this tool for anyone editing menus with ResEdit.

The Benediction

I have really not taken you much below the surface of ResEdit's possibilities in this brief exploration. But you should now understand how to make it do at least one practical task that may have seemed mysterious before, and have a better appreciation of the great utility Apple has provided to developers. ■

Laurence H. Loeb is an electrical-engineer-turned-dental-surgeon in Wallingford, Connecticut. He is comoderator of the macintosh conference on BIX. He can be reached on BIX as "lloeb."

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M260	M261	M262	M263	M264	M265	M266
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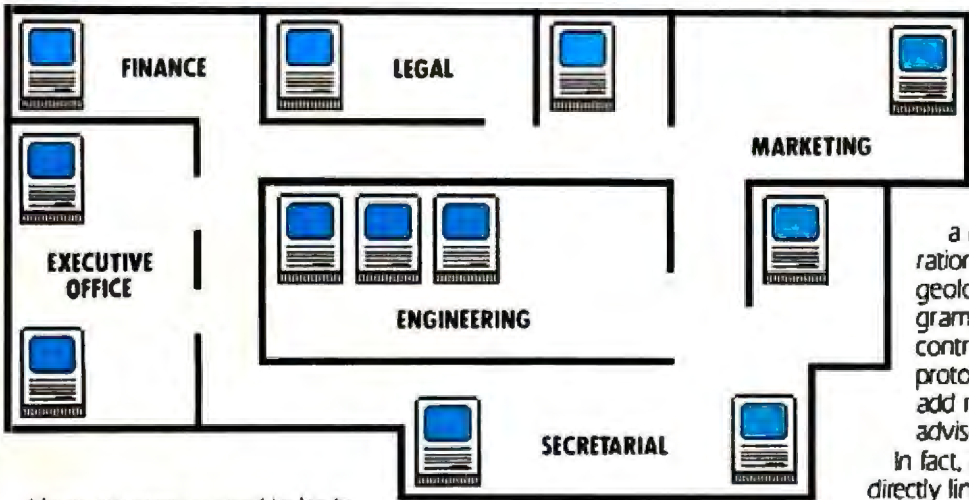

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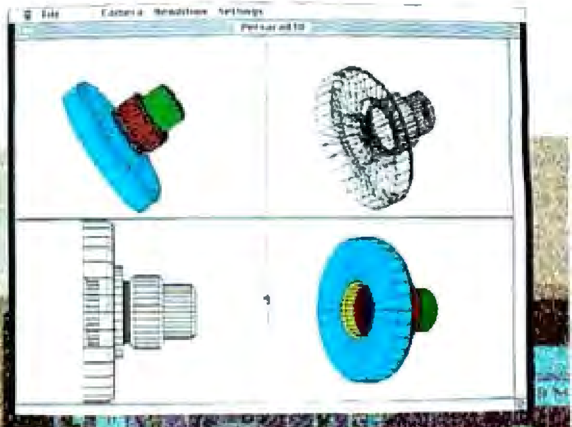

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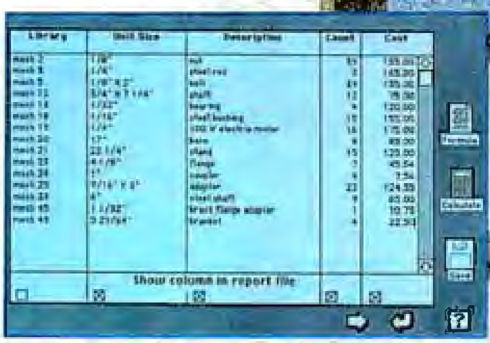

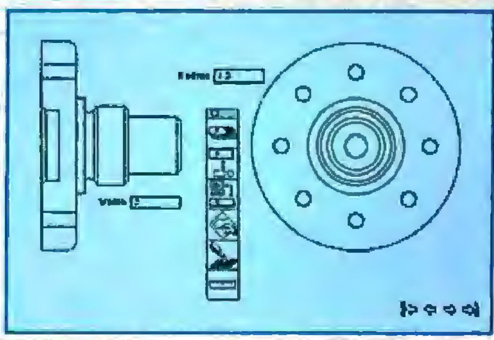

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Object-Oriented Programming

The phrase "object-oriented" is becoming one of those buzzwords that you hear from everyone. It's also becoming one of those topics that no two people agree on. But what does "object-oriented" really mean?

The basic idea behind the object-oriented approach is very simple. We perceive the world around us as a variety of objects. When we look at a plant, we see a plant, not a mass of individual atoms. We can divide the plant into leaves, flowers, stems, and roots, but we still see those items as units, as objects.

If we subdivide the bits and pieces of the plant into molecules, even they are groupings of different atoms that we also perceive as single units. To carry the analogy one step further, traditional procedural programming deals with the atoms, while object-oriented programming deals with the plant.

Thus, from the outside, object-oriented means the familiar; it means the way you normally look at the world around you; and it inherently makes sense. From the inside, however, it's a lot more complex than that.

This month's In Depth section sheds some light on the inner workings of object-oriented programming, languages, and interfaces. In "What's in an Object?" Dave Thomas provides an entrance into the object-oriented world. He describes the basics and the terminology and gives an overall view of the field.

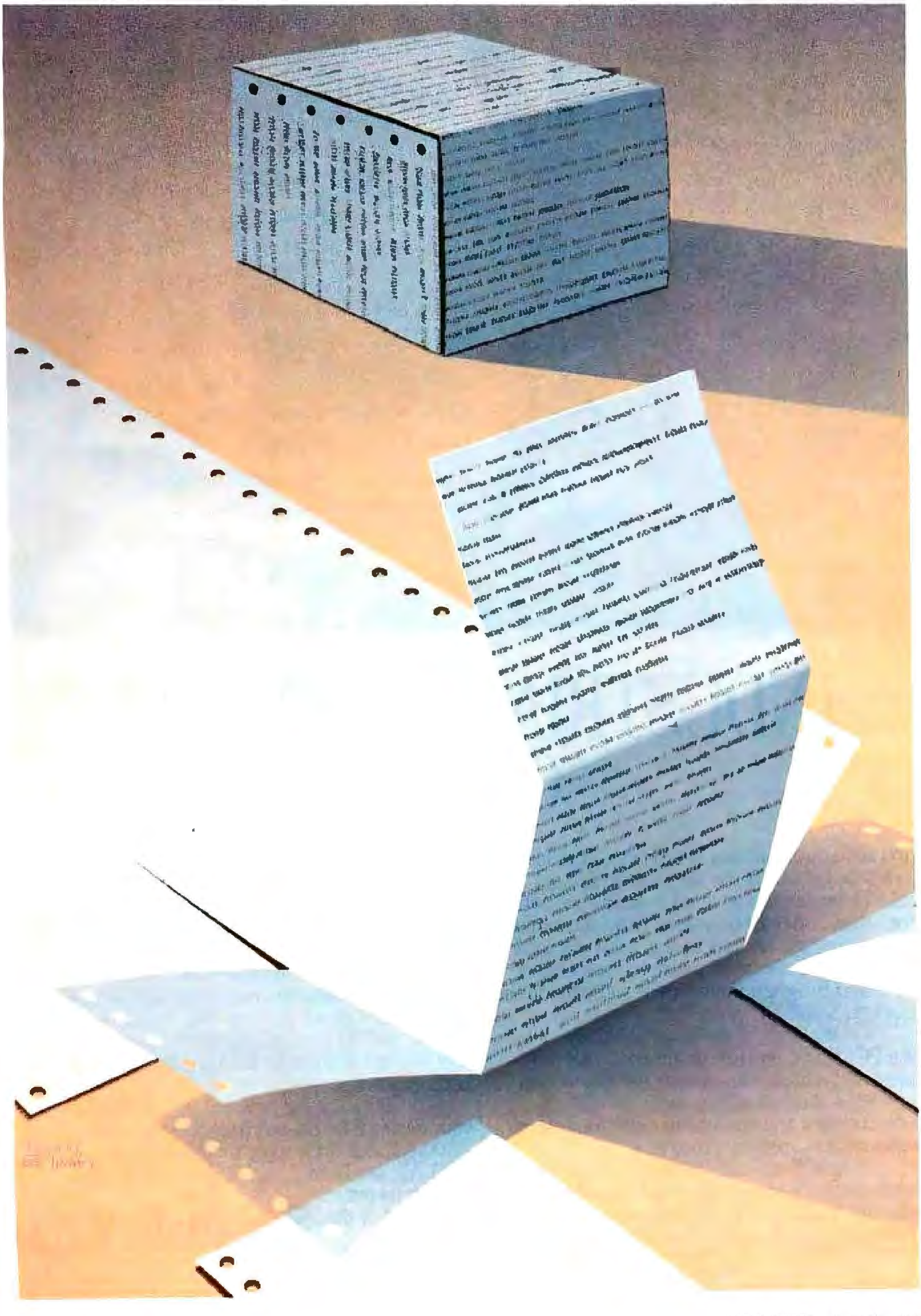
Then, in "Learning the Language," Peter Wegner goes into the details of object-oriented languages, how they handle things and how they are organized. He also defines the differences between object-based, class-based, and object-oriented languages.

In their article "Separation of Powers," Mahesh H. Dodani, Charles E. Hughes, and J. Michael Moshell discuss object-oriented user interfaces—how they work, and why they are popular. And they are popular: Consider the success of the Macintosh user interface.

In "The Next Step," BYTE's Tom Thompson discusses the inner workings of the NextStep user interface from NeXT.

We've been hearing it from psychologists for some time now: Some of us are right-brained (more artistic, more intuitive) and some of us are left-brained (more logical, more analytical). Traditional computer languages and interfaces, with their structure and detail, have appealed to those of us who are left-brained. On the other hand, object-oriented languages and interfaces, with their emphasis on perception and the whole picture, invite those of us who are right-brained to join the computer revolution as well.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth



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What's in an Object?

Even limited object-oriented systems let you build your own integrated applications quickly

Dave Thomas

Object-oriented programming encourages code reuse rather than reinvention. It encourages prototyping and code polishing. It rewards the development of generic functions.

Object-oriented programming enables you to create software that can be readily comprehended and shared with others. Unlike more traditional programming methods that are based on concepts such as data flow or mathematical logic, object-oriented programming directly models the application. Programs perform computations by passing messages between active objects, which are computer analogs of entities in the real world.

An object-oriented financial application, therefore, might see Customer objects sending debit and credit messages to Account objects. The Account objects might then cooperate to maintain Cash-on-Hand, Accounts-Receivable, and Accounts-Payable objects.

Likewise, an object-oriented electronic CAD system might model a circuit as a set of Component objects, each holding a collection of Pin objects that connect through Net objects to the Pins of other Components. When a Component asserts a signal on one of its output Pins, the Pin sends a message to its Net that asserts the signal to all its other connecting Pins.

Breaking with Tradition

Breaking down an application into entities and relationships that are meaningful to end users is a common conventional programming-analysis technique. Unlike conventional programming, however, object-oriented programming preserves this same decomposition through the design and implementation phases. This makes the software more tangible to nonimplementers who have application knowledge.

This also means that you can reuse objects in similar applications in the same area. Reusing, rather than reinventing, software speeds the development and maintenance of large applications.

You design and implement an object-oriented system, then, as a simulation that assigns state and behavior to each of the natural objects in the application. For example, an object-oriented language like Smalltalk formalizes the notion of an object and makes it the natural unit of modularity. You implement an object's state by giving it a private, persistent memory. Its behavior is implemented as a set of procedures or operations (called methods in Smalltalk) that have access to the private memory.

In traditional programming systems, data and procedures are separate entities; the programmer is responsible for

continued

applying active procedures to passive data structures, and frequently for ensuring that the procedure will work correctly on the data types to which it is applied.

By contrast, an object-oriented programming system (OOPS) doesn't view an object just as passive data but as the combination of its private state and the methods that manipulate it. (See the text box "What Took So Long?" on page 234.)

Methods and Messages

Only the methods of an object have access to its state, and a method can only be invoked by sending the object a message. The distinction between a message and a method is subtle but important. Since a method is part of an object and not a global entity, there is no problem with a Line object and a Circle object both having a method named *draw*.

Sending the draw message to a Line invokes its draw method; sending the same message to a Circle invokes a different method. Thus, you always get the appropriate behavior for the draw operation.

It is quite common in object-oriented systems to code multiple classes of an object that respond to the same messages, as in the Line and Circle example. The ability of different objects to respond differently to the same message is known as *polymorphism*. This approach is clearly superior to using a huge case statement for all the known graphical data types in a single global draw procedure.

Polymorphism is partly responsible for a well-known characteristic of object-oriented systems: a style of programming sometimes referred to as differential programming or programming by modification. It is very easy to plug new objects into the system if they respond to the same messages as existing ones. For instance, if a Window object expects all graphical objects to be able to draw themselves, then it is very easy to add Rectangle objects to a system that previously had only Lines and Circles.

The other characteristic of most object-oriented languages that supports differential programming rather well is called *inheritance*. This is the ability to define a new object that is just like an old one except for a few minor differences. For example, if you were writing a banking application, you could define a Savings-Account object that is just like the existing Bank-Account object but with a few extras. Savings-Account will inherit all of Bank-Account's state and methods.

All these features—the encapsulation of state and methods together, differential programming via polymorphism, and inheritance—create a different style of programming.

A Shared Vision

It is often said that you can always tell a good idea when many claim to have discovered it. While most attribute the origins of object-oriented programming to Simula67 and Smalltalk-80, the object concept has many proponents. Simula67 demonstrated the modeling power of a class-based programming language. Smalltalk-80 introduced the concepts of an integrated language, a programming environment, a user interface, and a class library.

Future programming systems will be based on the concepts of object and message.

Early explorers in the OOPS field include the AI community, which developed many object-oriented systems for knowledge engineering, including Hewitt's Actors, MIT's Flavors, and Xerox's Loops. Applications such as Schlumberge's Strobe and Intellicorp's KEE (Knowledge Engineering Environment) demonstrate the power of the OOPS metaphor. For several years, leading researchers in operating systems have advocated an anthropomorphic programming style using lightweight processes in systems such as XOR's THOTH, Open Systems' Harmony, and Quantum Software Systems' QNX.

In programming-language research, information hiding (encapsulation) has been the guiding principle in the development of abstract data type systems found in languages such as Alphard, CLU, and Ada. While many of these systems lack the concept of inheritance, they constitute an important class of systems that Brown University's Peter Wegner calls object-based systems.

Elementary Particles

Many object-oriented pundits believe that objects and messages, arranged in some configuration, form the elementary particles of software. In recent years, we have come to accept the notions of data structure and control structure as requirements of all programming systems. Future systems will be based on the concepts of object and message.

I'll briefly discuss object-oriented programming terminology. The concepts are intentionally illustrated with simple examples. However, to appreciate the benefits of OOPS, you will need to use a real object-oriented programming environment, such as Smalltalk, on an interesting application. Like most important ideas, the concepts of object and message are deceptively simple.

The four most important concepts of object orientation are encapsulation, message passing, inheritance, and late binding.

Encapsulation

An object consists of an encapsulated representation (state) and a set of messages (operations or procedures) that can be applied to that object. Encapsulation is the technical name for information hiding.

Instead of organizing programs into procedures that share global data, the data is packaged with the procedures that access that data. This concept is often called *data abstraction* or *modular programming*. Languages such as Modula-2 and Ada, unlike Pascal and C, support this concept.

The goal here is to separate the user of the object from its implementer. The user is no longer aware of how the object is implemented (using an array or linked lists, for example). Users can only operate on an object using those messages that the implementer provides.

This has the obvious benefit that you can change the implementation of the encapsulated object without affecting the applications using it. Your operating system is such an object (albeit a large one).

The application programmer who uses the standard C file I/O library, for example, has no difficulty porting from one operating system to another. File-oriented applications using this protocol run on DOS, Unix, and the Mach Unix Kernel without modification, although the underlying implementations are completely different.

Pointers are often the antithesis of encapsulation. For example, the C address-of (&) and dereference (*) operations allow you to bypass the protection boundary provided by objects. Object-oriented programming extends Pascal's safe-pointer notion to provide a powerful

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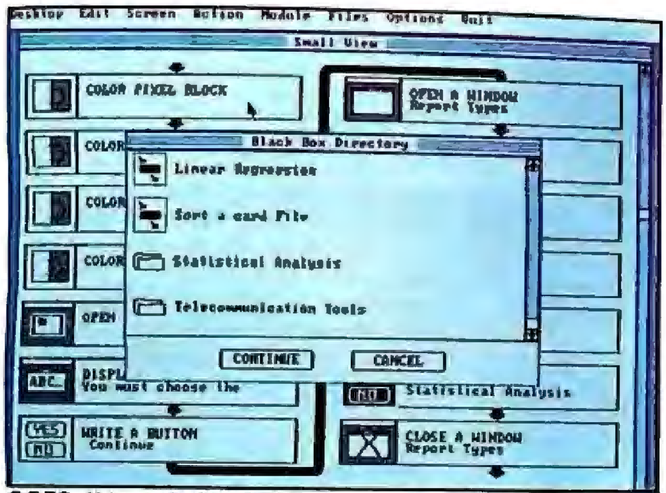

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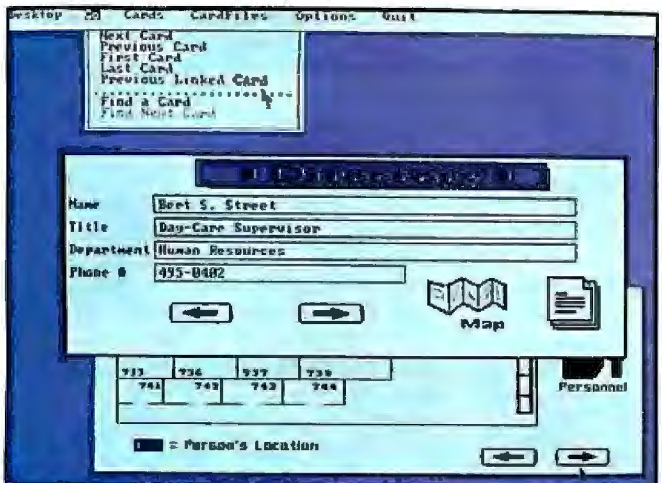

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What Took So Long?

If object-oriented programming is so great, why isn't everyone using it? Why is it still not well understood despite its 1960s and 1970s roots?

The first reason is that both the Simula67 system and the Smalltalk-80 system were relatively inaccessible to the North American software community until the 1980s. The pioneering work on Smalltalk-80, for example, was held captive at the Xerox Palo Alto Research Center until the BYTE issue of August 1981.

And it was only three years ago that the first conference on Object-Oriented Programming Languages, Applications, and Systems (OOPSLA) was held. Only five years ago, languages such as Objective-C, C++, and Eiffel didn't even exist.

The second reason is that many of those first introduced to Smalltalk thought of it as only a windowing system rather than a revolutionary programming environment. This is exemplified by the many interfaces using windows and a mouse. You should note, however, that while many interfaces copied Smalltalk's user interface, none of these systems let you touch or modify the underlying objects. In many cases, the flexibility of open systems like Smalltalk can be achieved only on powerful hardware. Current processors like the Intel 80386 and the Motorola 68020 fit the bill.

programming metaphor without pointers. It has been my experience that even the use of object-oriented programming style in C and Pascal programs reduces the number of pointer bugs. The Macintosh and Microsoft Windows environments clearly demonstrate the difficulty of developing applications using dynamic pointer-connected data structures.

It is extremely difficult to build robust applications in a language where you must manage dynamic storage, which is why we still need tools like memory protection and hardware debuggers. Environments like Smalltalk never crash the system. Instead, a notifier (debugger) window appears, indicating the error (e.g., when an object does not understand a message).

Class versus Instance

Modern programming languages make distinctions between a type definition and a variable declaration. Each time a procedure is called in C, for example, the local variables are instantiated (allocated and initialized).

In object-oriented languages, the definition of a type is often called a *class*. A class definition defines both the instance variables (state or representation) and the methods (operations) for objects of that class.

Similar to a type in Pascal, object-oriented languages use a class for the purpose of creating instances of it. While it's possible to allocate objects using a stack discipline like Pascal or C, most object-oriented languages dynamically create objects by sending some form of "new" or "create" message to the class.

Figure 1 illustrates the difference between the Account object that defines class Account and instances of Account. The class object provides a mechanism for sharing the methods, since the same method code is used for each instance of the class. One important benefit of this approach is that each object is self-identified, since it carries its type with it.

This turns out to eliminate many programming problems, since all objects know their type and how to print themselves. When a program bombs, you don't have to write a complex debugging routine to display a data structure. The more sophisticated languages, such as Smalltalk and CLOS (Common Lisp Object System), remove the need to worry about storage by providing an automatic garbage collector. The advantages of automatic reclamation of unused objects are numerous.

Message Passing

The use of the word *message* versus *procedure* suggests a looser connection between the object and its user. It leaves open the question of how the message will be realized (by a jump to a subroutine, a system trap, or an interprocess communication in a multitasking or distributed system).

In most cases, the messages are organized into public and private categories. Public messages are generally accessible. Private messages, however, can only be executed by the object itself. They are not available (visible) to outside users.

Message passing facilitates software maintenance by eliminating the type-specific `If` and `Case` statements, which must be updated each time an application is modified to accommodate a new type.

Listing 1 shows the organization of an existing application for handling banking transactions. The program is well structured, with a procedure for each transaction: withdraw, deposit, and transfer. The problem is, each time a new account type is added, the program must be updated.

Suppose you are developing an application in C that needs to run in many environments, such as the Macintosh, X Windows, Presentation Manager, and NextStep. If you anticipated this requirement and have been very careful, you would have common source code across all platforms. By using the C preprocessor, you conditionally build the source for the appropriate platform as illustrated in listing 2. Maintaining common code will be extremely difficult because you will have to update the common code for each platform. A mistake anywhere can result in a major bug that is propagated to each platform. The readability of the code is significantly decreased, and the development time for any given version is increased.

Both of these problems illustrate the clear advantage of having type-based dispatching performed by a common message-passing routine. To provide a usable abstraction for the user, such as Deposit or Open Window, you must provide and maintain another layer of encapsulation.

When you program with an object-oriented language, you are relieved of maintaining message passing. Your only responsibility is to place the new or updated code for the operation (method) in the appropriate class definition.

Smalltalk and Objective-C use an explicit message-passing syntax of the form `account deposit: 50`. Languages such as C++, CLOS, Eiffel, and Trellis/Owl use the traditional functional syntax `deposit (amount,50)`. These are called generic or overloaded functions, since there are multiple definitions of the functions for different classes (types).

A Common Inheritance

Inheritance is the major feature distinguishing an OOPS from other programming systems. Every OOPS provides simple inheritance in one form or another. Inheritance increases code sharing by allowing the language rather than the programmer to reuse code from one class in another related class.

Consider a simple banking application that must operate on several different account types. I will call the basic account type "Account." Account denotes the most general type of account. Savings Accounts, Checking Accounts, and BonusSavings accounts are more specialized accounts that have additional properties. Each of the account types includes an account number, an account owner, a balance, and an interest rate. All accounts allow you to deposit funds at any time. Savings Accounts do not allow check withdrawals, but checking accounts do. BonusSavings accounts have a higher interest rate, but the accounts cannot be used for cash or check withdrawals for a specified period.

You can use inheritance to capture the similarity and differences in the account types using the Smalltalk code shown in listing 3.

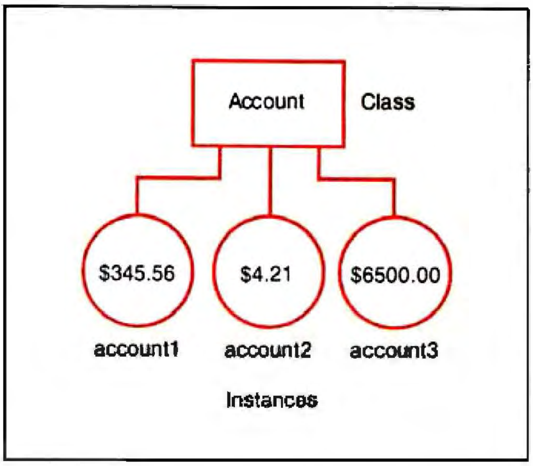


Figure 1: *An illustration of the differences between the Account object and the Account instances.*

We say that Savings and Checking are subclasses of Account, and that BonusSavings is a subclass of Savings. Both the methods (deposit, withdraw, and check) and the representation (accountNumber, accountOwner, balance, and rate) of an object can be inherited. When the check: 500 message is sent to an instance of BonusSavings account, the method executed is the one defined in Savings. Figure 2 shows the inheritance diagram for the account classes.

Most languages perform representation inheritance at compile time and method inheritance at run time. While it's generally a good idea to inherit common behavior, it's often undesirable to inherit representation. The existing systems, such as the Smalltalk class library, don't differentiate between the logical and implementation hierarchies. The logical hierarchy organizes the classes based on their behavior. The implementation hierarchy simplifies the implementation of a given class.

Parts: The Keys to Reusability

Inheritance is not the only way to share code and promote reuse. *Parts* let you

continued

Listing 1: *This segment of a Pascal application for handling banking transactions is clearly well structured. Unfortunately, each time a new account type is added, the program must be updated.*

```
Type
  Account = Record
     Type    : (CDA,GIC,BONUS);
     Balance : Money;
     ...
  End;

Procedure deposit (account:Account, amount:Money)
Begin
     Case Account.Type of
    CDA:   CADdeposit (account, amount);
    GIC:   GICdeposit (account, amount);
    BONUS: Bonusdeposit (account, amount);
     End;
End;

Procedure withdraw (account:Account, amount:Money)
Begin
     Case Account.Type of
    CDA:   CADwithdraw (account, amount);
    GIC:   GICwithdraw (account, amount);
    BONUS: Bonuswithdraw (account, amount);
     End;
End;

Procedure transfer (account1, account2:Account, amount:Money)
Begin
     Case Account.Type of
    CDA:   CADtransfer(account1, account2, amount);
    GIC:   GICtransfer(account1, account2, amount);
    BONUS: Bonustransfer(account1, account2, amount);
     End;
End;
```

Listing 2: *The beginning of the conditional source for each of the different platforms: Macintosh, X Windows, Presentation Manager, and NextStep. Maintenance will involve updating the common code for each platform.*

```
draw(...)
#ifdef PM
    pmdraw(.....)
#ifdef X
    xdraw(.....)
#ifdef Mac
    quickdraw(...)
#ifdef Next
    psdraw(...)
    openWindow(...)
#ifdef PM
    pmopenwindowC
#ifdef X
    xopenwindow (...)
#ifdef Mac
    macopenwindow (...)
#ifdef Next
    psopenwindow (...)
    readevent(...)
#ifdef PM
    pmgetnextevent(...)
#ifdef X
    xgetnextevent(...)
#ifdef Mac
    getnextevent(...)
#ifdef Next
    psgetevent(...)
```

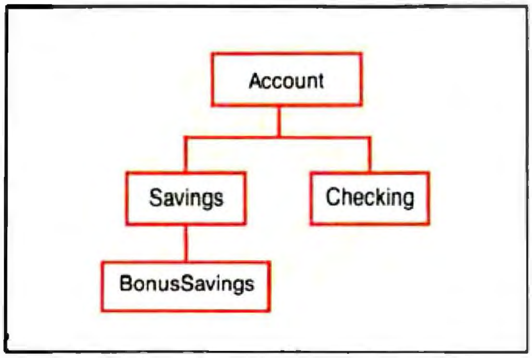


Figure 2: *The inheritance diagram for the account classes.*

Listing 3: *Here the Smalltalk code uses inheritance to capture the similarities and differences in the banking-application account types.*

```
class name        Account
superclass        Object  "Every object is a subclass of
                           something, in this case Object"
Instance variable names   accountNumber accountOwner balance rate
                          "The state of the object"

instance methods

deposit: amount
     "Deposit amount into the receiver (an Account)."
     balance := balance + amount.

withdraw: amount
          "Withdraw amount into the receiver."
          amount > balance ifTrue: [
              accountOwner
               error: 'Not enough money in this Account.'
          ].
          balance := balance - amount.

 check: amount
          "The code for check withdrawals."
           self withdraw: amount  "Note: Here we
                                   re-use the method we
                                   have already defined."

class name                 Savings
superclass                 Account
instance variable names    <none>

      check: amount
          accountOwner
              error: 'You can't write checks against
                      this account'

class name                 Checking
superclass                 Account
instance variable names    <none>

class name                 BonusSavings
superclass                 Savings
instance variable names    period   "The minimum deposit period."
                           depositDate  "Date of last deposit."

    withdraw: amount
         depositDate + period < Date today
             ifFalse: [ accountOwner
                          error:  'You can't withdraw from
                                   this account yet'
                      ].
         ^ super withdraw: amount
```

construct compound objects such as windows. Therefore, you can use inheritance as a mechanism to create objects that share properties with similar objects, and you can use parts as a mechanism for assembling composite objects. It's easy to confuse the parts hierarchy (such as the house in figure 3) with the inheritance hierarchy.

This error is signaled by the inability to inherit useful properties. Some existing window systems also suffer from the fact that much of the window structure is inherited rather than assembled from parts. There is no explicit syntax for parts programming. You might expect a `partOf:` construct. Instead, parts are constructed using instance variables.

Figure 3 illustrates the classes for a house. When you describe composite objects, you must describe how they are created and how components are added and modified.

Early versus Late Binding

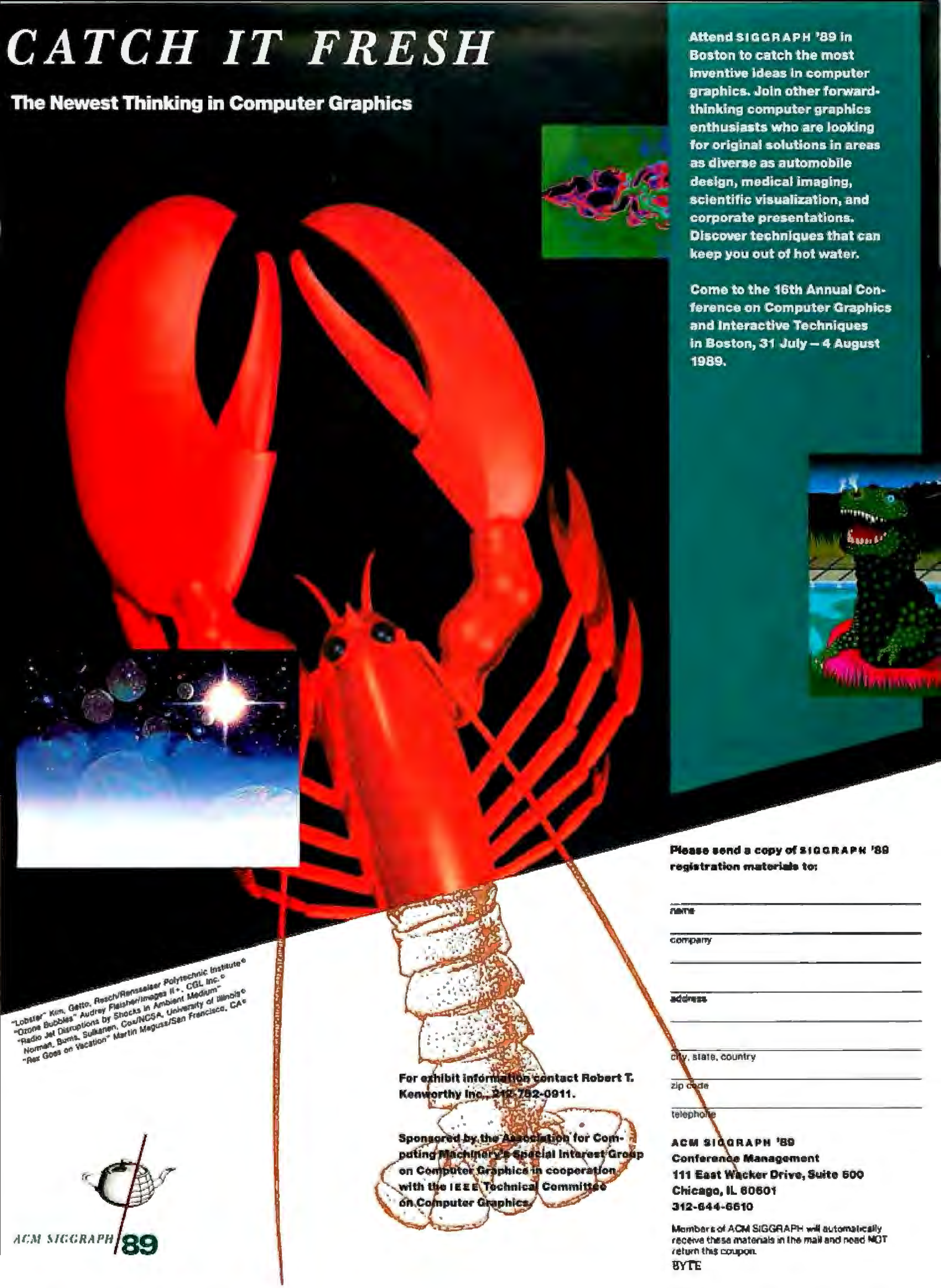
Once you accept the benefits of a new language or tool, you will probably question its efficiency. Clearly, in listing 1 you didn't know the type of the object until run time, so you had to perform the Case statement in order to determine which method to execute. This is called run-time interpretation of message passing—late or dynamic binding. Obviously, in figure 2, you knew the type of the window system at compile time; therefore, you could early-bind the messages for "draw" and so forth.

Early binding is only possible in the cases where the types are known at compile time, as is common in languages like C and Pascal. Smalltalk and CLOS use late binding, since in these languages it is the objects, not the variables, that are strongly typed.

The proponents of early binding argue that it provides a significant performance advantage. Those who support late binding argue that types get in the way of rapid prototyping and end-user programming in particular. Do you think that HyperCard and Lotus 1-2-3 users would like to have to type their cards and cells?

It seems impossible, for example, to have the convenience of a Smalltalk collection class in a strongly typed language like C++. In Smalltalk, collections can contain any objects. Given an inventory collection, for example, it is possible to add a class into the inventory at any time. In C++, all programs using the inventory must be recompiled with the new class added to the existing union type for inventory. If you allow union types, then

continued



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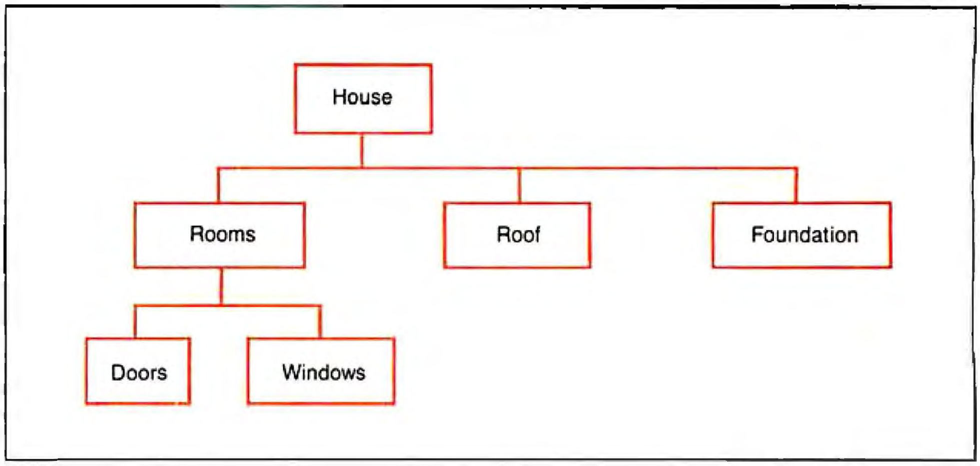

Figure 3: *This graphic illustrates the classes for a house. When you describe composite objects, you must describe how they are created and how components are added and modified.*

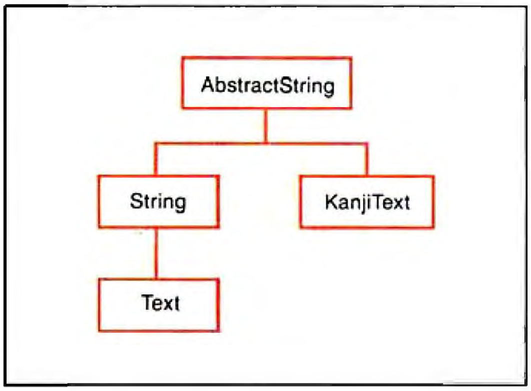

Figure 4: *Abstract classes, shown here, make it easy to extend and modify programs.*

implicitly there must be a run-time lookup anyway. Finally, the current implementations of Smalltalk and CLOS typically dispatch methods faster than C procedure calls, so there isn't a significant price for the flexibility.

Abstract Classes

Experience has shown that method inheritance is a good idea but that, in many cases, representation (variable) inheritance is not. Consider an editor that uses objects of type String to represent lines of text.

String has all the methods for appending and inserting strings, so it is convenient to represent Text as a subclass of String. String has a representation as an array of characters (bytes), which is inherited by Text. This works nicely until you want to handle kanji or multifont text, at which point you need another representation, such as 2 bytes per character. Since you can't redefine the representation of Text, the easy way to do it is to copy String into a new class, KanjiText.

While this solves a short-term requirement, it increases code bulk by duplicating code. The real problem is yet to come. Suppose the simple paragraph editor is not called on to handle large files and that a fast search function is required. You simply redefine the search method in class String to use your new fast search routine. Unfortunately, this doesn't propagate to KanjiString because you no longer have all the methods for String in one place.

Fortunately, there is a simple solution that is standard practice for experienced object-oriented programmers. You make a new class, AbstractString, which has all the methods of String but no representation. You then define String as a subclass with representation of an array of bytes, and KanjiText as a subclass of AbstractString with representation of an array of words (see figure 4).

An *abstract* class is a class that you never make an instance of. It contains the methods common to all subclasses. Abstract classes make it much easier to extend and modify programs that require different representations.

If everything is a class, then a class object must itself have some class. The concept of a *metaclass*—where classes in the system are, in turn, instances of some class (called MetaClass in Smalltalk)—is another important facility provided by the more powerful object-oriented languages. This facility has many important benefits (e.g., extensibility, debugging, and locality of description) but is unnecessary for understanding and using objects.

Subtypes versus Subclasses

Smalltalk, Actor, CLOS, Objective-C, and C++ support the concept of subclass inheritance. Eiffel and Trellis/Owl are based on a more stringent notion called *subtyping*.

Subclassing is a sharing mechanism that permits code and representation to be inherited. Subtyping is stricter than subclassing, since it guarantees that an instance of a subtype can always be used in place of a supertype. Ideally, subtype compatibility would guarantee that the subtype had the same behavior as the supertype, but in practice it only verifies that the operations defined on the subtype have the same name (and types) as the supertype. The subtype must provide all the operations defined on the supertype.

Multiple Inheritance and More

Clearly, not everything can be organized into a single taxonomy (inheritance) tree. Single-inheritance systems require that you organize classes into a tree structure. This can sometimes result in deep inheritance structures that can be awkward to use. Many alternatives based on multiple inheritance have been proposed and implemented in C++, CLOS, Trellis/Owl, Effiel, and some Smalltalk variants.

Unfortunately, the benefits of multiple inheritance are often outweighed by the complexity required to resolve ambiguities in variable and method name conflicts. Others familiar with object-oriented issues argue that objects should not have classes. Rather, objects should be cloned from an exemplar or prototype. The prototype systems make use of a code-sharing technique called *delegation*. Instead of an object executing the

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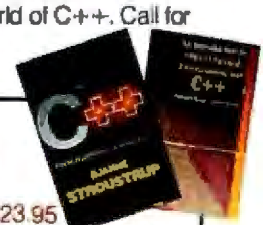

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method inherited from its superclass, the message is automatically delegated to the superclass where it is executed.

We are just beginning to understand the benefits and weaknesses of these more advanced code-sharing techniques. In particular, there has been no substantial class library, say the equivalent of Smalltalk's, implemented using them.

The Development Effort

The pressure to develop new, complex, integrated products in 18 to 24 months can only be addressed by a new product-development life cycle. Rapid prototyping that reuses existing software components is central to this new design and development approach.

In such a system, you first develop a display prototype to perform initial user-interface testing. You follow this with a full simulation that is, in fact, an executable specification of the final product. You then refine the simulation and, where required, reimplement to build the final product.

There are several alternative approaches to object-oriented design, including the methods proposed by Grady Booch, Ivar Jacobson, Bertrand Meyer, and James Rombaugh. Object-oriented design begins with the identification and classification of the objects in the application:

- physical versus conceptual;
- active versus passive;
- temporary versus permanent versus persistent;
- part versus whole;
- generic versus specific;
- application private versus public; and
- shared versus nonshared.

You can then organize the objects into several different groups:

- families of objects that share much commonality (inheritance);
- part/whole relationships;
- communities of interacting data types (different classes that together make up a coherent application); or
- classes that are used by many applications (base classes).

Once you identify the important objects, you must specify the operations that the objects provide. You must divide the operations into "base" (primitive) and "extended" (nonprimitive), identify those operations that are used only internally (private operations) and those that are public operations, and then develop a specification for each operation.

OOPS and You

OOPS promises much more than a point-and-click window interface. Carefully designed class libraries let you quickly assemble applications from prefabricated parts. The power of even limited systems, like HyperCard and Lotus Macros, shows how quickly end users can build their own integrated applications, given the appropriate framework.

Class libraries, unlike the passive click art and text libraries just becoming available on CD-ROM, will allow you to build custom applications from existing ones easily.

For software developers, object-oriented programming provides the opportunity to build substantial applications based on the work of others. This presents a challenge to those individuals who have always worked alone using their own tools and style.

I see the programming community dividing into class producers and class consumers. Class producers will provide classes in specialized areas for use by class consumers. Class consumers will assemble existing classes, with some of their own creation, to build custom applications. Object-oriented technology will not make this happen. However, it does make it feasible to talk about sharing at this level.

Perhaps the first step you can take to get involved in object-oriented programming is to learn Smalltalk. Smalltalk is the first and only completely object-oriented environment. Unlike the superficially more familiar hybrid systems, such as C++, Smalltalk forces you to think in terms of objects. For this reason, many instructors who teach systems such as Objective-C and C++ recommend learning Smalltalk first.

However, if you are wondering if you will have to program in Smalltalk, the answer is no. It is unclear what language will dominate the future of OOPS. It is already possible to program in object-oriented dialects of your favorite language, be it C, Pascal, or BASIC. But the concepts learned using Smalltalk will serve you well whatever language and class library you choose. ■

Dave Thomas is an associate professor at Carleton University in Ottawa, Canada, the president of Computer Based Information Systems, and an associate editor of the Journal of Object-Oriented Programming. *You can reach him on BIX as "dathomas."*

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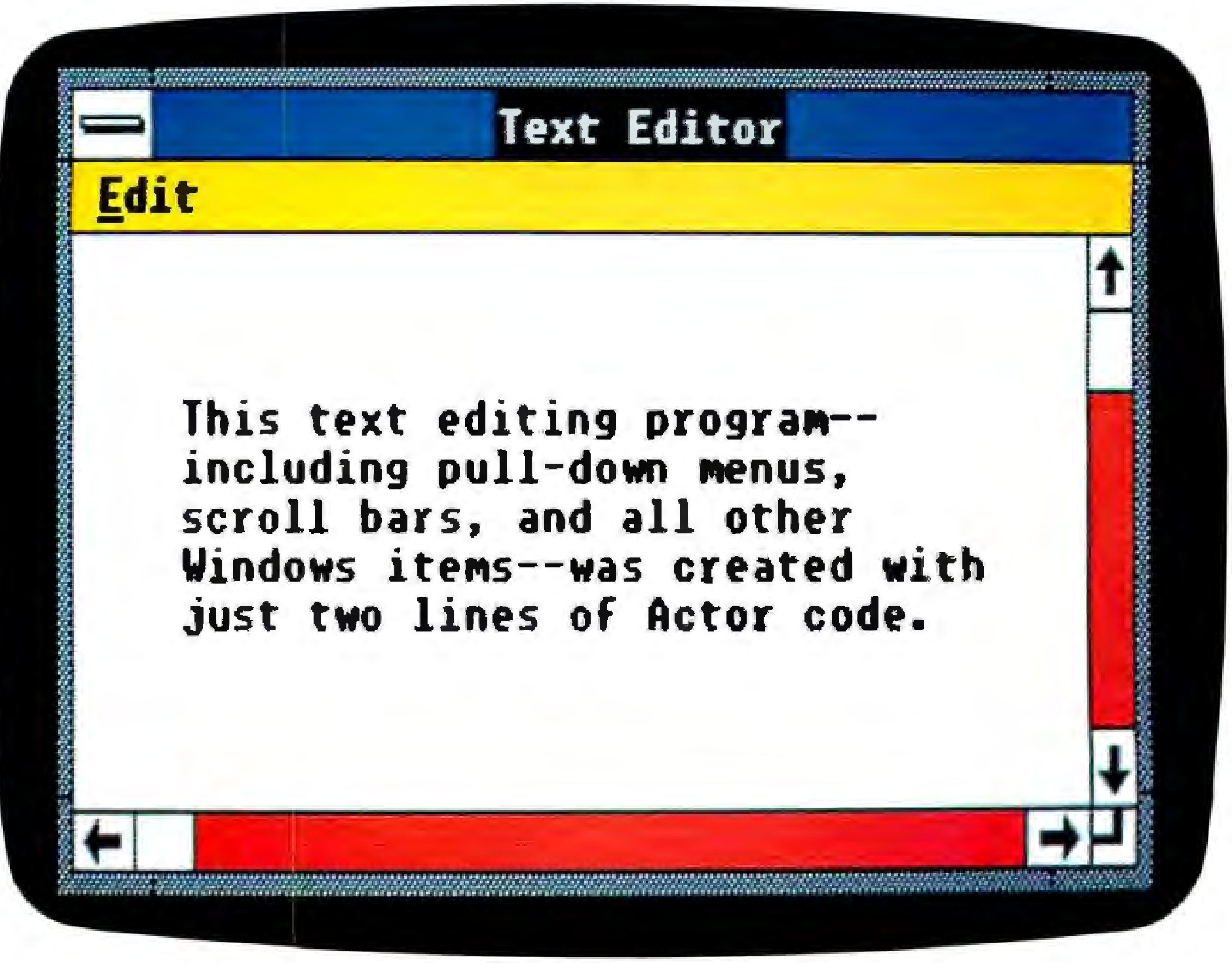

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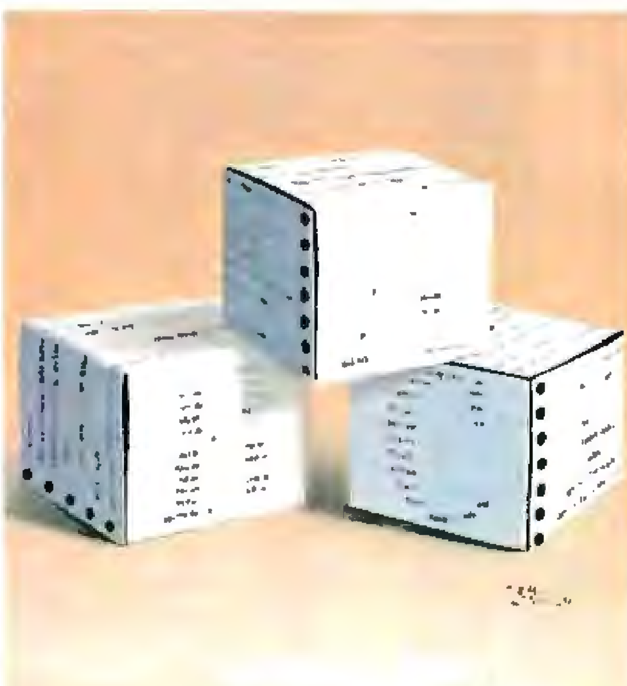
Learning the Language

Object-oriented programming trades the ability to reuse individual operations for efficiency and conceptual simplicity

Peter Wegner



With the software crisis of the late 1960s, structure and simplicity became the basis of language design rather than undisciplined expressive power. The discipline of software engineering was born, and a number of structured-programming and structured-design methodologies were proposed as a basis for applications programming. Emphasis shifted from thinking of programs as sequences of statements to thinking of them as collections of interacting modules. Ada, developed as the Department of Defense's response to the software crisis, supports various kinds of modules, including functions, procedures, packages, tasks, and generic program units. (References for the languages mentioned in this article are shown in the text box "Language References" on page 249.)

The first object-oriented language, Simula, developed in the mid-1960s, featured classes whose instances consisted of sets of operations with a local state, co-routines that simulated parallel execution by "resume" operations, and subclasses that inherited operations and state from parent classes.

This article is an extension and adaptation of concepts described in the OOPSLA '87 conference paper in reference 1. It identifies the basic concepts of object-oriented programming and examines design alternatives both for traditional sequential object-oriented languages and for concurrent and persistent languages for object-oriented programming as a whole.

Objects, Classes, and Inheritance

A language is said to be *object-based* if it supports objects as a language feature, where objects are defined as follows: An object has a set of operations and a local shared state that "remembers" the effect of operations. The value that an operation on an object returns can depend on the object's state as well as the operation's arguments. The state of an object serves as a local memory that is shared by operations on it. In particular, other previously executed operations can affect the value that a given operation returns. An object can learn from experience, storing the cumulative effect of its experience—its invocation history—in its state.

Language support of objects is worthwhile because linguistic objects can directly model objects in the real world, like banks, people, ships, and so forth. However, many practical object-oriented languages impose additional language requirements so you can classify and organize objects within the language. In particular, they require that objects belong to a *class* and that classes support *inheritance*.

continued

A class is a template that "new" or "create" operations can use to create objects. Objects of the same class have common operations and, therefore, uniform behavior. Classes have one or more interfaces that specify the operations accessible through them. A "class body" specifies code for implementing operations in the class interface.

A class can inherit operations from *superclasses* (those above it), and its operations can be inherited by *subclasses* (those below it). An object of the class C, created by `C new`, has C as its base class and can use operations defined in both its base class and its superclasses. Inheritance from a single superclass is called single inheritance; from multiple superclasses, multiple inheritance.

The Semantics of Objects

Different language subcultures have fundamentally different notions of what an "object" is (see figure 1). Functional objects arise in functional object-oriented languages, such as OBJ2, and in logical ones, such as Vulcan. Their interfaces are object-like, but the objects lack an identity that persists between operations. An operation that transforms the state results in the creation of a new object with the given interface and a new state.

Passive, or "server," objects become active when a synchronous message or a remote procedure call invokes their operations. These are the traditional objects of Smalltalk and C++ and are the default when I use the term *object* without qualification. This lets me include the packages of Ada, the modules of Modula-2, and the objects of Simula and CLU among the entities I call objects.

Active, or "autonomous," objects can execute autonomously even when other objects do not invoke them. They include monitors, strongly coupled concurrent objects, and distributed concurrent objects.

Slot-based objects are defined in terms of their instance variables, or slots, as in Flavors and CLOS (Common Lisp Object System). You can dynamically add methods for slot-based objects with DEFMETHOD operations, which specify the class, or flavor, to which you want to add them.

The default definition excludes functional objects, because they don't have a notion of object identity, and slot-based objects, because they allow you to add new methods dynamically. Perhaps I should broaden the default to include slot-based objects, since Smalltalk also permits dynamic addition of methods; however, it is less frequently used, because its objects are normally created with their methods in place.

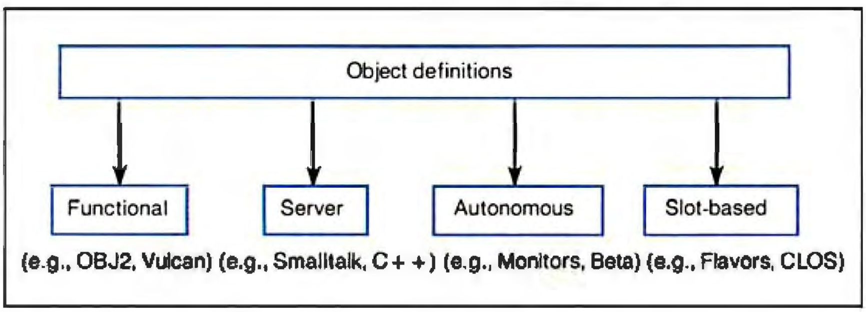


Figure 1: *Objects in different language subcultures.*

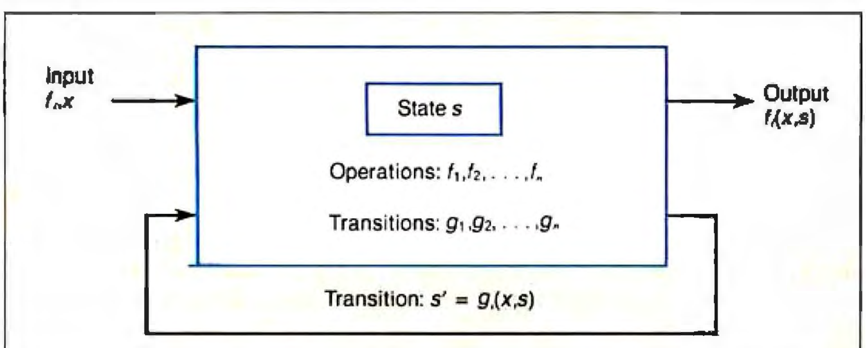


Figure 2: *An object with operations* $f_1, f_2, \ldots, f_n$. *Thus, operation symbols* f_i *are associated with symbols on the input tape, internal actions are associated with the state-transition function* $g_i(x,s)$, *and outputs are associated with operations* $f_i(x,s)$.

Objects can be modeled by automata whose state represents the object's state and whose input symbols represent operations with their arguments. Figure 2 illustrates an object with operations $f_1, f_2, \ldots, f_n$. An operation f_i with argument x in state s results in output $f_i(x,s)$ and state transition $s' = g_i(x,s)$. Thus, operation symbols f_i are associated with symbols on the input tape, internal actions are associated with the state-transition function $g_i(x,s)$, and outputs are associated with operations $f_i(x,s)$.

You can describe objects with a variant of `let` notation:

```
let x₁ = a₁, x₂ = a₂, ... in
  f₁(p₁) = body of f₁
  f₂(p₂) = body of f₂
  ...
  endlet
```

The variables $x_1, x_2, \ldots x_n$ correspond to instance variables, while $p_1, p_2, \ldots p_n$ correspond to parameters of the operations (messages) $f_1, f_2, \ldots f_n$. The semantics of `let` clauses representing objects differs from the `let` notation of functional programming: When an operation executes, it can modify instance variables.

An instance variable x can appear in operations $f_1, f_2, \ldots f_n$ as a nonlocal variable. Thus, the object-oriented style of specifying operations encourages, and even requires, sharing nonlocal variables among several operations. Such sharing makes it difficult to reuse operations of one class in another.

Object-oriented programming sacrifices the reusability of individual operations to gain efficiency and conceptual simplicity. It concentrates on making objects and classes reusable through encapsulation and inheritance.

Properties of Inheritance

The inheritance hierarchy in figure 3 defines persons and elephants as subclasses of mammals, and students and females as subclasses of persons. Instances (below the dotted line) are grouped into classes, while classes (above the dotted line) are categorized by their superclasses. Thus, inheritance serves to group classes in much the same way that classes serve to group values (see reference 2). While subclasses, such as students and females, may overlap in the real world, they cannot generally overlap in object-oriented languages, because every object must belong to precisely one base class.

Inheritance is a powerful organizational principle for concepts, because it can capture natural mechanisms, such as specialization, abstraction, approximation, and evolution. Thus, elephants specialize the properties of mammals; *mammal* is an abstraction of the concept of *elephant*; the properties of mammals approximate those of elephants; and elephants evolved from early species of mammals. Classes serve to model concepts, and class inheritance makes it easier to manage hierarchical relationships among concepts.

In software engineering, inheritance is used not only for classification, but also for system evolution and incremental modification. The ability of inheritance to flexibly specify incremental change is an invaluable tool in software engineering, but it requires a mechanism that is fundamentally more powerful than classification. For example, Smalltalk's inheritance mechanism is designed so you can use it to model software evolution as well as to classify.

Constraints on incremental modification include behavioral, signature, and name compatibility, and cancellation (see reference 3). Behavioral compatibility requires that the behavior of the modified entity, whether class or object, be compatible with its parent's behavior. Similarly, signature compatibility requires that the set of names and types of components, or attributes, of the parent be compatible with the modified entity's. Name compatibility asks only that the names of the parent's components be compatible. And cancellation allows you to cancel parental attributes in the modified entity.

These forms of incremental modification are associated with different underlying models and are studied by different research groups. Behavioral compatibility is associated with algebraic models (see reference 4), signature compatibility with lambda calculus models (see reference 5), name compatibility with implementation models like Smalltalk's, and cancellation with AI models, which are often concerned with such questions as whether penguins are birds although they cannot fly.

Class-based and Object-Oriented

You can define subclasses of object-based languages in terms of the constraints on the objects' properties. The requirements that objects belong to a class and that classes support inheritance are examples of such constraints. An object-based language is a class-based, or classical, language if every object must belong to a class. A class-based language is an object-oriented language if an inheritance mechanism can incrementally define class hierarchies.

Object-oriented programming sacrifices the reusability of individual operations to gain efficiency and conceptual simplicity.

Class-based languages are a proper subset of object-based languages, while object-oriented languages are a proper subset of class-based languages (see figure 4). Moreover, these language classes are useful in distinguishing between existing object-based languages on the basis of their language features, and in relating such distinctions to the language's support of a methodology.

Ada is object-based, but it is neither class-based nor object-oriented, according to my definition, because its objects, or packages, do not have a class, or type. CLU is class-based, because its clusters are effectively classes. They serve as templates for creating instances and allow instances to be "first-class objects" in that you can assign them to variables, pass them as parameters, and use them as components of structures. However, CLU doesn't have inheritance for defining the hierarchical relations between clusters, so it is not object-oriented. Simula and Smalltalk are object-oriented according to my definition.

Figure 4 can be seen as an inheritance hierarchy using object-oriented techniques to classify object-based languages. You can think of class-based languages as inheriting the attributes of object-based languages, and of object-oriented languages as inheriting the attributes of both class-based and object-based languages.

Let's briefly consider the effect of objects, classes, and inheritance on programming methodology. Objects serve to group operations with the data they will transform, and to provide a data-oriented principle for program design. Classes serve to manage collections of objects, allowing them to be passed as parameters, assigned to variables, and organized into structures. Class inheritance organizes collections of classes so that class hierarchies can describe application domains.

Object-based languages such as Ada support object functionality. But mechanisms outside the language, like libraries, must handle object management because it's not supported within the language. Class-based languages provide some degree of object management but none for class management. Object-oriented languages allow both objects and classes to be managed within the language, thereby providing a uniform mechanism for both application design and implementation. They are "wide-spectrum languages," because they support both the high-level design of class

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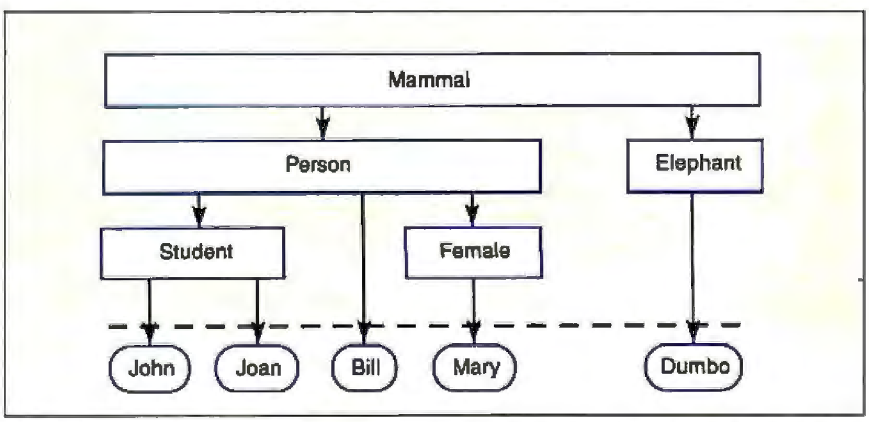

Figure 3: *An inheritance hierarchy. Persons and elephants are defined as subclasses of mammals, and students and females as subclasses of persons. Instances (below the dotted line) are grouped into classes, while classes (above the dotted line) are categorized by their superclasses.*

hierarchies and the low-level implementation of objects.

Data Abstraction and Strong Typing

Objects whose state you can access only through their operations are called *data abstractions*. Data abstractions hide an object's data representation from its users. For example, stack data abstractions whose data is accessible only through push and pop operations hide the stack representation (by a list or an array) from their users. This type of a data abstraction is called an *abstract data type*.

The notion of an object type is strongly related to that of a class. But types are motivated by type checking and can be defined by a predicate for recognizing expressions of the type, while classes determine collections of objects and can be defined by templates for object creation. Types have type-checking semantics, while classes have instance-creation semantics (see figure 5).

The definition of types as predicates and classes as templates leads to a definition of subtypes in terms of predicate modification and subclasses in terms of template modification. Subtypes are defined in terms of the constraints that determine a subset of the set defined by the parent predicate. Subclasses are defined in terms of template modifications that can involve radically modifying or even canceling template components.

A language is said to be *statically typed* if you can determine the types of all expressions at compile time. A language is said to be *strongly typed* if you can determine the type compatibility of all expressions representing values from the static program representation at compile time. Static typing implies strong typing, but strongly typed languages don't require the ability to determine the types of expressions at compile time as long as they satisfy the weaker condition of operator/operand compatibility.

Object-oriented languages with data abstraction and strong typing are a narrower class of languages with stronger structuring properties than the class I've chosen to call object-oriented. This narrower class excludes Simula67—whose objects are not data abstractions because other objects can access their instance variables—and Smalltalk, which is not strongly typed because you can assign values of a different type to its variables at different points of execution. The term *object-oriented* has been carefully defined to be sufficiently narrow to exclude languages like Ada, Modula, and CLU, and sufficiently broad to include languages like Simula and Smalltalk.

Object-oriented languages that have strong typing and require all objects to be data abstractions are called *strongly typed object-oriented languages*. Strong typing and data abstraction have the common objective of strengthening object modularity, but they are independent in the sense that strong typing is possible for objects that are not data abstractions (as demonstrated by Simula67), and data abstraction is possible without strong typing, and indeed without any typing at all (as demonstrated by Smalltalk).

Should object-oriented languages require abstraction and strong typing? Smalltalk has consciously avoided strong typing in order to achieve dynamic binding, while Lisp-based object-oriented languages in the Flavors tradition have consciously avoided both strong typing and abstraction.

Flavors goes even further and doesn't actually have objects as a language primitive. It has the notion of a data template to which you can attach operations. It doesn't specify operations, but you can use it as an anchor for operations. Thus, Flavors-style languages are not, strictly speaking, object-based but serve as a substrate that you can use in an object-based or object-oriented way.

The inclusion of data abstraction and strong typing is clearly not an unqualified benefit. It involves a trade-off between structure and discipline on the one hand and flexibility and efficiency on the other. Abstraction is good when you can commit yourself to particular abstractions early in the design process. But it can be unduly constraining when you are unsure of the precise abstractions appropriate to a problem and wish to experiment with abstractions as part of the design and prototyping process.

This is often the case with AI applications or with other experimental applications concerned with understanding concepts that underlie a class of problems rather than with solving a specific problem. Lisp-based object-oriented systems are intended for such applications and consciously provide nonabstract objects to enhance the conceptual flexibility of problem solving.

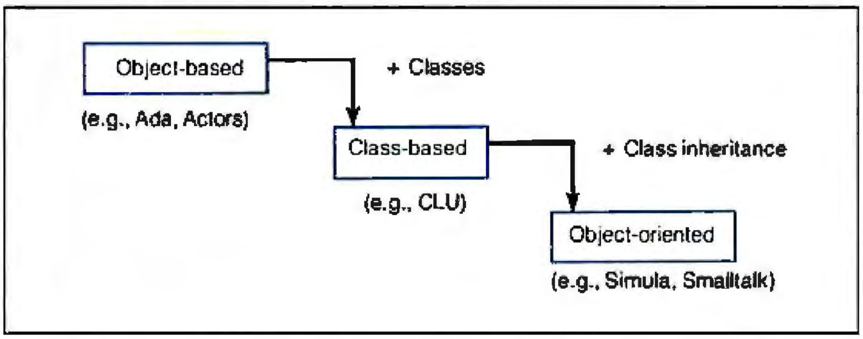

Figure 4: *From object-based to object-oriented languages. Class-based languages are a proper subset of object-based languages, while object-oriented languages are a proper subset of class-based languages.*

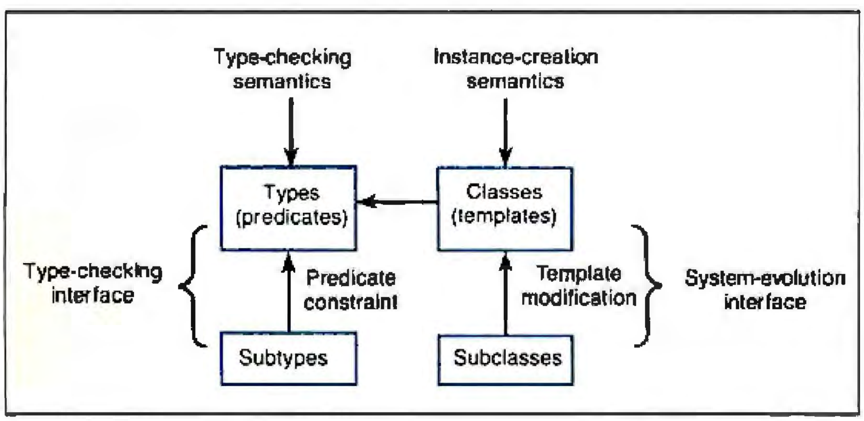

Figure 5: *Types versus classes. While strongly related, types are motivated by type checking and can be defined by a predicate for recognizing expressions of the type, and classes determine collections of objects and can be defined by templates for object creation.*

Does it make sense to have nonabstract, strongly typed languages? Although languages like Simula illustrate that commitment to strong typing is possible without commitment to abstraction, this may be a historical accident. It may well be that nonabstract objects are useful primarily for untyped formalisms where the absence of both abstractions and types encourages conceptual flexibility.

Typed formalisms can discourage experimentation to such an extent that nonabstract objects are no longer useful. However, this is just speculation, and closer analysis might well reveal that nonabstract, strongly typed objects are, in fact, useful in certain kinds of experimental applications.

In spite of these reservations, the accepted wisdom is that strongly typed object-oriented languages should be the norm for applications programming and especially for programming as a whole. An object-oriented environment should probably support Lisp-style untyped programming for prototyping and strongly typed object-oriented languages for traditional applications programming. Moreover, there should also be a provision for automatically freezing experimental prototype code to turn it into strongly typed code if and when it is ready to use for production programming.

Language Classes

I have now identified five progressively smaller language classes in terms of progressively stronger language requirements:

1. In object-based languages, objects are supported.
2. In class-based languages, objects belong to classes.
3. In object-oriented languages, classes support inheritance.
4. In object-oriented data-abstraction languages, classes support information hiding.
5. In strongly typed object-oriented languages, types are determinable at compile time.

If you add concurrency and persistence to this set of language features, you can define the class of concurrent, persistent, strongly typed object-oriented languages as strongly typed object-oriented languages that support concurrency and persistence (see reference 1). *Classless* languages are those languages that support objects without classes and provide flexibility in creating objects in singleton classes or objects that can change their class in executing operations.

Classless languages can in turn be subdivided into *prototypical* languages, which support inheritance, and *actor-like* languages, which support concurrency but not inheritance. Prototypical languages were pioneered by Henry Lieberman (see reference 6). Actor-like languages gain flexibility in defining concurrency mechanisms by giving up the structuring mechanisms of classes and inheritance (see reference 7).

Figure 6 illustrates a new methodology for exploring language design tradeoffs by viewing language features as design dimensions of a language design space. This example has seven features: objects, classes, inheritance, data abstraction, strong typing, concurrency, and persistence. Features can be binary (i.e., either a language has them or it doesn't), or they can have a number of alternative realizations, as do objects,

continued

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classes, and inheritance.

There is a potential language class corresponding to each of the 128 subsets of the seven language features, but some of the classes are more interesting than others. I associate names with interesting classes and have examined trade-offs in methodology resulting from including or excluding particular features. This approach to examining the spectrum of possible object-oriented languages is useful in that it provides a systematic mechanism for exploring the design space of object-oriented languages.

Object-based Concurrency

Concurrent object-based languages model the world with concurrently executable objects called *processes*. A process has an interface of executable operations or entry points and one or more threads of control, either active or suspended. Process-based languages are object-based languages whose objects, or processes, can execute concurrently.

The smallest executable element within a process is called a *thread*. A thread is a data structure that becomes active when it is loaded into a processor. You can pass threads to processes as message requests, and you can queue them in message buffers until a process is ready to execute them. They can be suspended if the conditions aren't appropriate for them to execute, and reactivated when the conditions recur.

You can classify processes by the properties of their threads: Sequential processes have a single thread of control; quasi-concurrent processes have at most one active thread of control; and concurrent processes have multiple threads of control (see figure 7).

Sequential processes, like those in Ada and NIL, generally have a body of code with an interface of entry points where messages to perform operations can be queued. An invoking operation (an incoming message) must wait until the currently executing process is ready to accept it. When it is, a *rendezvous* occurs that joins the incoming and active threads of control to synchronize them and allow argument communication. It then separates the threads so that invoking and invoked processes can again proceed in parallel.

Quasi-concurrent processes suspend a thread of control's execution while it waits for a condition to be fulfilled, and they resume its execution when the condition is satisfied. They differ from sequential processes by having "condition queues" of suspended threads, as well as entry queues of threads that are waiting to enter the process. An incoming thread can become active only if the current thread terminates or is suspended, or if the incoming thread fuses with the active thread by a mechanism such as a *rendezvous*. Monitors are an example of quasi-concurrent processes.

In concurrent processes, there is no restriction on active threads, and an invoking operation can freely create a new thread. But attempts to access shared data in critical regions can cause a thread to be suspended until the access can be safely accomplished. Concurrency within processes allows more finely grained control that lets you delay suspension from the time of process entry to that of critical-region entry.

The concurrent languages CSP, Ada, and NIL all have sequential processes. Monitor-based languages such as DP,

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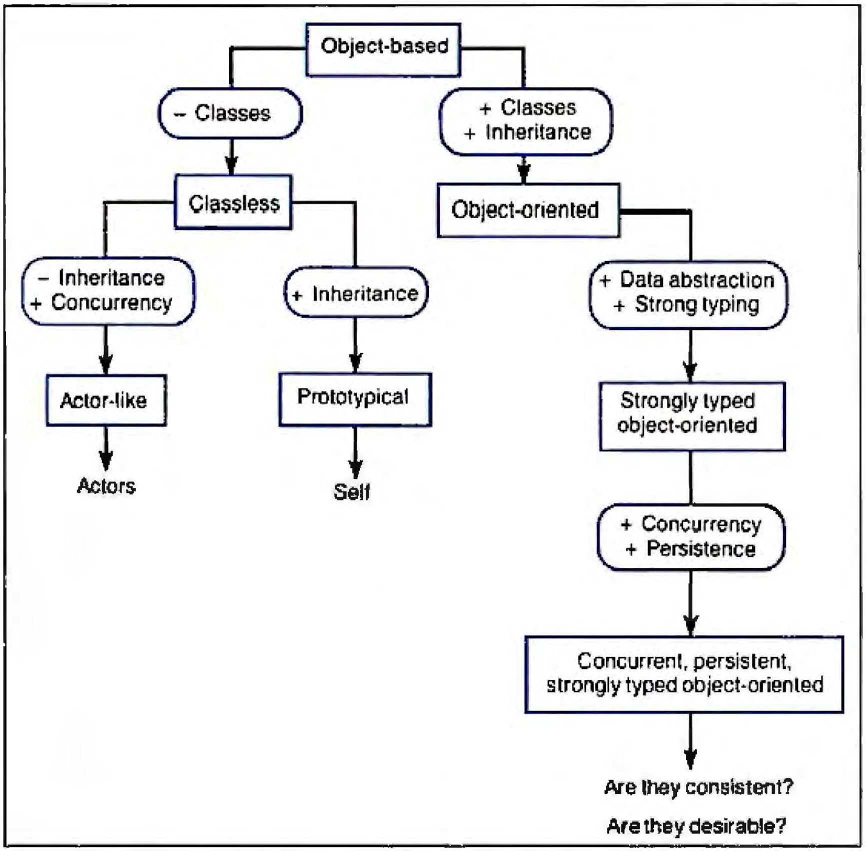

Figure 6: *Classes of object-based languages. Note how the language features are used as design dimensions of a language design space. There is a potential language class corresponding to each of the 128 subsets of the seven language features, but some of the classes are more interesting than others.*

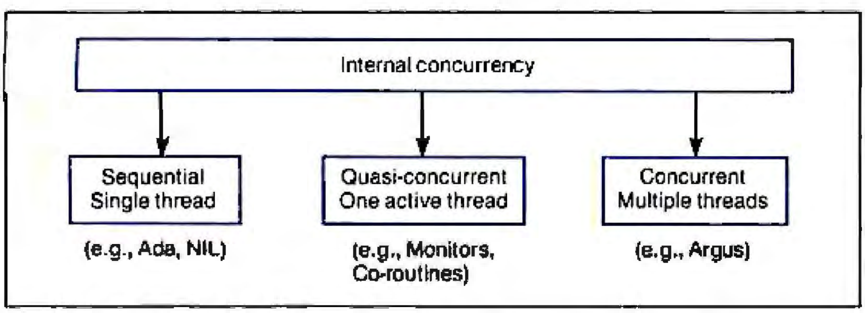

Figure 7: *Internal process concurrency. You can classify processes by the properties of their threads: Sequential processes have a single thread of control; quasi-concurrent processes have at most one active thread of control; and concurrent processes have multiple threads of control.*

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ABCL/1, and Orient 84K have quasi-concurrent processes. Actor languages and Argus have concurrent processes (called guardians) with multiple threads of control.

The question of whether processes should have internal concurrency can be addressed at the levels of both conceptual modeling and language design. Conceptually, fully concurrent processes more naturally model some applications. For design and implementation, however, sequential and quasi-concurrent processes allow the units of modularity and concurrency to be the same, and they result in much simpler languages than do concurrent processes.

Concurrent processes permit units of modularity to contain multiple units of concurrency. Thus, they require distinct synchronization and communication mechanisms for inter- and intra-process concurrency at both the language and system levels (see reference 8).

However, concurrent processes are more uniform in allowing you to use the same concurrency primitives both within and between processes. Concurrent processes have a hierarchical, rather than a flat, process structure. Moreover, they allow a more finely grained concurrency and are more expressive in modeling real-world situations that require such concurrency.

The step from sequential to quasi-concurrent processes makes scheduling threads within a process more flexible without causing mutual-exclusion problems for simple access to data structures.

Adding persistence to an object-oriented language allows it to be used as a basis for database implementation.

However, quasi-concurrent processes present mutual-exclusion problems when processing transactions, because suspending a thread in the middle of a transaction could violate the transaction's integrity constraints.

Transactions are an atomic unit of work that can require temporary association with a collection of resources. You can view them as "temporal modules," in that they represent uninterruptible temporal units of execution. Quasi-concurrent processes will not present any mutual-exclusion problems for atomic operations, but they cause problems when you try to combine the temporal modularity of transactions with the traditional spatial modularity of objects and processes.

Concurrent languages based on quasi-concurrent processes, such as ABCL/1 or Orient 84K, are harder to extend to transaction processing than languages based on concurrent sequential processes. Thus, there is a trade-off between flexibility and extensibility in replacing sequential with quasi-concurrent processes.

Concurrent object-oriented systems must be able to handle transactions and must therefore deal with temporal modularity (atomic actions) as well as spatial modularity (atomic objects).

Distributed Processes

A distributed process is a process with a separate address space; that is, it cannot directly access any resources outside its local address space and can communicate with the outside world only by message passing. Design alternatives for distributed processes involve interaction between the units of modularity (the unit that defines the user interface), concurrency (the unit that represents a single thread), and naming (the unit that determines name space). (See figure 8).

The unit of modularity determines the interface between the users of a module and the information hidden within it. It determines a visibility barrier for resources within a module that look outward. The unit of modularity determines the granularity of data abstractions, the unit of concurrency determines the granularity of thread synchronization, and the unit of naming (name-space boundary) determines what set of names in the

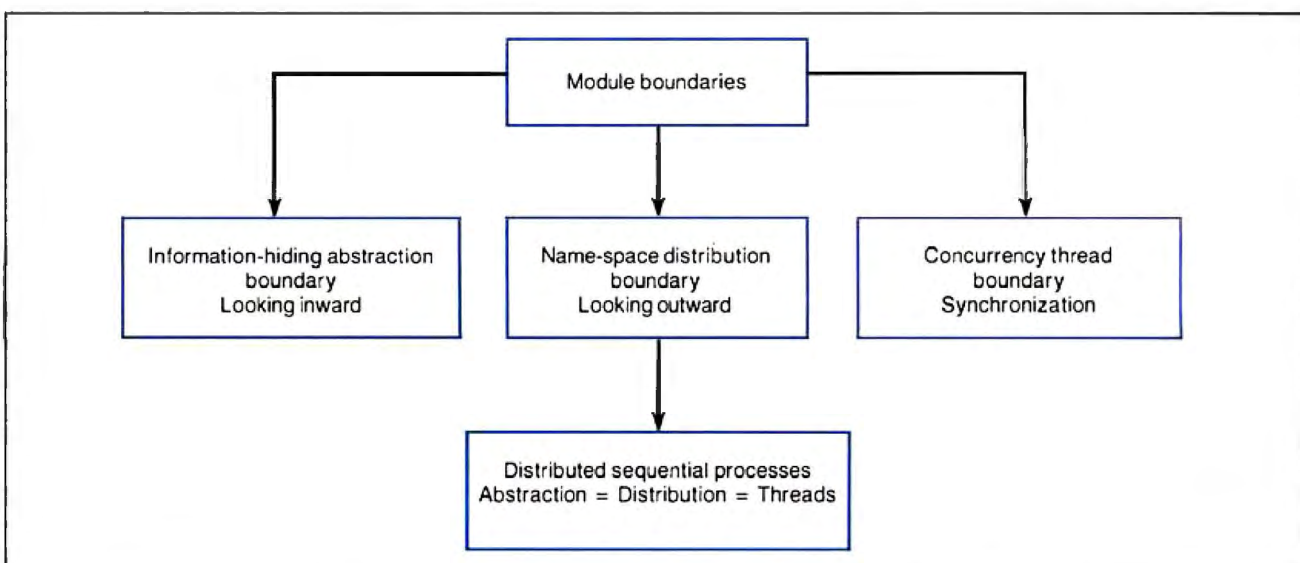

Figure 8: *Units of modularity (left), naming (center), and concurrency (right). Design alternatives for distributed processes involve interaction between the units of modularity (the unit that defines the user interface), naming (the unit that determines name space), and concurrency (the unit that represents a single thread).*

environment is known at any point in the program.

Processes for which the units of modularity, concurrency, and naming are the same are called *distributed* sequential processes. They are aesthetically appealing because you can identify the interfaces for message passing, mutual exclusion, and transactions. But this clean identification of interface, concurrency, and name space comes at a cost of conceptual flexibility and efficiency. Flexibility is sacrificed because the unit of sharing must have the same granularity as the units of modularity and concurrency, so sharing among modules or concurrent units is precluded. Efficiency is sacrificed because of the high cost of making the transition between distributed components.

An important dichotomy in distributed systems is the one between *statically* interconnected distributed processes—where the connections of each process to its environment are determined at process-creation time and can't be changed during the lifetime of the process—and *dynamically* interconnected distributed processes, where language commands can change those connections during execution.

Ports in dynamically interconnected distributed processes are variables to which you can assign process connections, or channels. It is prudent to associate types with ports and to permit connection only if the type and I/O mode of port values are compatible with those of the port's variable. You can think of input ports as sockets and output ports as plugs that must fit the sockets. Dynamically interconnected distributed processes can be modeled by a modifiable plugboard with wires corresponding to channels of communication.

Object-Oriented Persistence

Persistence is a property of data that determines how long it should be kept. In traditional languages, the lifetime of data usually does not transcend the lifetime of a particular program. Some data, such as locally declared data or procedure parameters, has an even shorter lifetime. Databases store data whose persistence transcends that of individual programs. Adding persistence to an object-oriented language allows it to be used as a basis for database implementation.

A database can be viewed as a long-lived object or process with special properties. It is globally accessible, or sharable, by many users. Usually, access is asynchronous from the user's point of view, and you can think of the database as a nonterminating process that services asynchronous user requests.

Asynchronous access can be handled either directly by the database process or by a database server that organizes user requests and feeds them to the database. The database itself can be a sequential process (dealing with requests in a serial order), a quasi-concurrent process, or a fully concurrent process with locks that enforce mutual exclusion for data access. Database processes need the following special features:

- To support persistence, you need a strong notion of object identity that is independent of the key used in object selection and that persists across programs and projects.
- You need a query language that can process traditional database queries (such as finding the set of all employees that make more money than their managers). This kind of query can involve objects of more than one type and produces results that are collections of objects. Queries in relational database languages can be viewed as `select` operations on an aggregate type, namely the type `set` or `relation`. They have the form `select(set,predicate)`.

Query complexity and efficiency are determined by the nature of the predicate. Relational query languages specify all queries in terms of a restricted set of primitives whose optimization has been extensively studied. Object-oriented query languages must accommodate the greater richness of object-oriented specifications for which optimization is not as well understood.

One of the issues in object-oriented query languages is to make them efficient so that the user doesn't pay in efficiency for the flexibility provided by object-oriented programming.

- Since object-oriented databases are particularly suited to managing evolutionary systems, they require a mechanism for version control and other tools for evolving systems.
- Databases should be able to specify constraints and check that constraints are not violated as the database is modified. This can be achieved by using active variables or triggers (see reference 9).
- Multiple views should be supported with automatic updating of all views when the data is modified. Lazy updating for views that are not currently active is clearly appropriate.

Object-oriented programming in the 1980s is becoming as fashionable and important as software engineering techniques, like structured programming, were in the 1970s. The term *object-oriented programming* has become a buzzword that everyone uses, but no one knows what it is. In characterizing the varieties of object-oriented programming, I have tried to make the different uses of this term more precise.

I believe that if Ada were designed now, it would likely be designed as an object-oriented language, and that concurrent, persistent, object-oriented languages may well become the standard method for programming as a whole in the 1990s. Object-oriented programming has a very bright future. ■

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Separation of Powers

Object-oriented user interfaces promise evolutionary—rather than revolutionary—upgrades

Mahesh H. Dodani, Charles E. Hughes, and J. Michael Moshell

Good user interfaces are difficult to construct. When WordStar's user interface was redesigned to produce WordStar 2000, the effort was a major one, about equivalent to writing an entire new program.

Such an enormous effort suggests that little or no code from the previous version could be reused. This is probably due to the old user interface being intimately intertwined with the code that supported the word processing application. Such a total overhaul of code to introduce the latest interaction technology must clearly be avoided.

In the last decade, software has rapidly progressed from noninteractive to highly interactive programs. The direct involvement of users during the execution of these interactive programs has completely altered our view of how programs should interface to the outside world.

User interaction forces software engineers to consider many human-factors issues, such as ease of use and the presentation of information. These concerns have led to interaction styles that include graphical displays, menu-based input, and mouse-based selection.

As a result, many products that prospered five years ago would meet with an early demise if they were introduced today. Even the successful interactive graphical products of today may be subject to early obsolescence if they do not evolve with the emergence of newer interaction technologies.

Interactive software provides a large incentive to implement the user interface as an independent component. Separation from the application has several advantages. First, you can subdivide the user interface into components that can be glued together. Such an approach lets you use these components without a detailed understanding of the underlying implementation. Second, you can rapidly modify the interface to be reused in other applications that have similar interaction requirements. Third, you can alter or even replace the interface with no adverse effects on the code that defines the application. Finally, you can develop the interface in an iterative manner, in which you produce successive prototypes until you find a design that satisfies the needs of the application and its users.

From these advantages, a number of principles and techniques emerge. The principles are reusability and encapsulation. The techniques are rapid prototyping and iterative development. To support the production of interactive graphical interfaces, you need a design methodology and a development environment that support each of these principles and techniques. This is where

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object-oriented design and programming come into play.

Layer upon Layer

One way to make user interfaces easier to design and change is to characterize the components of an interactive software system. This characterization must effectively separate the application from the interaction style.

Conceptually, we divide the components of an interactive software system (see figure 1) into the following three layers: the application layer, the code that actually does the work; the user-interface layer, the code that directs the interaction; and the virtual-terminal layer, the display software that draws graphical primitives, writes text, and collects user inputs (e.g., keystrokes and mouse moves).

The flexibility of such a decomposition is evident, even when applied to the design of other interactive systems. Take, for example, an automobile. The user interface corresponds to the steering wheel, pedals, and gearshift; the application layer to the engine, transmission, wheels, and chassis; and the terminal layer to the basic metal and plastic from which the steering wheel and so on were built.

Clearly, it is beneficial for the automobile designer to completely separate the user interface from the application. Who wants to try to drive by directly handling a hot, dirty engine? More importantly, this separation lets you use the same interface for a 4-, 6-, or 8-cylinder engine, an automatic or manual transmission, and so on. Furthermore, it lets you upgrade the interface (e.g., replace analog gauges with digital ones) without redesigning the application.

Software engineers have been forced to consider human-factors issues.

Effective software engineering is largely dependent on the development environment (see reference 1). Therefore, the majority of current user-interface research is aimed at building user-interface development environments. UIDEs have certain characteristics. They automate the development of much of the interactive software. They usually allow a declarative specification of how users interact with the system. They provide the necessary basis for rapid prototyping and incremental development of the user interface. And they provide a test bed for comparing competing approaches to interface development.

We can identify a hierarchy of four different types of UIDEs that might help us achieve these characteristics.

1. *Graphics packages* provide the facilities to manipulate the basic elements of graphical input and output. Graphical input is concerned with managing and manipulating input devices, such as keyboards, mice, and tablets. Graphical output concerns the display of color, text, and geometric shapes, such as lines, circles, and rectangles.
2. *Windowing systems* extend graphics packages so they can both create and manage the interaction of one or more applications. The base windowing system, a graphics package with some additional high-level facilities (such as menus), is the substrate on which sophisticated multiapplication interactive systems are built.

These systems provide two additional components to manage interaction. The window manager provides facilities to manipulate overlapping windows, and the input manager controls the interface between input devices and applications—that is, which applications obtain input from which devices.

3. *Frameworks* provide facilities with which to construct the components of a software design, or "skeleton." For example, a compiler framework enables you to construct a lexical analyzer, a parser, a symbol table, a type checker, and a code generator. Frameworks also let you define and manage the interfaces between these components.

User-interface frameworks are concerned with presenting application information to the user, accepting user input, and invoking application functions. Furthermore, user-interface frameworks must define and manage the communication between the application and the user interface. Frameworks are akin to libraries that support conventional programming environments, together with a specified "cookbook method" of interface construction.

4. *User-interface construction sets* are collections of high-level tools that let you interactively configure and construct user interfaces. Ideally, construction sets are built on top of frameworks.

The user interfaces of most currently available interactive software systems are built in an ad hoc manner on top of graphics or windowing subsystems. However, such an approach is costly and time-consuming, since you must build each user interface from scratch.

Looking at Three Frameworks

Ideally, a framework is a set of abstract classes (i.e., classes that are never instantiated to produce objects, but merely serve as the basis for subclasses), with one abstract class for each major component of the design. A set of messages defines the interfaces between the components.

The effectiveness of a framework is dependent on the ease with which you can use and reuse it. In studying reusability, it is convenient to classify frameworks as either "white box" or "black box" (see reference 2).

A white-box framework is one whose

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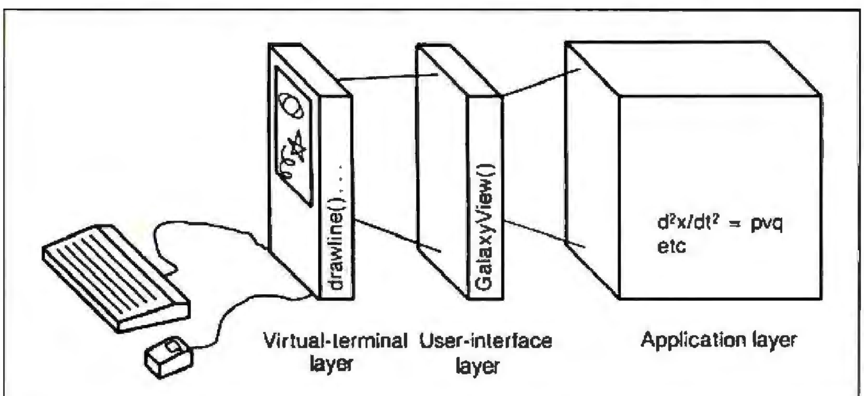

Figure 1: *The components of an interactive software system. The application layer actually does the work; the user-interface layer directs the interaction; and the virtual-terminal layer handles the details of the actual interaction.*

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use requires knowledge of its internals—that is, its implementation. It provides top-level control and sequencing of activities and can therefore be seen as an extensible skeleton. You can tailor interfaces for a particular application by creating subclasses from this skeleton.

In contrast, a black-box framework requires only that you provide the components that define the application-specific behavior. It uses these components to automatically generate the object-oriented software. Thus, black-box frameworks require that you understand only the external interface of the major components. Their main advantage is that they provide an ideal foundation for developing construction sets. Black-box frameworks exist in other areas of software, but they are not yet readily available for user interfaces.

The MacApp Framework

The MacApp white-box framework (see reference 3) equips you with a prefabricated standard Macintosh user interface for any application. The basic premise of MacApp is to provide a user interface that automatically handles the characteristics common to all applications, such as resizing the windows, and to let you plug in application-specific details, such as the contents of each window. Since MacApp provides the user-interface code, you can either use these standardized interfaces directly or customize them to suit the peculiarities of a particular application.

Specifically, the MacApp framework (version 2.0) includes the following four components.

1. The *application* component is the primary controller of the interactive system. Its main purpose is to receive input events, classify them, and invoke appropriate application-specific event handlers. It also provides a set of standard global functions for creating document objects, opening documents, and quitting the system.
2. The *document* component provides the hooks for describing the application. Documents manage and manipulate the application data structures and are responsible for communicating their current status to view objects. Documents are also responsible for reading their data from, and writing it to, backing store.
3. The *view* component manages an application's display and controls interaction with it.
4. The *command* component interfaces between the application and the user interface. Each document has an associated command component responsible for performing the commands (i.e., changing application data and updating views) and, most importantly, for undoing the commands, if appropriate.

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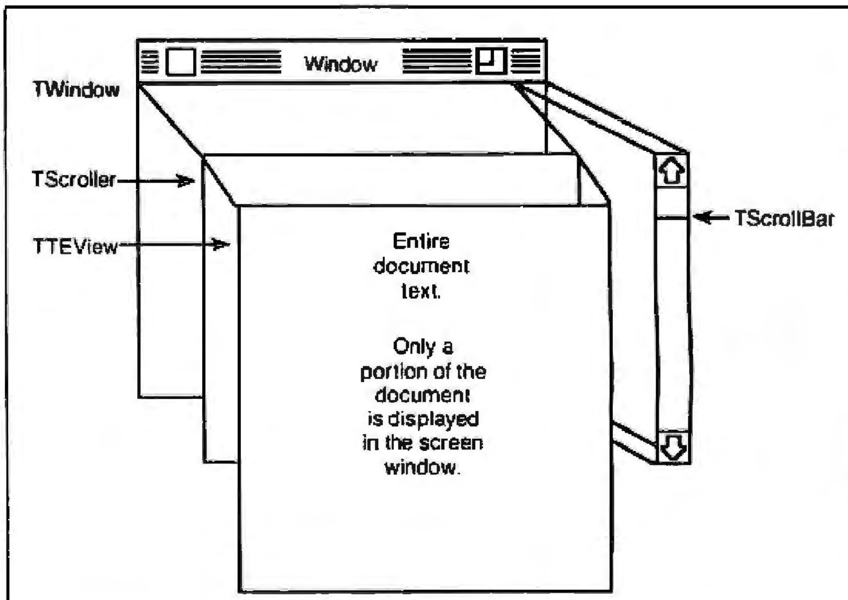

Figure 2: *The four views of the MacApp window architecture: the actual window, the scroll area, the scroll bar, and the text view. These four views are presented in three layers: first, the window itself; second, the scroll area and bar; and third, the text.*

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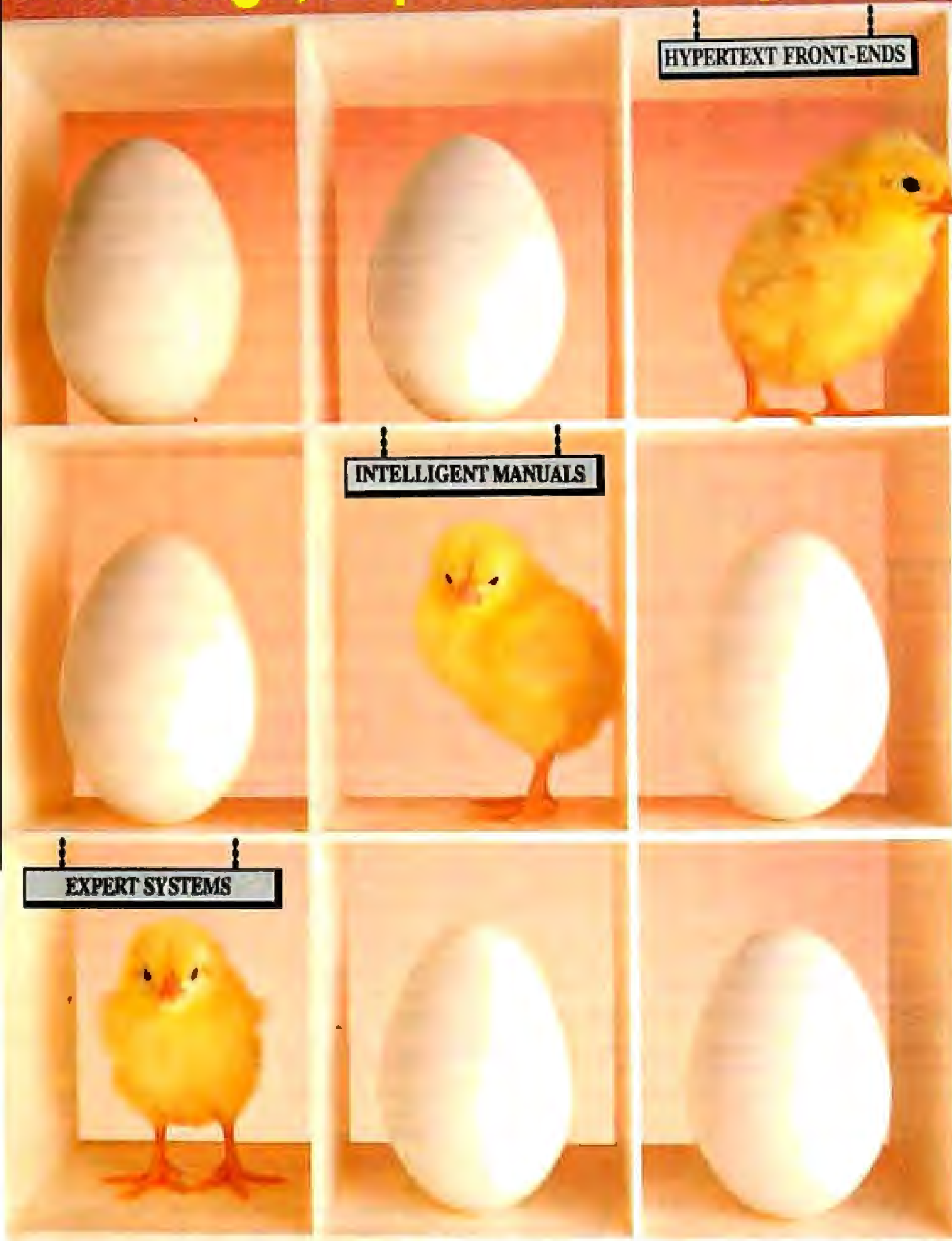

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An abstract MacApp application consists of one or more views, one or more documents, and a single application object. A view can exist without any associated document, but each document (if it is to be displayed) must be associated with a view. A view can be contained in a superview, and it can contain zero or more subviews.

Whenever a view is displayed, its contents are drawn first, followed by the display of each of its subviews. Consequently, the highest-level view in a hierarchy can serve as a background for its subviews.

For example, a typical Macintosh window might be formed from four views: the window itself, the scroll area, the scroll bar, and the view that displays the text (see figure 2). This window is presented in three layers. The bottom layer is the window with its standard grow box; the second layer is the scroll area with its scroll bar; and the top layer is a portion of the associated document.

In MacApp's class hierarchy, TView is a class that describes behavior common to all display objects, including nesting, focusing, drawing, and event handling. All objects involved with displaying must therefore be described within subclasses of TView. TWindow is a predefined subclass of TView that describes standard Macintosh window behaviors, including opening, closing, and resizing.

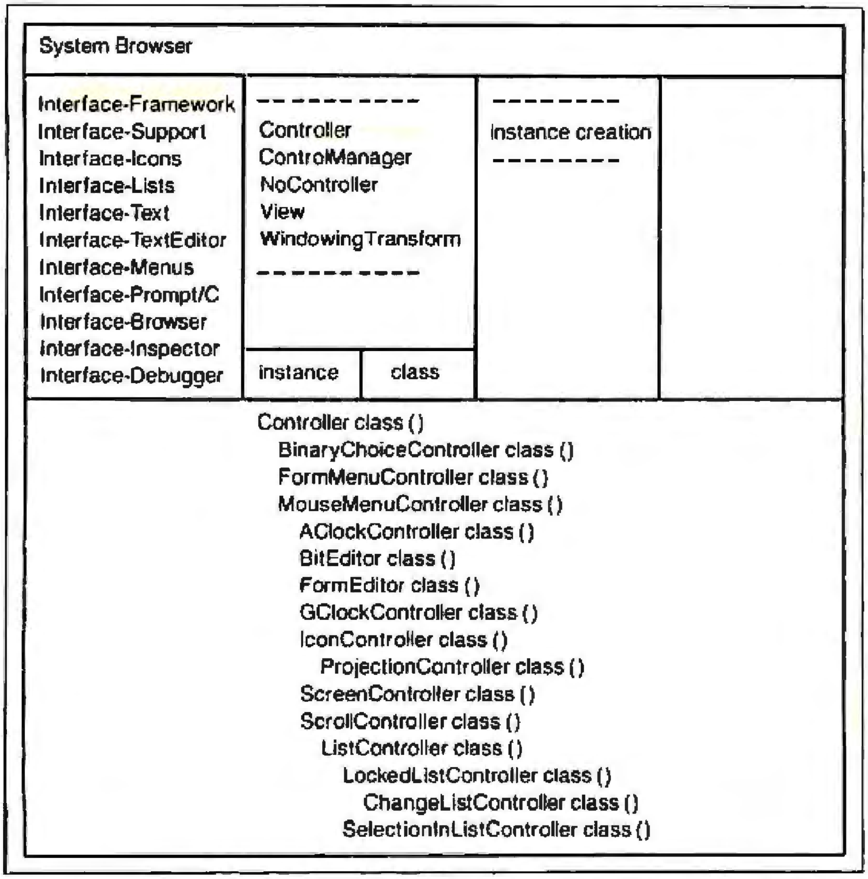

Figure 3: *A typical Smalltalk user interface, the Smalltalk system browser. Through the browser, you can study, use, and alter any of the classes that make up the Smalltalk environment.*

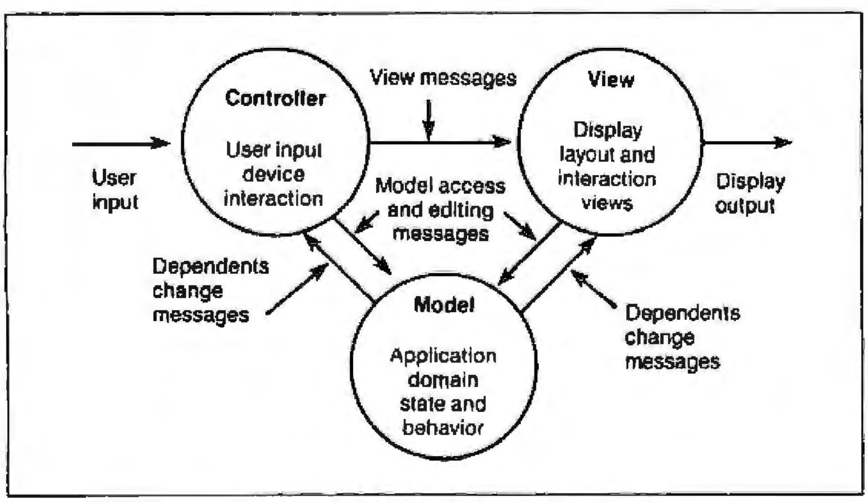

Figure 4: *Model-view-controller relationships. Views display the application's status, controllers manage interaction, and the model performs the requested action.*

The MVC Framework

The model-view-controller framework (see reference 4) facilitates constructing standardized user interfaces for the Smalltalk environment (see reference 5). A typical Smalltalk user interface is depicted in figure 3. The MVC framework constructs a user interface with standard facilities common to all applications, and it provides the necessary hooks to allow application-specific behavior to be attached. The availability of the code for the user interface lets you fine-tune the interface to suit the particular application.

An abstract Smalltalk application consists of a model, which in turn consists of a set of related view-controller pairs. Views display the application's status while controllers manage interaction. Controllers act as the interface between the user and the application, as well as between the application and its views. The interaction between the three components is shown in figure 4.

The standard interaction cycle is as follows. The active controller accepts user input and invokes the appropriate application function within the model. The model performs the requested action and broadcasts the change to its dependents—that is, its set of view-controller pairs. The views update their displays through application-provided information.

Specifically, the MVC framework consists of the following components:

1. The *model* component lets you define an application. It also lets you connect view-controller pairs as dependents and

broadcast changes to these dependents.

2. The *view* component is concerned with display. It is equivalent to windows in most systems, allowing for the creation and management of subwindows (or subviews). Views provide standard facilities for clipping, transformation, and display. The top-level view is a standard system view that provides common facilities for resizing and movement. Note that each view is associated with exactly one model and one controller.

3. The *controller* component provides the basic facilities to coordinate the user with the appropriate view and application model. Standard controllers handle predefined views, including a menu controller for mouse-based pop-up menus, and a scroll controller to handle scrollable windows. The active controller is in charge of obtaining user input and invoking the appropriate application-specific function to handle it.

The ICpak 201 Framework

Stepstone's ICpak 201 graphical user-interface class set is an object-oriented user-interface framework for Objective-C (see reference 6). This framework is designed around the metaphor of a modern cartoonist producing animation. Typically, a cartoon is constructed as layers of acetate, where the background is painted on the bottom layer, the main characters on the next layer, and additional props on the topmost layer. These layers form a single frame of the animation sequence.

A standard topmost layer of a typical user interface constructed with ICpak 201 is depicted in figure 5. This layer is similar to Smalltalk's topmost views and is responsible for presenting the image that the user manipulates, as well as controlling interaction with the user. The controller aspect of the layer is separated from its image to let you modify the interaction. The controller is either transparent or opaque, to allow or disallow passing control to the layers below the current one.

The ICpak 201 framework follows a three-way factoring of interfaces similar to Smalltalk's MVC framework. For example, all menus within the interface have an independent (abstract) model that collects the choices, and a corresponding view-controller pair that represents the concrete image of the menu model and allows menu selection.

The ICpak 201 class hierarchy provides a rich set of prefabricated components to create standardized user interfaces. You can modify these classes, as you can other object-oriented frameworks, by creating subclasses to construct specialized user interfaces.

Construction Sets

The basic problem with these user-interface frameworks is that using them requires intimate knowledge of the underlying structure and implementation. This implies a steep learning curve for constructing interfaces, making them usable only by technically expert designers.

A natural way to reduce the complexity of using frameworks is to provide tools (or construction sets) that automate the process of building interfaces. Such construction sets require an underlying framework that either is a black box or enforces a well-defined consistent user-interface design strategy.

Various characteristics of construction sets differentiate them from frameworks. Construction sets automate the construction of user interfaces; they are interactive tools; they don't require that you understand the implementation details of the user interface; and their simplicity allows end users to modify (or customize) the user interfaces of interactive applications.

ViewEdit

A major part of creating user interfaces within MacApp is instantiating view objects and describing relations between them through a hierarchy. Instantiating a predefined view within MacApp requires assigning values for each of the view's fields. You can do this either procedurally or declaratively.

To define a view declaratively, you create a view resource that basically defines the characteristics of the intended Macintosh window by describing the root window and its subviews (which eventually include scroll and display views). A view is described simply by listing options that correspond to the instance variables defined for each view class supported within MacApp.

ViewEdit (see reference 7) is a construction set for interactively defining views and building view hierarchies. It lets you create individual views, define their characteristics, and place them in windows, thereby defining a view hierarchy. For example, in a typical view-editing scenario, the window might be made up of four views. Of these four, two subviews might be text views; the other two might be clusters (sets of buttons), each of which contains several nested subviews representing the contents of these clusters.

This construction set includes three major tools. The *selection* tool allows you to select a particular view for editing. You can edit the parameters of the selected view, which presents the possible settings for the topmost window, such as a "go away box," "stagger windows," and so on. The *sketching* tool allows you to create new views in a fashion similar to drawing a rectangle in MacDraw. For instance, you can add a pop-up menu view as a subview of the currently se-

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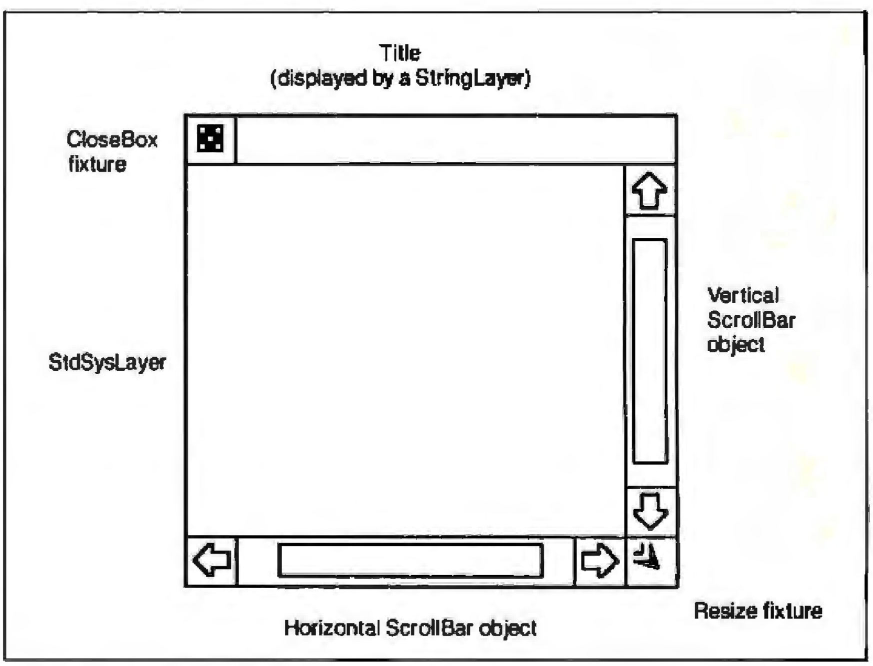

Figure 5: *A standard system window in ICpak 201.*

lected view using the sketching tool. Finally, a *moving* tool lets you modify the view hierarchy by grabbing views and dragging them into different areas.

Glazier: An MVC Construction Set

Experience with Smalltalk's MVC framework revealed that the view-controller pairs of interfaces dealing with standard (model) objects, such as lists, text, and code, were similar. This led to

User interfaces should be easily customizable by system designers and, more importantly, end users.

the creation of a set of classes called *pluggable views* that factor out these common behaviors and let you specify them as parameters in an interface-creation message. The pluggable views automatically create the view-controller pair for the intended model and thus are good examples of black-box frameworks.

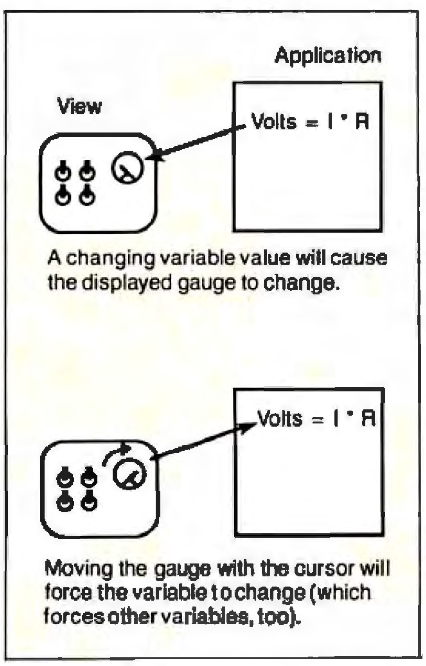

Figure 6: *An illustration of constraints.*

Glazier (see reference 8) is a construction set for interactively building windows for Smalltalk's standard pluggable views. To create a new window, you select a standard pluggable view and specify its size and location. Glazier automatically creates the subclasses (of the corresponding pluggable view) to implement the new window. You can then change the predefined standard methods inherited by the new class to achieve behavior specific to the application model.

Glazier also provides the following facilities to manipulate the newly created window: adding subviews, or panes; adding new instance variables to customize the new window's behavior; interactively placing, or relocating, the subviews; and interactively creating dependencies between instance variables and panes in the window to make it easier to manage changes.

Constraints

A novel approach for user-interface construction sets is based on the notion of constraints (see reference 9). In constraint programming, statements like $x = y + z$ specify a relation between objects that must be maintained. Unlike conventional programming, this expression doesn't say that you obtain x's value from the current values of y and z. Rather, it says that the values of these three variables must always be consistent with the equality that is expressed by this relation.

A change in the value of x results in a change to one or both of y or z. A change to the value of y could be accommodated by changing the value of x, as in a conventional system, or by changing z, or even by changing both. (Maintaining this relationship is the responsibility of the underlying constraint-satisfaction system, not the programmer.)

The two-way nature of constraints means that a change to one dependent object may cause changes in another object, with neither being in control. Thus, you could constrain a gauge appearing on the user's screen (see figure 6) so that its position matches the value of a variable in the currently running application. If the application changes the value of this variable, the screen image is updated. Symmetrically, if the user moves the gauge's dial, the application's variable is altered to accommodate this change.

Great Promise

User-interface research is still in its infancy. A mature technology implies user interfaces that can evolve to accommodate ever-changing interaction styles, techniques, and devices. Moreover, such interfaces should be easily customizable by system designers and, more importantly, end users.

As you can see from looking back at figure 1, the user has only one interface for an application. How can you achieve the flexibility of multiple interfaces without forcing users to become programmers? There is no answer yet, but the object-oriented paradigm shows great promise as the basis for achieving such a mature technology. ■

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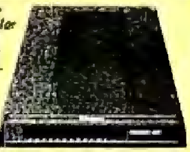

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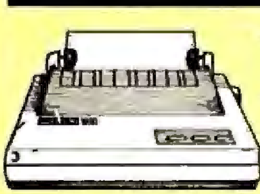

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The Next Step

Object-oriented programming simplifies and speeds software development with the NeXT computer's NextStep

Tom Thompson

Without a doubt, designing software for today's high-powered microcomputers is more complicated than ever. This is partially because the new breeds of multitasking operating systems are so complex, but also because it's so very difficult to design and test graphics-oriented user interfaces.

Both Macintosh applications and OS/2 programs use an event-driven paradigm at the core of their operation. This structure provides the flexibility required of a graphical interface where you trigger an *event* (hitting a key or clicking on the menu bar with the mouse) at any given time or in any given order.

But this flexibility exacts a price: The code loop that manages the graphical interface and processes these events—called an event loop—is complicated, and it requires a steep learning curve to understand how it works and how to design code to fit within it. Seasoned Mac and OS/2 programmers keep "skeleton" files handy that contain this basic event-loop source code. Designing a new application then becomes a matter of fleshing out the skeleton file. However, it still takes a considerable amount of time to organize an application's functions to fit within the framework of the skeleton.

When NeXT introduced its computer, its designers faced the same situation. While the NeXT computer has powerful hardware, it also has a very complicated application environment: a multitasking Mach Unix kernel and the same event-driven user interface that turns Mac and OS/2 software design schedules into confetti. So NeXT concentrated on creating an object-oriented development environment that would simplify the design and creation of the event-driven interface and allow easy access to the machine's resources. The tools to do this are part of NextStep, the environment in which every NeXT program lives.

NextStep

To get a good picture of how to write programs for the NextStep environment, you must first understand the environment itself. NextStep consists of four components: the Window Server, the Workspace Manager, the Application Kit, and the Interface Builder.

The Window Server manages the low-level system functions. The Display PostScript interpreter embedded within it handles all drawing to the screen, and it manages hardware events generated by the mouse and keyboard. The Window Server handles the events that deal with managing the display, such as moving windows, bringing them to the front, and resizing them. The Window Server forwards

continued

events directed at applications, such as a mouse-click in a window, to the target application.

The Workspace Manager operates at a higher level: It manages the files and applications on the system. It displays files in the current directory, lets you examine them, and, if you like, lets you delete them by dragging them to a "black hole" icon that operates like the Mac's Trashcan. You start NeXT applications through the Workspace Manager, and applications are shown as icons that can be "docked" at the right of the screen.

The Application Kit gives programmers access to the computer's many resources. It accomplishes this by supplying a library of 38 tested objects that provide services (see figure 1). Some objects are ready to use, while others you will modify to suit your needs. Some of these objects, such as Window, Button, and View, are visible on the display, and others, such as Application, Speaker, and Archiver, are not. All of them, visible or not, help implement the basic functions that a NeXT application needs to run.

The Interface Builder (called IB for brevity) application serves several important functions during application design. First, it lets you prototype and build the application's user interface. You do this either by using existing objects from the Application Kit or by creating custom objects and describing their interface. IB uses a powerful and intuitive visual interface that reduces this chore to a series of mouse-clicks and keystrokes.

Second, IB lets you modify the contents of instance variables. By modifying specific instance variables, you visually determine the connections between user interface objects and the application code. That is, you decide what object receives the message emitted by a specific control object.

Finally, IB creates a description file that describes these objects and their instance variables. This file is used at run time to actually establish the appearance of the interface and the message connections between the various objects, as described in your session with IB.

You construct a NeXT application by first using IB to design and test a user interface. Then you determine what underlying objects you need to satisfy the application's design requirements. Finally, you implement these underlying objects. In situations where you must write unique code to implement application-specific functions, you use an Objective-C preprocessor originally developed by Stepstone Technologies and an ANSI C compiler bundled with the NeXT computer.

Where the application must draw to the screen or deal with a user event, you normally use the objects provided in NeXT's Application Kit. It's important to note that the source code for these objects is *not* provided, but the great flexibility of the object-oriented design and the IB allows you to modify the behavior of these objects without having to edit and compile their original source code.

It's in the Objects

Many of the Application Kit's objects, such as Font and Window, will be familiar to a Mac programmer, and in many respects they serve the same purpose. They should not be confused with Mac resources, however. The characteristics of these objects are unique to the NextStep environment, and some require further explanation.

The Application object provides the fundamental support structure for an application's execution. The Application object establishes the application's connection to the Window Server. It reads

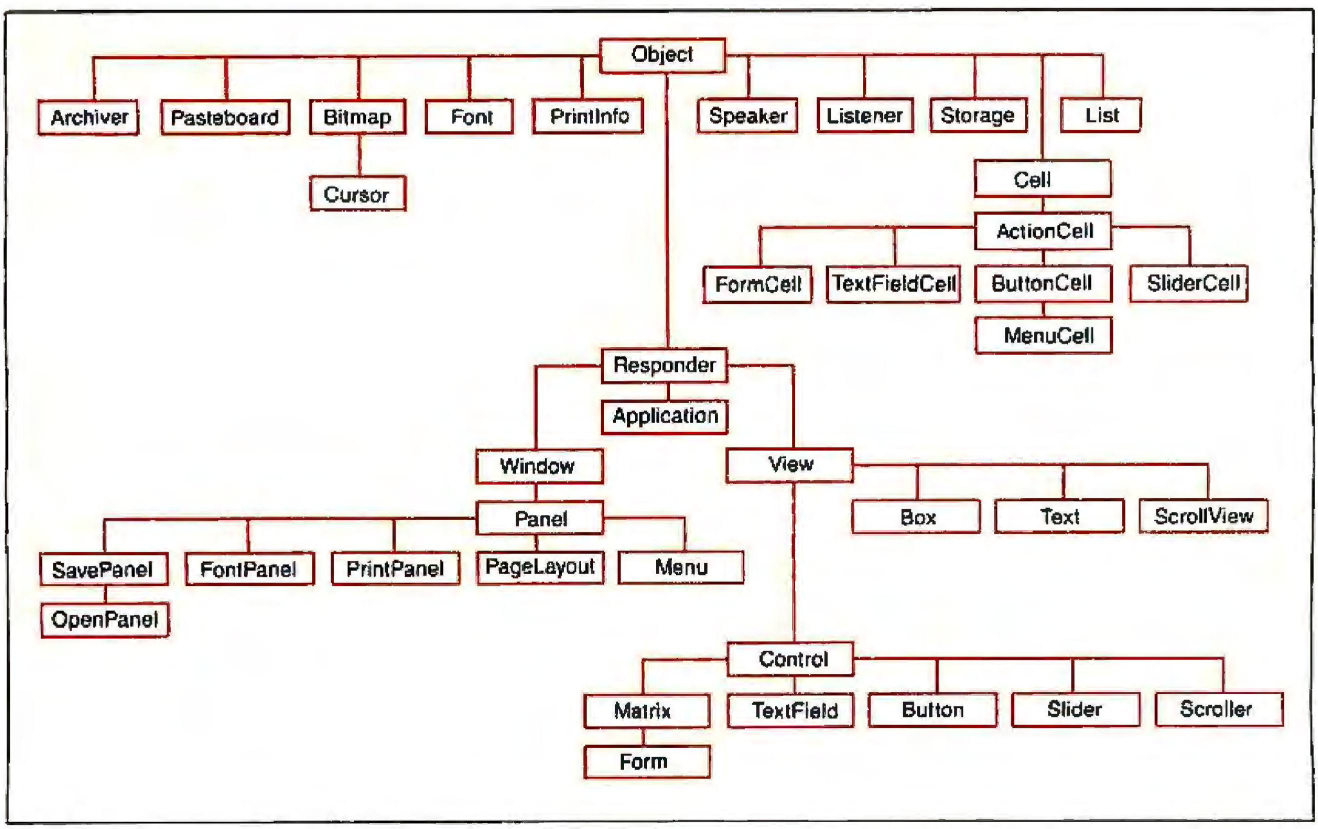

Figure 1: *The 38 objects in the NextStep Application Kit. These objects provide the core functions that an application needs to run.*

the IB description file and instantiates the application's objects and their instance variables based on this file's contents.

The Application object also manages a list of all the windows used by the program. Each application must have one, and only one, Application object.

The Application object's function is analogous to the event-loop skeletons used by Mac and OS/2 programmers. It receives events from the Window Server, translates them into event messages, and then passes these messages to the appropriate objects to handle them. As an example, for a window event (say, a mouse-click inside a window), the Application object receives the event from the Window Server and translates it into an event message. This message gets passed to the Window object associated with the event. The Window object might then pass this message to objects visible in the window. A Panel is a special type of Window object used to present dialog boxes or menus.

These visible objects in either Windows or Panels are called Views. As figure 1 shows, many of the objects in the Application Kit are direct or indirect classes of View.

A View object supplies the framework for drawing in a window and the methods for acting upon event messages dispatched to them. Views define the location, size, and orientation of the PostScript coordinate system that they draw within. The View object also handles any image clipping. Since a View uses floating-point PostScript coordinates, it's easy to translate, scale, rotate, or flip the image's coordinate system.

Since all classes of View are visible, a View must define a mechanism to draw itself on the screen. This mechanism is the *display* method. Display first saves the current PostScript state. Then it sets up the temporary coordinate system that the View uses to draw in the window and its clipping area.

Next, a method containing Objective-C code and PostScript commands called `drawSelf::` draws the View's image. Display then sends display messages to Views that it owns, called *subviews*, informing them to draw themselves. When the subviews finish, display restores the previous graphical state and exits.

Although subviews have their own local coordinate system, they operate within the coordinate system of the Views that own them, called *superviews*. All Views in the window are ultimately owned by a single View, called a *contentView*. This relationship between Views and their subviews becomes a hierarchy that determines the order in which Views get drawn and how they receive event messages.

This View hierarchy becomes a powerful tool for managing images in a window. For example, suppose a View object is an aircraft control panel that has subviews composed of gauges and switches. If the coordinates of the control panel View change, the coordinates of the gauges and switches change as well.

As another example, suppose you want the control panel to display itself. You send a display message to the window that owns the control panel. The window redraws itself, then sends a display message to the control panel. The control panel View calls its `drawSelf::` method that redraws its image. The control panel View then sends the display message to each of its subviews, and they in turn execute their `drawSelf::` methods. In this way the entire control panel, gauges and all, is redrawn.

The Responder object supplies a safety net of default behavior for event messages should objects in your application fail to do so. It does this by defining methods for every event message. The action these methods take is to pass the event message to whatever object is defined as the "next responder," which by default is the View's superview.

Since many of the visible objects inherit the Responder's behavior, it supplies the logic by which Views deal with events. For certain events, a View might have methods that override the Responder's behavior. However, for events for which the View has no corresponding methods, the Responder's behavior takes over: The View passes the message up the View hierarchy until an object deals with it. You normally don't use the Responder object yourself.

Also be aware that all Control objects, such as a slider, override much of the default behavior defined by Responder.

Bitmap, Control, and Text Objects

The Bitmap object stores the bit map of an image. You use the Bitmap object to display static images, such as pictures or icons. It's also useful for storing complex images that must be drawn quickly many times.

For example, suppose you have an intricately shaded View object called Molecule that you plan to use in a chemistry demonstration application. As part of the demo, you want the molecule's image to bounce rapidly around the screen. To do this, you use PostScript commands to render the image into a Bitmap.

In Molecule's `drawSelf::` method, you "composite" the Bitmap to various locations inside your View. Compositing consists of the fast multibit pixel operators added to Display PostScript by NeXT. This way, you use the Bitmap to move the molecule's image about the screen and avoid the computationally expensive task of executing Molecule's PostScript commands to redraw it each time.

Control objects implement visible controls, such as radio buttons, switches, or sliders. They use another object called a Cell that knows how to draw the control and "highlight" it (i.e., darken and then lighten the control's image) in response to a user event. Cells also save the Control's target and action information (more on this later).

The Control object itself handles mouse tracking when it receives a mouse-down message, and it issues an action message in response to a subsequent mouse-up or mouse-down event. In the case of a slider control, for example, the Control object uses the Cell to display the slider's image and move it in response to mouse events. The Control object sets the range of values—perhaps representing voltages—that the slider emits and directs these values to the appropriate target object, which in turn executes a particular action method.

A Text object, not surprisingly, deals with ASCII text. The amount of text that can be stored in it is limited only by available memory. The Text object also stores information that describes the typefaces and point sizes used throughout the text. Text implements basic text-handling capabilities such as text selection (the portion of text chosen is highlighted), cut, copy, and paste operations. Text objects can also read and write Microsoft's RTF (Rich Text Format) files.

Perhaps one of the most powerful objects in the Application Kit with regard to application design is the Archiver object. The Archiver object lets you write an instance of a NeXT application and all its objects to an archive file on disk. It also reads an application from an archive disk file into memory.

It's important to note that all instance variables in each object are saved in this archive operation. This means that when the archived program is read back into memory, the values of its instance variables are recovered. In other words, the entire state of the application at the time it was archived is restored.

For example, say you're working on a manuscript using a text editor applica-

continued

tion. You've got a window of a certain size and position on the screen opened to a Text object with the text you see here stored in it. It's late, and you decide to stop work. For this particular application, when you tell it to quit, it issues an archive message to all its objects. The Window object saves its size and screen location in its instance variables. The Text object archives the text you've just entered, plus information on the various fonts you used, what part of the text was visible in the window, and even what section of text was highlighted for a planned cut-and-paste operation.

Since every Application Kit object knows how to archive itself, this makes for an extremely clean application design: You don't have to write special code to save user preferences or restore the application's state to the last session in which it was used.

Since only instance variables are archived, however, you should avoid the use of global variables in an application. If you happen to write an object with unusual storage requirements, you should provide methods to properly archive and restore the state of the object. While Objective-C provides an archiving mechanism for object-oriented programs, NeXT implemented its own archiving functions in this object.

When to Speak, When to Listen

The Speaker and Listener objects provide an object-oriented interface on top of Mach's interprocess communication system. Both of these objects have a number of methods that translate messages into the Mach IPC protocol. Speaker and Listener are used to send messages between applications and also can be used to implement high-level interprogram communications.

For example, when you call the "Define" function from within a NeXT application to look up a word, its Sender object opens a connection to the Webster's application. Then a Define message is sent in IPC format, which has a character string that contains the word in question. Webster's Listener has a method that looks for such messages. When it receives the message, a search begins based on the word embedded in the message. When the search ends, the Webster's application opens a window that displays the results of the search.

Putting It Together

As you can see, the Application Kit has a number of highly useful objects. The next thing a programmer must do is assemble these objects into a working application. NeXT's IB application lets you do this, and do it quickly. As stated earlier, it's used both to build the user interface and to establish how the objects communicate with one another.

I'll start with the user interface. You select a visible object to be used as a control, perhaps a button, from a library of control objects presented by IB. Using the mouse and keyboard, you alter the button's dimensions (you might make it bigger) and text display (changed from "OK" to "Save File").

For IB to operate on visible objects this way, the objects must be designed carefully. The object's `drawSelf::` method must use instance-variable values and not hard-coded constants. This lets you drag an object about on the screen where you want it and then adjust its size.

IB also allows you to modify the values of instance variables in an object. This lets you change the name of the Button in the example above. But this capability brings me to IB's second function: You can change the linkages between an application's interface and the objects within it.

The normal course of communication between control objects and application objects is through a *target/action paradigm*. That is, an event on a control object—that button you just built—sends an action message ("save file") to a target object. The target object responds by executing the action method that saves your data to a file on the disk drive.

This target/action paradigm lets you design precise message routes between the user interface and the methods that handle the work. More important, it lets you use IB to change these routes to different objects at a later date. You do this by modifying the instance variables that determine these connections.

To see how this is done, I'll give you a closer look inside a Control object—specifically, a Cell. Recall that Cells store target and action information. This is done with two instance variables, named, appropriately, `target` and `action`. `Target` indicates what object to notify when the proper event occurs, and `action` is the action message to be sent. As an example, suppose you click on that "save file" button. The Button's mouse-down method highlights the button. When a mouse-up event occurs, the Button dispatches the message stored in `action` to the object whose name is stored in `target`.

IB presents a Connect window that lets you define the target/action relationship between objects. You select the objects you want to work with by dragging their images to either a Sender or a Target slot in the Connect window. For the object designated as a Target, the Connect window shows you a list of the object's action messages as text. You can't modify the message names from the Connect window, but you can choose which message the Sender emits from this list. If you now drag an object into the Sender slot and click on the "patch cords" that connect the two slots, the patch cords close, indicating that the target/action relationship is established. You can optionally have the target object direct output to another object, perhaps a gauge.

IB's technique of visually establishing the message routes in an application is simple yet powerful. It makes the programmer's job of designing the connections between the user interface and the application code easy.

Run-Time Binding

Making life simpler for the programmer required a carefully thought-out design for NeXT software. As you can see, this design relies heavily on object-oriented programming to make it work. However, additional effort goes on behind the scenes to supply the flexibility IB provides in making target/action message connections.

When you compile an object, the character strings that make up the object's messages are stored in a *local message table*. The compiler also produces two other tables. The first is a *selector translation table* that maps a unique binary selector code to the character string that represents the message. The second table is a *message dispatch table* that contains pointers to every method defined in the class. The selector codes in the selector translation table serve as a run-time reference to the method names in the message dispatch table. At run time, this message dispatch table plays the crucial role of directing an object's action message to its target method.

Recall that when you work on an Application object with IB, the target-action connections and their messages are stored in IB's definition file. As the application starts, these definitions are loaded by the Application object. The run-time system uses the definitions to establish the contents of each Control's `target` and `action` instance variables.

When an event occurs, the affected Control translates the message stored in `action` into a selector code. The selector code is sent to the target object, as determined by the contents of `target`. The system then searches the message dispatch table of the target object for the selector code that was emitted by the Control. Now you see the reason for the selector code: It's faster to do a binary comparison than the character-by-character comparison required if the actual text of the message strings was used for the search. If a match occurs, the corresponding pointer in the message dispatch table directs the thread of execution to the appropriate method. If there is no match, the search resumes in the message dispatch table of the object's superclass. This mechanism for establishing links between the messages and their targets at run time is known as *run-time binding*.

The benefits of run-time binding are twofold. First, it lets objects send messages to other objects without regard for the target's class until run time. Second, it permits modification of the application's user interface without recompiling the application. The price you pay for this binding mechanism is performance: It takes about twice as long for a target method to receive a message versus using a subroutine call. Considering the power of the NeXT computer and the flexibility in designing the application interface, this trade-off is reasonable.

NextStep makes extensive use of object-oriented programming concepts. First, OOP packages code into functional modules that can be effectively used without knowledge of their contents (the "black box"). For example, the intricate event-loop code that manages the user interface is encapsulated in the Application object.

Class inheritance allows Application Kit objects to "borrow" behavior, as from the Responder object. Inheritance also lets programmers customize existing objects for unique behavior without writing the object from scratch.

Finally, run-time binding provides a powerful but flexible means to simplify application design without whiling away the hours compiling source code. NextStep uses all these aspects of OOP to provide a revolution in software design. While I've only watched NextStep being used, I'm eagerly looking forward to the chance to try it myself. ■

ACKNOWLEDGMENT
I would like to thank Bruce Blumberg of NeXT, Inc., for his patience in explaining the key concepts behind NextStep. Without his help, this article could not have been written.

Tom Thompson is a BYTE senior technical editor at large. He can be reached on BIX as "tom_thompson."

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Color Smalltalk
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An Ada environment framework
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Waltham, MA 02154
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Servio Logic Development Corp.
15025 Southwest Koll Pkwy., 1A
Beaverton, OR 97006
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IRIS
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Palo Alto, CA 94303
(415) 857-4233
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An object-oriented language, expert system, and hypertext system
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473A Malden Bridge Rd.
Nassau, NY 12123
(518) 766-3000
Inquiry 999.

Labview 2.0
An icon-based graphical programming language for the Macintosh
National Instruments Corp.
12109 Technology Blvd.
Austin, TX 78727
(512) 250-9119
Inquiry 1000.

Layout
A software-development system and hypertext product
Matrix Software Technology Corp.
One Massachusetts Technology Center
Harborside Dr.
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(617) 567-0037
Inquiry 1001.

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A Macintosh application-development framework
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Inquiry 1002.

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OOPS board for ATs
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23844 Hawthorne Blvd.
Suite 200
Torrance, CA 90505
(213) 375-4700
Inquiry 1003.

Objective-C 4.0
The Objective C Compiler
ICpak 201 Graphical User Interface
Objective-C Interpreter
The Stepstone Corp.
75 Glen Rd.
Sandy Hook, CT 06482
(203) 426-1875
Inquiry 1004.

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Traveling Software, Inc.
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The Oregon C++ Software Development Environment

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6915 Southwest Macadam Ave.
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A programming language and development environment

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Three Results Way
P.O. Box 1003
Marlborough, MA 01752
(508) 467-4806
Inquiry 1012.

Vbase
A database with integrated languages

Ontologic, Inc.
47 Manning Rd.
Billerica, MA 01821
(508) 667-2383
Inquiry 1013.

Books and Literature

The Object-Oriented Programming, Systems, Languages and Applications (OOPSLA) '88 Conference Proceedings. The Association of Computing Machinery (11 West 42nd St., New York, NY 10036).

Shriver, Bruce, and Peter Wegner, eds. *Research Directions in Object-Oriented Programming.* Cambridge, MA: The MIT Press, 1987.

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Stroustrup, Bjarne. *The C++ Programming Language.* Reading, MA: Addison-Wesley, 1987.

Weiner, Richard S., and Lewis Pinson. *Introduction to Object Oriented Programming and C++.* Reading, MA: Addison-Wesley, 1988.

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BATTLE OF THE CHIPS

Frank Hayes

Is the battle between the Intel 80286, 80386, and 80386SX just a family feud?

Or does it make a difference to you?

The 80286 processor is the chip that not so long ago brought AT-class computers more power than PC-compatible machines had ever produced before. But is it outmoded and obsolete now? Has it been replaced by the 80386 and its low-speed cousin, the 80386SX?

That's what Intel (which designed all three chips and is the exclusive manufacturer of the latter two) has been suggesting ever since it introduced its new generation of chips. After all, says Intel, the 80386 clocks faster, addresses more memory, and runs more software than the 80286.

But in recent months, two other companies that make 80286 chips, Advanced Micro Devices and Harris Semiconductor, have been singing a different tune. Both companies have speeded up the 80286 to what were previously 80386-only speeds. Harris's fastest 80286 CPU runs at 20 MHz (faster than the 80386SX and as fast as many 80386s). AMD's fastest chip is a 16-MHz 80286, but the company expects to be making a 20-MHz chip next year—and both AMD and Harris expect to create a 25-MHz version within a year.

The two chip makers aren't alone in singing the praises of the 80286:

Gordon Campbell of Chips & Technologies says the 80286 is "hands down the most effective in the industry." "We'll see a 10-year life cycle for the 80286, and almost 10 years of growth," says Campbell.

Joel Jewitt of Everex says that "the demand for 80286 processors (the high-end ones) will remain strong," since their performance capabilities are comparable to the 80386, and their price/performance ratio is much better.

Andrews Czernack of Zenith points out that low-power versions of the 80286 are perfect for portables.

Russ Werner of Microsoft says the 80286 is the least expensive chip with the power to run graphical interfaces and multitasking.

Larry Fortmiller of AST sees another perspective: "Buying an 80386SX is a political decision, not a technical one. People are asking their DP managers for 80386 machines; the pressure is on to get them, even when a fast 80286 would probably be more than adequate. The 80386SX lets a manager put an 80386 on the desks of people who don't really need the full power of an 80386 but who think that they have to have the latest hardware."

But while 80286 chip and clone makers fight to win back the hearts and minds of users who want the very newest—and Intel and 80386 clone makers fight to keep them to themselves—the real advantages of each chip may be getting lost in the shuffle. There are advantages to each CPU—and the newest isn't always the best.

80286 versus 80386

Ironically, when an 80286 and an 80386 are running DOS programs at the same speed, they achieve roughly the same performance. When Intel first introduced the 80386, it ran substantially faster than the 80286s that were available at the time. But with AMD's 16-MHz 80286 and Harris's 20-MHz chip, the 80386 no longer has the advantage that its wider registers once gave it. Either CPU can run OS/2, as well as all MS-DOS software.

But the two chips aren't identical by any means. The 80386 can run all the software that the 80286 can, but the converse isn't true. True power users want the ability to do real multitasking. Even though there are versions of Xenix and other multitasking operating systems for the 80286, multitasking doesn't become really secure until the processor is designed for it.

It is not an easy task to make the 80286 perform multitasking or mode switching (moving between protected mode and unprotected mode). The mode is determined by the logic of one of the processor pins when the processor is either powered up or reset. The BIOS can specify the state, but you can change the mode only by resetting the 80286. Jerry Pournelle describes the process this way: "You have to clunk it over the head and knock it out. When it's waking up—but before it realizes it's been reset—you shout: 'Stop! Stop! Don't reset! It's all a terrible dream.'"

The 80386, on the other hand, is designed for simultaneously running multiple operating systems with multiple protected-mode virtual 8086s (for each MS-DOS process) and, at the same time, a *real-mode* 80386. The 80386 processor handles memory management far more efficiently and with greater flexibility than the 80286 does.

These might seem like strong reasons to choose an 80386 machine. And they are, if you require efficient multiprocessing. But most application programs do not require the features of the 80386 if they are run in the traditional PC manner, one at a time.

According to both AMD and Harris, when you run a typical application on an 80386, it's likely to be slower than on an 80286. Because of design differences between the two CPUs, that may be true—in theory. But a BYTE Lab comparison of computers built around both chips indicates that if there's a difference, it's very slight. A 20-MHz 80286 is just about the same as a 20-MHz 80386.

What Makes Fast Fast?

However, there are other factors besides CPU speed that can affect how fast a computer runs software. One is the speed of memory—how many CPU wait states the RAM requires to

continued

The 80386 Power Users

Ben Smith

If your plans include any of the following, you need an 80386 machine:

• *Unix V/386*, from Interactive (Santa Monica, CA), and *Locus, Microport, and Xenix-386*, from SCO (Santa Cruz Operations, Santa Cruz, CA). These all require the Intel 80386 to run: They are licenses of the Unix operating system that have been specifically designed to take advantage of the multitasking strengths of the 80386. Each publisher also offers either Merge 386 or VP/ix, which are extensions to the operating system that allow it to run multiple virtual 8086s with MS-DOS concurrently with Unix. Unix is a multiuser operating system that provides for facilities similar to a LAN's but without many of the hardware expenses and hassles.
• *Windows/386*, from Microsoft (Bellevue, WA). The 80386 version of this well-known DOS extender takes full advantage of the 80386, offering true multitasking. This product is as close to Presentation Manager as you will get without running OS/2.
• *VM/386*, from IGC (Santa Clara, CA). This is another, less graphically oriented way of using the 80386 to run concurrent DOS applications.
• *DESQview 386*, from Quarterdeck (Santa Monica, CA), is the most popular DOS extension for multiprocessing.
• *Concurrent DOS 386*, from Digital Research (Monterey, CA), the originators of the CP/M operating system and GEM. It lets you attach as many as nine terminals to the 80386 machine. Each terminal can be running a separate DOS product. This is actually multiuser, multitasking DOS.
• *PC-MOS/386*, from The Software Link (Atlanta, GA). This is another multitasking DOS that uses special dot (.) prefixed commands to manage the tasks.
• *Omniview*, from Sunny Hill Software (Seattle, WA). This one is especially well suited to working with networks, and it also takes advantage of the multitasking abilities of the 80386.
• *Theos 386*, from Theos Software Corp. (Walnut Creek, CA). A completely different multiuser, multitasking operating system specially designed for transaction processing and real-time processing such as manufacturing/process control.
• *Soft-ICE*, from Nu-Mega Technologies (Nashua, NH). This debugger runs the target application as one process in a virtual 8086 machine while watching it from another process.
• *Turbo Debugger virtual-mode operation*. From the Borland (Scotts Valley, CA) Turbo Professional developer's packages, it has similar facilities to those of Soft-ICE.
• *Paradox 386*, also from Borland. It is the most popular of the application programs (as opposed to operating systems) that specifically use the 80386. Paradox 386 was developed with Phar Lap DOS-Extender (see below) to take advantage of the 80386's ability to address very large blocks of memory as one continuous block. If more memory is required than is physically available, virtual memory automatically fills the requirement. These 80386 memory management features plus the 32-bit operation can improve an application's performance by up to a factor of five on the same computer.
• *386 DOS-Extender*, from Phar Lap (Cambridge, MA). This is a set of development and run-time tools that allow MS-DOS applications to take advantage of the 80386. Though Paradox 386 is the best known of the products using these tools, over one hundred other application programs use them.

In the general-use category, most programs that need to include network drivers use the 386 DOS-Extender to overcome the 640K-byte limitation of MS-DOS. Many minicomputer and mainframe CAD/CAE programs have been moved to 80386 machines. These products include Anvil 5000PC from Manufacturing & Consulting Services (Irvine, CA); Workview 3000 from View Logic Systems (Marlborough, MA); and Future Designer 386 from Futurenet (Chatsworth, CA).

In addition, there are programs for finite element analysis, linear programming, and, of interest to mathematicians, Mathematica 386, the phenomenal symbolic math modeling and graphics program.

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keep up. A second is whether there's a floating-point unit (typically an 80287 or 80387 FPU) in the system.

Wait states slow down the CPU's ability to work: The processor must spend a significant amount of time waiting to get data or instructions from memory. Zero-wait-state machines are available, but some computers using inexpensive RAM may have two wait states or more. Other computers use a cache to cut the wait states to a minimum.

Curiously, the 80286 handles wait states slightly *better* than the 80386—but both processors lose about 10 percent to 15 percent of their processor speed for every wait state required. For example, a 20-MHz CPU with two wait states will run only about as fast as a 16-MHz CPU with no wait states. It is clear that the fewer wait states required, the faster the computer will run.

While wait states slow a CPU down, a floating-point unit can speed it up significantly—but only if the software being used can make heavy use of the FPU for number crunching. This is where the 80386 has an advantage, and it's a big one: It can use either an 80287 or an 80387 FPU; the 80286 is limited to an 80287.

Right now, there are no high-speed 80287s to match the fast 80286s from Harris and AMD. As a result, an 80386 with an 80387 is significantly faster than an 80286 with an 80287. (An 80386 with an 80287 shows no significant improvement over an 80286 with an 80287.) Although AMD has promised a faster version of the 80287, it's not likely that you'll see it in computers before the end of this year.

The 80386 machines are typically much more expensive than equivalent 80286 machines—by about 30 percent. But while the 80386-based systems generally have a higher price tag, they are also likely to come with faster hard disk drives, I/O, and video. These features let software run at top speed. You can get similarly high-speed hard disk drives and video systems for an 80286-based system, but it's less likely that

continued

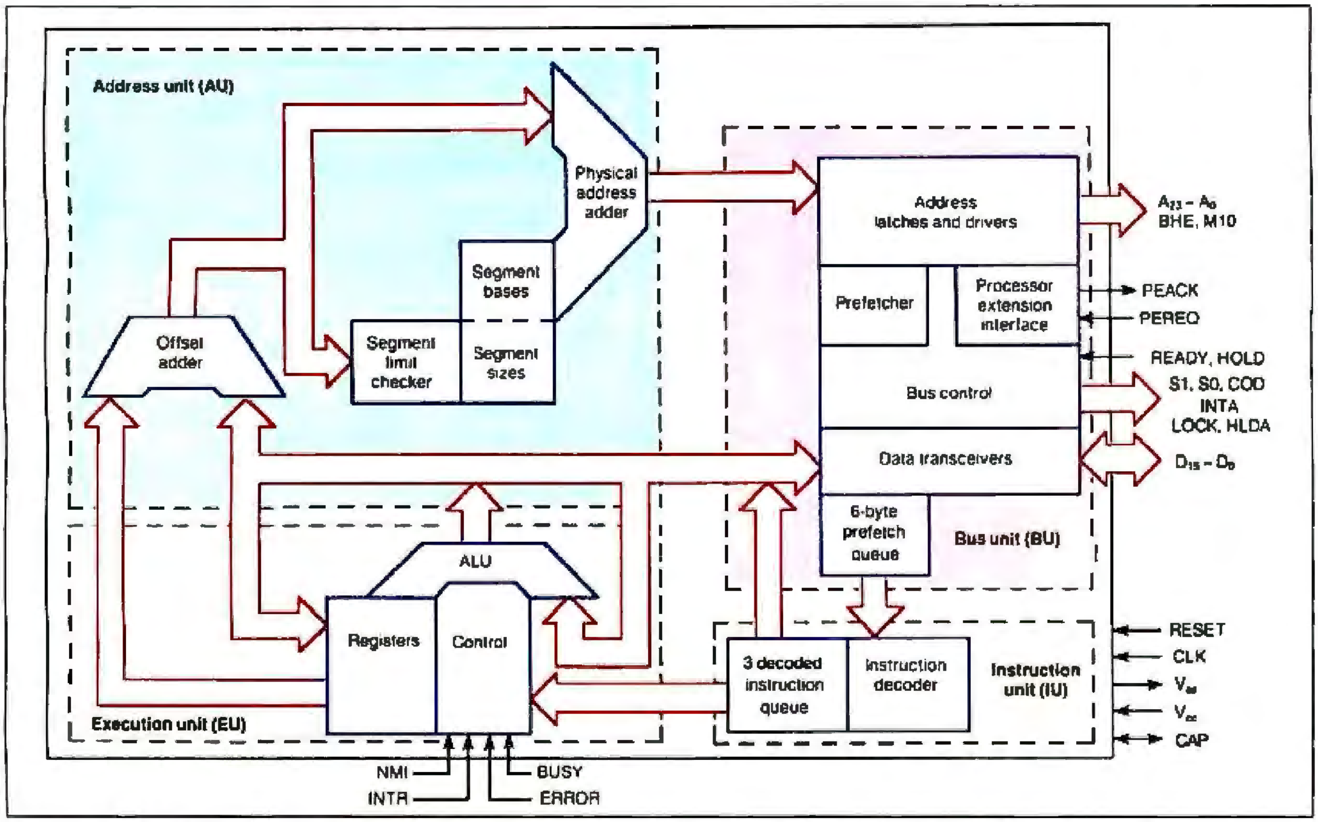

Figure 1: *The 80286 CPU architecture. Though there are provisions for many sophisticated memory management and process-control features, the majority of applications only use the chip as a fast and efficient 8086.*

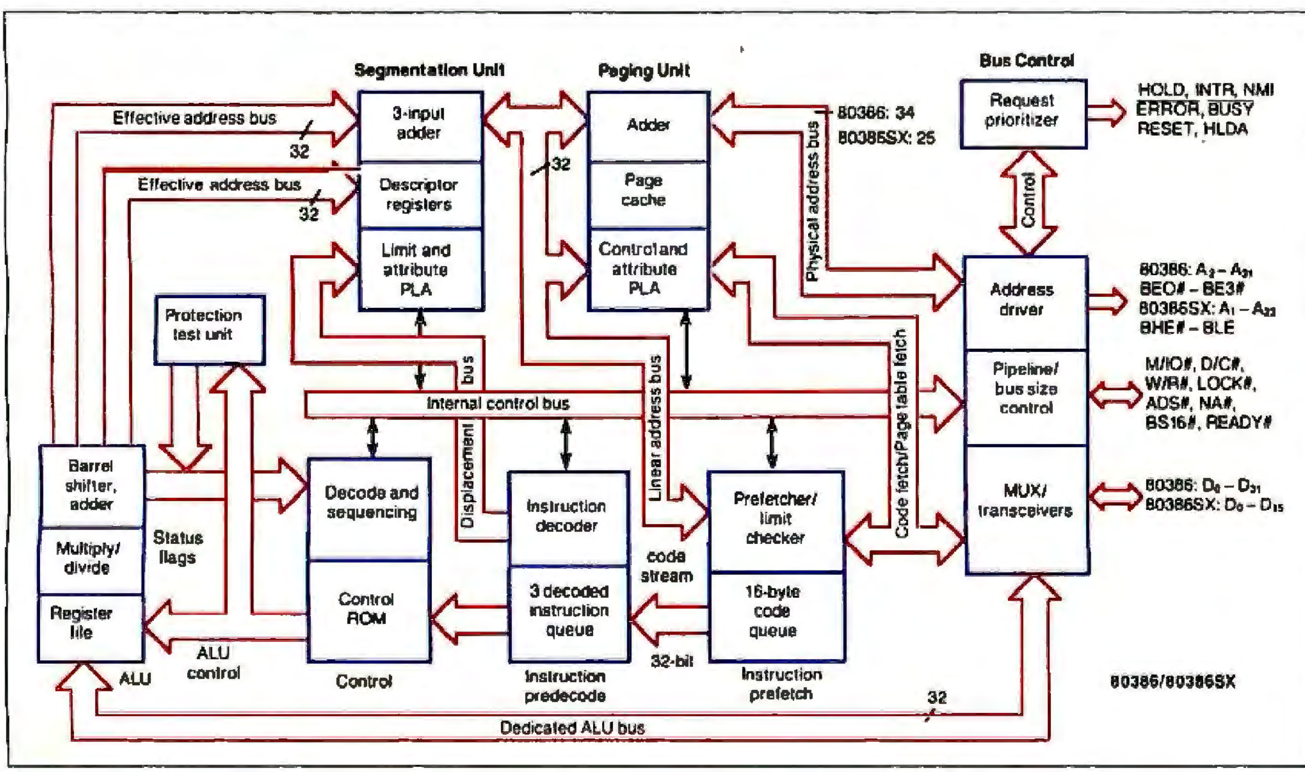

Figure 2: *The 80386 CPU architecture. The only major difference between the 80386 and the 80386SX is the number of lines in the internal physical address bus and in the external data bus.*

Battle of the SXs

Michael E. Nadeau

Debating the pros and cons of the 80386SX CPU from the user's point of view has been mostly an intellectual exercise. Until recently, the only machine available was the Compaq 386s (see "SX Appeal" by Jeff Holtzman in the November 1988 BYTE). With more systems being introduced, we are now seeing the range of performance, price, and configuration that other vendors might offer.

BYTE has also looked at two other 80386SX machines: the Twinhead Superset 490 Model A and the NCR PC916sx. These units represent two very different design philosophies. The Superset 490 uses a standard motherboard design in a small-footprint box with only four 16-bit expansion slots, which mount horizontally. The NCR is a backplane design in a full-size case with six open slots (two 8-bit and four 16-bit). The price difference between the machines is significant, too: $3399 for the Superset 490 and $5195 for the PC916sx in base configurations.

Twinhead Superset 490

Our Superset 490 unit was a preproduction model, though Twinhead said it was equivalent to the models that would be shipping as of January. It runs at 16 MHz with zero wait states. Our unit came with a 1.2-megabyte 5¼-inch floppy disk drive, a 40-megabyte 28-ms MiniScribe hard disk drive, the optional 80387SX math coprocessor, a 101-key Qtronix keyboard, and 1 megabyte of memory on the motherboard. Also standard are serial, parallel, and mouse ports; a three-button mouse (which we did not receive); a clock/calendar, and Twinhead's Magic Combo graphics card and driver. Magic Combo converts a 640- by 200-pixel color display into a 720- by 350-pixel mode that emulates monochrome formats. It is supposedly compatible with IBM MDA, CGA, HGCA, and Plantronics standards.

The Superset 490 uses the Phoenix Neat286 BIOS with the P9 modification for the 80386SX CPU. It also sports an Eagle graphics BIOS that supports the Magic Combo card. The main board can hold up to 8 megabytes of memory.

Performance is the story. We ran only the low-level system benchmarks. On the CPU index, the Superset 490 bettered the Compaq 386s (1.93 vs. 1.86) but was slower than the Dell 220 (2.72) and the 16-MHz IBM PS/2 Model 70-E61 (2.11). On the FPU index, it bested the Dell 220 with its 80287 chip (4.91 vs. 1.73) but fell behind both the Compaq 386s and the Model 70 (5.03 and 5.50, respectively). (See table A.)

NCR PC916sx

The NCR unit bears a closer resemblance to a high-end 80386. It has more expansion slots, a beefier power supply, a 1.44-megabyte 3½-inch floppy disk drive, VGA graphics, NCR's own BIOS, and 1 megabyte of 80-ns memory on the processor board, which you can expand up to 5 megabytes. The remaining standard features are similar to those on the Twinhead. The unit is also speed-switchable between 8 and 16 MHz. The 80387SX math coprocessor is an option.

The PC916sx actually has eight slots, but one is taken by the 80386SX processor board and another by what NCR calls a Personality Card, which integrates the disk controllers, serial and parallel interfaces, and VGA card.

NCR has priced this system at $5199, close to the Compaq 386s. This is a computer for people who are willing to pay for a well-known name and want all their expansion opportunities open. In fact, NCR calls its design Incremental Workstation Architecture, which means you can drop in an 80386 processor later if you need the extra power.

As table A shows, performance is similar to the Superset 490, with a 1.87 CPU index.

Where's the Beef?

On the surface, there seems little reason to buy an 80386SX system. You can get more powerful 80286 machines for less and 80386 machines for slightly more. However, if you have an eye toward running 32-bit software on a 16-bit budget, the SX might make sense.

With that in mind, Twinhead seems to have the more reasonable approach. The best-selling PCs are still the 80286-based systems by a wide margin. Twinhead and other like-minded vendors are apparently hoping to siphon off sales from the high-end 80286s with the stripped-down 80386 computers. It might work if the price difference between the 80386 and 80386SX CPUs holds. After all, look what Henry Ford did with his V-8 in 1932.

On the other hand, NCR seems to have designed a computer that can be configured to meet a wide range of customers' needs. That flexibility comes at a price: Like the Compaq 386s, a fully configured PC916sx could easily cost over $10,000. At that level, customers have to ask themselves why they aren't buying a true 80386 system.

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Table A: *Indexes of low-level performance benchmarks.*

	Superset 490 80386SX 16 MHz	NCR PC916sx 80386SX 16 MHz	Compaq 386s 80386SX 16 MHz	Dell System 220 80286 20 MHz	IBM PS/2 Model 70-E61 80386 16 MHz
CPU index	1.93	1.87	1.86	2.72	2.11
FPU index	4.91	N/A	5.03	1.73	5.50
Disk index	1.45	1.34	1.78	1.40	1.55
Video index	1.17	1.11	1.87	2.02	1.93

These indexes show performance relative to an IBM AT (where AT = 1). For details, see "Introducing the New BYTE Benchmarks," June 1988 BYTE.

you'll find such high-performance features included as standard equipment.

The Review Update in the December 1988 BYTE ("Benchmarks at a Glance") summarizes the BYTE Lab's benchmark results for several dozen computers we've tested. For the most part, computers with the 80386 are faster overall than those with the 80286—even when the processors run at the same speed; this is probably because of the extra standard features of the 80386 computers.

If you're in the market for a speedy number cruncher, a fast 80386 with an 80387 FPU is the fastest you can buy right now—and for most of this year.

The 80386SX

What about the Intel 80386SX? That's the version of the 80386 that has a 16-bit data bus like the 80286 (instead of the regular 80386's 32-bit data bus). Because the same amount of data is being squeezed through a narrower doorway, it can't perform at the level of an 80386—yet it's still almost as expensive as one.

There are some discouraging facts about the 80386SX processor. First, it can't run any faster than 16 MHz. Intel plans to work on faster versions, but only after it has filled the current demand for the 16-MHz model and its supporting family of chips.

Our tests of early 80386SX machines show that a fast-enough 80286 computer can offer all the speed an 80386SX machine has—and typically for a much lower price.

AMD claims that the 80386SX is significantly slower than an 80286. This is based on their comparison of the Compaq 386s computer to the Everex Step 286/16. Our tests of early 80386SX machines show that a fast-enough 80286 computer can offer all the speed an 80386SX machine has—and typically for a much lower price. (See the text box "Battle of the SXs" on page 278.)

The 80386SX is a relatively slow, relatively expensive CPU. A math coprocessor makes a difference—but even with an 80387SX FPU, a 16-MHz 80386SX is no faster than a 20-MHz 80286 with a much slower 80287 FPU. In addition, several clone makers have complained privately that 80386SX CPUs are in very short supply (Intel is the only source of the chips); this suggests that they won't be dropping much in price in the near future.

What do you get for paying a premium price? Only one real benefit: the ability to run 80386-based software. DESQview 386, Unix V/386, and special applications such as Borland's Paradox 386 are all written specifically to take advantage of the 80386's special features, and to skirt the restrictions of the 16-bit operating systems MS-DOS and OS/2. But your common, everyday MS-DOS software doesn't take advantage of any of the benefits of the 80386.

Companies Mentioned

NCR Corp.
Personal Computer Division
Dayton, OH 45479
(800) 544-3333
Inquiry 1105.

Twinhead International Corp.
30 Chapin Rd., Bldg. K
P.O. Box 702
Pine Brook, NJ 07058
(201) 808-1688
Inquiry 1104.

Back to the Future

Microsoft predicts that most IBM PC-compatible computers will continue to run MS-DOS until at least 1990, when there will finally be a significant number of programs for OS/2. An 80386 version of OS/2 isn't likely to arrive until 1990 or 1991, and even then, most OS/2 software will still run on 80286-based machines.

On the other hand, if you are buying for the long-term future, there is no question that the 32-bit operating systems and applications will have a longer shelf life. The new thrust of applications development is for Unix V/386 and for the eventual 32-bit version of OS/2. Even now, Intel is working on the 80486 (though it is rumored to be just an incremental step from the 80386).

If you want to use software and operating systems that have been written specifically for the 80386 (see the textbox "The 80386 Power Users" on page 276), the 80386SX may offer some hardware savings as long as the 32-bit SIMMS remain a valuable commodity. Or, if you use software that might gain some efficiency from the 80386 (e.g., if you need raw number-crunching power), the ability to use the 80387 math coprocessor would make an 80386 a worthwhile investment. In such a case, even if you are not running an 80386 operating system, an 80386-based computer may still be your best bet at the present time.

Test your software on both 80286 and 80386 machines before buying. You'll pay a premium for an 80386; make sure you get the additional performance you're paying for. The 80386 may be sexy, but that's not a good enough reason for buying an 80386-based machine.

Finally, if your main consideration is to continue to run the software you run now, let price and performance be your guide. Your best bet is probably an 80286 machine—but make sure that the typically lower prices of 80286 machines don't saddle you with a slow hard disk drive, slow memory, or a slow video system.

No, the 80286 isn't dead. Until prices come down and performance improves on the 80386 family, the 80286 is still the CPU of choice in the price/performance arena. The 80386 has an advantage only if it's using an 80387 coprocessor or if you want to use software that depends on the 80386's instructions. For the next year at least, the 80286 will still give you far more bang for your buck. ■

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CACHING IN ON MEMORY SYSTEMS

Small amounts of fast RAM boost system performance

cache \'kash\ *n.* *[F, fr.* cacher *to press, hide...]* **1 a:** *a hiding place esp. for concealing and preserving provisions or implements* **b:** *a secure place of storage* **2:** *something hidden or stored in a cache*
—Webster's Ninth New Collegiate Dictionary

These days, it is increasingly difficult to find a high-end computer system that does not use a cache—a small amount of high-speed memory that holds recently accessed data to boost performance. In this installment of Under the Hood, I'll explain the inner workings of these high-performance memory systems.

CPUs Accelerate

Since the beginning of the microcomputer industry, chip makers have raced to make their processors run faster and faster. In the days of the S-100 bus and CP/M-based microcomputers, you had prestige if you owned a system in which the Z80 microprocessor ran flat out at a blazing clock speed of 4 MHz. At that speed, the Z80 needed to get information back from RAM roughly 200 nanoseconds—billionths of a second—after it asked for it. If the RAM couldn't deliver the data in that amount of time—and in some systems it couldn't—the computer's circuitry would have to make the CPU wait until the data was ready, which is called a *wait state*.

Another system of that era, the Apple II, clocked its 6502 CPU at slightly more than 1 MHz, and it needed to get the data back from RAM within 600 ns. (This was slow enough that there was actually time for the video circuitry to access the RAM in between CPU reads and writes.)

The time that it takes for a RAM to return data after it is "asked for it" (i.e., after you send it an address and any needed control signals) is called the RAM's *access time*. Table 1 shows a list of common microprocessor chips, along with the maximum access times their RAM chips must have if wait states are to be avoided.

Keeping Pace with CPU Speeds

As you can see, the more powerful the microprocessor, the faster the RAM needs to be to let it operate at full capacity. And while RAM speeds have continued to increase over time, they have not kept pace with CPU speeds.

In 1977, a typical static RAM chip had an access time of 250 ns, while the most common DRAMs had an access time of 450 ns. As of January, these figures have decreased to 30 to 45 ns for a moderately priced SRAM chip and 80 to 100 ns for a typical DRAM chip. This decrease in access time is more than a factor-of-5 improvement, but still not enough to satisfy the current crop of data-hungry CPUs. What to do?

The designer could use only fast SRAM chips, but the resulting system might be too costly for all but the most well-heeled customers. Dell Computer, the only IBM PC-compatible company to try this approach, dropped its SRAM-only Model 300 last year.

Alternatively, the designer could use only the less expensive DRAM chips and rely on special circuit design tricks like interleaving, page mode, nibble mode, and static column mode to make these RAMs operate at top speed. (For more information on these trade-offs, see "Keeping Up with the CPU" by Mark L. Van Name in BYTE's Fall 1988 *IBM Special Edition*.)

Some manufacturers—Cheetah in particular—claim that a clever DRAM design using page mode is sufficient to meet even the grueling demands of a 33-MHz 80386 system. Most manufacturers, however, use a cache.

The Locality Principle

Caches work because of a phenomenon known as the *locality principle*, which states that a von Neumann CPU (i.e., one that executes instructions sequentially) tends to access the same memory locations over and over again. In situations where speed counts, like tight loops, the CPU will repeatedly fetch and execute the same instructions. In addition, the CPU is likely to use many of the same memory locations, like counters and pointers, repeatedly. Thus, if each memory object that the CPU accesses is saved in fast RAM for immediate reuse, there is a high probability that you'll save time on the next access.

In essence, a cache works just this way. When the CPU needs data from memory, the cache circuitry checks to see if the information is already in the cache. If it is, the memory system can read the data very quickly and deliver it to the CPU with no delay. This situation is called a *cache hit*. However, if the required data is not in the cache, the system requires an access to slower memory. This situation is called a *cache miss*, and the microprocessor usually incurs a few wait states.

Data retrieved during a cache miss, however, is also written into the cache's faster memory, so that if the computer accesses the same location again (i.e., if the locality principle holds), there will be no delay the second time around.

Associativity—Finding Data in the Cache

In order for a cache to speed up memory accesses, it has to be able to find the data the CPU needs—and find it fast. How does a cache organize the data it saves so it can get to it quickly? The answer depends on the *associativity* of the cache.

The simplest sort of cache to under-

continued

stand, though the hardest to implement, is called a *fully associative cache* (see figure 1). This sort of cache simply remembers the most recent data accessed—as much as it has room for. That is, if there are *n* locations in the cache, the cache always holds the contents of the last *n* memory locations accessed by the CPU. When a cache miss occurs, the cache circuitry picks a location in the cache memory, loads it with the data that's retrieved from slower main memory (the part of RAM that isn't in the cache), and records the fact that the data is there.

This sort of cache is called fully associative because any location in the cache can be associated with (i.e., can hold the data from) any location in main memory.

In practice, however, few computer systems use fully associative caches. Why? In order to determine whether a hit or a miss has occurred, the cache logic must be able to check every single location in the cache to see if it contains the needed data—and complete this arduous task in a very short time (typically, 10 ns or less).

Table 1: *Speeds of common microprocessors. The last column shows how fast RAM chips must be to allow zero wait states in a real-world design. Within microprocessor families, this number is roughly inversely proportional to clock speed.*

Microprocessor	Clock speed (MHz)	Access time required for zero wait states (ns)
Synertek 6502	1	500
Zilog Z80	4	200
Intel 8088	4.77	450
Intel 80286	8	120
	10	100
	12	80
Intel 80386	16	60
	20	50
	25	40
Motorola 68000	8	200
	10	150
Motorola 68030	16.67	60[1]
	20	50

[1] Timings are for synchronous cycles

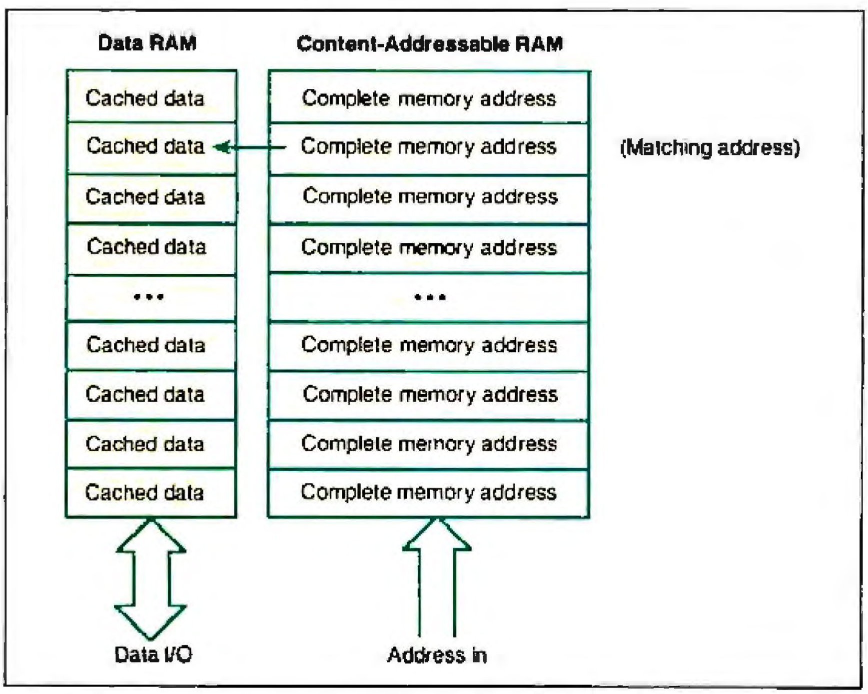

Figure 1: *A fully associative cache consists of a bank of data RAM and a content-addressable RAM containing the address where each data item came from. When each memory access occurs, the content-addressable memory is searched for the address of the required data. If it's found, the corresponding location in the data RAM can be used to complete the access. Since content-addressable memory is complex and expensive, fully associative caches are rare.*

Set-Associative Cache

While it's possible to design circuitry that checks every location in the cache, it's usually more economical to restrict the number of places where the data from a particular memory location can go so there are fewer locations to check. Such a cache is called a *set-associative cache* (see figure 2) because there is a limited set of places in the cache where the data from a particular main memory address can be saved.

In a typical set-associative cache, each memory location can be associated with *k* locations in the cache, where *k* is an integer (usually a power of 2). This is called a *k-way associative cache.* Many PC-compatible computers, for instance, use the Intel 82385 cache controller, which can implement a two-way associative cache ($k = 2$).

Direct-Mapped Cache

A cache that can store the contents of a particular memory address in only a single place in cache memory (i.e., a one-way associative cache) is called a *direct-mapped cache.*

A direct-mapped cache is the simplest, least expensive, and potentially fastest type of cache. Why? Because, instead of searching the cache to see where the needed information might be, all the cache circuit needs to do is check to see if a single location has the right data in it.

Let's suppose, for instance, that a cache has 8192, or 2^{13}, words of fast memory in it. Each cache location can then be addressed by a unique 13-bit number. If we associate each address in the cache with all the addresses in main memory whose lower 13 bits are the same, no calculations are needed to determine where to look for the cached data. The hit-or-miss decision is reduced to a single comparison operation, in which the remaining bits of the main memory address are compared to the upper bits of the address from which the cache data came. This direct mapping saves both time and circuitry, and thus is the most commonly used method.

Performance and Associativity

You might think that a direct-mapped or set-associative cache would not perform as well as a fully associative cache, since there is always a chance that the microprocessor could simultaneously use code and data areas with the same least significant bits. In fact, however, the probability of this happening is lower than you might think.

Most microcomputers use, at most, a two-way associative cache. And some of the most economical speedup cards for PC-class machines, which replace the

continued

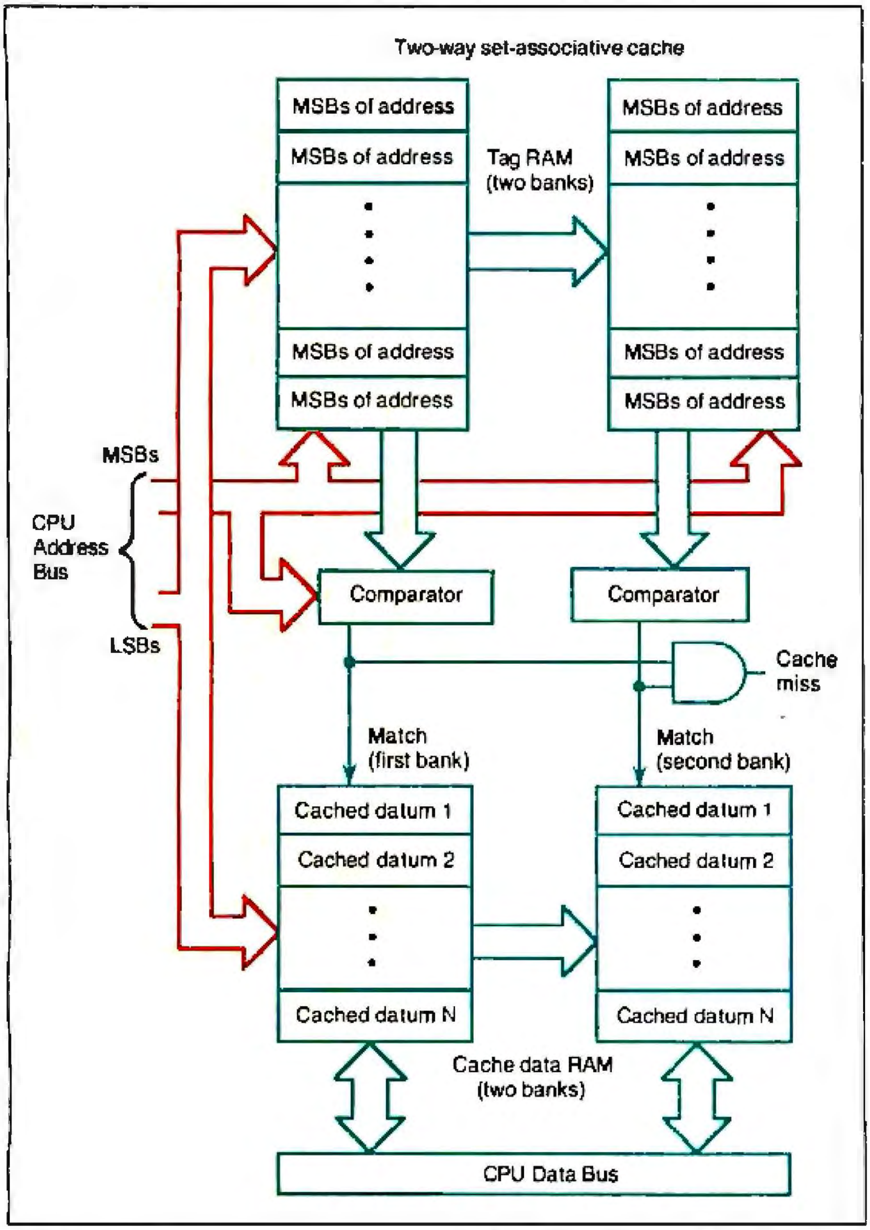

Figure 2: *In a two-way associative cache, the least significant bits of the memory address select a set of two cache locations. Each location has a "tag" that contains the most significant bits of the main memory address whose contents are stored there. Only two comparators (i.e., logic circuits that compare numbers) are necessary to determine if one of the locations contains the needed data. A direct-mapped cache is similar, but it has only one comparator, one column of tag RAM, and one column of data RAM. A four-way associative cache would have four of each.*

8088 microprocessor with a faster 80286, gain massive performance improvements by using a small direct-mapped cache between the 80286 and the 8-bit PC memory.

A direct-mapped cache can be easily implemented without a relatively expensive cache controller like the Intel 82385. In fact, it often pays to use a direct-mapped cache and more cache memory instead of a two-way associative cache controller and less memory. (This is the approach taken by the Everex Step PC compatibles, among others.)

Table 2, from Intel's *80386 Hardware Reference Manual*, shows some actual empirical data on cache performance. It shows hit rates—the percentage of accesses that produce cache hits—for cache configurations in which the cache size, associativity, and line size (i.e., the size of each location in the cache) vary. At a hit rate of 93 percent, which is the maximum shown in the chart, a system with DRAM will perform only 7 percent slower than if SRAM was used for the entire system memory.

Replacement Strategies

Once a system with a cache is running, it doesn't take long before each location in the cache holds data from somewhere in main memory. The question then arises: When a cache miss occurs, which location in the cache will be mapped to a new place in main memory to accommodate the new data? In a direct-mapped cache, each main memory location can map to only one place in the cache, so this is not an issue. However, in a set-associative or fully associative cache, a choice must be made, and the algorithm used to make the decision is called the cache's *replacement strategy*.

When the CPU writes to a memory location in a cached system, we must make sure that both the cache and main memory are updated.

In an ideal universe, the cache would be prescient: It would know exactly which memory locations the CPU was going to access. It could free the slot in the cache that corresponds to the location that would not be reused for the longest time. When computer scientists talk about this ideal strategy, they give it the name OPT, for optimal. All evaluations of feasible strategies are based on this desirable but unattainable goal.

In the real world, several strategies are possible. The simplest, and perhaps the most obvious, is called *random replacement* (RAND). In this scheme, at random, the cache simply picks a location to replace. It's common for a system that uses this overly simple strategy to throw away useful data.

More common in real-life systems is a strategy called *least recently used*, or LRU. Given the choice between several slots in cache memory, the cache logic picks the one that the CPU has read or written least recently.

LRU turns out to be a much better replacement strategy than RAND. Why? A good way to understand this is to observe that if time were reversed, the least recently used location would become the one read again. In this kind of cache, each write incurs the same speed penalty as a cache miss, and the processor is slowed down accordingly—in other words, LRU would become OPT. Now, even though we can't run time backward, we know by the locality principle that accesses to a memory location tend to occur in bunches. It's therefore a good bet that LRU will guess correctly about which locations are to be used in the future.

Updating Main Memory

When the CPU writes to a memory location in a cached system, we need to make sure that both the cache and main memory are updated. There are three commonly used strategies for doing this: a *write-through cache*, a *cache with posted writes*, and a *write-back cache*. In a write-through cache, the simplest kind, each CPU write goes both to main memory and into the cache (so it will be available if it is read again). In this kind of cache, each write incurs the same speed penalty as a cache miss, and the processor is slowed down accordingly.

Some or all of this delay can be eliminated if the cache implements posted writes. In a posted write, the data goes to cache memory right away, and the CPU "thinks" the write has completed before the information actually reaches main memory. (The term *posted* comes from the same root as postage and post office, and it means somewhat the same thing. The cache circuitry tells the CPU that the write is complete once the data is on its way—in the mail, as it were—to main memory.) Execution continues, and the CPU doesn't wait unless it needs to access main memory soon thereafter. A separate-state machine—part of the memory circuit—completes the write cycle after the CPU has moved on.

Table 2: *The hit rates for different cache configurations with the 80386 microprocessor. Line size is more important than associativity in determining performance for each cache size.*

Cache configuration			Cache performance	
Size (bytes)	Associativity	Line size (bytes)	Hit rate (%)	Performance ratio over noncached DRAM
1K	Direct-mapped	4	41	0.91
8K	Direct-mapped	4	73	1.25
16K	Direct-mapped	4	81	1.35
32K	Direct-mapped	4	86	1.38
32K	Two-way	4	87	1.39
32K	Direct-mapped	8	91	1.41
64K	Direct-mapped	4	88	1.39
64K	Two-way	4	89	1 40
64K	Four-way	4	89	1 40
64K	Direct-mapped	8	92	1 42
64K	Two-way	8	93	1.42
128K	Direct-mapped	4	89	1.39
128K	Two-way	4	89	1.40
128K	Direct-mapped	8	93	1 42

Even better results can be obtained with a write-back cache. In this scheme, most CPU writes go solely to the cache. Main memory is updated only when the cached location has been written and is then replaced by the replacement strategy. A "dirty bit," associated with each location in the cache, is used by the cache circuit to determine if main memory needs to be updated. The Everex Step PC-compatible computers were the first to implement a write-back cache, but others in the industry are likely to follow suit.

Table 3: *How some high-performance 80386 machines implement their caches. All but two use the Intel 82385 cache controller.*

Computer	Cache architecture
ALR FlexCache 20386	82385 cache controller (32K bytes)
ALR FlexCache 25386	Extended emulation—proprietary hardware emulation of 82385 cache controller with added features (64K bytes)
Compaq 386/20, 25	82385 cache controller (32K bytes) and concurrent I/O (flex architecture)
Dell System 310	82385 cache controller (32K bytes)—20 MHz—and interleaved RAM
Everex Step 386/25	Proprietary write-back direct-mapped cache (64K to 256K bytes)
IBM PS/2 Model 70	82385 cache controller (64K bytes)—25 MHz

Cache Coherence and Snooping

It stands to reason that, in order to work correctly, a cache must ensure that its copy of the data in main memory corresponds to the actual contents. This is called *coherence*. Coherence is easy to achieve if the CPU is the only entity that can ever change the contents of memory. However, in systems with peripherals that perform direct memory access (DMA), the cache needs to find out when a main memory location has been changed by something other than the CPU—a peripheral, for instance—so that it knows its copy might no longer be valid.

By the same token, if a cache implements posted writes or a write-back strategy, it must ensure that a DMA device gets the correct data rather than an obsolete value from main memory.

The process in which a cache watches to see how peripherals are accessing memory is called *snooping*. Ideally, snooping should be able to occur concurrently with other cache operations. Virtually all cache controllers—including the 82385—implement this function.

In the 82385, a write-through cache, a DMA write to a main memory location invalidates the cache's copy of the data in that location. The write-back cache in the Everex Step computers operates even more efficiently. The cache controller actually accepts the data from the DMA device, keeping the cache data valid. Similarly, when a DMA device reads memory, Everex's cache can supply data directly to the device without delay.

Internal Microprocessor Caches

The Motorola 68030 and Texas Instruments TMS34010 microprocessors contain built-in caches. The Motorola chip has a 256-byte instruction cache and a 256-byte data cache, while the TI chip has only a 256-byte instruction cache. All these caches are direct-mapped, and the instruction caches are loaded in bursts of four 32-bit longwords (providing an opportunity for the design to use nibble mode to fill the cache quickly). The Intel 80386 does not have an internal cache, though it does attempt to prefetch instructions before it needs them.

The speed contest in the microprocessor world shows no sign of slacking off, and we will most likely see CPUs from Intel and virtually all other manufacturers with on-chip caches. However, since real estate on microprocessor chips is extremely tight, these caches will not obviate the need for external caches. In fact, external caches will most likely need to be specially designed to efficiently handle requests from the on-chip cache controllers.

Cache Problems

While caches usually provide significant improvements in memory system performance, they sometimes fail to work as well as they should—most often because the basic assumption of locality is violated. For instance, a simple linear search algorithm, which scans a large expanse of memory for a particular pattern, can wipe out some or all of the useful data in a cache.

Multitasking systems may switch between many contexts, each accessing a different set of code and data. One particular danger in multitasking systems is *thrashing*. Thrashing occurs when a cache location is reloaded repeatedly because two or more processes happen to use memory locations that map to that slot.

There's no foolproof way to avoid the problem of thrashing, though large caches and set-associative caches are less prone to thrashing than smaller and direct-mapped ones. However, even in the worst cases, there is likely to be some locality of reference and hence some benefit from the use of the cache.

Intensive I/O may also cause inefficiencies in certain cache designs. The Intel 82385, for instance, invalidates cache entries whenever DMA occurs to a location in the cache. Thus, I/O operations may flush the very locations that the CPU will shortly be accessing. The usual solution to this problem is to update the cache rather than to invalidate the entry.

Finally, it's possible for code and data to compete for the same areas of the cache. Many systems avoid this by having two caches—one for code and one for data. As mentioned earlier, the Motorola 68030 uses this scheme for its internal cache.

Cache Results

Despite a few potential pitfalls, caches have proven to be a highly effective means to maximize memory system performance. Once the exclusive province of mainframe computers, caches are now an important part of most high-end designs (see table 3). We can expect that more and more designers will increase performance by putting a cache controller under the hood. ■

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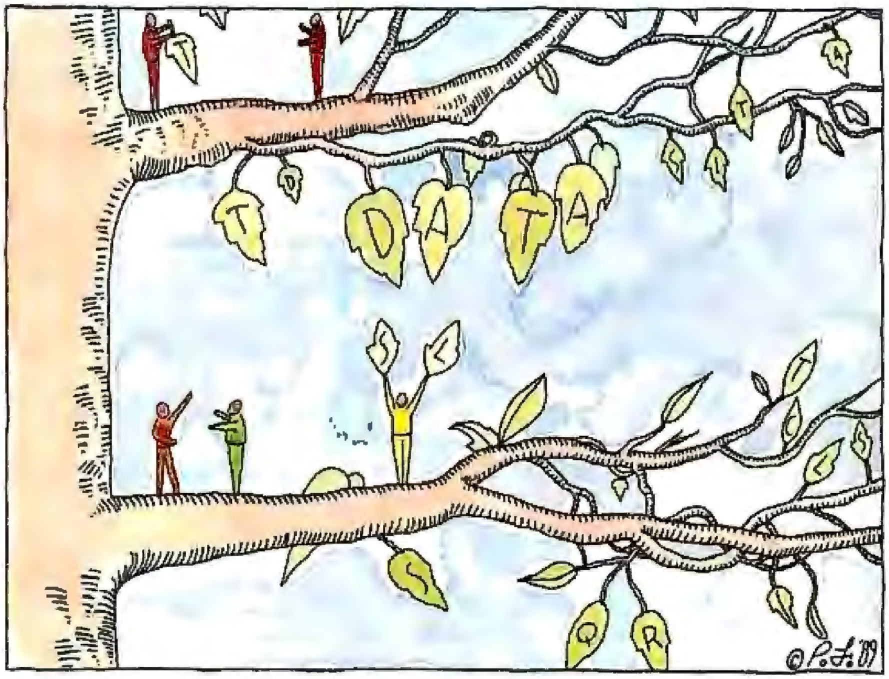
Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Part 3

TREES 'N KEYS

ZSAM provides speedy, keyed-file access to those mega-databases



I've spent the last two articles describing routines for the B-tree database system that I dubbed ZSAM. But a pile of routines is just a pile of routines until you actually put them to some use; knowing how to search a B-tree for its inorder successor doesn't build a client database system.

You can't just sit down at the keyboard and begin typing in raw data. First you have to take a serious look at how you're going to structure your database. This means you've got to ask yourself questions like "What information do I really need to keep on file?" and "How do I want to access the information? By ZIP code? By the customer's last name?" Once you've determined the structure of your database and how it's to be accessed, you can then decide what your data files will look like, how many key files you'll need, and how the keys in the key files will be constructed.

This month, I'll present a couple of examples of ZSAM database applications. I'll show you how to pull together all the algorithms that I have described in the last two columns into a working application. First, you'll want to read through the text box "The C Interface" on page 292; it gives a detailed description of the ZSAM library functions. You'll need to refer to this text box throughout the rest of the article.

Example Database 1: A Bibliography

I thought of this first application some time ago, when I wanted a way to computerize BYTE's annual index. Most of all, I wanted to be able to rapidly locate all BYTE articles on any particular topic. I didn't need the article's entire text in the database—just its title, issue date, and page number. I decided that it would also be nice to keep track of authors in case I needed to find out who had done articles on a topic.

Figure 1 is an outline of the database structure that I came up with. As you can see, the database consists of four key files and four data files:

• The master key file (MASTER.KEY) consists of 7-byte-wide keys that point to a record in MASTER.DAT. Records in MASTER.DAT hold the titles of the BYTE articles and a key, constructed from the concatenation of the article's date (4 bytes, YYMM format), its page number (2 bytes), and a counter (1 byte). This counter, also known as an enumeration byte, is a means of resolving the conflict that would occur if two articles were to start on the same page and map to the same key in MASTER.KEY.

For an example of using the counter byte, the first article encountered has a key like "YYMMPP0," and the second has a key like "YYMMPP1." Each character position represents a byte. YYMM represents the ASCII numerals for year and month; any necessary zeros are prepended. PP represents the page number in 16-bit binary, with each byte swapped and the most significant byte first. The keys are therefore stored in the tree in ascending page-number order. The last digit is a single binary byte representing decimal 0 to decimal 256.

Building this key is only a little tricky. When you enter a new article in the database, the application program builds the key in the form "YYMMPP0" and uses ZSAM functions to search for that key in the file. If ZSAM doesn't find the key, the application program can insert the new key into the key file. But if ZSAM does find an existing duplicate key, the program must increment the counter byte

continued

ILLUSTRATION: PAUL FISCH © 1989

and repeat the search process with "YYMMPP1," eventually arriving at an unused key. This becomes the new entry's master key.

• The keywords-to-article key file (KEYWORDS.KEY) consists of 16-byte keys for the BYTE index topics. An article like "Programming in Macintosh BASIC" would have the keywords `Programming`, `BASIC`, `Apple`, and `Macintosh` associated with it in the KEYWORDS.KEY file. Each (topic) key in KEYWORDS.KEY points to a linked set of records in the data file called KEYWORDS.DAT; each record in that record set contains a master key pointing to a record in the MASTER.DAT file. For example, the single key `Apple` might point to a record set holding a dozen entries, and each entry holds a master key that points to the article's title in MASTER.DAT.

• The author-to-article key file (AUTHART.KEY) associates authors with articles. Keys in the AUTHART.KEY file consist of the author's last name and first initial. Each key points to a record set in AUTHART.DAT that, as in the KEYWORDS.DAT data file, holds a list of master keys ultimately pointing to the appropriate entries in MASTER.DAT. This file lets the user type in something like "Thompson, T" and receive a list of all articles penned by Tom Thompson.

• Finally, the article-to-author key file (ARTAUTH.KEY) attaches authors' names to each article. Every key in ARTAUTH.KEY is a master key (same as in MASTKEY.KEY), but now each key points to a data-record set (in ARTAUTH.DAT) that is the list of the full names of the authors of the article (20 bytes are allotted for each author name).

Here are a couple of examples to help you understand how the application handles the database when you want to retrieve information.

• You select `Apple` as a topic. The program searches the KEYWORDS.KEY file and reads the first of the set of `Apple` records in KEYWORDS.DAT. This record is a master key. The program uses this key to search the MASTER.KEY file, receiving the title of the article from MASTER.REC. It displays the title. Now, using that same master key to search ARTAUTH.KEY, the application can retrieve the authors' names from ARTAUTH.DAT and display them.

• You remember the last name of the author of a particularly interesting article. The name is Williams, but you can't remember his or her first name or initial.

The application program will use the partial key `Williams` (padded with nulls) to search the AUTHART.KEY file. This search will yield a key-not-found error, so the program performs a seek-next-key operation (ZSAM's READNKR( ) function), which locates the first key of the form `WILLIAMSxxxx` and returns the record holding the master key. The application program uses the master key to retrieve the article title from MASTER.KEY/MASTER.DAT files. Finally, the program uses the master key with ARTAUTH.KEY and ARTAUTH.DAT to retrieve the names of the article's authors so that you can see if the Williams you found is the one that you remember.

continued

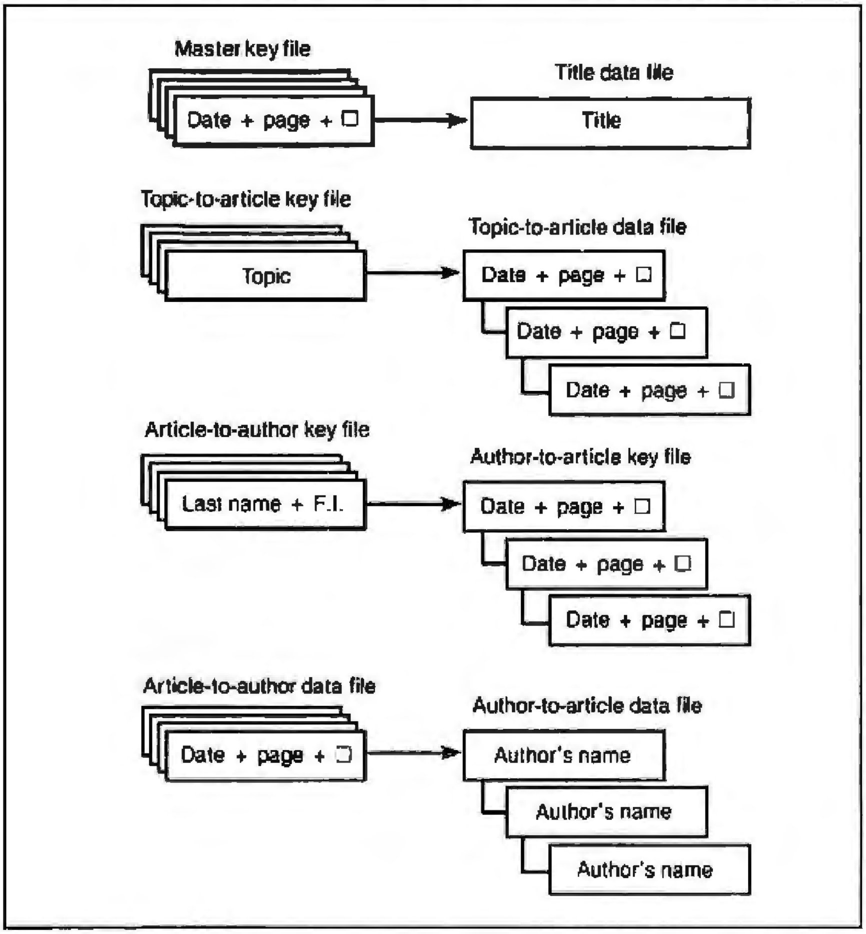


Figure 1: *Database for a simple bibliographic reference system. Key files on the left provide access to the data files on the right. Articles and associated authors can be referenced by issue date, topic, or author's name. (The box character indicates the count byte; see the text for an explanation of its meaning.)*

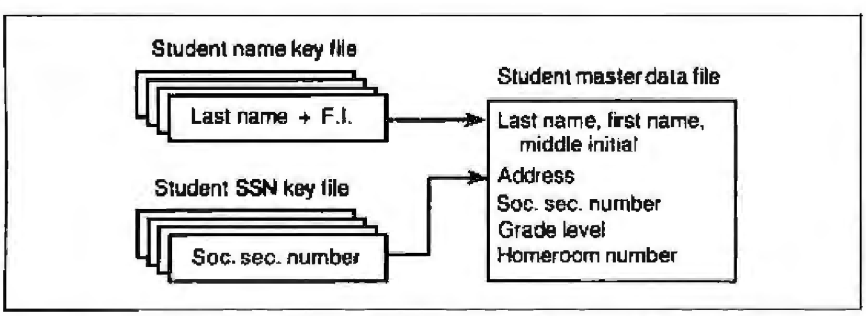


Figure 2: *This diagram represents a student-record database. Two key files reference the same data file, so a student's information can be accessed by the student's name or social security number.*

If you indicate that it's not the right Williams, the program will use READNKR( ) in AUTHART.KEY to see if there are other authors with the same partial key, repeating the whole process. If it is the right Williams and you indicate that you want to see other articles he's done, the program will use the read-next-data-record function (READNDR( )) in ARTAUTH.DAT to retrieve the next article's master key from the record set.

Example Database 2: Multiple Indexes

One feature not shown in the example above is ZSAM's ability to associate multiple key files with a single data file so that you can access a record by more than one route. Examine the database diagrammed in figure 2. This is a portion of a student-record-keeping system. In most cases, you're happy to access the student's data by last name. Let's say that a report comes in from a parent that her son is ill and will not be in school for the week. The secretary asks for the child's name, calls up the student's information, and makes an entry in the student's records about the lost week.

However, there are times when it is more convenient to access a student's information using social security number as the key. (At the university I attended, all grade reporting was done using social security numbers as the student identification number.) As you can see in figure 2, two key files point to a single data file, and a student's master information is accessible via either the student's name or social security number. How can you build such a structure using ZSAM?

When you add a new student's information to the database, the program should use

```
ZCREATKR(KFNUM,DFNUM,
  KEY,REC)
```

with KFNUM set to SNAME.KEY and DFNUM set to SMASTER.DAT. (KEY points to a string holding the student's last name and first initial, and REC points to the student's master record data.) This adds the student's name key to SNAME.KEY, creates the master record in SMASTER.DAT, and associates the key with the record. Next, the program should call

```
ZINSERTK(KFNUM,DFNUM,KEY)
```

with KFNUM set to SSN.KEY and DFNUM set as above. Now, however, KEY points to a string holding the student's social security number. ZINSERTK( ) assumes that DFNUM's internal pointer has been set to some valid record (in this case, the student's master data), to which the routine associates the new key. No new record is created; ZINSERTK( ) merely fills in the data pointer portion of the new key with the number of the current record in DFNUM. The result is that both the social security number key (in SSN.KEY) and the last name key (in SNAME.KEY) point to the master data record (in SMASTER.DAT).

Perhaps you're wondering how a deletion operation would work on such a two-key one-record arrangement. Let's assume a student leaves the school and you want to remove that student's records from the database. The program should first call:

ZSAM can associate multiple key files with a single data file.

```
ZDELETEKR(KFNUM,DFNUM,
  KEY);
```

with KFNUM set to SNAME.KEY's file number and DFNUM set to SMASTER.DAT's number. KEY would point to a string holding the student's last-name key. This deletes the name key and the master record. Then, it should call

```
ZDELETEK(KFNUM,KEY);
```

with KFNUM set to SSN.KEY and KEY pointing to a string holding the student's social security number. This deletes the social security number key. As in ZINSERTK( ), no data file is involved.

As a programmer, you can use the multiple-key-files technique to build very complex databases. In a client database, clients' data can be accessed by name, social security number, or driver's license number. If you want to be able to access all clients in a particular city, county, or ZIP code area, you can use the count byte technique as in the MASTER.KEY file in the bibliographic example to allow a single ZIP-code key to point to a list of client names.

continued

The C Interface

ZSAM is a B-tree file management system written in 8088 assembly language and interfaced to Borland's Turbo C (although it shouldn't be difficult to attach it to other C compilers—or other high-level languages, for that matter).

ZSAM provides all the routines I've described in this series of articles. I've also thrown in some additional C code for creating, opening, and closing ZSAM files.

You call ZSAM routines via C functions, which in turn call the assembly language library. I think it's worth pointing out that the assembly language library does not perform file I/O directly. Since file I/O is already provided in the C run-time library, I've written the ZSAM assembly language routines so that they turn around and call C library functions to perform file reads and writes. The result is C functions calling assembly language functions calling C library functions.

Here is a list of the routines provided by the ZSAM interface code:

```
ZOPENK(FNAME,KFNUM)
char *FNAME;
unsigned int KFNUM;
```
Opens key file FNAME and associates it with number KFNUM. ZOPENK( ) creates a node buffer and allocates space for the key file's header information. When you write a program that uses ZSAM, you define two constants; one indicates the maximum number of key files that you can open simultaneously, and the other indicates the maximum number of data files that you can open simultaneously. These constants serve to define the size of arrays of pointers to the key- and data-file header information. KFNUM is actually an index into the arrays; think of KFNUM as a file handle.

```
ZCLOSEK(DFNUM)
unsigned int DFNUM;
```
Closes the key file associated with KFNUM. ZCLOSEK( ) updates the key file's header information. Thus, you *must* call ZCLOSEK( ) for any open key files before terminating your program. Remember, the header information includes data like the file's root sector. If you've opened a key file and added keys that have caused the B-tree to grow, you have to update the header information before you close the file, or the identity of the new root sector will be lost.

```
ZOPEND(FNAME,DFNUM)
char *FNAME;
unsigned int DFNUM;
```
This routine is the data-file counterpart to ZOPENK( ). The data file FNAME is opened and associated with DFNUM. ZOPEND( ) creates a data-record buffer and allocates space for the data file's header information.

```
int ZCLOSED(DFNUM)
unsigned int DFNUM;
```
Closes data file DFNUM. As with ZCLOSEK( ), any data file that you have opened using ZOPEND( ) must be closed with ZCLOSED( ) before your program terminates.

```
int ZREWINDK(KFNUM)
unsigned int KFNUM;
```
Rewinds key file KFNUM.

```
int ZREADKR(KFNUM,DFNUM,KEY,REC)
unsigned int KFNUM,DFNUM;
char *KEY,*REC;
```
Read keyed record. KEY is a pointer to a character string containing the target key. If the target is found in file KFNUM, the data pointer associated with that key is assumed to point to a data record in DFNUM. ZREADKR( ) reads that data record and copies its contents into the character array that REC points to. (This routine uses the algorithm described in SEEK_KEY.)

```
int ZREADNKR(KFNUM,DFNUM,
  KEY,REC)
unsigned int KFNUM,DFNUM;
char *KEY,*REC;
```
Read next keyed record. This routine positions the internal pointers of file KFNUM to the current key's inorder successor (which becomes the new current key). The new current key is copied into the character array that KEY points to, and its associated data record (from DFNUM) is copied into the character array that REC points to. If DFNUM is a complex file, ZREADNKR( ) returns the head of the record set and leaves the data file's internal pointers set to the head record. (This uses the algorithm described in SEEK_NEXT_KEY.)

```
int ZREADNDR(DFNUM,REC)
unsigned int DFNUM;
char *REC;
```
Read next data record. DFNUM must be a complex data file. DFNUM's internal pointers are moved to the next record (in the current record set); this record is copied into the character array that REC points to. (This uses the algorithm described in READ_NEXT_RECORD.)

```
int ZCREATKR(KFNUM,DFNUM,
  KEY,REC)
unsigned int KFNUM,DFNUM;
char *KEY,*REC;
```
Create keyed record. The key string that's pointed to by KEY is added to KFNUM. REC points to a character array that holds the record to be associated with KEY. REC's contents are added to DFNUM, and a data pointer to this new record is attached to the new key in KFNUM. (This uses the algorithm described in CREATE_KEY.)

```
int ZINSERTK(KFNUM,DFNUM,KEY)
unsigned int KFNUM,DFNUM;
char *KEY;
```
Insert a new key. This routine operates similarly to ZCREATEKR( ), but it does not create a new data record. KEY points to a key string, which is added to KFNUM. A data pointer to the current record in DFNUM is attached to the new key. If DFNUM is a complex data file, then the data pointer identifies the head record of the current record set.

```
int ZWRITEDR(DFNUM,REC)
unsigned int DFNUM;
char *REC;
```
Write data record. The contents of the

Finally, since ZSAM permits keys of up to 64 bytes, you can do hierarchical sorting. Say you're building an accounting system and you'd like to be able to generate a report showing transactions sorted first by account number and next by date. You just create a key file whose keys are composed of the account number with the transaction date appended and a final count byte (or word) tacked on the end to make each key unique. Using the READNKR( ) function, you can step through the file, accessing the transactions in the desired order. If you want the transactions in date order, you current data record in DFNUM are overwritten by the character string that REC points to.

```
int ZAPPENDDR(DFNUM,REC)
unsigned int DFNUM;
char *REC;
```

Append data record. A new record is created in DFNUM and is loaded with the character string that REC points to. This new record is appended to the current record set in DFNUM and becomes the new current record. (This routine uses the algorithm that was described in APPEND_RECORD.)

```
int ZDELKR(KFNUM,DFNUM,KEY)
unsigned int KFNUM,DFNUM;
char *KEY;
```

Delete keyed record. Key file KFNUM is searched for KEY; if found, that key is deleted from the file, and its associated data record is then deleted from DFNUM. If DFNUM is a complex data file, the entire record set that KEY points to is deleted. (This routine uses the algorithm described in DELETE_KEY.)

```
int ZDELK(KFNUM,KEY)
unsigned int KFNUM;
char *KEY;
```

Delete key. The key file KFNUM is searched for KEY; if found, that key is deleted. Any data record associated with KEY is unaffected.

```
int ZDELD(DFNUM)
unsigned int DFNUM;
```

Delete data record. Data file DFNUM must be a complex data file. The current record is deleted from the current record set. (This uses the algorithm described in DELETE_RECORD.)

```
int ZREWINDD(DFNUM)
unsigned int DFNUM.
```

Rewind data record set. Data file DFNUM must be a complex data file. The current record set is rewound so a subsequent call to ZREADNDR( ) will return the set's head record. (This routine uses the algorithm described in REWIND_SET.)

construct another key file (pointing to the same data) with keys made up of DATE + ACCOUNT NUMBER + COUNT BYTE. Your only real limit is the amount of space on your hard disk.

End of File

As extensive as ZSAM is, it's not the final word in a database management system. For one thing, it doesn't begin to address relational operations on the database; those are functions you'd have to add on top of the ZSAM routines. (You can do that while you're adding a Structured Query Language front end, right?) Some of the more reasonable additions to ZSAM might include the following:

- Multiple indexes per key file. Each record in a key file is 512 bytes long. The header information is placed on the first sector of the file (offset 0), but since this information takes up only a small portion of the entire sector, there's ample room for more header information. The information for a given index would be located at a fixed offset within the first sector. So, if you had a data file that was keyed by date, client number, and ZIP code, instead of having to open three files to get at all the indexes, you could keep them all in one key file. And since all key nodes are the same length, the indexes could share a common available-for-reuse list.
- Allowing multiple records per key. This involves moving the functions for appending an enumeration byte (or word) into the ZSAM routines rather than having to manipulate the byte separately, as in the bibliography example. For a key file that allows multiple instances of the same key, simply expand the key length to account for the enumeration quantity. (Expanding it by 1 byte would allow for 256 copies of the same key in the file; expanding it by 2 bytes would allow for 65,536 instances of the same key.) Adding a replicate key would involve scanning through the existing keys until you located the first available value for the enumeration quantity.
- Tighter coupling between the key and data files. The header information of each key file could also include which data file it was associated with, and what portions of a data record are put together (and how) to create the key. For example, the key file holding social security numbers in the student database would contain header information that would say (translated to English): "Keys in this key file are composed of the character string starting at offset 25 within each data record." Offset 25, of course, is where the student's social security number is stored.

This arrangement has an added benefit of safety. If the key file gets clobbered, but the header information and data file remain intact, a program can recreate the index by simply scanning through the data file and reinserting the keys into the index. And speaking of safety...

- Safety features. When the key file begins to grow, it becomes more sensitive to corruption. Not that the failure rate goes up; it's just that the amount of information you stand to lose gets larger and larger. Some B-tree file management systems open a temporary file when an update is about to take place (like an insertion or deletion). Then, for each sector that the routine is about to modify in the B-tree, it first writes an unaltered copy of the sector into the temporary file. The temporary file is erased (or overwritten) only after the entire update has been completed successfully. So, if there's a system crash in the middle of the update that would otherwise leave the file damaged, you can restore the file to its state prior to the update by retrieving the sectors saved in the temporary file.

In humongous key files, where a power failure might spell the loss of a multimegabyte database, the added time required to write the records into the temporary file can be significantly less than that needed to rebuild the database.

- Variable-length keys. These have the advantage of letting you pack more keys on a key node. You'll have to precede each key with a key count. Determining whether the number of entries has exceeded a node's capacity becomes a little tricky; nevertheless, all the algorithms that I've presented in this column remain largely unchanged.

Next Month

I'll take another look at floating-point operations; this time, I'll present a binary-coded decimal floating-point package.

Author's note: *The complete ZSAM package is available on BIX as the file ZSAM.ARC. It is also available in a variety of other formats. See page 3 for details. The listings contain the source code for the assembly language routines and the C interface code. They also contain the programs that I used in the bibliography example, plus some sample data.* ■

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

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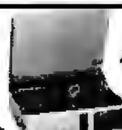

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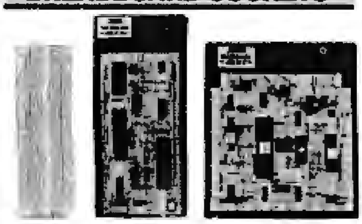

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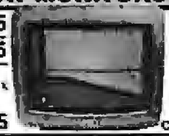

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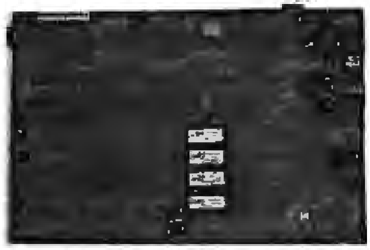

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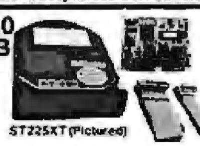

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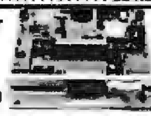

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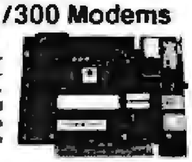

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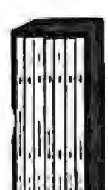

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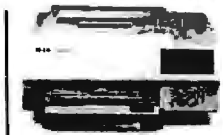

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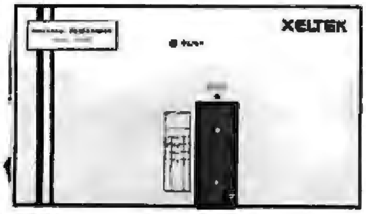

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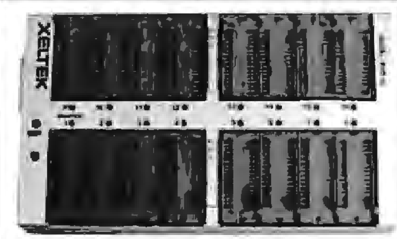

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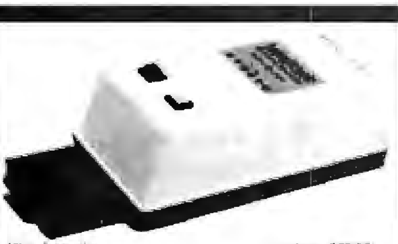

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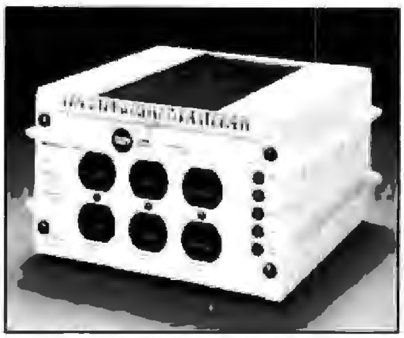

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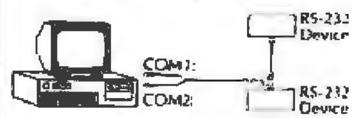

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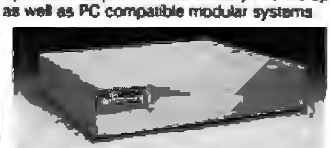

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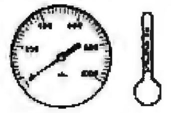
A-BUS™ NEWS

REMOTE DATA ACQUISITION AND CONTROL



Although affordable, powerful and easy to use, the A-BUS I/O system until recently had a major limitation: it had to be located close to the controlling computer. Now two new serial adapters from Alpha Products have removed this restriction. Any computer with an RS232 port can control the A-BUS line of data acquisition and control cards.

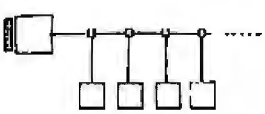
Using standard telephone type cable, the A-BUS system can be located up to 500 feet away from the computer. With the addition of a Modem the A-BUS system can be controlled from anywhere. As with all A-BUS cards, the adapters are easily installed and are programmed using standard commands.

NEW SERIAL PROCESSOR HAS BRAIN

Besides implementing a full A-BUS on a serial port, the low cost SP-127 A-BUS Serial Processor fills a great need in remote data acquisition. It includes a complete BASIC interpreter and can run programs independently of the host computer. This distributed processing relieves the host of housekeeping chores and low level decision making. The SP-127 can read and log data at set intervals for later reviewing or recalling at the host's convenience.

The Serial Processor, which communicates with any computer through an RS232 port, includes a complete BASIC interpreter and 32K of memory. Adding a Modem turns the SP-127 into a automated remote data and control station.

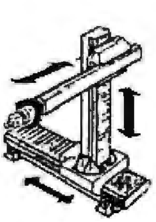
THE A-BUS ON NETWORK



Unique features such as the new "Serial Nodes" greatly expand the usefulness of the A-BUS. These inexpensive ($49) devices provide the ability to connect up to 16 complete A-BUS systems to a single serial port on any computer. The node also functions as a repeater to increase the reach of the adapter beyond the 500 foot limit

The nodes work in conjunction with the company's SA-129 Serial A-BUS Adapter. Plant-wide data collection and control will become widespread thanks to the system's low cost, outstanding capabilities, and ease of use.

ADVANCE IN MOTION CONTROL



Seeking new heights in motion control and robotics, Alpha's Smart Quad Stepper Controller outperforms systems costing 5-10 times more. This $299 board includes a multitasking microprocessor capable of controlling 4 stepper motors simultaneously at speeds up to 1000 steps per second. Four Axis positioning is perfect for robot arms, positioners, pick and place, etc.

Commands are intuitive; plain English words and a forgiving syntax make it easy to write (and edit) command sequences. Scaling factors allow for meaningful units of your choice, and 32 bit floating point arithmetic ensures accurate calculations. The "learn" feature involves storing a series of movements so that even a complex sequence can be repeated easily. Alpha's engineers thoughtfully included direct drivers for small motors, and a variety of inputs (limit switches, remote keypad, panic button, etc.).

An SC-149 can be set up quickly and easily, minimizing development time and allowing more effort to be devoted to the rest of the robotic project.

ALPHA Products

(203) 656-1806 Darien, CT 06820

Circle 16 on Reader Service Card

A-BUS™ MAGIC

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It used to be difficult and costly to do process control, robotics, data acquisition, monitoring and sensing with your computer. Now the low-cost A-BUS system makes it easy to do almost any project you can imagine.

Versatility. A-BUS cards handle most interfacing, from on/off switching, to reading temperatures, to moving robot arms, to counting events, to sensing switches...

Adaptability. The A-BUS is modular, allowing expansion well beyond your needs. It works with almost any computer, or even as a remote data station with the new serial adapters.

Simplicity. You can start using the A-BUS in minutes. It's easy to connect, and software is a breeze to write in any language.

Reliability. Careful design and rugged construction make the A-BUS the first choice in specialized I/O.

An A-BUS system consists of: ▪ An A-BUS adapter plugged into your computer ▪ A cable to connect the adapter to 1 or 2 A-BUS function cards. ▪ The same cable will also fit an A-BUS Motherboard for expansion to up to 25 cards in any combination.

NEW: REMOTE A-BUS! Use the new Serial (RS-232) Adapter or Processor to control any A-BUS system. Cards can be up to 500 ft away using phone type cable, or off premises using a modem. Call or send for the new A-BUS Catalog which covers all the products.

Important

All A-BUS Systems: ♦ Come assembled and tested ♦ Include detailed manuals with schematics and programming examples ♦ Can be used with almost any language (BASIC, Pascal, C, assembler, etc.) using simple "IN" and "OUT" commands (PEEK and POKE on some computers) ♦ Can grow to 25 cards (in any combination) per adapter ♦ Provide jumper selectable addressing on each card ♦ Require a single low cost unregulated 12V power supply ♦ Are usually shipped from stock. (Overnight service is available.)

About Alpha Products

Founded in 1976 for the purpose of developing low cost I/O devices for personal computers. Alpha has grown to serve over 70000 customers in over 60 countries. A-BUS users include many of the Fortune 500 (IBM, Hewlett-Packard, Tandy, Bell Labs, GM...) as well as most major universities. A-BUS products are U.S. designed, U.S. built, and serviced worldwide.

Overseas distributors: England: Caldy Science Assoc. Ltd., Merseyside, 051 342 7033. Australia: Brumby Technologies Pty. Ltd., NSW, 759 1638. France: Cosem, Rungis, 46 86 64 75

Inputs, Outputs, etc.

Analog Input: 8 analog inputs. 0-5.1V in 20mV steps (8 bits). 0-100V range possible. 7500 conversions/second. AD-142: $142

12 Bit A to D: Analog to digital converter. Input range -4V to +4V, expandable to 100V. On-board amplifier. Resolution 1mV. Conversion time 130ms. 1 channel. (Expand to 8 channels with the RE-156 card.) AN-146: $153

Relay Card: 8 individually controlled industrial relays each with status LED's (3A at 120VAC contacts, SPST). RE-140: $142

Reed Relay Card: 8 reed relays (20mA at 60VDC, SPST). Individually controlled and latched, with status LEDs. RE-156: $109

D/A converter: 4 Channel 8 Bit D/A converter with output amplifiers and separate adjustable references. DA-147: $149

24 line TTL I/O: Connect 24 input or output signals (TTL 0/5V levels or switches). Variety of modes. (Uses 8255A) DG-148: $72

Digital Input: 8 optically isolated inputs. Input can be 5 to 100V voltage levels or switch closures. IN-141: $65

Digital Output Driver: 8 outputs: 250mA at 12V. Drive relays, solenoids, stepper motors, lamps, etc. ST-143: $78

Clock with Alarm: Powerful clock/calendar. Battery backup. Timing to 1/100sec. Alarm relay, LED and buzzer. CL-144: $98

Touch Tone Decoder: Each tone is converted into a number which is stored on the board. PH-145: $87

A-BUS Prototyping card: 4x4.5" card. Will accept up to 10 I.C.s. With power & ground bus. PR-152: $16

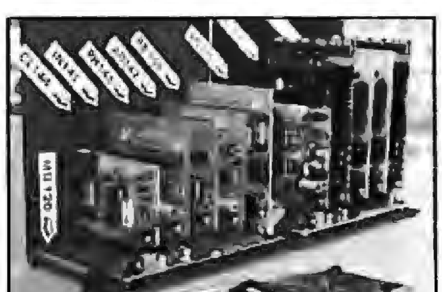
Counter Timer: Three 16 bit counters/timers. Use separately or cascade for long (48 bit) counts. CT-150: $132

Call our application engineers to discuss your project.

Motion Control

Smart Quad Stepper Controller: The world's finest. On board microprocessor controls four motors simultaneously. Uses simple English commands like "MOVE ARM 10.2 INCHES LEFT". For each axis, you control coordinates (absolute or relative), ramping, speed, units, scale factors, etc. Many inputs for limit switches, etc. On the fly reporting of speed, position... Built in drivers for small motors (such as MO-103 or 105). SC-149: $299

Options: ▸ 5 amp/phase power booster for 1 motor: PD-123: $49
▸ Remote "teach" keypad for direct motor control: RC-121: $54



A large A-BUS system with two Motherboards
Adapter in the foreground plugs into PC,XT,AT type slot.

Stepper Driver Kit: For experimenting with stepper motors. Includes 2 MO-103 motors and a ST-143 dual driver PA-181: $99

Stepper Motors: (4 phase, unipolar)

MO-103: 2¼" dia. ¼" shaft. 7.5°/step. 12V. 5 oz-in torque. $15
MO-104: 2" dia. ¼" shaft. 1.8°/step. 5V. 60 oz-in torque. $45
MO-105: 1.7" square. .2" shaft. 3.75°/step. 12V. 6 oz-in. $15

A-BUS Adapters

▸ Can address 64 ports and control up to 25 A-BUS cards.
▸ Require one cable. Motherboard required for more than 2 cards.

A-BUS Parallel Adapters for:

IBM PC/XT/AT & compatibles. Uses one short or long slot.	AR-133: $69
Apple II,II+,IIe Plugs into any slot inside.	AR-134: $52
Commodore 64,128 Plugs into Expansion Port on back.	AR-139: $48
TRS-80 Model 102,200 Uses 40 pin "Systembus"	AR-136: $76
Model 100 (Tandy portable) Plugs into socket on bottom.	AR-135: $75
TRS-80 Model 3,4,4D Y-Cable available if 50 pin bus is used.	AR-132: $54
TRS-80 Model I Plugs into 40 pin expansion box.	AR-131: $39
Tandy Color Computers Fits ROM slot, Multipak or Y-Cable	AR-138: $49

A-BUS Cable: Necessary to connect any parallel adapter to one A-BUS card or to first motherboard. 50 pin, 3 ft. CA-163: $24
Special Cable for two A-BUS cards CA-162: $34

Serial Adapter: Connect A-BUS systems to any RS-232 port. Allows up to 500 ft from computer to A-BUS. SA-129: $149

Serial Node: To connect additional SA-129/A-BUS systems to a single RS232 serial port (max 16 nodes). SN-128: $49

Serial Processor: same as above plus built in BASIC for off-line monitoring, logging, decision making, etc. SP-127: $189
Use SA-129 or SP-127 with modems for remote data acquisition.

Motherboard: Holds up to 5 A-BUS cards in sturdy aluminum frame with card guides. A sixth connector allows (using cables CA-161: $12) additional Motherboards to be added. MB-120: $105

Power Supply: Power pack for up to 4 cards. PS-126: $12

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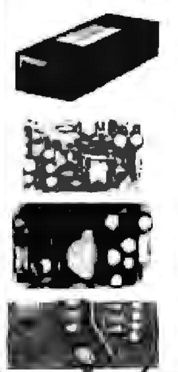

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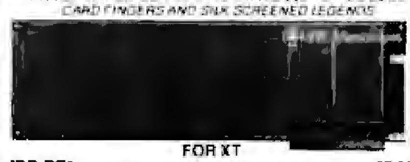

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168-3C

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SNAP APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

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1x40	RIGHT ANGLE LEAD	1.49
2x40	2 STRAIGHT LEADS	2.49
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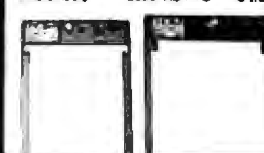
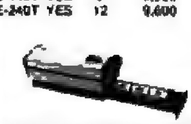


EPROM ERASERS

SPECTRONICS CORPORATION

Model	Timer	# of Chips	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$ 69
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189



- SHIRT POCKT SIZE!
- ERASES MOST EPROMS/EPLD'S IN 3 MINUTES
- ALL SIZES UP TO 4 AT A TIME

DATARASE II

IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.87	1.29	1.60	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.48	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	–	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' PLASTIC RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

PC SOLDERLESS BREADBOARDS

- 62 CLEARLY LABELLED BUS LINES
- ACCEPTS UP TO 24 14-PIN ICS
- 1940 TIE POINTS
- EXTERNAL FEMALE DB25 D-SUB CONNECTOR

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D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.46	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	–	.79	2.27	–
	FEMALE	DBxxSR	.55	.75	–	.85	2.49	–
WIREWRAP	MALE	DBxxPWW	1.69	2.56	–	3.89	5.60	–
	FEMALE	DBxxSWW	2.76	4.27	–	6.84	9.95	–
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	–	2.25	4.25	–
	FEMALE	IDBxxS	1.45	2.05	–	2.35	4.49	–
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	–	–
	PLASTIC	HOODxx	.39	.39	–	.39	.69	.75

ORDERING INSTRUCTIONS:
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE 59¢

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GENDER-FF	FEMALE-FEMALE	7.95
GENDER-MM	MALE-MALE	7.95
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GENDER-NM	NULL MODEM	8.95
GENDER-JB	JUMPER BOX	8.95
GENDER-MT	MINITESTER	14.95
GENDER-VGA	DB9-DB15	19.95
GENDER-9-25	DB9-DB25	4.95

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IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	–	4.95	4.95	–	5.95	–	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	–	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

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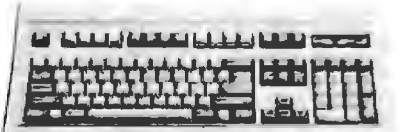

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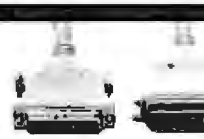

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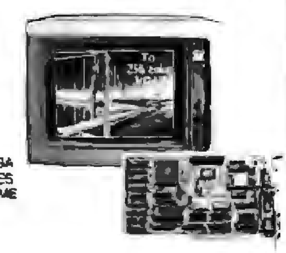

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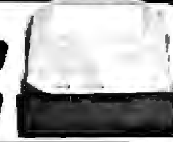

SIZE	MODEL	AVG. SPEED	HT	DRIVE ALONE	With MCT Controller HDC	RLL	AFH	AFH-RLL
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60MB RLL	ST-277	40 ms	Half	$449	-	$499	-	$589
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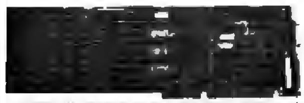

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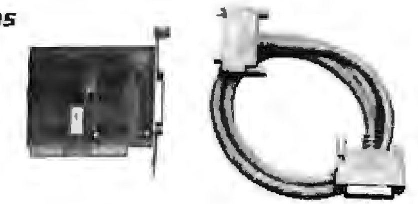

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COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

In the front of the April BYTE will be Microbytes, What's New, and Short Takes. We've scheduled hands-on looks at SideKick for Presentation Manager, PhotoMac, Sharp's Wizard, Discus Rewritable, DOSTALK, System Sleuth, and Disk Technician Advanced.

April's **Product Focus** will be on uninterruptible power supplies. Since we ran a two-part series on UPSes last year, we've been deluged with inquiries and requests for more information. Responding to reader demand, the BYTE Lab has taken a look at a dozen units designed to spare your equipment from the vicissitudes of the power grid.

System reviews include the CompuStar from Wells American, which offers a dual-bus option and your choice of CPUs. Additionally, we'll look at the new Compaq Deskpro 386/20E.

Hardware reviews currently in the lineup include Sharp and Howtek color scanners for the Mac and three fax modems for the Mac.

Software reviews on tap include Theos 386, a multitasking operating system from Theos Software; and Extend, a simulation toolkit from Imagine That.

Application reviews include two families of products for the Mac—statistical packages and presentation software.

IN DEPTH:

Computer-aided software engineering is April's topic. Articles will include an overview by Michael Gibson, an attempt to define the parameters of the discipline by Capers Jones, and a discussion of the most widely used methodologies by their principal proponents and inventors: Chris Gane, Ed Yourdon, Peter Chen, Ken Orr, and Larry Constantine. Also, the case for and against CASE will be the subject of an article by Robert McIlree.

FEATURES:

This section will contain the Hands On articles, Brett Glass's Under the Hood and Rick Grehan's Some Assembly Required. Brett will be discussing **BIOSes**, while Rick will present a **binary-coded-decimal floating-point package**.

SPECIAL SUPPLEMENT:

The April issue will also contain **a special supplement on graphics**. It will contain articles on the following subjects: the RenderMan standard; ray tracing; scientific visualization, editing techniques, and graphics interface standards; and a comparison of the Mac II, the Amiga, and the IBM PS/2 as graphics-capable personal computers.

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1) If you are a new Reader or have lost your I.D. Card, circle #1 on the Reader Service Card. We will immediately send your personal TIPS Reader I.D. Card.

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2) Write your Reader Number, as printed on your Reader I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: (413) 637-3170 and wait for voice commands.

ENTER YOUR I.D. AND ISSUE NUMBERS

5) When TIPS says "Enter Reader Number"
(Enter by pushing the numbers and # - symbols enclosed in the boxes on telephone pad ignoring blank boxes)
Enter ☐☐☐☐☐☐☐☐☐☐ [#] [#]

6) When TIPS says "Enter magazine code & issue code"
Enter [1] [#] [3] [9] [#] [#]

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. ☐☐☐☐☐ [#] [#] 6. ☐☐☐☐☐ [#] [#] 10. ☐☐☐☐☐ [#] [#] 14. ☐☐☐☐☐ [#] [#]
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5. ☐☐☐☐☐ [#] [#]

END SESSION

8) End session by entering [#] [#]

9) Hang up after hearing final message
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Title ______________ Phone (____) ________

Company ______________________

Address ______________________

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A. What is your level of management responsibility?
1 ☐ Senior-level Management
2 ☐ Other Management
3 ☐ Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)
1 ☐ Administration
2 ☐ Accounting/Finance
3 ☐ MIS/DP/Information Center
4 ☐ Product Design and Development
5 ☐ Research and Development
6 ☐ Manufacturing
7 ☐ Sales/Marketing
8 ☐ Purchasing
9 ☐ Personnel
10 ☐ Education/Training
11 ☐ Other: __________

C. Please indicate your organization's primary business activity: (Check one.)

Computer-Related Businesses:
1 ☐ Manufacturer (Hardware, Software)
2 ☐ Computer Retail Stores
3 ☐ Consultants
4 ☐ Service Bureau/Planning
5 ☐ Distributor/Wholesaler
6 ☐ Systems House/ Integrator/VAR
7 ☐ Other: __________

Non-Computer-Related Businesses:
8 ☐ Manufacturing
9 ☐ Finance, Insurance, Real Estate
10 ☐ Retail/Wholesale
11 ☐ Education
12 ☐ Government
13 ☐ Military
14 ☐ Professions (Law, Medicine, Engineering, Architecture)
15 ☐ Consulting
16 ☐ Other Business Services
17 ☐ Transportation, Communications, Utilities
18 ☐ Other: __________

MARCH
IRSD002

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Title (____) Phone

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Address

City State Zip

A. What is your level of management responsibility?
1 ☐ Senior-level Management
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3 ☐ Non-Management

B. What is your primary job function/principal area of responsibility? (Check one.)
1 ☐ Administration
2 ☐ Accounting/Finance
3 ☐ MIS/DP/Information Center
4 ☐ Product Design and Development
5 ☐ Research and Development
6 ☐ Manufacturing
7 ☐ Sales/Marketing
8 ☐ Purchasing
9 ☐ Personnel
10 ☐ Education/Training
11 ☐ Other: ______

C. Please indicate your organization's primary business activity: (Check one.)

Computer-Related Businesses:
1 ☐ Manufacturer (Hardware, Software)
2 ☐ Computer Retail Stores
3 ☐ Consultants
4 ☐ Service Bureau/Planning
5 ☐ Distributor/Wholesaler
6 ☐ Systems House/Integrator/VAR
7 ☐ Other: ______

Non-Computer-Related Businesses:
8 ☐ Manufacturing
9 ☐ Finance, Insurance, Real Estate
10 ☐ Retail/Wholesale
11 ☐ Education
12 ☐ Government
13 ☐ Military
14 ☐ Professions (Law, Medicine, Engineering, Architecture)
15 ☐ Consulting
16 ☐ Other Business Services
17 ☐ Transportation, Communications, Utilities
18 ☐ Other

MARCH
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M15	M16	M17	M18	M19	M20	M21
M22	M23	M24	M25	M26	M27	M28
M29	M30	M31	M32	M33	M34	M35
M36	M37	M38	M39	M40	M41	M42
M43	M44	M45	M46	M47	M48	M49
M50	M51	M52	M53	M54	M55	M56
M57	M58	M59	M60	M61	M62	M63
M64	M65	M66	M67	M68	M69	M70
M71	M72	M73	M74	M75	M76	M77

M78	M79	M80	M81	M82	M83	M84
M85	M86	M87	M88	M89	M90	M91
M92	M93	M94	M95	M96	M97	M98
M99	M100	M101	M102	M103	M104	M105
M106	M107	M108	M109	M110	M111	M112
M113	M114	M115	M116	M117	M118	M119
M120	M121	M122	M123	M124	M125	M126
M127	M128	M129	M130	M131	M132	M133
M134	M135	M136	M137	M138	M139	M140
M141	M142	M143	M144	M145	M146	M147
M148	M149	M150	M151	M152	M153	M154

M155	M156	M157	M158	M159	M160	M161
M162	M163	M164	M165	M166	M167	M168
M169	M170	M171	M172	M173	M174	M175
M176	M177	M178	M179	M180	M181	M182
M183	M184	M185	M186	M187	M188	M189
M190	M191	M192	M193	M194	M195	M196
M197	M198	M199	M200	M201	M202	M203
M204	M205	M206	M207	M208	M209	M210
M211	M212	M213	M214	M215	M216	M217
M218	M219	M220	M221	M222	M223	M224
M225	M226	M227	M228	M229	M230	M231

M232	M233	M234	M235	M236	M237	M238
M239	M240	M241	M242	M243	M244	M245
M246	M247	M248	M249	M250	M251	M252
M253	M254	M255	M256	M257	M258	M259
M260	M261	M262	M263	M264	M265	M266
M267	M268	M269	M270	M271	M272	M273
M274	M275	M276	M277	M278	M279	M280
M281	M282	M283	M284	M285	M286	M287
M288	M289	M290	M291	M292	M293	M294
M295	M296	M297	M298	M299		

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A. Do you have management responsibilities within your company?
1 ☐ Senior-level management
2 ☐ Other management
3 ☐ Non-management

B. Reason for request: (Check all that apply.)
1 ☐ Business use for yourself
2 ☐ Business use for your company
3 ☐ Personal use

C. For how many Macintosh personal computers do you *currently* buy, specify or approve brands of products?
1 ☐ 10 or less
2 ☐ 11–25
3 ☐ 26–99
4 ☐ 100 or more

D. For how many Macintosh personal computers will you buy, specify or approve brands of products *within the next two years?*
1 ☐ 10 or less
2 ☐ 11–25
3 ☐ 26–99
4 ☐ 100 or more

E. *In total*, how many Macintosh personal computers is your *entire* organization considering for purchase within the next two years?
1 ☐ 10 or less
2 ☐ 11–25
3 ☐ 26–99
4 ☐ 100-499
5 ☐ 500 or more

F. What type of personal computer do you primarily use?
1 ☐ IBM AT or 80286-based compatible
2 ☐ Compaq 386 or 80386-based compatible
3 ☐ IBM PS/2 (with Micro-Channel) or compatible
4 ☐ Apple Mac (except Mac II)
5 ☐ Apple Mac II
6 ☐ Other

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