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BYTE

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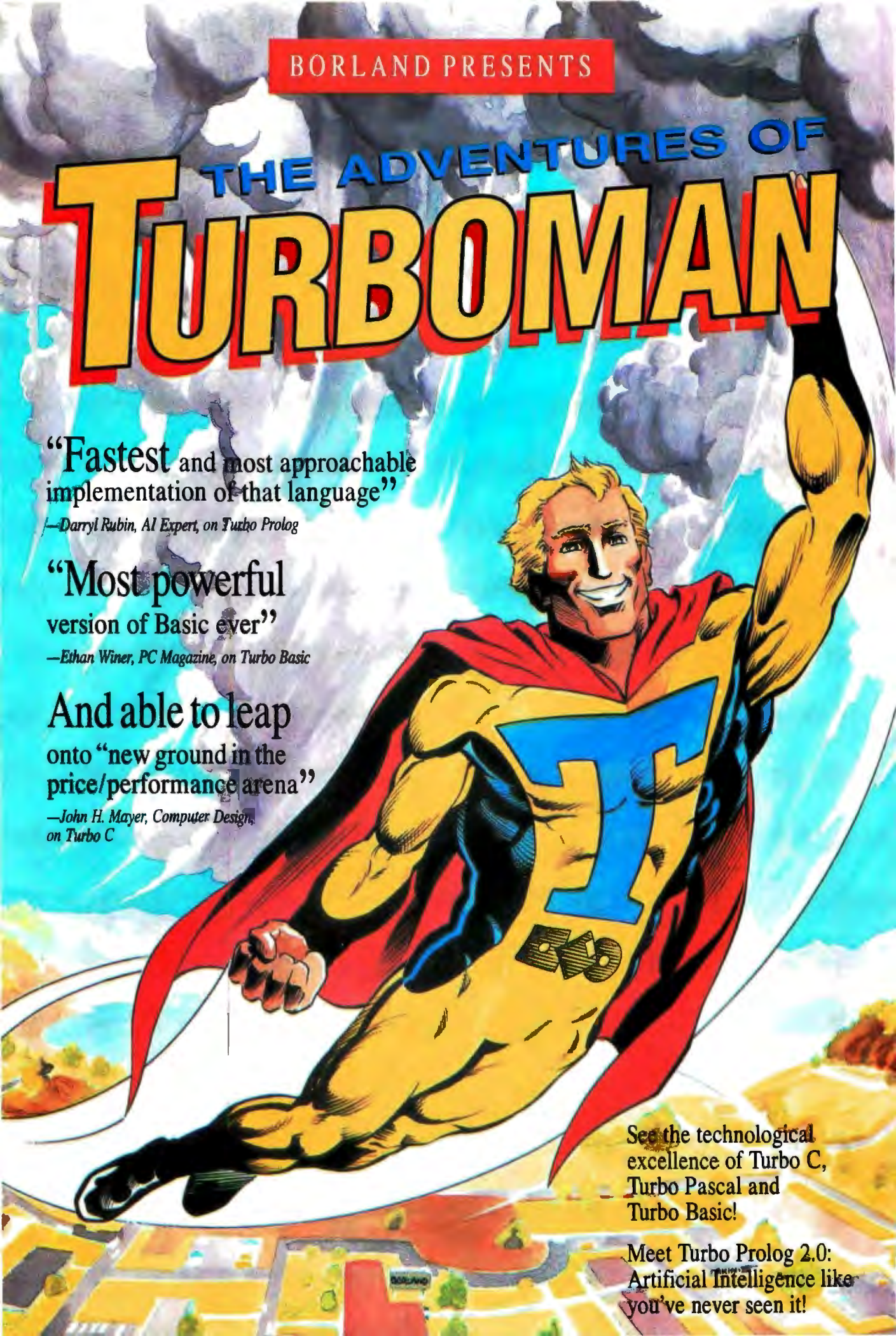
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—Darryl Rubin, AI Expert, on Turbo Prolog
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—Ethan Winer, PC Magazine, on Turbo Basic
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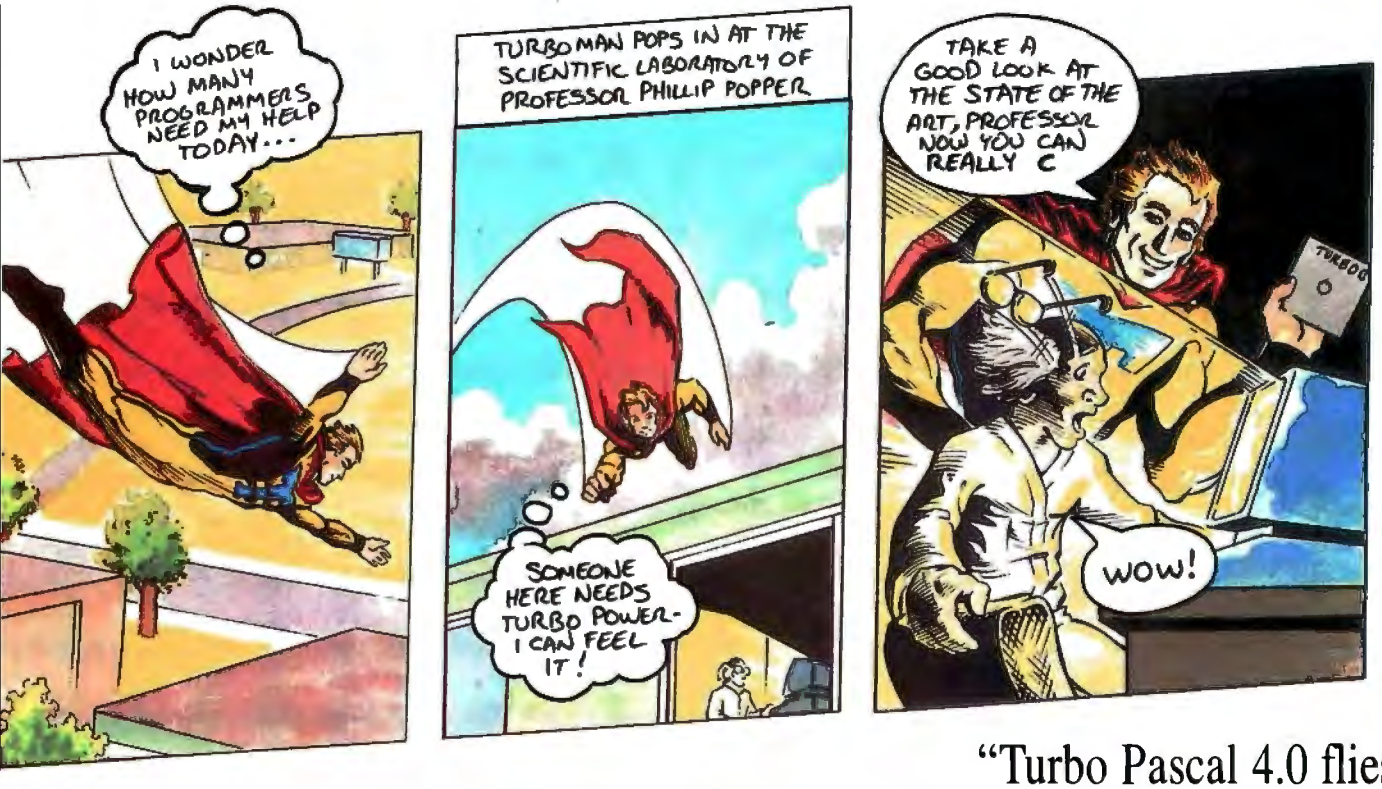

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Heap Sort

	Turbo C 1.5	Microsoft C 5.0
Compile time	4.7 sec.	16.3 sec.
Compile & link time	7.4 sec.	19.5 sec.
Execute time	10.5 sec.	15.5 sec.
Object code size	1119	1313
Execution size	6392	7891

Sort benchmark run on an 8 MHz IBM AT using Turbo C version 1.5 and the Turbo Linker version 1.1; Microsoft C version 5.0 and the MS overlay linker version 3.61.

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1987 Programmer's Journal

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	Turbo Basic 1.1	QuickBASIC 4.0 Compiler	QuickBASIC 4.0 Interpreter
Compile & Link to stand-alone EXE	3 sec.	7 sec.	—
Size of .EXE	28387	25980	—
Execution time w/80287	0.16 sec.	16.5 sec.	21.5 sec.
Execution time w/o 80287	0.16 sec.	286.3 sec.	292.3 sec.

The Elkins Optimization Benchmark program from March 1988 issue of Computer Language was used. The Program was run on an IBM PS/2 Model 60 with 80287. The benchmark tests compiler's ability to optimize loop-invariant code, unused code, expression and conditional evaluation.

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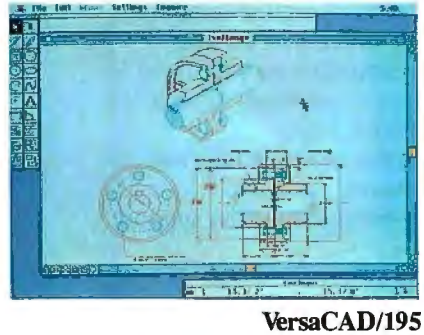

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Circle 249 on Reader Service Card

TOUCHING ALL THE BASES

Hybrid speed demons, a new 80386 chip, four new monthly columns, and an In Depth section on the C language

Just 90 days ago, a handful of relatively new 20-MHz 80386-based machines sat comfortably at the top of the heap: the fastest desktop computers. Today, they have been relegated to second-tier status by a veritable explosion of 25-MHz computers.

Their reign, in turn, also may be brief: We know of at least one manufacturer who is preparing 30-MHz motherboards using "goosed" 25-MHz chips. (If it turns into a working product, you'll read about it in a future BYTE.)

But, at least for now, 25 MHz is as fast as it gets for real, desktop machines using more-or-less conventional architectures. The enhancements usually include fast RAM accessed by a proprietary 32-bit-wide memory bus and built-in disk caching. The rest of such a machine tends to be built from stock IBM PC AT-class parts. Our cover story gives you an early look at preproduction models of four examples of this new wave of hybrid speed demons.

Speaking of hybrids, the cover story also discusses the Compaq 386S, a very-small-footprint machine that uses a new kind of 16-MHz 80386 chip: It's 32 bits wide internally, but it communicates with the outside world through an IBM PC AT-style 16-bit bus. (No, at this time, you can't use the chip as a plug-and-play replacement for an 80286. To date, the only such replacement we know of is the Cheetah Adapter/386, which we covered in April 1987.)

This new chip, which is called the 80386SX, may produce a whole new kind of IBM PC AT-class machine based on the 80386. (The 80286 could be pushed downward into entry-level machines.) In theory, this would simplify things, because everyone above the entry level could standardize on 80386-specific software and thus circumvent some of the current hoop jumping required to cope with the limitations of the 80286. (An entry-level user isn't likely to bump up against the 80286's shortcomings.) It's a development that bears close watching.

While enhancements abound on the IBM PC side, the machines based on the 68000 family haven't exactly been dead in the water, either—witness the steady stream of new products for the Macintosh.

In fact, there's so much interesting Macintosh material, that we've placed a special Macintosh supplement between this month's Products in Perspective and In Depth sections. Be sure to take a look.

With all this activity, it's getting more difficult to stay abreast of all the important developments in microcomputing—harder to touch all the bases. That's why we've added four new monthly columns starting with this issue. They'll help ensure that you get the information you need—when you need it—in these critical areas:

OS/2: You've read about the theory, you've seen some sample code, and you may have seen an actual OS/2 application in action. But chances are, you don't own a copy of OS/2 yet. Noted OS/2 consultant Mark Minasi's "OS/2 and You" column offers some welcome perspective on making the move to OS/2 by combining technical insights, practical tips, and plain old common sense.

Communications: Brock Meeks, an award-winning author, writes about his passion: telecommunications. Each month, Brock's "COM1:" column will offer a mix of "hard" and "soft" telecommunications topics, examining the technology and issues relating to point-to-point and area computer communications.

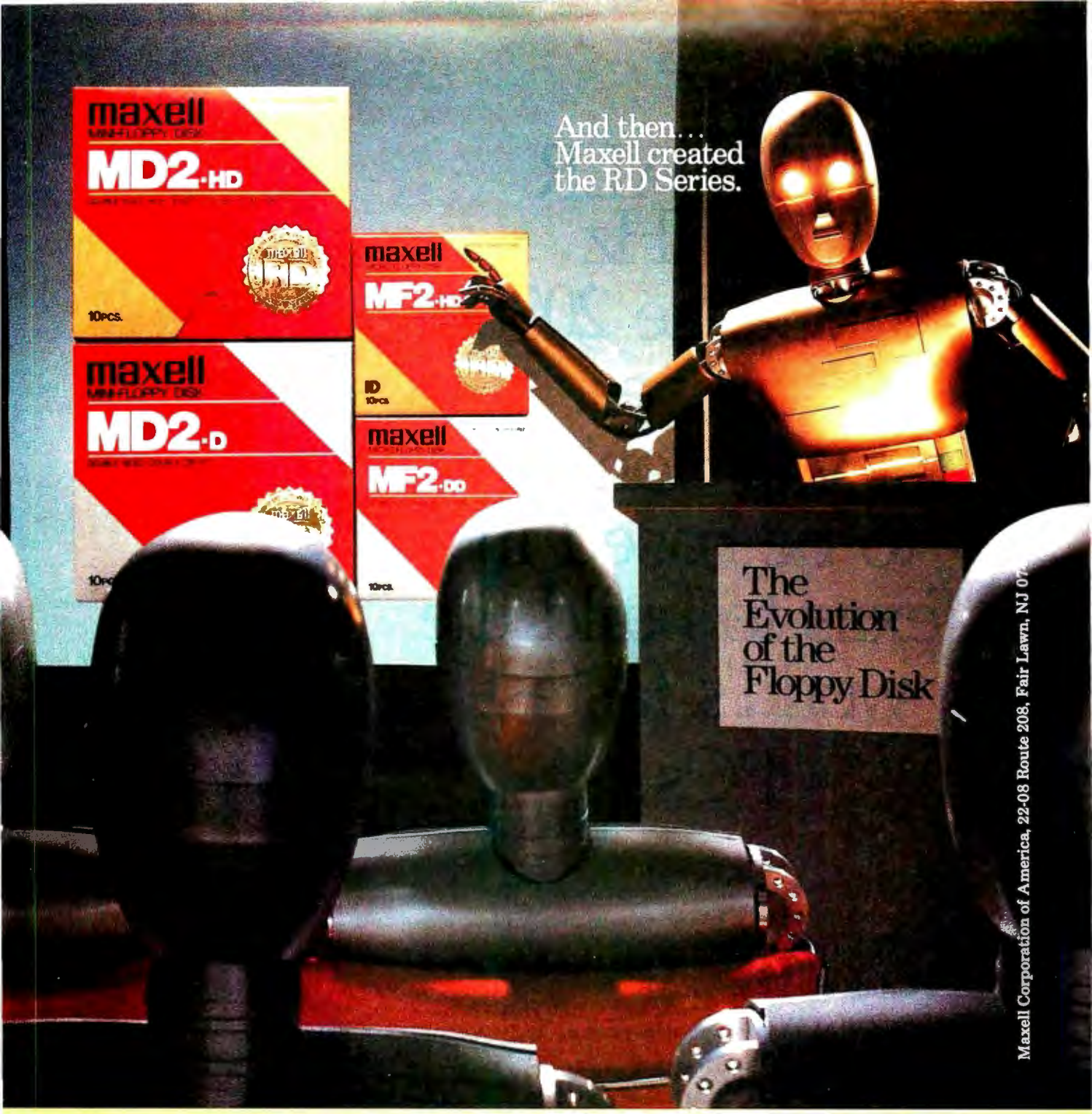
Business: Wayne Rash's name is familiar to longtime BYTE readers: He's a regular and popular contributor. When he isn't writing for BYTE, Wayne makes his living as a computer consultant to government and business. His specialty is solving the distinctive problems encountered by those who deal with large installations of microcomputers—networking, security, operational issues. . .the list of possible bottlenecks is almost infinite. Proven solutions to those myriad problems are the focus of his "Down to Business" column.

Macintosh: Don Crabb is another familiar name. Don has been a regular reviewer of Mac products for us. He's a participant in Apple's educational consortium and a frequent beta tester of new Mac products. The "Macinations" column is Don's forum to share his experiences with us.

This month's In Depth section also deserves special attention: It focuses on the top language for serious software development today. Virtually every major software package available today was coded in C: The C language is quite literally the foundation of today's software industry.

For our In Depth, we went to the folks who literally wrote the book: We have excellent articles by Kernighan and Ritchie, Bjarne Stroustrup, and others. (Dennis Ritchie is the designer of the C language; he and Brian Kernighan are the authors of the standard "K&R" reference on C. Bjarne Stroustrup is the creator of the general-purpose, object-oriented superset of C called C++.) This In Depth also features an unusually rich two-page Resource Guide. It's definitely a keeper.

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



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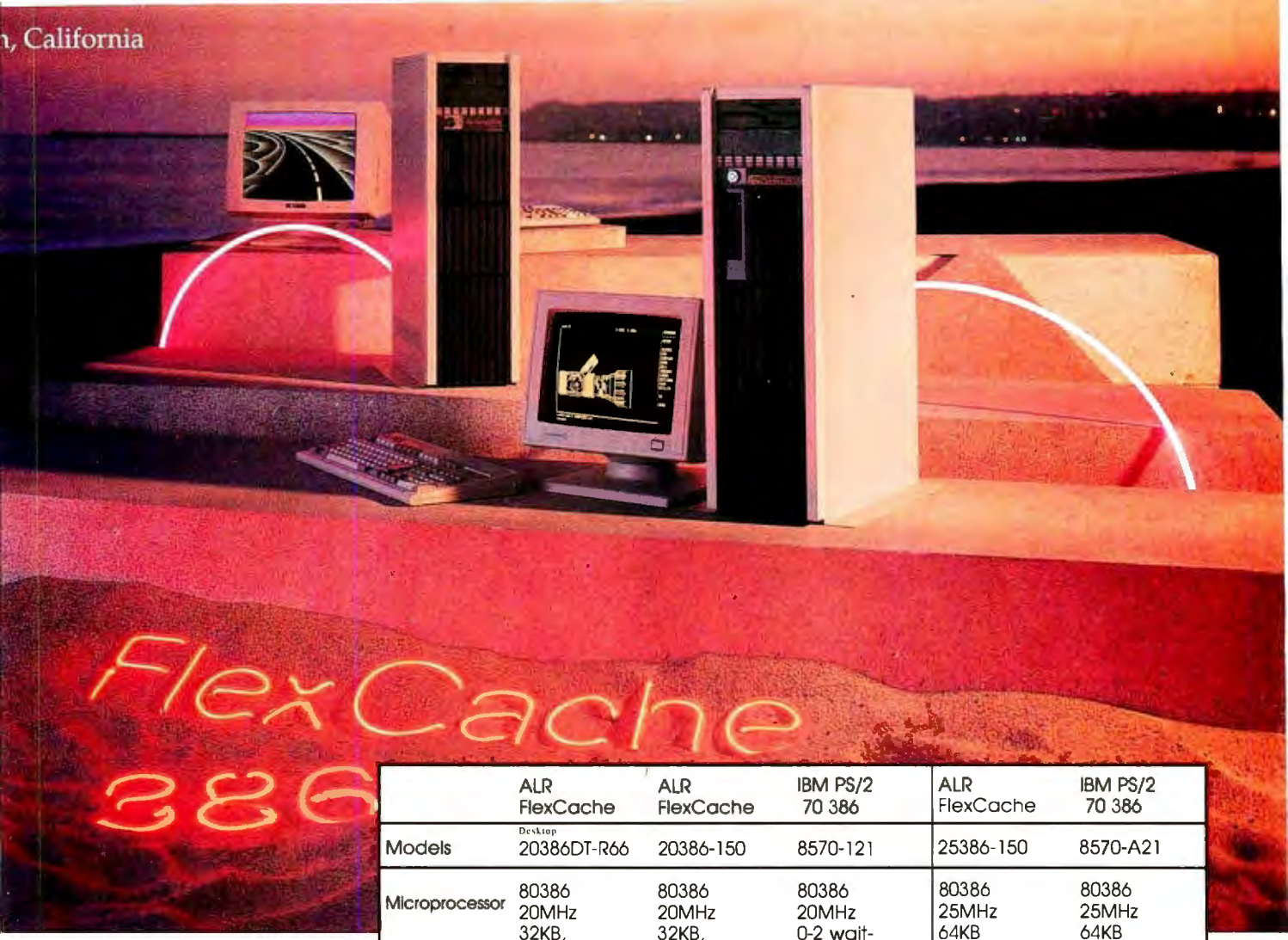

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MICROBYTES

Staff-written highlights of developments in technology and the microcomputer industry

Experimental Adder Circuit Could Speed Up Clock Cycles

Probably the most fundamental operation in computing is the use of logic gates to add two register values. The speed of register-to-register addition plays a large role in determining a computer's clock cycle speed. A typical 16-MHz machine would have an add time of 62 nanoseconds (this figure does not include register-to-register times, which would increase the number somewhat); high-performance machines like the VAX typically have an add time of 45 ns.

Researchers at Stanford University have developed a new adder circuit that they hope will speed up addition times to about 1 ns for full 32-bit addition. The "subnanosecond arithmetic project," directed by professor Michael Flynn, is sponsored by the Center for Integrated Systems, a very large scale integration (VLSI) research center funded by several major electronics companies.

The adder circuit is based on a new addition algorithm that combines the best features of three commonly used addition algorithms: Ling's algorithm, the carry look-ahead algorithm, and the conditional sum algorithm. The adder circuit requires only three gate delays (the time span between the input and the output of the final sum), while current adder circuits generally require about eight gate delays.

"Ultimately," Flynn said, "we're trying to create a technology to achieve 1-ns cycle times." He sees the adder circuit as the first step in that direction. However, the speed of the new circuit won't have much impact until other major processing bottlenecks, such as memory and cache access speeds, are also accelerated. The entire design of microprocessors will have to change in order to realize 1-ns processing speeds, Flynn said.

The first prototype is currently being fabricated using emitter coupled logic (ECL) gates. Flynn said he hopes the first chip will yield an addition speed of about 1.5 ns. The research group is also working on a CMOS version. The next phase of the project will include the development of a bipolar ECL floating-point multiplier circuit.

The "subnanosecond" project is futuristic, but Flynn sees more immediate potential for application of the adder and multiplier circuits in floating-point coprocessors.

ParcPlace Hopes Smalltalk Makes It Big

Although BYTE devoted almost an entire issue to Smalltalk in August 1981, the object-oriented programming environment has remained relegated to academic and research institutions. In that issue 7 years ago, Dr. Adele Goldberg wrote that the "Smalltalk system is taking flight into the mainstream of the computer programming community." As president of ParcPlace Systems (Palo Alto, CA), a new company dedicated to promoting and enhancing Smalltalk, Goldberg hopes to make good on that claim, although somewhat belatedly.

ParcPlace is working on new features for the environment, including expanded libraries of "reusable parts" and "reusable frameworks" (a series of interacting reusable parts). These libraries will enable designers of user interfaces to select graphical objects or a sequence of activities involving objects for use in their designs, similar to how a conventional programmer might call an existing function from a library for use in a program. "We're trying to provide tools for development of new interfaces, but we're dedicated to the standards of the vendors," Goldberg said. Objects consistent with AT&T's new Open Look version of Unix, for example, would be included in the Smalltalk reusable-parts libraries. "Our objective is to provide a malleable information environment where you can specify the user interface you want and find parts in libraries. Not everyone is a graphic artist or human factors expert," Goldberg said.

Other projects that ParcPlace is working on include graphical interfaces for Structured Query Language (SQL) database systems, and interfaces to object-oriented databases with extensible data types and "active objects" stored in the database. An active object can actually interact with the

continued

Nanobytes

• The current **shortage of 1-megabit single in-line memory modules** (SIMMs)—chips that are widely used in Apple Computer's Macintosh and LaserWriter—is likely to continue for another year, an Apple executive says. Apple chief operating officer **Del Yocam** said it will take until the "middle of next year" for supply of the chips to reach acceptable levels for manufacturers. This could mean, sources said, that Apple will have to delay introduction of new machines, such as an enhanced Mac SE. Yocam said the scarcity of 1-megabit chips is due to Japanese failure to foresee the growth in demand for 1-megabit chips and the Reagan administration's trade embargoes. The memory chips Apple already has under contract will have to be used in units already in production. You can go into certain computer shops and buy the SIMMs, but you'll pay a pretty price for them.

• Only 2 percent of the computer software sold in the Arab Middle East is legitimate, according to Oliver Smoot, executive vice president of the Computer and Business Equipment Manufacturers Association. Smoot said the **98 percent piracy rate** is largely among users working for governments and state-owned companies.

• Many users didn't like

continued

NANOBYTES

it, but one software industry executive thinks it's time to bring back **copy protection** for certain types of programs. "I think copy protection for business software went away prematurely," said Ken Wasch, executive director of the Software Publishers Association. Wasch told a group of Amiga developers in Washington, DC that software companies gave in to user demands too easily. "All we have to protect ourselves is moral persuasion," he said. Wasch added that the SPA uses litigation as a second line of defense.

• In the future, **laser printer engines** with very high resolution may not be required, says president Luis Villalobos of Conographic (Irvine, CA), which makes PostScript-compatible printer controller cards that go in IBM PCs and compatibles. Villalobos said he has seen 300- to 600-dot-per-inch monochrome and color print engines, beyond the prototyping stage, that can vary dot size and/or intensity to produce apparent resolutions of 1000 to 3000 dpi. Color images produced on these systems can rival conventional optical-based printing techniques, Villalobos said.

• Meanwhile, CSS Labs (Irvine, CA) is coming out with a **laser printer controller card** that has its own INMOS **Transputer** and could, the company says, crank out 45 pages per minute. The GRIP board for IBM PCs and compatibles will work with several laser engines, the company said. When not working on printing tasks, the

continued

user when selected. For example, active objects could be used to monitor the database system to keep track of who's using it and for what purposes, or for more mundane tasks such as automatically sending electronic mail to other users of the database network. ParcPlace is also working on development tools for C++ (an object-oriented language based on C), which Goldberg said "complements Smalltalk-80 and gives C programmers the chance to look at extensible data types."

In the last year, ParcPlace has made available a version of Smalltalk-80 for the Macintosh, and the company expects to have an MS-DOS version in beta testing this summer. Priced between $695 and $1295, the Smalltalk versions for the Macintosh and MS-DOS are fully compatible with the versions of Smalltalk running on Sun, Apollo, and Hewlett-Packard workstations.

In any case, Goldberg has high hopes for Smalltalk. She points to software developers, such as Borland's Philippe Kahn, talking about incorporating "Smalltalk-like features" in their products. And she sees the move in the microcomputer world toward graphical interfaces and the need for portability across operating systems as golden opportunities for Smalltalk.

Synchronous SCSI Seen as Coming Standard for Peripherals

As CPU performance keeps increasing, the I/O speed of disks and other peripherals is becoming the major bottleneck in system performance. The best solution to the I/O bottleneck is the synchronous small computer system interface (SCSI), according to some product designers. Adaptec (Milpitas, CA), a major manufacturer of disk controllers, sees increasing use of embedded SCSI connections in hard disk and tape drives, as well as in other peripherals such as printers, said product manager Danial Faizullabhoy. "In a year or so," he said, "SCSI will be the de facto peripheral interface."

Synchronous SCSI is attractive because it is about 40 percent faster than asynchronous SCSI and also outperforms "native bus interfaces" such as the IBM PC AT bus and IBM's Micro Channel, proponents say. While the standard AT bus has a maximum data transfer rate of 1 megabyte per second and the Micro Channel transfers at about 3 megabytes per second, synchronous SCSI clocks in at about 5 megabytes per second. Although Faizullabhoy does not see SCSI replacing native bus interfaces, he said that Adaptec expects most major computer manufacturers, including IBM, to have built-in synchronous SCSI ports in the next product cycle, if they don't have them already.

Adaptec will soon be announcing new controller products using synchronous SCSI. According to Faizullabhoy, the next phase in the development of SCSI will be moving up to 16-bit bandwidths. In the 1990s, he said, we'll see 32-bit-bandwidth SCSI interfaces. Meanwhile, ESDI will drop off, leaving primarily SCSI and native bus interfaces dominating the market, he said.

AMD's Database Manager Chip Replaces Software Routines

A new microprocessor peripheral that could speed up database management tasks by replacing software with hardware has been developed by Advanced Micro Devices (Sunnyvale, CA). The Am95C85 Content Addressable Data Manager (CADM) coprocessor is designed to take over from the CPU such data-manipulation tasks as sorting, searching, inserting, and deleting records. It could be used in networking and communications, file serving, high-speed graphics systems, and other areas that require fast data manipulation.

The Am95C85 uses 1.6-micron CMOS technology and contains 1K byte of RAM and a control unit. The control unit enables a single command to access the CADM's memory without having to provide physical addresses. According to the company, the chip can provide content-addressable searches for 8-byte fields in less than 10 microseconds. The chip's architecture enables cascading up to 16 of the devices for large database systems.

AMD has been working on the processor for 4 years, said Dave Horton, a development manager for the chip.

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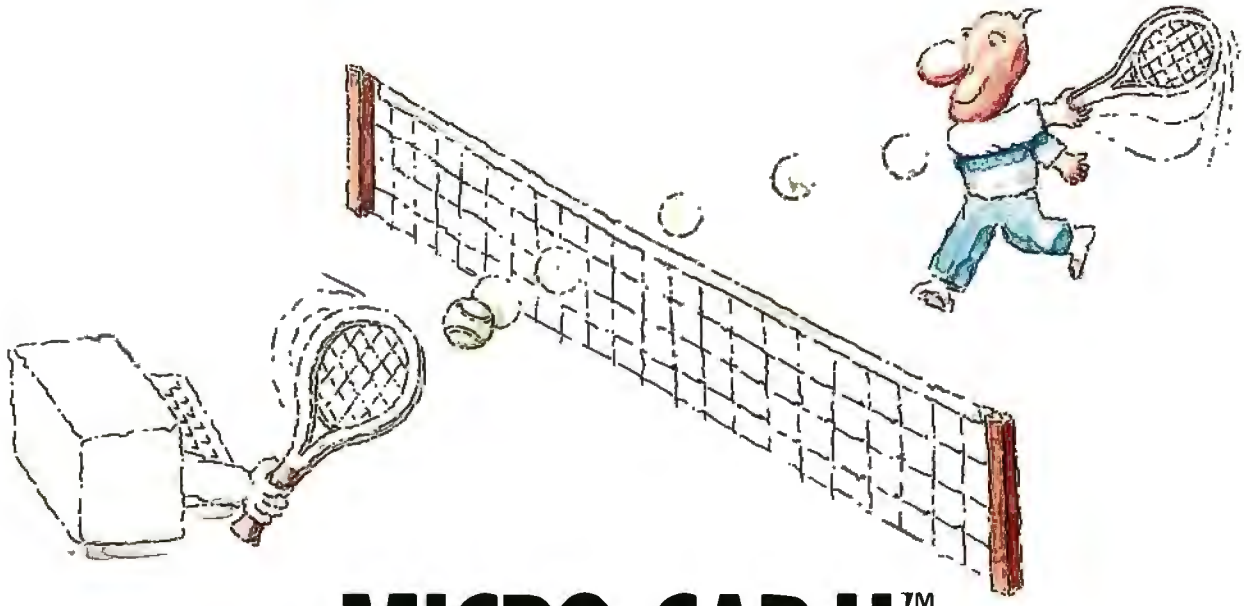

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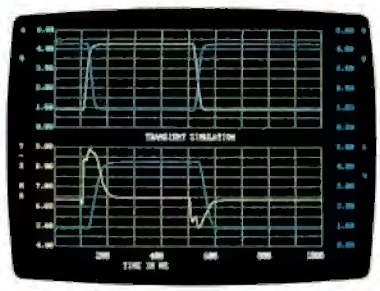

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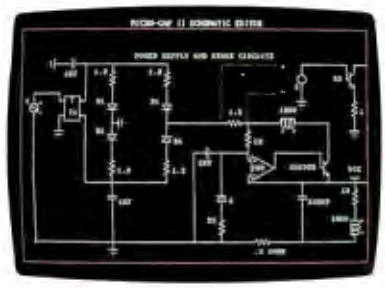

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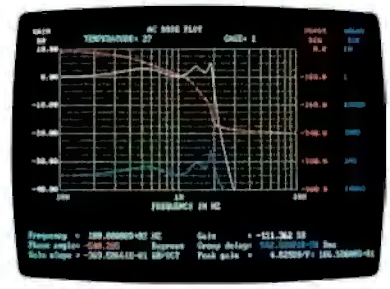

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NANOBYTES

on printing tasks, the board could be used as a high-speed coprocessor.

• In a move seen as a crucial step in U.S. efforts to overtake Japan's leadership in the semiconductor industry, the Department of Defense will boost its **funding of Sematech** (Austin, TX), the chip-research consortium, by $100 million a year through 1992. Sematech chairman Sandy Kane responded to criticism that the Pentagon will pull the group's research into defense-oriented projects. "Our work is not going to be defense-related," he said. According to Kane, the Pentagon recognizes that "a healthy U.S. semiconductor industry will ultimately be good for the national defense."

• "If you ask me what the **future of the microcomputer** is, it is in multitasking and parallel processing," says Henri Rubin, chief operating officer of Commodore International (West Chester, PA). In an interview with BYTE, Rubin said that Commodore's use of coprocessor communications is an indication of where the company is going technologically. The Amiga maker has been a leader in supporting both Motorola and Intel processors within the same computer, he said. "Some people say we just have two computers in a box," he said, "but that's not true. It's more than that."

• Our trend signaler isn't blinking brightly yet, but we could be seeing a **drop in prices of gallium-arsenide chips**. GigaBit Logic (Newbury Park, CA) has cut prices of its high-speed GaAs

continued

"We saw the need to offload some tasks from the system CPU," he said. "One of the problems we faced, though, was like the chicken and the egg: The hardware people didn't want to build boards when there was no software to access the chip, and the software folks didn't want to port their code when there was no hardware to use it."

The chip uses a new memory cell that's "sort of a cross between RAM and FIFO," Horton said. "The cells enable us to split memory at a certain point, holding all memory above the split constant while letting us shift the remaining memory up or down, adding or deleting records." Horton theorized that the first PC application board probably would have one or two chips on-board, with sockets for a total of up to 16.

Currently, AMD has a demonstration board and software available. The first commercial product that will use the chips will be a network bridge, from a European company, that will detect packet-address information in real time and direct it along the correct path in the network. In such an application, there is no time for the conventional lookup table approach.

CADM prices are $49.20 for the 12-MHz version and $66.50 for the 16-MHz version in quantities of 100. The chips are available now.

The Electric Cadaver

Two doctors at Stanford Medical Center have developed an electronic textbook for anatomy students that clearly demonstrates the potential power of hypertext and multimedia concepts in electronic publishing. The Electric Cadaver was developed by Dr. Robert Chase, a specialist in anatomy, and Dr. Steven Freedman, a physician with a long-standing interest in electronic publications for medical practice and training.

Built on a Macintosh II with Apple's HyperCard, the Electric Cadaver is a dynamic cross-referencing system that describes the structure and function of each part of the human anatomy. (Freedman built the first version 4 years ago on an IBM PC AT using Ashton-Tate's Framework). Images are displayed in digitized form on the computer screen and simultaneously in analog form on a videodisk player. The user can click on any part of the human body and then select from an index of topics on the screen.

Most parts of the anatomy are presented both in x-ray and bone structure form; many parts are shown from different angles and magnifications. In addition, results of physical injuries can be visually described. For example, clicking on the facial nervous system displays a normal human face on the screen. By then clicking on indicated "injury zones" on the map of facial nerves, you can see the resulting types of paralysis in the face on the screen.

The HyperCard application includes an indexing system that can select any image on the videodisk player via serial communication. The Electric Cadaver has a "Frame Editor" that lets users customize the electronic textbook by adding or editing frames, adding text, and creating animated sequences. The system demonstrated to Microbytes included video movies, developed by Chase, of various anatomical functions, as well as still-frame images.

The still-frame images are derived primarily from a database of 1600 anatomical images (which was developed with the help of the man who invented the View-Master). The images were converted in two-dimensional format to a videodisk by photographing each frame on a high-quality video camera, adding captions with a character generator, and converting the videotape to videodisk.

According to Chase and Freedman, the Electric Cadaver is a tremendous timesaver as a teaching and reference tool for medical students. "Traditionally," Freedman said, "students develop their own 'metabooks' by excerpting, compiling, and cross-referencing source material from multiple text books and other references. This is an incredible waste of time."

The electronic textbook eliminates the need for this kind of tedium and provides a much more visual and instructive presentation of the information to be learned, Freedman said. The system is also useful as a reference for physicians and surgeons; for example, a doctor could use the system to compare a CAT scan or x-ray of an unhealthy patient with a corresponding image of a normal anatomy in the Electric Cadaver.

Chase and Freedman hope to digitize the Cadaver's images in three dimensions, using a system like Digital Video Interactive, which would allow the graphics to be dynamic and adjustable so that students could change parameters (such as bone density). The doctors plan to add images from microscopic anatomy and are also exploring the use of bar code readers and other pointing mechanisms so that the system could be connected to a real cadaver.

continued

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percent. GBL cut its 16G040 2-gigabit-per-second Clock and Data Recovery chip from $180 to $75, and its 12G014 1K-byte static RAM chip (2.5-ns cycle time) from $92.80 to $45.

• **MIDI Expo West** is set for September 10–11 at the Anaheim (CA) Marriott Convention Center. Last year's New York version attracted 3500 musicians, composers, software writers, and equipment designers. This year, the program's educational track will cover such topics as MIDI basics, computer music, and sampling techniques. For more information, contact Tony

continued

YARC Claims 50-MHz Operation for Mac II Booster Board

YARC Systems (Westlake Village, CA) has developed a coprocessor board for the Mac II that the company says can cause applications to run about 10 times faster than on a standard Mac II. The McCray board is based on Advanced Micro Devices' 32-bit Am29000 processor and Am29027 floating-point processor. YARC claims that a Mac II equipped with one of the $4295 boards can outperform many expensive workstations.

The McCray takes advantage of the NuBus multiple-master capability that enables boards to access the bus directly, put addresses on the bus, and communicate with other boards to facilitate parallel processing, said YARC president Trevor Marshall. The standard Macintosh interface remains intact, he said.

Marshall noted that the McCray's 50-MHz operation is beginning to strain the current printed-circuit-board technology. "While the board is only about 12 inches long, propagation delays at 50 MHz along the signal paths had to be accounted for when we were adjusting timing," said Marshall. When asked about potential radio-frequency interference from the McCray, Marshall said that because the board has no link to the outside, such as a serial connector, radiation would not be a problem.

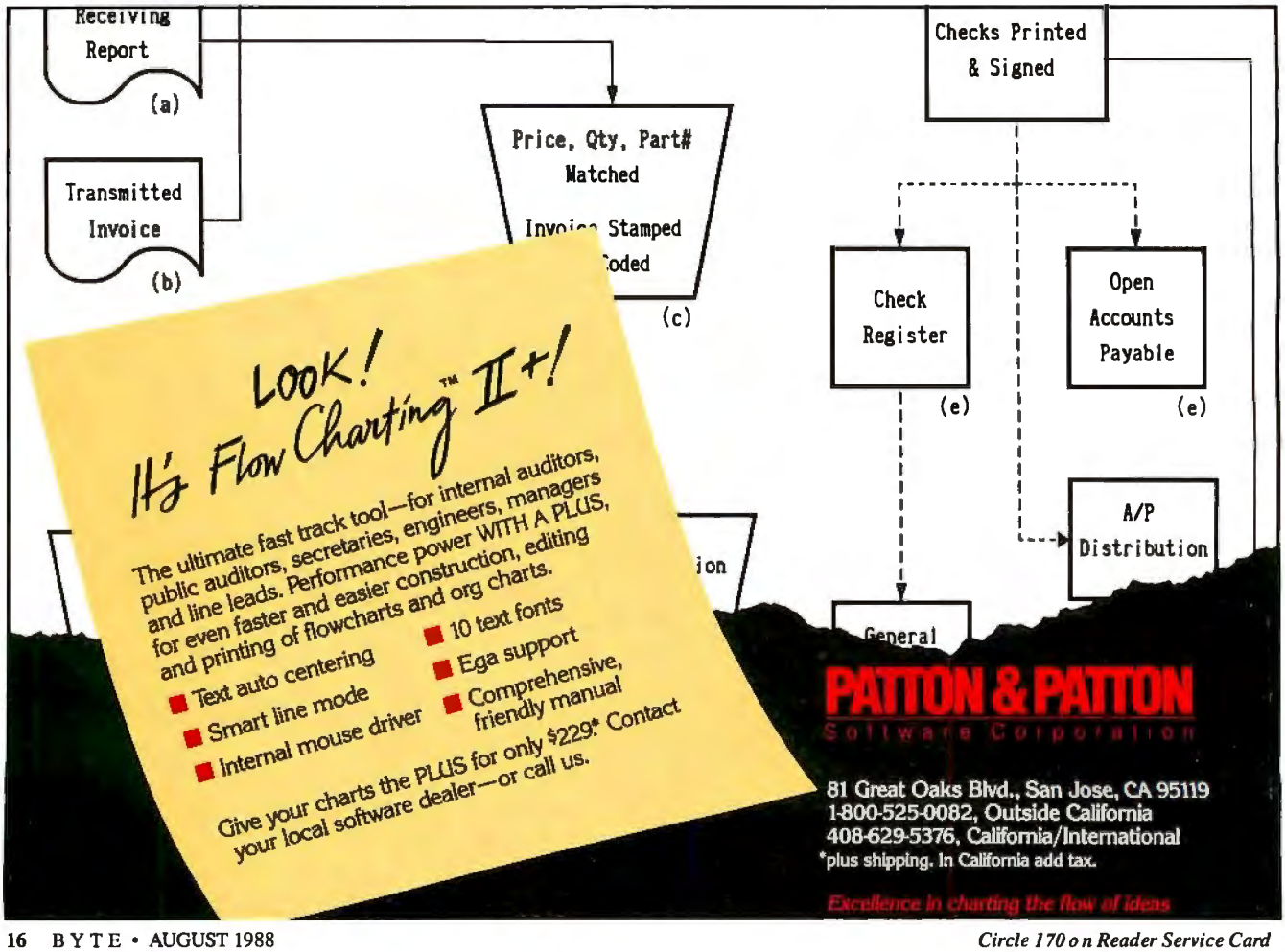
The McCray has 2 megabytes of instruction RAM in a "mostly zero-wait-state" configuration and 512K bytes of one-wait-state data memory; a daughterboard slated to be available soon will increase data memory to 2.5 megabytes.

The McCray requires a Mac II with 1 megabyte of memory, a hard disk drive, a color or monochrome display, the Apple 32-bit ROM upgrade (for early machines), and an average of 10 watts of power. The standard operating system is the Macintosh Finder. An assembler, linker, and debugger are also available.

You can load up all the available slots in the Mac II and expansion chassis with McCray boards and let the Mac's MultiFinder and 68020 assign parallel processing tasks.

YARC, which spells Cray backward, stands for Yet Another Ruddy Coprocessor, the firm says.

continued



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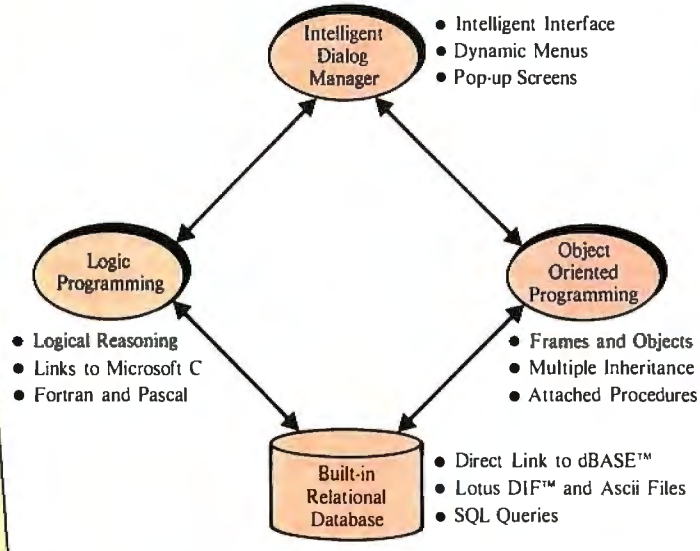

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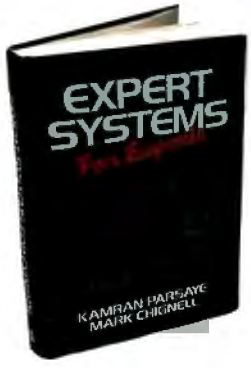

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mation, contact Tony Scalisi at Expocon, 3695 Post Rd., Southport, CT 06490, (203) 259-5734.

• Discovery Systems (Dublin, OH) has cut the price of mastering **CD-ROM disks** to $1500 and the cost of duplication to $2 per platter. The optical disk manufacturer says the CD-ROM business is gaining momentum, what with Apple's CD-ROM drive and Tandy's decision to sell such drives in its retail stores.

• *Understanding Neural Networks: A Primer* is now available from Graeme Publishing (Amherst, NH). The publisher says the $95 report is an "easy-to-read overview of scientific and commercial develop-

Mac II Operating System Will Interface with NuBus

Apple Computer (Cupertino, CA) is readying a new operating system for the Mac II. Multitasking Realtime DOS (MR DOS) is a message-based operating system that can interface with the NuBus used in the Mac II. Apple is trying to avoid unnecessary NuBus interface work on the part of card makers by giving them a standard set of communication services to applications.

Apple first used MR DOS internally on the MacAPPC card, which performs LU 6.2 gateways to IBM machines. Diagnostics such as code downloaders and dumpers are included, as are the schematics for the board's hardware (which has its own 68000 processor and local memory). The card has 24 square inches of prototyping surface.

"We've taken the hard part of making a NuBus master and encapsulated it, providing an area where developers can add their value," said an Apple representative. "The more mundane things are done, so you now have a standardized platform. The operating system was released to help this standardization. It also allows us to move various products across different types of [Apple] cards. Communications stacks for different protocols can be ported easily now. We are committed to having intelligent cards. That may not be the only way to go, but that's the way we are going in the communications and networking environment at Apple."

Since source code to the operating system will not be released, developers will have to depend on Apple to maintain the operating system for them as the Mac hardware platform changes.

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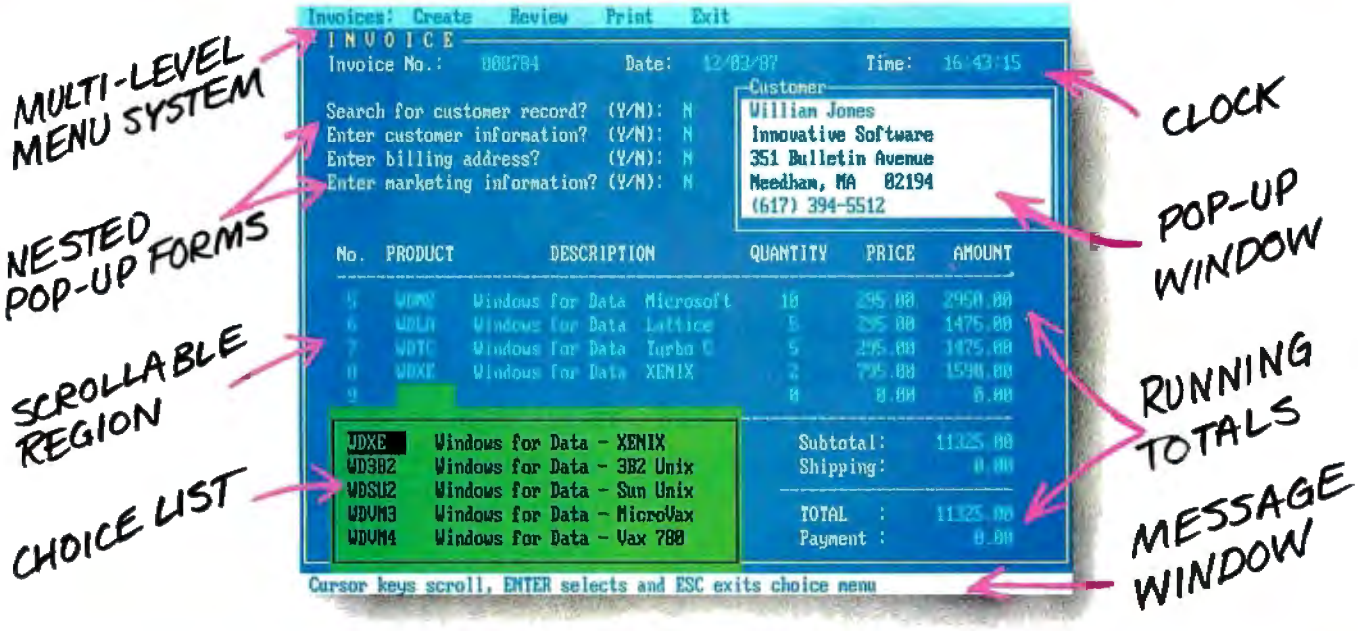

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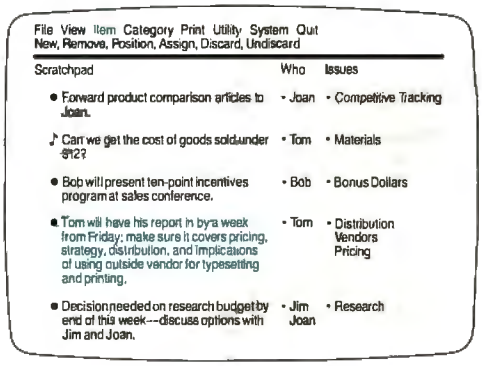

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Issues	Product Ideas	Who	Department
• Packaging	• Accept packaging bids until the end of October.	• Liz	• Operations
• Materials	♪ Make sure synthetic materials are reliable.	• Sue	• Operations
• Research	• Have Tom break down market research results into best case/worst case scenarios.	• Tom	• Marketing
• Distribution Vendors Pricing	• Tom will have his report in by a week from Friday; make sure it covers pricing, strategy, distribution, and implications of using outside vendor for typesetting and printing.	• Tom	• Marketing
• Distribution	♪ Do Tom and Bob think we need to adjust distribution mix?	• Tom Bob	• Marketing Sales

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File: C:\AGENDA\FILES\ISSUES 06/21/88 11:00
View: Issues by Person

Issues	Joan	Priority	When
• Research	• Decision needed on research budget by end of this week—discuss options with Jim and Joan.	• High	• 06/25/88
• Competitive Tracking	• Forward product comparison articles to Joan.	• Low	• 07/07/88
Issues	**Bob**	**Priority**	**When**
• Distribution	• Do Tom and Bob think we need to adjust distribution mix?	• High	• 06/22/88
• Bonus Dollars	• Bob will present ten-point incentives program at sales conference.	• Medium	• 06/29/88

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LETTERS

Efficient Recursion

In his article on benchmarks ("Problems and Pitfalls," June 1988, page 217), Alfred Aburto Jr. remarks on the significant performance difference between a simple loop to compute Fibonacci numbers and the recursive algorithm used in the benchmark. The inference he draws from this, that "Apparently, recursive function calls are highly inefficient," is a common misapprehension of such data. Instead, it is recursive *algorithms* that are often laughably inefficient and nonlinear. A loop for the 24th number requires only 24 iterations, whereas a recursive algorithm for the same number involves 92,735 procedure calls, typically extravagant for recursive statements of simple problems. (Why are Lisp programs slow?) It seems that his function calls are in fact quite efficient if something done nearly 3900 times as often takes only 4500 times as long.

Greg Bailey
Santa Barbara, CA

Bit-Map Assistance

I have found "Better Bit-Mapped Lines" (March) very helpful in implementing an extremely fast line-drawing routine. While coding the Pascal into assembly language, however, I noticed that the `dx_diag` and `dy_diag` increments in octant 4 should be interchanged (see figure 4 on page 253).

This could have introduced a subtle bug, and I thought maybe others could avoid problems, especially when coding in assembly language, where it is tempting to turn these `dx` and `dy` increments into `INC`s and `DEC`s.

David Miller
Cedar Falls, IA

Test Facilities

I was delighted to hear about your new testing facilities (Editorial, April). Benchmark comparisons and manufacturers' statements of Mean Time Between Failures are fine for choosing among a group of similar machines, but what an ever-increasing number of people in science and industry really need to know about their potential purchase is, "Just how much abuse can this machine take?" Computers originally intended for home and the office are turning up in ever more exotic environments, with ever-decreasing margins between operation and failure. The big concern then becomes what kind of safety margin is left to work with.

WE WANT TO HEAR FROM YOU. *Please double-space your letter on one side of the paper 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.*

Because of space limitations, we reserve the right to edit letters. Generally, it takes four months from the time we receive a letter until we publish it.

A lab of the type you describe could supply people with some much-needed information. The thought of running expensive computer equipment into the ground may seem a little drastic, but the savings in time, money, and equipment might well be worth it. I hope you aren't reluctant to push your tests to the limit. It could be of value to many of us.

Eric J. Pilger
Honolulu, HI

Clearly Fuzzy

The idea of "fuzzifying" Prolog as presented in "When Facts Get Fuzzy" by Bradley L. Richards (April) is certainly appealing. Unfortunately, the author's Prolog code lacks clarity and precision; rather than adding separate predicates such as `fuzzyy(TruthValue)` and `threshold(ThresholdValue)`, it is simpler to add an extra argument to each fuzzy fact.

For instance, rather than

```
scary(king_kong) :- fuzzy(0.5)
```

it is simpler to write

```
scary(king_kong,0.5)
```

and then pass the truth value as an argument, rather than performing obscure manipulations of the database with "assert" and "retract."

Stewart Rosenberg
Trouy, France

Corrected Attribution

In Pete Wilson's otherwise interesting comparison of processor architectures ("The CPU Wars," May), there is an error.

The 6502 was not "originally designed by Mostek." It was designed by M.O.S. Technology, which did *not* later contract its name or otherwise become Mostek. As early as 1977, M.O.S. Technology had already been purchased by Commodore (copyright page and introduction to *The First Book of KIM*.) Mostek is still a separate company. The 6502 has been made by several companies, including Rockwell.

It is my understanding that the 6502 and M.O.S. Technology were created by a team that broke off from Motorola, I assume after losing some design arguments over the 6800. The team created a machine with one accumulator rather than two, but—far more important in the real world—two index registers, including one with the powerful capability of indexing indirectly from page zero for rapid (if not automatic) movement of gstrings and blocks. The first model (6500) was plug-compatible with the 6800 but priced at about one-fifth the 6800. The second model, the 6502, was much better because it had a built-in clock, reducing the chip count.

Perhaps most important, while Motorola was uptight and bureaucratic about samples of its $90 chips, M.O.S. Technology gave away samples of the 6502 ($20 each, list), including to two guys named Steve who put it in the Apple. It was also put in a lot of video games and controllers. (So maybe the comment on page 239 about 6502s being in closets is correct. I'm writing this letter on an

continued

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Mike Firth
Dallas, TX

WORM Standards

I welcomed "A Quintet of WORMs" by Wayne Rash Jr. (February), but I was surprised that it said nothing about standards—or the lack of them. It seems to me that WORMs will not take off as a form of data storage until there is an agreed standard format, as has happened with the High Sierra format for CD-ROM. There has been a massive development of CD-ROM since the adoption of this standard, such that it could easily become a standard feature of PCs in the next few years.

I work in a social research unit, and in the near future I expect we'll be using desktop machines to analyze large data sets for which we currently use mainframes. For example, data from the next census in both the U.S. and the U.K. is likely to be distributed on CD-ROM. However, the initial mastering costs will probably make it prohibitively expensive to produce some of the smaller, less widely used data sets on CD-ROM, such as the U.K. General Household Survey or the U.S. Health Interview Survey. WORMs would be a convenient and relatively low-cost way of distributing such data sets. Yet this is unlikely to be attractive to either the users or the distributors of such datasets when there is no standard format. With no agreement on a standard, presumably IBM's own format will become a default standard, even though IBM produces only a one-sided WORM drive while others are producing double-sided drives.

The other drawback, from the user's point of view, is the proliferating number of drives that seem to be required—floppy disk drives, CD-ROM drives, and WORM drives—not all of which are likely to fit into one box. I have noticed that WORM cartridges look quite different from CD-ROM disks. Is it at all likely that there will be a single drive that will read both CD-ROMs and WORMs?

Charlie Owen
London, England

Hartley's Limitations

Before you discard the Fourier transform in favor of the Hartley, be aware of some serious limitations ("Faster Than Fast Fourier" by Mark A. O'Neill, April). The trivial nature of the so-called cas

continued

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☐ BUSINESS 2—Expressgraph business graphics. Chart your data and find trends. Color graphics req.
[2] CAD 1a,b—(2 disks) Fingerpaint 1.2 advanced painting and Altamira object oriented design. Color.
[2] CAD 2a,b—(2 disks) DanCad3d, an advanced 2D/3D drafting program w/animation. 640K, color.
[2] COMM 2a,b—(2 disks) Procomm 2.42, an excellent modem program with terminal emulation.
☐ EDUCATION 3—PC-Fastype 1.20 typing tutor, ideal for beginners and advanced students alike.
[2] FINANCES 3a,b—(2 disks) Express Calc 3.12, a powerful and user friendly spreadsheet program.
☐ GAMES 8—Striker helicopter attack and Risk, the game of world domination. Color required.
☐ GAMES 12—Backgammon (play the computer) and Wheel of Fortune based on the gameshow.
☐ GRAPHICS 1—Record and play back screen images! Excellent for demo, etc. Color required.
[3] GRAPHICS 2a,b,c—(3 disks) An excellent 3-D surface modelling and shading program. Color.
[2] INFO 2a,b—(2 disks) Zip-Phone, national areacode/prefix to zip-code cross reference.
[2] LANGUAGE 3a,b—(2 disks) The A86 3.09 macro assembler and debugger for 8088/86/286s.
[2] SHELL 4a,b—(2 disks) Automenu and HDM II 4.04 hard disk prog. for custom full-screen menus.
☐ UTILITIES 5—Hard disk utilities for verifying, formatting, parking and optimizing your disk drives.
☐ UTILITIES 6—Advanced utilities including Mark/Release (remove resident progs w/o reboot!)
☐ UTILITIES 7—More advanced utilities including Masterkey (undeletes files from hard disks).
[2] WORD 1a,b—(2 disks) PC Write 2.71, a powerful word processing system w/spell checker, laser supt.

Most software listed is shareware or user-supported.
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function (cosine x + sine x) should give rise to some suspicion: It is no more than a "colorized" sine function, with 45 degrees added to the angle and an amplitude equal to the square root of 2. The plain sine function would serve just as well.

The Fourier transform uses cos $x + j$ sin x, which preserves all the original signal information in two orthogonal functions—but which the Hartley simply lumps together. Consequently, any attempt to take the inverse transform is fraught with hazard—the original information has been lost. (The sum of two numbers is 7—what are the numbers?)

Anyone considering using this transform should be aware of its limitations.

John C. Polasek
Orlando, FL

Bigram vs. N-Gram

I read Roy E. Kimbrell's "Searching for Text? Send an N-Gram!" (May) with interest.

I wonder whether the developers considered using a "least-common bigram" (LCB) approach similar to that described by E. Onderisin (*Proceedings of the ACM Annual Meeting*, 1971) and implemented at IITRI (LARC Reports, 7 (1), 1974). The LCB method yielded improvements over traditional methods. Perhaps an LCB or a "least-common trigram" approach would be simpler and less resource-intensive here, too.

Peter Halpin
Great Falls, VA

You Call That Fast?

Mark O'Neill ("Faster Than Fast Fourier," April) claims that the fast Hartley transform (FHT) is twice as fast as the fast Fourier transform (FFT). The timings in table 1 compare O'Neill's algorithm with a simple (complex number) FFT for one forward and one reverse transform.

These timings show that there's more to speed than a smaller number of arithmetic operations. In particular, speed of array access is often crucial in "real" numerical applications.

In a comment on Bracewell's work, Bold (*Proceedings of the IEEE*, 73 (12), 1863–4) points out that a real FFT can be performed by a complex FFT on $n/2$ points, considerably faster than the times above. If speed really is crucial, FFT algorithms can be tuned to the architecture of the machine in use.

B. D. Ripley
Glasgow, Scotland

Elusive Shareware

I have been given a copy of a very good backup program called `Hardsave 1.0a`. It has a message saying "Shareware from `Andrew P. Wimple, Donations $20` please."

I would like to send Mr. Wimple a donation, but he has not left his address anywhere in the software. Do you or any of your readers know where he can be contacted?

Jeremy Brown
Leichhardt, Australia

Data Liberation

I am writing this letter to request a new Freedom of Information Act. I am referring to the availability of data structures for software.

continued

Table 1: *Timings comparing O'Neill's algorithm with a simple (complex number) FFT for one forward and one reverse transform.*

	n = 256		n = 1024	
	FHT	FFT	FHT	FFT
IBM PS/2 60 Turbo Pascal 4.0	5.16	3.62	23.51	19.56
+ 80287	0.88	1.09	4.02	5.54
RM Nimbus VX 16-MHz 80386	2.47	1.76	10.98	9.28
+ 80387	0.33	0.33	1.54	1.81
Atari ST Prospero Pascal 2.12	5.36	4.01	24.75	21.03
Sun 3/160 + 68881	0.32	0.38	1.55	1.90
+ 1164/5	0.25	0.18	1.17	0.83
VAX 8650	0.085	0.050	0.420	0.270

C++

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Zortech C++ is a 'true' compiler and fully conforms to Bjarne Stroustrup's specification as outlined in his book 'The C++ Programming Language'.

Previous implementations of C++ were actually 'translators' – only able to translate C++ source code into C. Of course, this was unacceptable due to the long translating and compiling times.

Now, C++ comes of age with the introduction of the world's first true C++ compiler – from Zortech!

■ **Object Oriented Programming**

C++ is to C what Modula 2 is to Pascal. C++ brings 'classes' to C, so you can create separate modules that contain their own data and data-related operations. These 'classes' then become new types that can in turn be used to create further modules – this allows you to practically create your own language.

■ **ANSI C Superset**

You don't have to throw away your existing C programs – C++ is a superset of ANSI C. Now, you can take your Microsoft C or Turbo C compatible programs and easily migrate to C++ to take full advantage of the new C++ features.

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Zortech C++ is compatible with 'Codeview' – Microsoft's industry standard source code debugger.

■ **Improved Program Structure**

As stated in 'The C++ Programming Language', by using C++ "It would not be unreasonable for a single person to cope with 25,000 lines of code".

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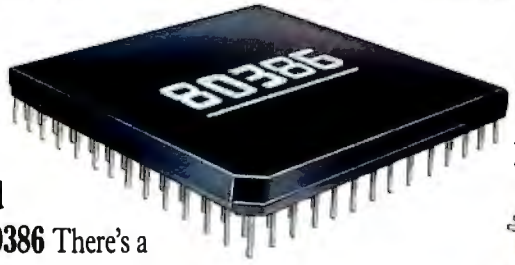

1. Designed for the 80386 There's a revolution taking place in desktop computing. A revolution that's been launched by a square wafer of silicon known as the 80386 microprocessor chip. It puts minicomputer potential at PC users' fingertips. It's a fact that virtually every leading PC manufacturer has built a "box" around this chip. And it's a fact that the "New Operating System" will, supposedly, even run on it. But, it's also a fact that *their* system wasn't designed for the 80386. Ours is. And it's called PC-MOS/386™

2. PC and PS/2 Compatible In designing PC-MOS, we knew our first priority was to exploit the minicomputer capabilities of 80386-based PCs & PS/2s. But we went further, and developed a system which would be fully compatible with the millions of existing PCs, PC ATs, and PC-compatibles. Power without sacrifice. You'd expect nothing less from the new standard bearer.

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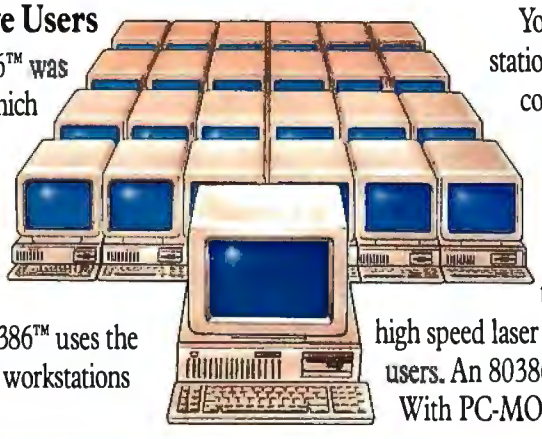
In a multi-user setting, PC-MOS/386™ uses the computing power of the host PC to drive workstations linked to standard RS-232 ports.



You can choose from a variety of workstations. Mix and match dumb terminals costing under $500 each with PCs and PS/2s running our terminal emulation software.

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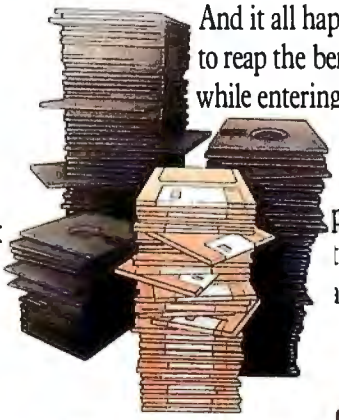
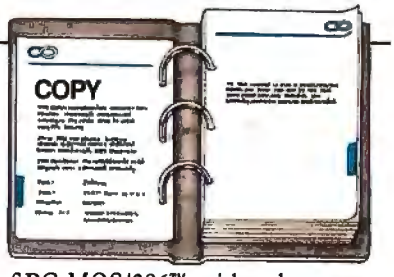
4. Thousands of DOS Programs PC-MOS/386™ gives you the best of the past, and the best for your future. Which means that while PC-MOS/386™ totally replaces your old DOS, you won't have to replace the programs you've spent a lot of time learning.



And it all happens so effortlessly. You'll continue to reap the benefits of your favorite DOS programs, while entering a new arena of power.

Think of it! Programs like dBASE III, WordPerfect, Lotus 1-2-3 and Symphony, WordStar, MultiMate...literally thousands of DOS programs–all compatible and multi-user available.

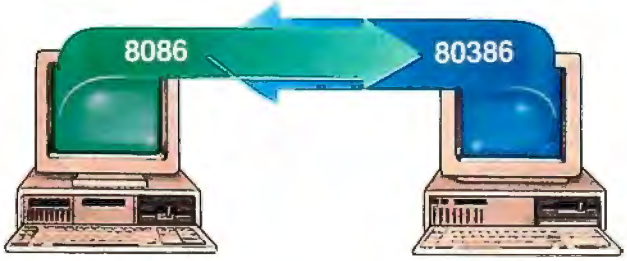
5. Familiar Commands Like DIR and COPY Just as you don't have to learn a whole new array of software to take advantage of PC-MOS/386™, neither do you have to learn an entirely new set of commands.



Instead, the system builds on the knowledge you already have. "COPY" still copies files, and "DIR" still gives you a directory listing. As you might expect, we didn't stop there. There's a wealth of features that have strengthened the commands you know, making them more powerful and easier to use.

# of Users Will Choose PC-MOS/386.™

6. Concurrently Supports Virtual 8086 and 80386 32-Bit Mode



80386-based PCs & PS/2s are dual-personality computers. To run DOS programs, they act as PCs with a 640K memory limit. But to take advantage of their minicomputer capacity, they operate in true 80386 mode which lets them address up to four gigabytes of memory. PC-MOS enables the 80386-host and its workstations to independently switch between these modes–making DOS compatibility and 80386 power simultaneously possible.

7. Multi-Tasking

While it's true you could look elsewhere for multi-tasking, why would you want to? The *other* multi-tasking operating system is not now, nor is it planned to be, multi-user. It won't even run multiple DOS applications in multi-tasking mode.

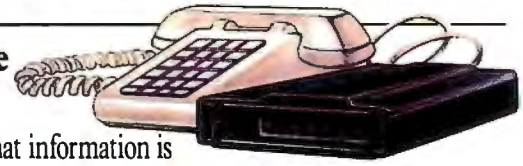
Now consider PC-MOS/386.™ At the touch of a key, you can switch between up to 25 different tasks. And if you have workstations connected to a host, they get multi-tasking, too. Finally...a system that won't hold you back.

8. File/Record Locking and Security

When you decide to implement either a network or a multi-user system, there's a two-fold problem which must be solved: protecting your work from accidental misuse and securing it from intentional theft.

PC-MOS/386™ solves both aspects of this problem. Password protected security allows you to assign file, directory, and task access to each user. Plus, files and records are locked using either PC-MOS' proprietary system or NETBIOS emulation.

9. Remote Access



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10. The Price...

As you evaluate operating systems, ask yourself if it's reasons you're considering...or rhyme. Ask if you're getting a system for tomorrow, or one that was made for yesterday. See if you're being forced to buy new hardware because of *their* software. And consider this.

Only one operating system in the world can give you the raw power, features, and functionality that you demand. Its name is PC-MOS/386.™ And it's immediately available in one, five and 25-user versions starting at $195.

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As a software developer and consultant, I am often called upon to aid individuals converting from one software package to another. The only problem is, very often it's difficult or impossible to obtain the data structure of the existing software package.

Recently I was asked to help a physician convert from one medical billing and insurance program, sold by one of the largest companies in the U.S., to a different package from a different vendor. This physician had used the original program for several years and had accumulated several thousand patient accounts in the system.

Both a colleague and I contacted the vendor and requested a map of the program's data structure. We did not request source code or any proprietary information, and we were willing to pay any necessary costs. Our request was firmly refused, and no amount of pleading, cajoling, or threatening could pry the data structure from this prestigious vendor. Needless to say, the resulting data conversion was difficult and expensive, and it involved a great deal of manually reentering data.

I honestly do not know why this company refused our request, but I have run across this response countless times with numerous software houses. Could it be that paranoia has become so widespread that it totally obscures the judgment of major software developers, or are they simply so petty that they will hold their existing users as unwilling captives so they can continue to milk them for upgrade and maintenance fees?

Whatever the reason is, it has no justification. It is inconceivable to me that any software vendor could refuse to furnish a data map, particularly when the data is as vitally important as accounts receivable.

Furnishing the data structure of a program is not at all comparable to furnishing source code. The data structure tells little, if anything, about how the program works—it merely shows the owner of the data just where and how it is stored. Furthermore, a map of the data structure is useful only to individuals who already own the program. In no way could furnishing data structures adversely affect the sales or proprietary rights of any software vendor. Quite the contrary: In my opinion, the failure to furnish data structures should serve as a strong deterrent to buying the program in the first place.

I think the time has come for all software vendors to furnish data structures with their programs. As more and more people become increasingly dependent upon computers for storing their vital data, they should have free access to that data. Even the most wonderful program might be obsolete next year, and even the largest vendor may be in Chapter 11 next week.

I strongly advise individuals considering the purchase of any software that may have a major impact on their lives to demand that the data structure of the program be furnished at the time of purchase. Whether they are programmers or not, if they need to convert to a different program in the future, they'll have to pay a programmer far less if the data structure is already available.

Evan P. Provisor
Sharon, CT

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csd:
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- Provides separate source, evaluation, program and history windows
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So if you're thinking about buying any other C compiler, think again. But this offer is only available for a limited time. So think fast. And see your software dealer or call 1-800-MWC-1700 soon. (1-312-472-6659 in Illinois.)

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Quattro and Benchmarks

Your comparison review of Quattro and Surpass ("Double Threats to Lotus

continued

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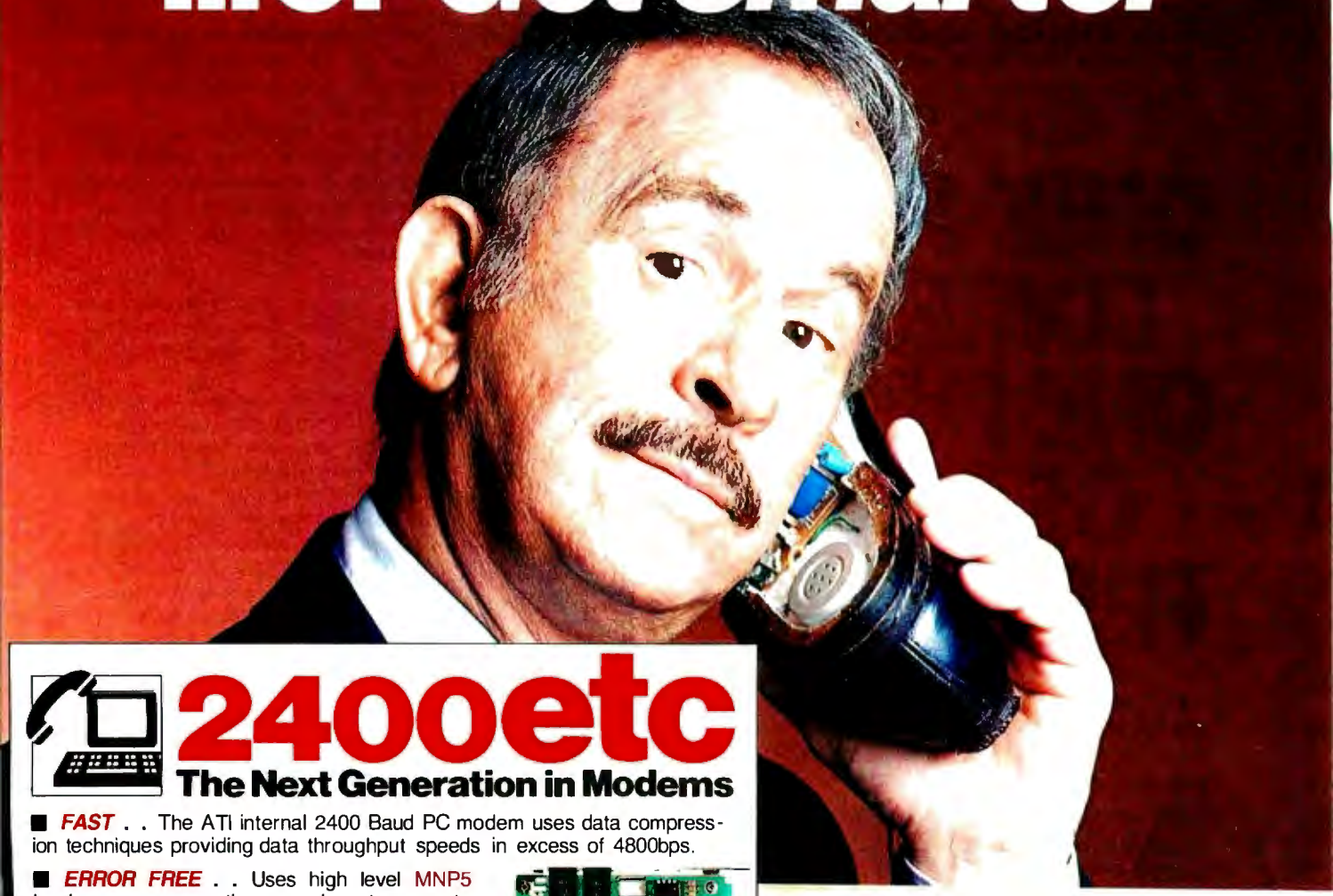

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1-2-3" by Diana Gabaldon, June) requires some amplification.

First, you didn't mention the two add-ins that are bundled with Quattro at no extra charge: Menu Builder and Transcript. Menu Builder lets users create menu trees that are customized to their specific needs. Quattro is shipped with both its own menu tree and one that emulates Lotus 1-2-3.

If your readers have ever lost valuable data, they'll appreciate Transcript. It provides a log file of keystrokes and commands selected throughout the spreadsheet session. Errors can be handled easily with the undo command. Transcript also protects against power failure or system crashes and audits changes made to a spreadsheet.

Second, Quattro provides a macro record and debugging environment. The macro record is an excellent way to create macros quickly and easily. It simply records the user's actions as they are performed. With the Quattro debugger, users can execute macros in slow motion (step by step), pausing as they go along, and set breakpoints that "freeze" a macro when it reaches a cell or satisfies a given condition. Users can execute a macro at full speed until it reaches a breakpoint, then continue either in slow motion or at full speed until the next breakpoint.

Your benchmark appears to be a historical "all cells dependent on one cell" model and is not representative of a real-world spreadsheet.

Lastly, your review summed up Quattro as being the first-time user's choice. On the contrary, our research shows that more than 50 percent of current Quattro users are previous Lotus 1-2-3 users.

Becky Jones
Product Manager
Borland International
Scotts Valley, CA

We're glad you mentioned the benchmarks: Our traditional spreadsheet benchmarks are deliberately not optimized for any one kind of operation—historically, we've made no assumptions about how a spreadsheet will be used. While this approach has the advantage of being open-ended and allows head-to-head comparisons of spreadsheets over time, these benchmarks certainly aren't perfect. For one thing, they lack fine detail that might allow readers to, for example, differentiate between performance in routine business matters versus performance in statistical number crunching.

We're changing our benchmarks: In our June issue, we rolled out BYTE's new system benchmarks for hardware. These, the first second-generation microcomputer benchmarks, produce results (from the most general to the most detailed levels) that are valid indicators of real-world performance in a variety of applications.

We're now in the process of doing the same thing for our suite of software benchmarks. Watch for our new, second-generation software benchmarks later this year.—Eds.

FIXES

Sorry, Wrong Number

In the June What's New on page 88, we printed the wrong telephone number for Plu*Perfect Systems. The correct number is (213) 395-4584.

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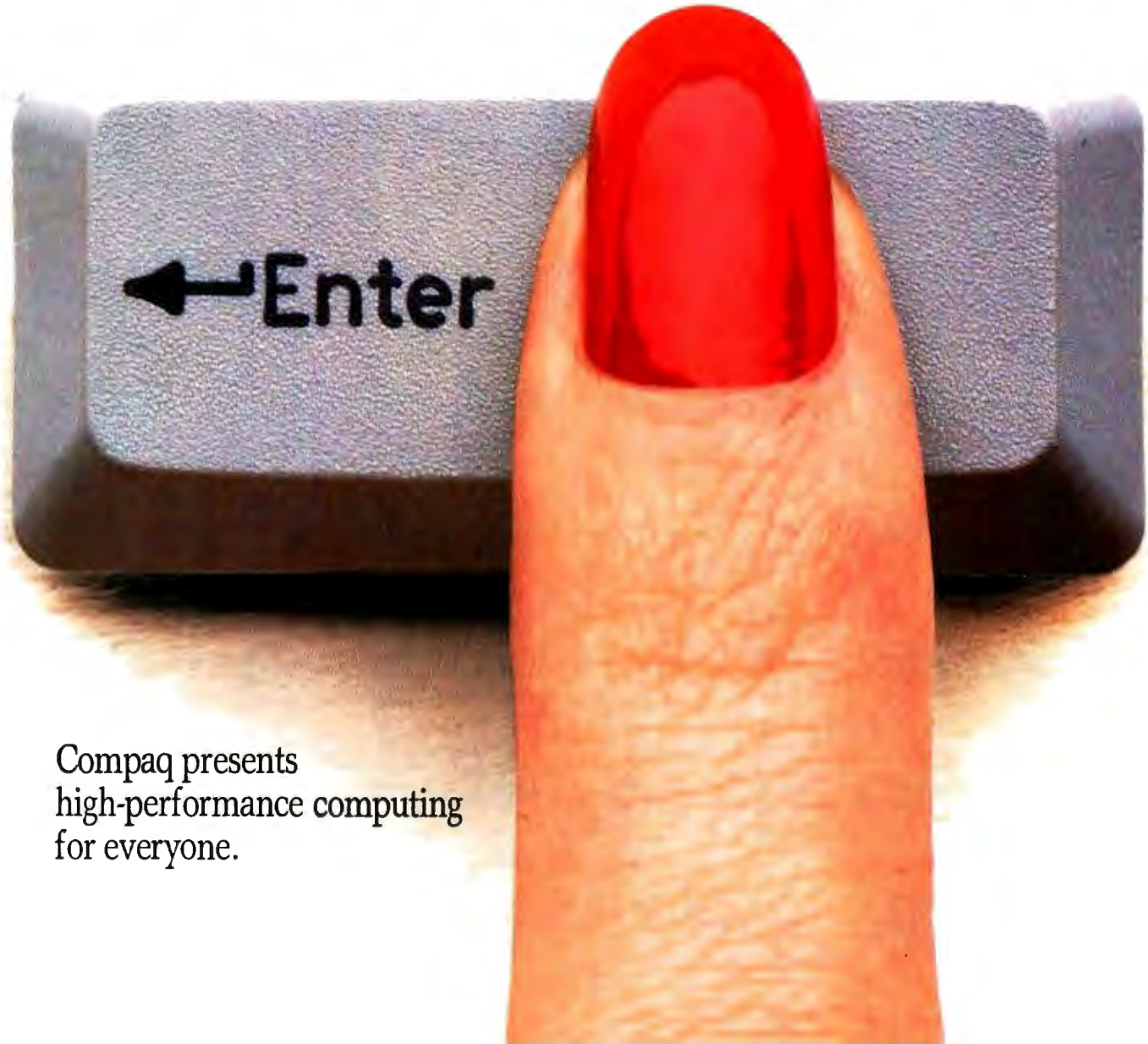

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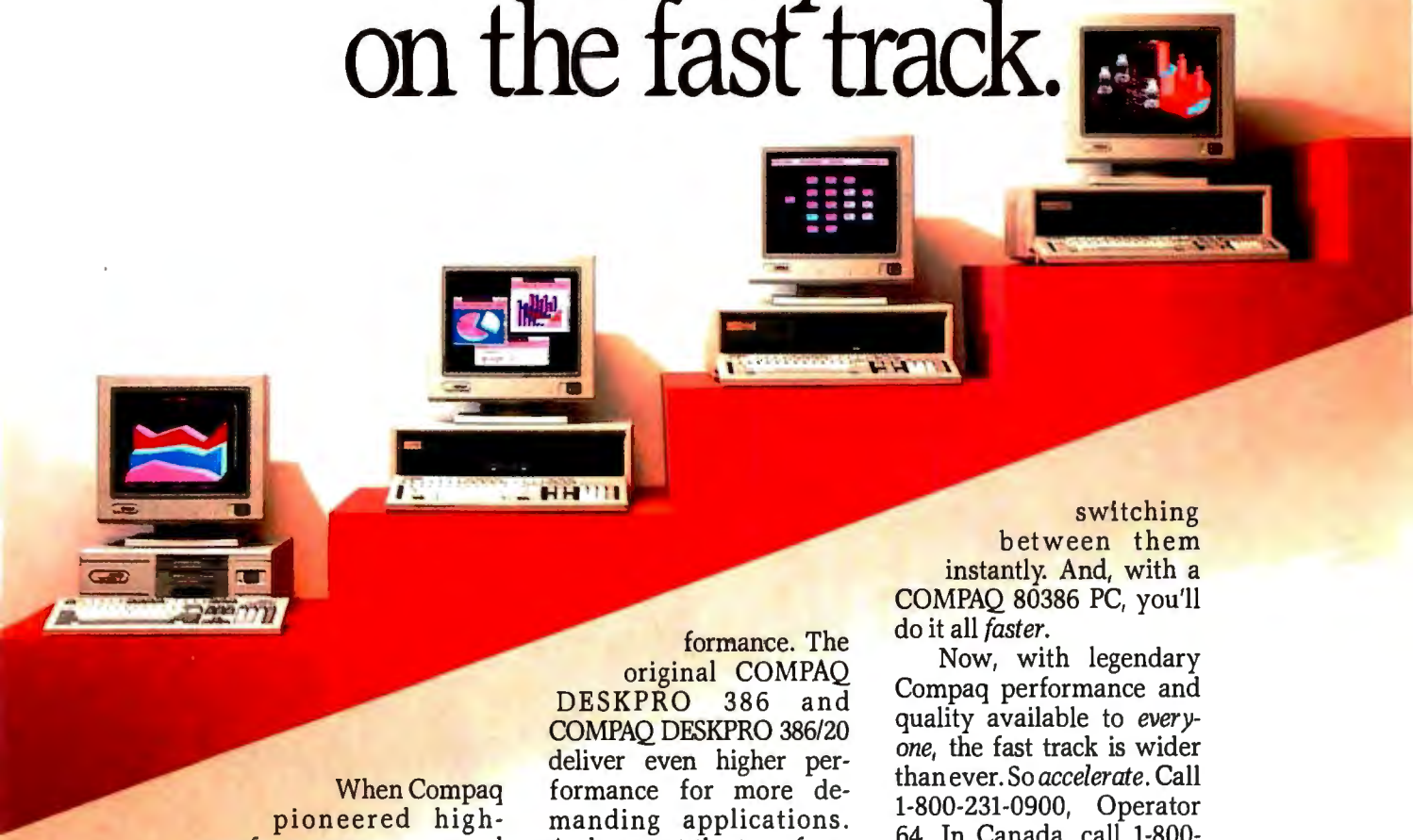

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*Hereafter referred to as 80386SX, 80386 and 80387 respectively.

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

BIX in Europe?
Dear Jerry,

I'm a student of economics and computer science, studying at the University of Karlsruhe.

There are three reasons why I'm writing to you. First, I really enjoy reading BYTE, because it's one of the best (if not *the* best) available computer magazines.

My second reason for writing is because I'd love to take part on BIX, but as you know, the German Bundespost ("post" is the "abbreviation" for Public Organization for the Suppression of Technology) is very restrictive concerning computer communications and, of course, is charging fairly high fees for any long-distance call.

Perhaps BYTE or McGraw-Hill could encourage activities to bring BIX to Europe. I'm thinking of a BIX bulletin board somewhere in Europe, whose contents would be sent to America once or twice a day and vice versa. This would already be a big leap forward, although it would not be as interactive as the original BIX.

Perhaps—and now I might just be daydreaming—BIX could advance to become IBIX (International BYTE Information Exchange), bringing together computer users from all over the world.

My third reason to write to you is that I've recently bought an inexpensive add-on board for my IBM PC AT. To find out what kind of board I'd bought, I went through all my issues of BYTE to locate any reference to Definicon Systems, the name on the board. I was lucky to find a pointer to an older BYTE in which the DSI-32 coprocessor board had been reviewed. I was very glad to realize that I now own a "tiny VAX" to plug into my computer (a DSI-32 board running at 10 MHz, complete with memory management unit and 2 megabytes of RAM).

I've already written to Definicon Systems for further information and software, and I hope to get enough to help get the board running. Since BYTE tried to encourage buying this board by having arranged special prices for Green Hills software, I believe there still may be many people who use the DSI-32 board. Perhaps some of them would be willing to exchange information or programs with me. Readers can get in contact with me at the address below.

Axel Mock
Dahlienweg 8E
7513 Stutensee 1
Federal Republic of Germany

Thanks for the suggestions. I find Definicon stuff blazingly fast.

I passed your comments on to George Bond, executive editor of BIX, who had this to say:

"We're interested in worldwide participation in BIX, too. Already BIX has members from North and South America, Europe, Africa, Asia, and Australia. We do recognize the high costs of BIXing from outside the U.S., and we are continually looking for ways to help users reduce them.

"Incidentally, although BIX is not available directly in Europe, another BYTE service—BYTEnet Listings—is. BYTEnet Listings is a BBS with code described in BYTE articles in its download areas. There currently are BYTEnet Listings boards in more than 30 nations worldwide."—Jerry

Solving Problems with `ASK`
Dear Jerry,

Last year, you wrote about having troubles with your resident software and gave an example of a batch file that rewrites the `AUTOEXEC.BAT` file. That's one solution, but I think I've got a better one.

The advanced edition of the Norton Utilities includes the program `ASK`, which is very useful for solving such problems in a tidy way. With `ASK`, you can build menus in a batch file, input into the batch file, and set the `errorlevel`

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.

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according to your input. (For a better explanation, just look it up in the Norton Integrator.) A better solution to your problem could look like this:

```
ECHO 1. Ready!, SuperKey, SideKick
ECHO 2. Lightning, SideKick
ECHO 3. DESQview
ECHO 4. Windows
ASK "What shall I load,"1234
if errorlevel 1 then goto .....
if errorlevel 2 then goto .....
```

If you want to stick to your method, you could write a little program that reboots the system via interrupt 25.

When you're using DOS 3.3, you can write better code using `call` instead of `goto`. This way your code will be much more readable.

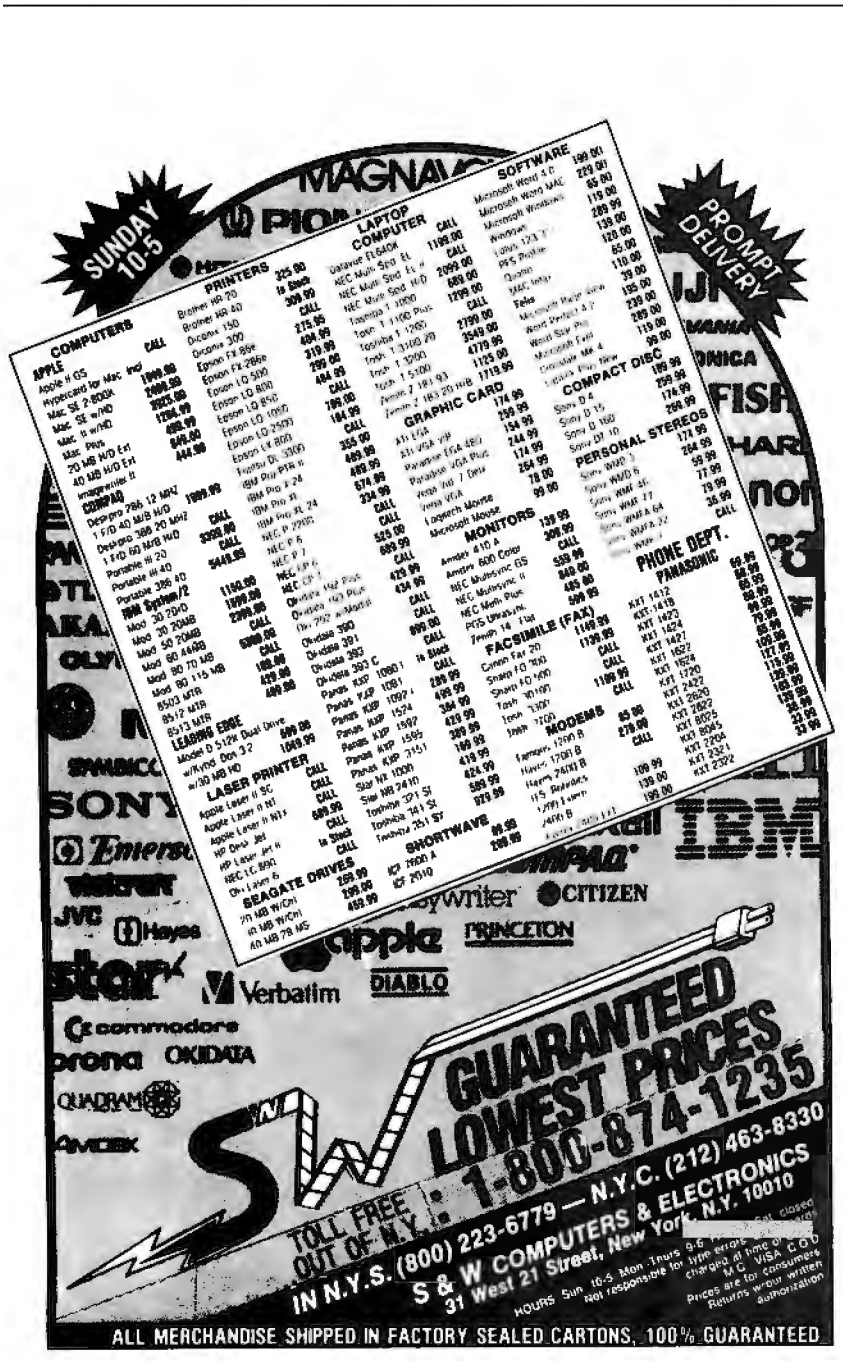
Now to your discussion about word processors. I do almost all my editing with the Norton Editor (yes, I'm a Peter Norton fan), which can do all I need and is very small. It also supports a mouse if connected. Just press the left mouse button, and you can move the cursor around; press the mouse button again, and you drop the cursor at the new location. I find that very useful. When it comes to output, I use TEX. My second-choice editor is MicroStar from the Turbo Editor Toolbox because it cooperates with Lightning so nicely.

P.S. Just in case you are interested, I am 14 years old.

Konrad Neuwirth
Vienna, Austria

Actually, I find that DESQview does pretty well on an 80386 for nearly every normal operation; when I want to run without DESQview, I generally want to change the `CONFIG.SYS` *file as well, and* `ASK` *won't do that.*

I'm a Peter Norton fan also.—Jerry



XyWrite's the One

Dear Jerry,

With rising frustration, I have read all the columns in your series on your search for a word processor that is transparent to you as a writer and yet has all the features that you as a hacker might want.

I am a practicing attorney, and as such I need to create nonstandard documents from scratch with reasonable regularity. I also lecture and have to prepare appropriate outlines in varying detail, tailored to the particular course.

Six or so years ago, I was introduced to XyWrite by the head of our word-processing department, in which we ran Atex at the time. I switched over from my then-beloved WordStar, and I've stuck with it ever since.

The key to XyWrite, which I don't believe you have yet had an opportunity to appreciate, is the ability to configure the program in just about any way you choose.

Do you want a keyboard that gives you all the editing functions without removing your hands from the keyboard? That's what I have. The keyboard driver for XyWrite is an ASCII file that loads when the program boots and can be rewritten to put all the editing functions under whatever mnemonic or ergonomic design you choose.

Suffice it to say that I have assigned to the Control key (or, in a few cases, Control-Alt or Alt-Shift) combinations of my choice all the following functions:

• Cursor movement: one space up, down, forward, or back; one word forward or back; one sentence forward or back; one paragraph forward or back; top

continued on page 201

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A108

ASK BYTE

Circuit Cellar's Steve Ciarcia answers your questions on microcomputing

A Drive for All Seasons

Dear Steve,

I'm looking for a 3½-inch floppy disk drive capable of coping with the IBM 1.44-megabyte format as well as the Apple 800K-byte format. I have asked most of the major brand representatives in Europe about this, but so far I've been without luck. I think there must be quite a market for such a device, so I don't understand why it should not exist.

H. Anjou
Gothenburg, Sweden

There's an old saying in this country that there's an oddball in every crowd. In the computer crowd, the oddball is Apple Computer. Apple's disk system for all its computers uses an unusual data encoding method called group coding, whereas modified frequency modulation (MFM) encoding is the basis for the dominant industry standard dictated by IBM. Apple's method is very software-intensive, using a variable-speed 80-track drive to obtain its 800K-byte-per-disk capacity.

The IBM 1.44-megabyte disk drive uses industry-standard controllers. The differences between the systems make designing a single drive to work with both a bit adventurous. At least two companies have attempted to market controllers that permit industry-standard 40-track double-sided drives to be used with the Apple II series; both failed. It seems highly unlikely that anyone will design and market a disk drive that works with both kinds of controllers with acceptable reliability. I'm not saying it can't be done—just that no one is likely to do it.—Steve

Alive and Kicking

Dear Steve,

Do you know where I can get software to let me use my Osborne 1 with a hookup to an IBM PC XT? I've tried several sources without success.

Steven Takle
Fridley, MN

I don't know of any specific software package that links Osborne or other CP/M machines to IBM PCs. Maybe you can find something on CP/M bulletin board systems (BBSes), CompuServe, or The Source. You can find a large list of user groups and BBSes in Computer Shopper *magazine.*

You can operate a PC from a remote computer of almost any type with some communications programs. Procomm, for example, has a host mode that provides many of the features of BBS control programs, and it has a shell-to-DOS function that allows the remote user full access to the PC. All I/O is redirected to the COM port. This would allow you to use Modem7 or some other program on your Osborne to run the PC remotely. Procomm is available on most local BBSes, or you can order it from Datastorm Technologies, Inc., 1621 Towne Dr., Suite G, Columbia, MO 65205. One advantage of downloading from a local BBS is that you can try it before you buy it.—Steve

IN ASK BYTE, Steve Ciarcia, a computer consultant and electronics engineer, answers questions on any area of microcomputing and his Circuit Cellar projects. The most representative questions will be answered and published. Send your inquiry to

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Protocol Problems

Dear Steve,

My computer is a Hewlett-Packard IPC, a machine that is apparently a poor stepchild.

My problem concerns connecting an external disk drive. According to the manuals, any drive that uses the Amigo or SS-80 protocol can be directly connected (via the HP-IB or IEEE-488) and operated using drivers in the operating system. Since I don't want to pay HP's price for its drives, I've been looking for another source. Unfortunately, no one has heard of the required protocols.

Do you know of a source of information? I've already tried HP and local dealers. I've also written to drive manufacturers, to no avail.

James A. Hazel
Bremerton, WA

A field that is evolving as rapidly as microcomputers creates its inevitable orphans and unsupported, expensive, and hard-to-find products.

For a number of reasons (but mostly by accident), the Seagate ST506 and ST412 hard disk drive interfaces have largely dominated, with a strong showing by the Shugart Associates system interface (SASI) and small computer system interface (SCSI). The HP-IB/IEEE-488 interface, though usable with hard disk drives, was developed to connect laboratory instruments to minicomputers; it is therefore less than optimal for hard disk drive applications. The newer, simpler Seagate and SCSI drives have dominated, with run length limited (RLL) coming on fast as a variant.

With this in mind, it should be no surprise to you that I haven't been able to locate any third-party drives that would be compatible with your system. Your choices would seem to be as follows: Go without a hard disk drive, buy HP's version, or get a different computer—such as a PC or PC compatible—for which bargain-priced drives are offered by dozens of suppliers.—Steve

Identical Printers

Dear Steve,

What is the difference between Epson- and IBM-compatible printers with regard to the Centronics interface? Is this difference a hardware- or software-dependent feature?

Also, is it possible to interface an

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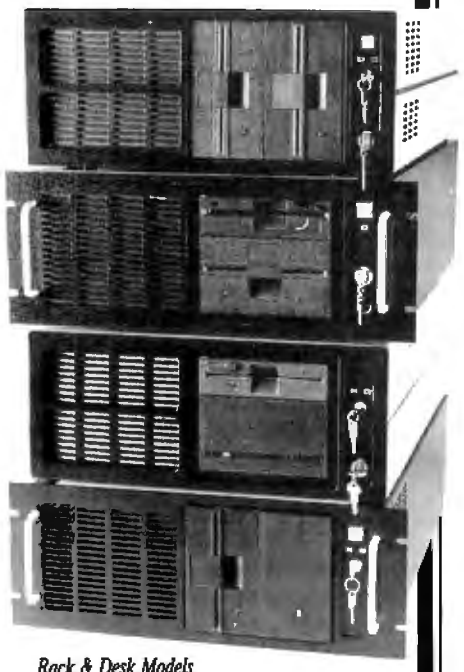

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Epson-compatible printer with an IBM PC? If so, how is this done?

Finally, I'd like to know the intricacies involved if you use a serial interface (RS-232C) for the printer.

V. Shyamasunder
Bangalore, India

The hardware for an Epson interface is identical to an IBM-compatible printer interface. This interface was originated by Centronics. The commonly used signals include 8 data bits, an active-low data-available strobe, an active-low acknowledge strobe, an active-high level busy signal, and ground signals. The difference between the two types of printers lies in the graphics mode each supports; the graphics mode is controlled by the computer via the high bit of data sent to the printer.

In graphics mode—high bit set—an IBM-compatible printer will reproduce the high-ASCII screen graphics character of the IBM PC family; a non-IBM-compatible Epson will produce different characters. In text mode, high bit clear, the two printers will produce the same output. You can use an Epson-compatible printer with an IBM-type computer, if the IBM graphics characters are not required, simply by connecting the computer and printer with a cable that has suitable connectors at the ends, typically either a 36-pin Amphenol-type connector or a DB-25 connector.

You can use a serial printer with an IBM-type computer via a COM port and a suitable cable—usually with a DB-25 connector on the printer end and a DB-9 or DB-25 connector at the computer end. Since many serial printers follow DTE (data terminal equipment) protocol rather than DCE (data communications equipment), you'll need a null modem adapter or cable for successful operation. These adapters interchange the data and handshaking lines. While it's easy for experienced users to construct cables and adapters for serial interfacing, it is frequently frustrating and time-consuming for novices. Sources such as Jameco Electronics and JDR Microdevices (both advertise in BYTE) carry ready-made cables and adapters that will prevent or eliminate most problems.—Steve

Polylingual Clone

Dear Steve,

I'm interested in buying an IBM AT clone. However, I need the system to operate in English and Japanese (my keyboard has four character types: English, kanji, katakana, and hiragana). In Japanese mode, I need to be able to select the character I need from a shift/function key and have this character displayed on the CRT or printer.

Many printers can print in different languages (e.g., the Epson can print in German and French), but Epson USA couldn't help me. I need this system to operate as a regular computer or word processor.

M. J. Cavanaugh
Steger, IL

A PC clone that writes in English and three different Japanese character sets sounds like a tough item to find in the U.S. market. The old Epson MX-80 printers sold in the U.S. a few years ago did include a katakana character set, but I haven't seen any other printers with this feature.

You may be able to use Microsoft Windows if you can get a copy of the Japanese version. Microsoft Systems Journal *(March 1988) contains an article on implementing Windows for Japanese computers. The article vaguely implies that a Japanese version of the PC AT or clone is required. It is not necessary for the printer to have the Japanese characters, however, because Windows uses its own fonts and prints in graphics mode when you use a dot-matrix printer.*

You may be able to find out if this approach is feasible by calling Microsoft at (800) 426-9400.—Steve

Computerized Slide Show

Dear Steve,

I am attempting to store some documents that are four to eight pages long on my IBM PC. The documents contain mostly text, but some have line drawings, graphs, and maps. I'd like to retrieve these documents and display them on the screen with as little extraneous display as possible. Most word processors and desktop publishing software display more than the document on the screen. What options do I have for storing and displaying documents in this manner?

I'm using an IBM PC AT with an EGA card.

Doyle L. Jones
Clinton, MS

If I understand correctly, you want to display documents page by page on your PC, but not necessarily for editing. In other words, you want a slide show.

There are a few programs that are designed especially for this kind of task. Two are Show Partner and Show Partner Professional by Brightbill-Roberts & Co., 120 East Washington St., Suite 421,

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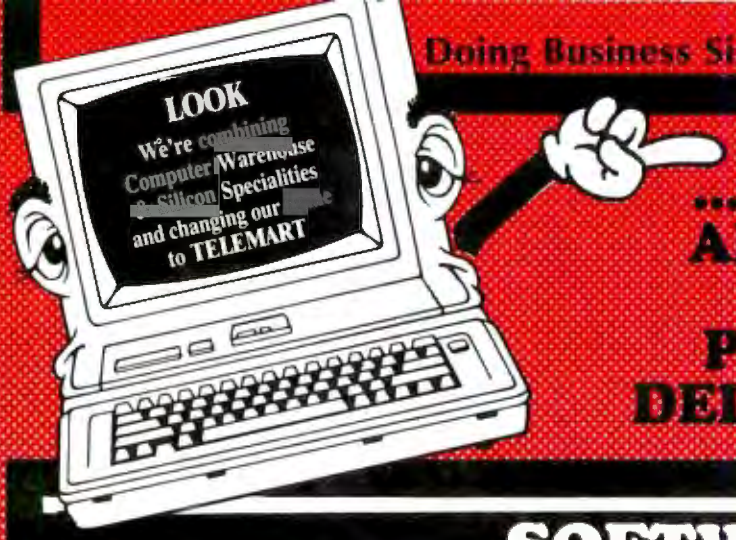

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Another is EGA Paint with EGA Slide by RIX Softworks, Inc., 18552 MacArthur Blvd., Suite 375, Irvine, CA 92715, (714) 476-8266.

These products are widely available from mail-order suppliers or in computer stores.—Steve

Communication Problems

Dear Steve,

I recently purchased a Macintosh SE, and I was under the assumption that such a sophisticated machine would hook up to my printer, a Toshiba P1340. I also assumed that any software—such as Microsoft Works and Lotus's Jazz—would also operate with the printer. No such luck. Although I have just begun searching, I have had equally poor luck in unearthing any information that will help me solve the problem.

My Toshiba is a good product, and I'd like to continue to use it with the Mac. I have an Apple IIe and have had no problems with any of the printers I have used with it. I can't understand why a superior machine would present such a frustrating limitation.

I do have an Orange Micro C/Mac/GS linked between my Panasonic 1091 and the Mac. However, printing is so slow that I could write the documents by hand faster. I don't consider this a realistic solution. I'd appreciate any suggestions.

David T. Barrat
Acton, MA

The success of the Macintosh computer, after an under-powered beginning, has been one of the more interesting phenomena of the post-1985 computer scene (parallel with, and quite distinct from, the overwhelming continued dominance of the IBM line and its clones). Perhaps the most distinctive characteristic of the Mac is its penchant for doing nearly everything in a non-IBM way. What works with IBM won't work with the Mac, and vice versa.

The individuality, though perhaps somewhat interesting, creates problems that aren't easily solved. Attempting to use the Mac with other than its own specially designed printers graphically illustrates some of those problems.

Your desire to use your Toshiba printer with the Macintosh is understandable, but it may not be possible. The Macintosh uses software drivers to communicate with devices like printers; these drivers can be found in the system folder. Apple Computer supplies drivers only for its Imagewriter and LaserWriter printers. To use a different printer, the appropriate driver must be installed in the system folder of the Macintosh. So far as I can determine, there is no driver available for your Toshiba printer. Unless you create your own driver (a nontrivial task), or one becomes available from another source, your Mac and Toshiba won't sing the same song or speak the same language.—Steve

Joyless Joystick

Dear Steve,

I'm trying to interface an external device to my Amiga 500 through the second joystick port. I have experimented and read a few books on the Amiga, but I can't find any way of doing output through the port. I've experimented with pokes and peeks, and I've found that I can input information through the port with the following code:

```
LOOP: PRINT PEEKW(14614540)
      POKEW 14614582,0
      GOTO LOOP
```

Could you show me how to do output through the port or refer me to some source?

Virender Dayal
Hoboken, NJ

I understand your desire to use an unused joystick port on your Amiga for output. Tinkering with hardware and exploring new applications is one of the true joys of computing. Your desire to get output, however, isn't practical.

There are essentially two kinds of connections to electronic circuits: inputs and outputs. Except in the case of specialized devices, like transceivers and analog switches, the two functions aren't interchangeable. The Amiga 500's joystick port is for input only, and there is no way—short of redesigning, cutting, soldering, and praying—that you can change this.—Steve

Do-It-Yourself CAD/CAM

Dear Steve,

I am an amateur engineer and designer with some professional experience in FORTRAN programming. I'm interested in knowing if I could construct a 1-megabyte computer that would have the capability for CAD/CAM operations and FORTRAN programming. I don't think I would need BASIC for my application.

My goal is to use CAD/CAM software to construct an item on the monitor, then cut the item in selected locations and use FORTRAN to make an engineering strength analysis. I could then redesign as necessary without removing the item from memory or even from the screen.

I see various companies that sell computer components. Can I buy a keyboard, motherboard, monitor, and other components to put together a system to help me with my engineering? I don't need the extra space and chips that I guess are needed for BASIC or, say, Symphony—I would use those resources for CAD/CAM and FORTRAN.

Joseph Weiss Jr.
South Hutchinson, KS

While I think you could construct a computer along the lines that you describe, I think it would be far more practical to purchase a standard one. There are a few things you haven't considered that make the decision fairly simple.

It turns out that all computers are pretty much the same under the hood, so any machine that can run FORTRAN or CAD/CAM programs will also run BASIC and other languages. You don't need additional hardware gizmos for those other programs; as far as the computer is concerned, they're all just programs.

By the same token, Symphony and all the other programs will run on the same IBM PC clone that will handle FORTRAN or AutoCAD, simply because they're programs written to use that hardware. In fact, you'll find that the CAD programs tend to have more stringent hardware requirements, because they need high-resolution displays, plotters, printers, digitizing tablets, and mice to handle complex graphic I/O.

If you're interested in CAD work, plan to buy at least an IBM PC AT clone with a 40-megabyte hard disk drive, a VGA-compatible monitor, and a mouse. That's the minimum hardware for reasonable performance. Hard copy output can go to either a laser printer or a plotter; the former can handle word processing with ease. But the tab will run about $5000 for all that hardware, and you won't realize significant savings by assembling parts from several vendors.
—Steve

Sounds in the Silence

Dear Steve,

I want to communicate by telephone with my cousin, who is hearing impaired. I'd like to be able to use my computer and a modem, but my cousin has only teletypewriter (TTY) equipment, and I understand that there is no modem that can connect to a TTY.

The president of the Maryland State Society for the Hearing Impaired tells

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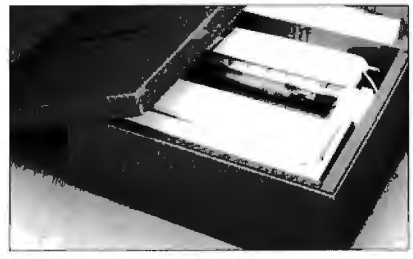

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me that the Bell Telephone System has a very expensive converter that will allow modems and TTYs to connect. He tells me further that the deaf community uses machines that are based on the TTY code because (a) such machines are readily and economically available, and (b) most of the members of the deaf community cannot afford the Bell System converter.

I think you can make an enormous contribution to the many people who are hearing impaired and to the microcomputer community as well. If such a converter exists, surely you can design equipment that will serve the same function and that can be made from economical and readily available parts.

George Allison
Essex, MD

I've received many useful suggestions for Circuit Cellar projects from readers such as yourself. I will seriously consider your suggestions concerning modem/TTY compatibility.

There are definitely some possibilities that deserve consideration and exploration. The microcomputer world is frequently afflicted with incompatibilities, and the differences between current microcomputer modems and the older TTY-based equipment illustrate the situation nicely.

While there are viable markets for various computer modems and TTY equipment, there is a much smaller market for protocol converters for the two communications methods. The small size of the market limits the amount of development you can accomplish without going broke.

As you said, there seems to be no general-purpose equipment on the market, other than the expensive converters sold by the phone company, that permits communication between a typical microcomputer and a TTY unit used by hearing-impaired individuals. Modifying existing commercial equipment is usually impractical unless the TTY capability has been designed into it from the beginning.

At one time Novation made an internal modem called the Apple Cat for Apple II series computers. After a simple factory hardware modification, you could use it with special software (available on disk from Novation) to work with the 45.5-bit-per-second, Baudot-coded (5-bit) protocol used by TTY. However, Novation no longer makes it. Texas Instruments also has a software package available for the TI Professional that lets that computer emulate a TTY terminal, but it works in conjunction with unique TI hardware and thus has little generality.

—Steve ■

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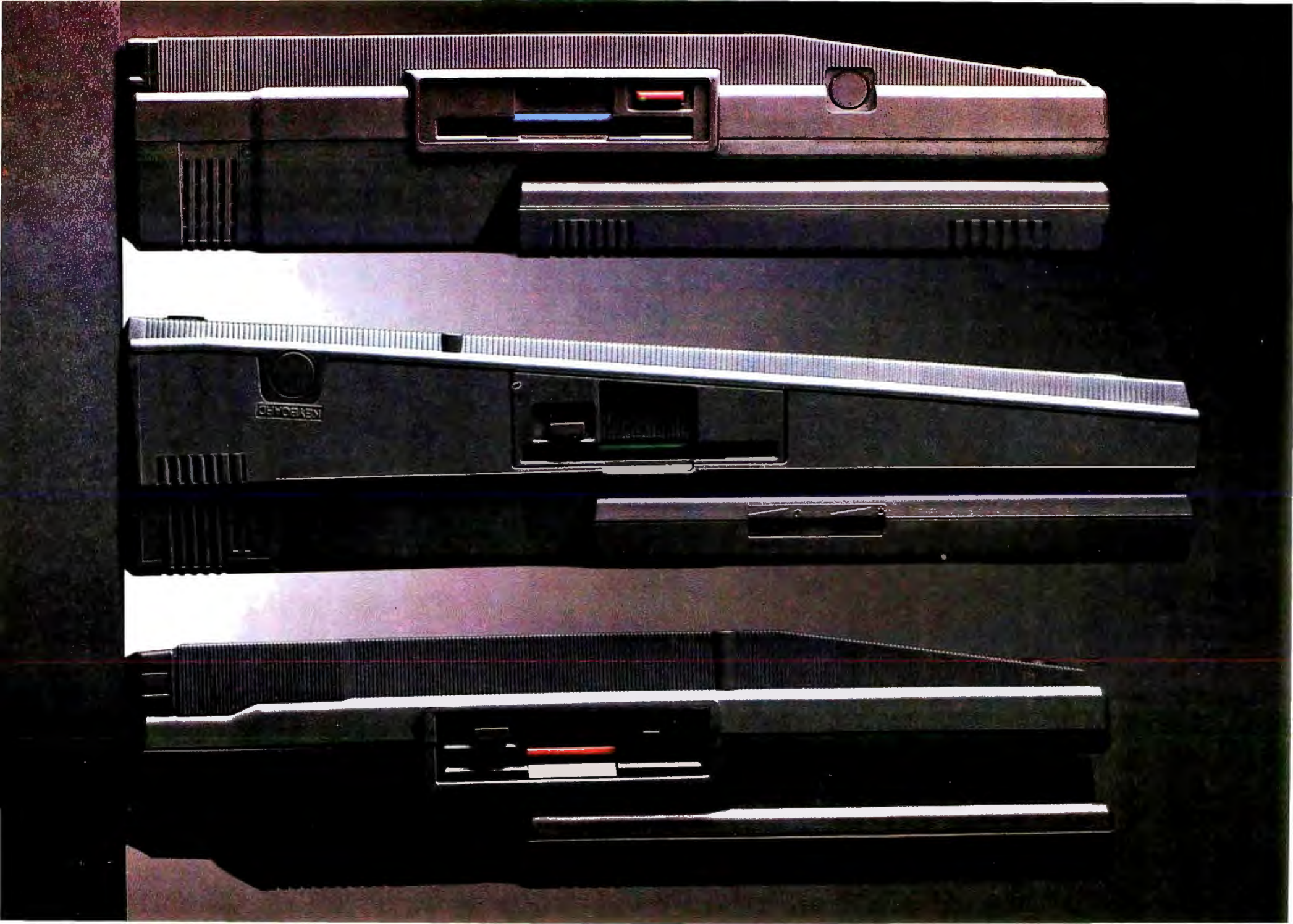

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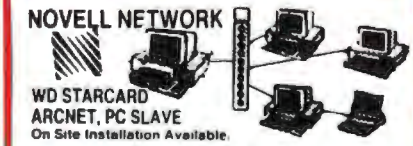

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BOOK REVIEWS

The Armchair Universe

by A. K. Dewdney

W. H. Freeman & Co., New York: 1988, 330 pages, $19.95 cloth, $13.95 paper

Reviewed by Hugh Kenner

For nearly two years, a Turbo Pascal program I play with on my Zenith Z-100 has been accumulating shortcuts and speedups. It examines areas near the border of the famous Mandelbrot set and represents their detail with colored patterns. It began as a direct translation into Pascal of a program that, being in interpreted BASIC, was far too slow. The author of the BASIC program had been guided by a short algorithm in the August 1985 *Scientific American*. My copy of that issue was long ago swiped by someone, and the library copy I recently consulted had lost the article to a vandal's scissors. I was pleased to find it reprinted in this first collection of A. K. Dewdney's Computer Recreations columns.

I suspect that's not an uncommon scenario. Dewdney is very likely responsible for more filched and mutilated copies of *Scientific American* than any other current author. He has also prompted, worldwide, uncountable hours of coding time. That's because he doesn't list programs; he states some interesting theme and shows you how to think about implementing it. At the back of *The Armchair Universe* is a list of suppliers, and Dewdney's tone dissuades you from even thinking about buying such canned software—an altruistic act, given that Dewdney himself might be one of the suppliers. He'd like us all to get our feet wet and our minds stretched by learning to program (i.e., think sequentially). He wants us to shed the chains of "software slavery," a state "inadvertently encouraged" by packagers.

This collection has something for almost everyone. If, like me, you're challenged by graphics, there are chapters entitled "The Mandelbrot Set" and "Wallpaper for the Mind." Higher Math? Try "Golomb Rulers" or "Hypercubes." Artificial Intelligence? Try "RACTER," "Facebender," "Checkers," more. Life? Puzzles? Simulations? They're all here. And if your fantasies run to aliens snuffing out benign systems, three pieces on "Core Wars" deal with plagues that propagate through memory, zapping anything they find except themselves.

Good Medicine for Pros

The great merit of Dewdney's approach is his patient, genial concentration on how to define a project and relax and think about it. His book might even be good medicine for pros who scorn the very idea of recreational computing. Thus he cites the solution of Jon L. Bentley (Programming Pearls columnist for *Communications of the ACM*) to the problem of finding anagrams. Assume the computer has access to a dictionary (as it must, to know if what it has found is a word). The obvious way is to exhaust the permutations, checking each in the dictionary. At 120 permutations for just 5 different letters, that's slow. But here's Bentley's "Aha!" way: Sort the letters of each dictionary word in ascending order; sort the resulting list; and pair its entries with the parent words, like this:

aecrs	acres
aecrs	cares
aecrs	races
aecrs	scare
aecrt	cater
aecrt	crate

That big but uncomplicated job once done, any anagram problem is reduced to a single-letter sort and a quick lookup. You want anagrams for *acres*? The sort is *aecrs*. The lookup finds *cares*, *races*, and *scare*. And that is all, so far as this dictionary knows.

One pleasure in *The Armchair Universe* problems is enjoying them in themselves (every day, in countless news-

continued

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In the Age of the Smart Machine: The Future of Work and Power

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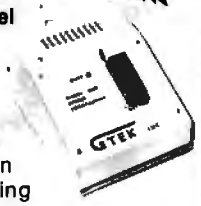

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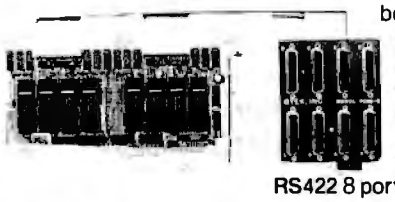

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papers, anagrams entrance the players of a game called Jumbles), and another is the light they can throw on deeper problems. A story I especially enjoy has Dewdney in a quarry marveling at a fossil trilobite, when a man named Smith, a professor of paleontology, happens by. Why, Dewdney asks him, did the trilobites become extinct? Why, Smith rejoins, is the name *Smith* so common? Those turn out to be the forms of the same question, and they prompt two related algorithms—PALEOTREE, in which genera and species survive, mutate, or die out; and NEOTREE, in which families (and their names) become extinct, leaving space for Smiths to flourish in. The chief difference is that NEOTREE has no parallel for new species evolving. (Though what about Smythe from Smith? In fine-tuning that program, I'd insert a Vanity Factor.)

Start with 1000 family names, and, by NEOTREE's showing, in about 23 generations three-quarters of them will be extinct. That's because it's the males who carry on the name, and the empirical probability is 0.317 that a family will produce no males destined to marry. Half the families are gone in some 3 generations, two-thirds in about 10. Thereafter, attrition slows down. Will the number ever shrink to 1? Perhaps in Googolplex years (that's 10 to the 10th to the 100th). Or more likely not. If Smiths are a tenacious tribe, so are Joneses.

Then there's the Voting Simulation dreamed up by two Britons. We start with a grid of randomly colored squares—say, blue for Republican, red for Democrat. We next assume that opinions follow those of forceful neighbors. Select a voter at random; select one of his eight neighbors at random; change his persuasion to that of the neighbor. Silently and rapidly, this simulates a lot of argument, a lot of malleability, and strange things happen. (Voters near an edge of the grid still have eight neighbors because left wraps to join right, top to join bottom. Yes, that does make the country toroidal. I have a feeling this game could be implemented on a spreadsheet.)

"First, large blocks of votes develop within the grid. The blocks are geographic areas where everyone has the same opinion." (Recall FDR's old Solid South.) "Then the blocks migrate around the grid, and for a while two blocks struggle for dominance. Finally, the two-party system collapses as everyone ends up voting the same way. The smaller block vanishes as democracy votes itself out of existence—or does it? This is a neat philosophical question."

Dewdney hastens to remark that as a model of the political process, this is "admittedly simpleminded." He also reports that even so simple a model leaves democracy looking pretty tough. Some readers reported that after an overnight run, considerable difference of opinion lingered. In Dewdney's own experience, achieving unanimity takes "the better part of a day": many million acts of random persuasion. (And what happens, he asks, if each beset voter crankily adopts an opinion the *opposite* of that random neighbor's? He doesn't tell, and I haven't tried it.)

Simulation vs. Reality

Many of Dewdney's chapters conjure up the besetting devil of Computer Simulations: Do I really gain insight into real-world events, or am I just amusing myself with a model so neat I can see how to program it? The chapter entitled "Sharks and Fish on the Planet Wa-Tor" is a good example. Fish die of being eaten by sharks; sharks die if they haven't eaten recently enough. Both have single offspring at fixed intervals (it works best when the sharks breed more slowly). Both move at random, point to point, north, south, east, west, with this complica-

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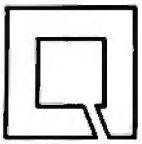

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tion: A shark will always move to (and eat) an adjacent fish when there is one.

I haven't tried this one, either, though the programming looks simple. What Dewdney reports is scenarios sensitive to geometry. Neither the initial distribution nor the actual movement seems important, but when a tight school of fish forms, then the sharks discover and destroy it, then die themselves for lack of food. Result: zero population of any kind. (Though sometimes a smaller school of fish, elsewhere on the screen, would go unnoticed until the sharks were extinct. Result: an ocean crammed with fish.)

An evident simplifying assumption is that nothing ever happens to fish, save getting eaten by sharks. Still, the game exhibits cyclic ups and downs that resemble the fluctuating numbers of predators and prey in situations that have been tabulated, as when Hudson's Bay Company counted a whole half-century's lynxes and hares. A lot of hares fed a lot of lynxes; then as hares drew near extinction lynxes died off, too, permitting a resurgent hare population... You see the pattern.

A graph of some very smooth things called the Lotke-Volterra equations looks rather similar, and they've been invoked to model predator-prey fluctuations. But by Dewdney's report, graphs derived from the Wa-Tor game look more like the Hudson's Bay data than Lotke-Volterra curves do. He's puzzled, though, by certain long-term instabilities. I'll leave it at that. Computer modeling still awaits its Leibniz.

BRIEFLY NOTED

In the Age of the Smart Machine: The Future of Work and Power *by Shoshana Zuboff, Basic Books, New York: 1988, 468 pages, $19.95.* The television introduced to entertain may end up shaping the very schedule of our days. The microwave bought for convenience may change the type of meals we eat. Thus, examining a technology only in light of its original intentions may obscure the actual effects. Such is the case with computers: They are installed in order to increase productivity, but, in fact, they fundamentally alter the work environment. Shoshana Zuboff takes a long, careful look at what happens to the workplace when computers are introduced.

Zuboff has two basic ways of looking. First, she uses her eight in-depth studies (1981 to 1986) of companies that had recently made the transition to computerization. Second, she puts observations about the current work environment in light of a history of work informed by her wide readings in philosophy, psychology, and sociology.

Zuboff takes the body as the focal point of her history of work. At first, work was physical labor that required bodily effort and bodily skills. As work has developed—or at least changed—throughout the centuries, it has been distributed, and the types of knowledge necessary have changed. (Zuboff's analysis of knowledge develops from her description of the different ways one's body inhabits one's environment, rather than beginning from an assumption that mind and body are fundamentally apart. This approach proves fruitful, in line with the work of the French phenomenologist Maurice Merleau Ponty.)

Zuboff looks to her case studies to find the state of work today. Her findings are not surprising. For example, at a pulp mill where workers went from checking on the pulping process by sticking their hands into the vats to checking a digital readout on a computer console, the workers have traded bodily involvement and skillful knowledge for a more abstract relationship with their

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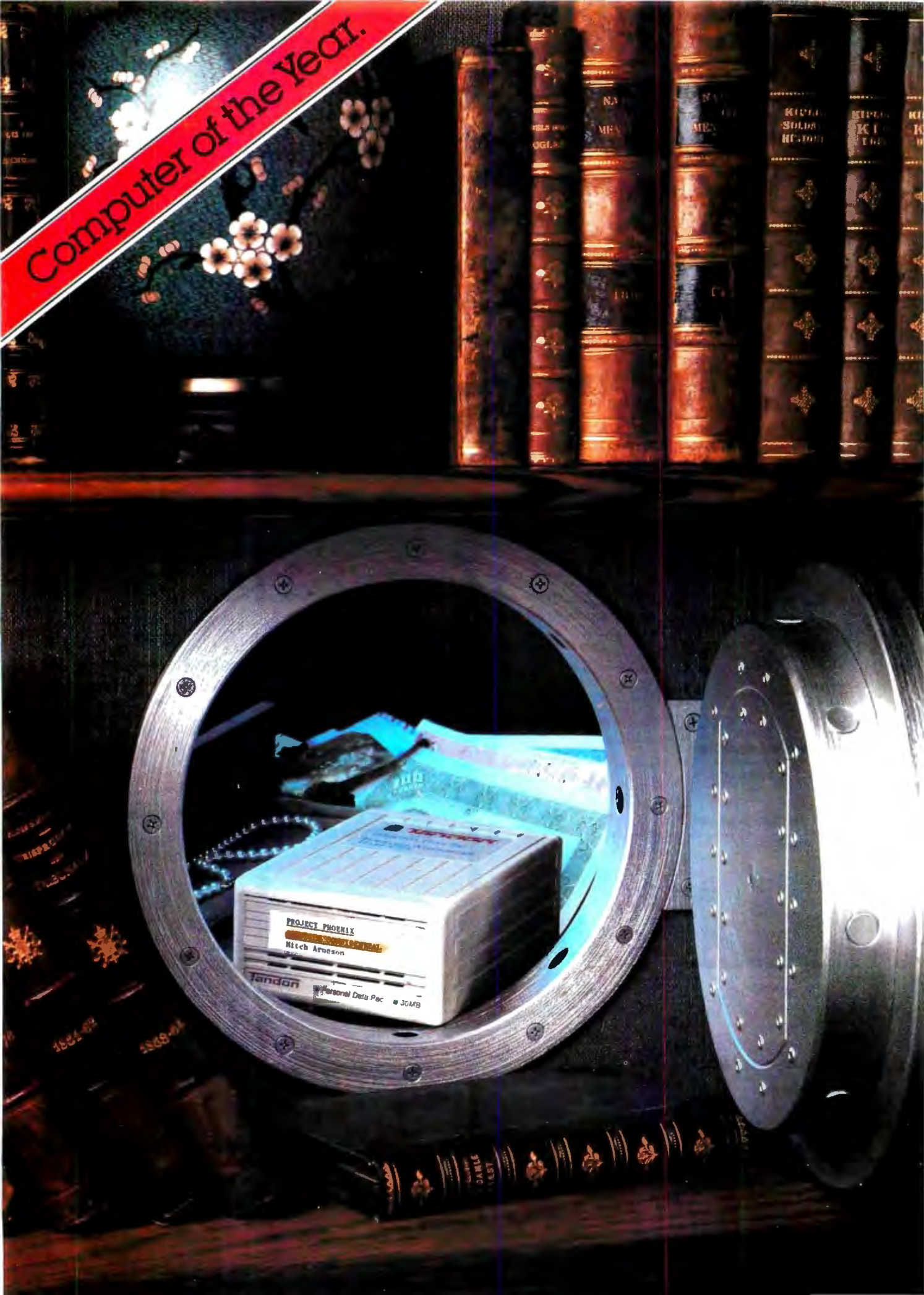
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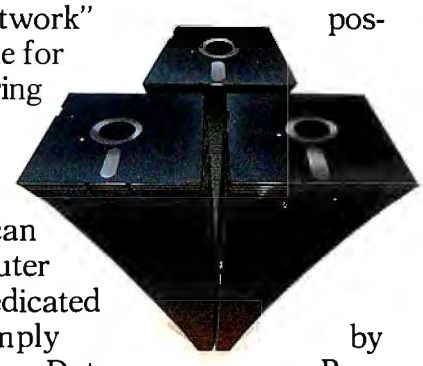

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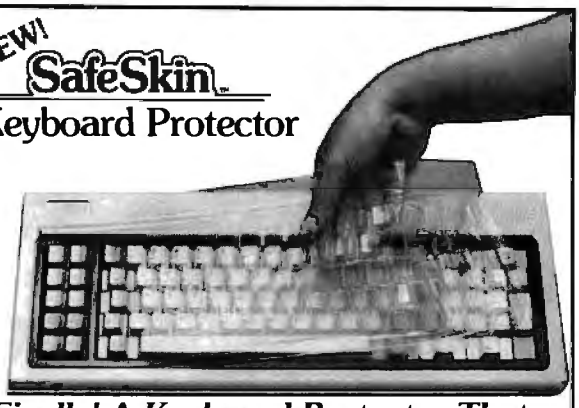

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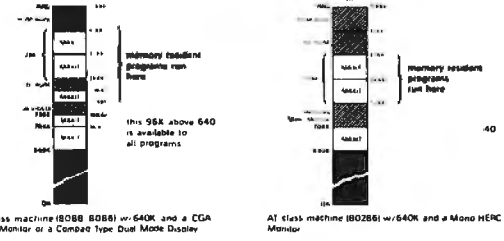

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work. Zuboff discovers that this has resulted in a certain amount of alienation. More interesting, she describes what happens to social relationships and work flow when employees are moved into cubicles to go one-on-one with a CRT.

Even when the results are not surprising, and even when the case study accounts go on too long, Zuboff keeps it interesting by putting the results into a larger historical and philosophical context. (She does, however, tend to suffer from the Academic Syndrome: She uses lots of jargon—"textualization" and "automaticity"—and discusses many marginally relevant authors.)

The second part of the book moves from the question of knowledge to that of power. Zuboff maintains that computerization changes the type and justification of managerial authority. Originally, a boss got the right to lord it over people because he or she was the owner. Then bosses received their legitimacy by virtue of having worked their way up the ladder. Now, bosses (or managers) have authority by dint of their mastery of the Science of Management.

Part Three discusses the techniques that "can shape and control behavior and so can be harnessed to the interests of those who employ them"—the techniques by which authority maintains itself in the computer-laden workplace. Frequently, computerization leads to increasingly centralized control, usually accomplished by centralizing knowledge (i.e., managers become information hogs). Yet Zuboff reports that several years after the transition, some companies were recognizing "the need for critical judgment at the information interface" and the value of "intellective skills" in analyzing and responding to digital information.

But the chief technique of control is "the information panopticon"—the omniscient, objective computerized record of all that occurs in the workplace or plant. Zuboff is particularly good at disclosing what life under that unceasing eye is like for both workers and managers.

At the end, Zuboff offers a brief view of a nonhierarchical organization that more uniformly distributes knowledge and skill. She also includes a section entitled "Dissent from Wholeness," which describes the disadvantages of this seemingly more egalitarian environment: a loss of sense of definition, rights, and autonomy.

At times tendentious, at times based on too few examples, at times too long, *In the Age of the Smart Machine* remains an important work.

—David Weinberger

Programmer's Guide to the Hercules Graphics Cards *by David B. Doty, Addison-Wesley, Reading, MA: 1988, 370 pages, $24.95.* This book delivers a comprehensive treatment of Hercules graphics cards. It is occasionally marred by a bit of hype and homage to Hercules Computer Technology, but it overcomes this with clear explanations of the architecture of each card, many solid programming examples, and some knowing advice on the design of graphics software. David B. Doty describes the original Hercules graphics card, the later RamFont card, and the latest InColor card in detail.

Because the Hercules cards are programmed without using the PC ROMBIOS, writing programs for them is decidedly different than programming for other IBM graphics adapters. Doty wrote his programming examples in Microsoft Assembler and Microsoft C, but the assembly language functions can be readily changed to work with the stack frame conventions of another compiler. The functions include detecting a Hercules adapter and its type, writing a dot, reading a dot, drawing a line, displaying text, drawing circles, filling a

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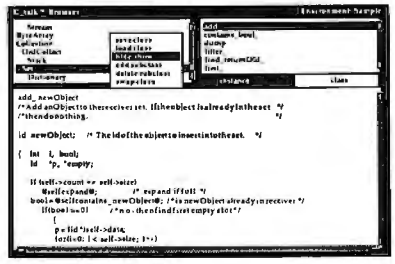

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(DEALERS: 44)

closed shape, printing a screen, and saving and restoring an image to and from a file. The source code contained in the book is available directly from the author for $30.

Today, Microsoft's C 5.0 and Borland's Turbo Pascal 4.0 provide comprehensive support for the original Hercules card, but Doty's book provides thorough background information, even for users of these languages. Whether the RamFont and InColor cards will succeed in the market as well as the original is still unclear, but for someone who needs to program for either, the book is essential.

—Ben Myers

Manufacturing Intelligence *by Paul Kenneth Wright and David Alan Bourne, Addison-Wesley, Reading, MA: 1988, 352 pages, $40.95.* This book is not only an excellent text for the engineer learning about factory automation, but it also serves as a good basis for an engineer about to specify an automation project. The authors ask all the necessary questions to determine what an automation project should accomplish. Written for the manufacturing engineer as well as the software engineer, *Manufacturing Intelligence* provides enough knowledge so that each can understand the mechanical and computational tasks required in factory automation.

The book is divided into four sections. The first describes the present and immediate future state of the machine tool industry. It also highlights one of the author's developments, Cell Management Language (CML), a software environment offering a high-level solution for controlling a number of incompatible machine tools and robots.

The second section goes over the different parts needed for intelligent machines to function. These include vision, machine control, and manipulators. The third section looks at how the knowledge and talent of a skilled craftsman can be transferred to an intelligent machine. Included here are examinations of artificial intelligence, flexible fixtures, and sensor technology. The last section of the book speculates on the future of manufacturing technology.

The book offers both a glossary and a good bibliography. The chapters are well cited, so readers can pursue any issue that is presented.

—Keith H. Erskine

HyperCard Power *by Carol Kaehler, Addison-Wesley, Reading, MA: 1988, 435 pages, $17.96.* This book is a review of the widely acclaimed Macintosh program for the novice and entry-level HyperCardarian. Copiously illustrated, it has great breadth of subject matter, but little depth. Carol Kaehler devotes only paragraphs to concepts such as passing messages to the next handler, yet she supplies practical and indexed hints. For instance, she explains how to make sure a card inherits the correct background—not a trivial task in some situations. She provides utility scripts in one chapter, but leaves the reader to extend them.

The book covers some of the HyperTalk language at the introductory level in one brief appendix. *HyperCard Power* is at its best when it shows simply and step by step how to accomplish unified HyperCard tasks. *—Larry Loeb* ■

CONTRIBUTORS

Critic and author **Hugh Kenner** lives in Baltimore, Maryland. **David Weinberger** works for Interleaf and lives in Brookline, Massachusetts. **Ben Myers** designs and writes IBM PC graphics applications and lives in Harvard, Massachusetts. **Keith H. Erskine** is a program coordinator for Sun Microsystems in Billerica, Massachusetts. **Larry Loeb** is a dental surgeon in Wallingford, Connecticut.

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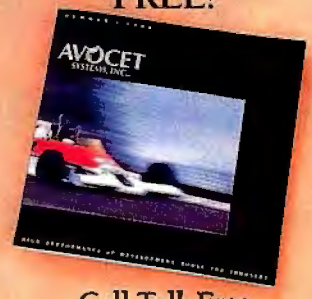

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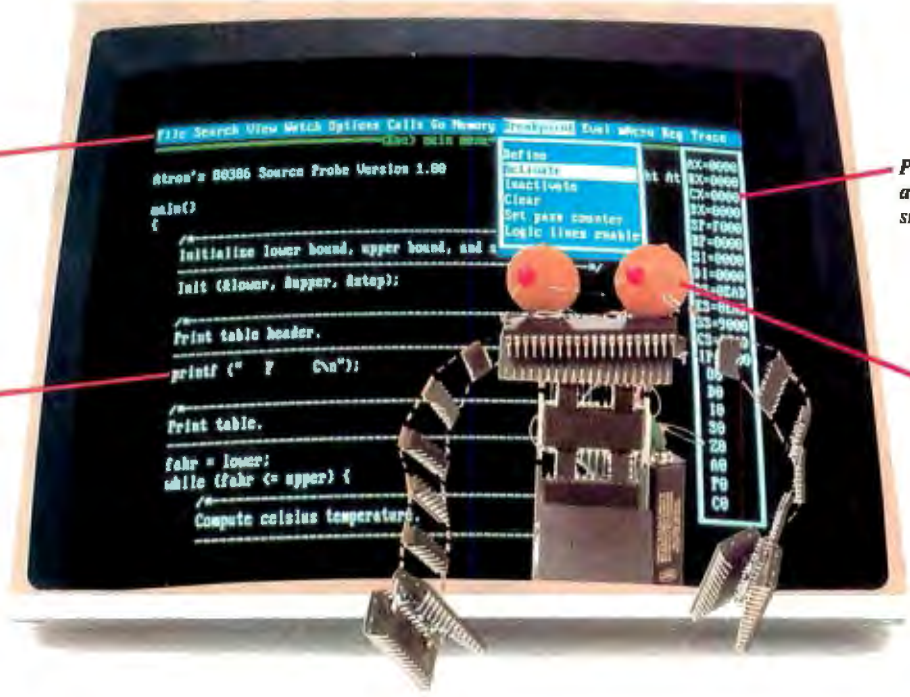

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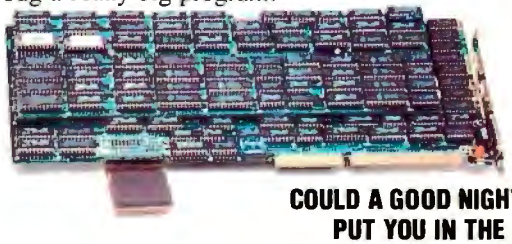

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Circle 15 on Reader Service Card

The Incredible Shrinking System Unit

Claimed to be the "world's smallest," Advanced Logic Research's latest systems are the FlexNode 286 and the FlexNode 386. Both occupy 4½ by 15 inches of desktop real estate and perform at 20 MHz with zero wait states by using paged interleaved cache memory.

The systems have 1.44-megabyte PS/2-compatible 3½-inch floppy disk drives and industry-standard 101-key keyboards. Both have four full-length 16-bit expansion slots, as well as an optional expansion unit that provides an additional four slots and support for a second hard and floppy disk drive. Within those additional slots, you can place ALR-designed ARCnet, Ethernet, or token-ring adapter cards.

The FlexNode 286 comes standard with 512K bytes of RAM, expandable to 5 megabytes with add-in cards. The 386 comes standard with 1 megabyte of RAM and can be expanded to 13 megabytes with an optional ALR RAM-Pak. There is also room for an optional math coprocessor.

Both machines include a four-slot backplane with a single RS-232C serial port, a parallel port, and a floppy disk controller.

Price: $1990 for basic 286; $2549 with 30-megabyte hard disk drive and controller; $2990 with 50-megabyte hard drive and controller; $3490 for basic 386; $3990 with 30-megabyte hard drive and controller; $4449 with 50-megabyte hard drive and controller.

Contact: Advanced Logic Research, Inc., 10 Chrysler Ave., Irvine, CA 92718, (714) 581-6770.

Inquiry 751.

The FlexNode system has a 5- by 15-inch base.

Laptop Makers Shed Light on Their Screens

Mitsubishi's mp286L laptop features a fluorescent backlit liquid crystal display (LCD) and four slots for add-in capabilities. The 12-/8-MHz, one-/zero-wait-state machine comes standard with a 6½- by 9¼-inch display and 640- by 400-pixel resolution.

Features include dual 1.44-megabyte 3½-inch floppy disk drives and 640K bytes of RAM that you can expand to 2.6 megabytes.

The CGA controller is in one slot, additional memory is in a second, and a built-in Hayes-compatible 2400-/1200-/300-bit-per-second modem is in the third. The fourth slot could be used for a local-area-networking card.

Weight is 16 pounds, not including the optional 7-pound battery pack.

Price: $3195; OS/2, $325.

Contact: Mitsubishi Electronics America, Inc., Computer Systems Division, 991 Knox St., Torrance, CA 90502, (800) 556-1234; in California, (800) 441-2345.

Inquiry 752.

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.

Multiuser 386 Power in an 11-inch Cube

Housed in an 11-cubic-inch box, the Unix-based QB2 386 from Cubix has the advantage of being MS-DOS-compatible while acting as a file server for up to eight processors or terminals.

It runs with zero- or one-wait-state performance because of an alternative banking scheme. When configured with 4 megabytes of memory, it runs with zero wait states. When configured with 8 megabytes, it runs with one wait state. The standard package includes an 80387 coprocessor and an Ethernet controller.

The QB2 386, as the name implies, is based on Intel's 80386 processor. It runs Unix version 3.0 and comes standard with 2 megabytes of RAM, expandable to 8 megabytes. In a standard configuration, it includes an 80-megabyte hard disk drive, a 60-megabyte tape drive for backup, and a 1.44-megabyte 5¼-inch floppy disk drive.

The built-in power-fail system involves nickel-cadmium batteries for 10-minute on-line protection. If the power stays off for longer than 10 minutes, another battery subsystem kicks in for up to an hour. Software that automatically shuts the system down is activated next, but not before the system tells you it's time to quit because it's operating on batteries.

Price: $8995.

Contact: Cubix Corp., 2800 Lockheed Way, Carson City, NV 89706, (702) 883-7611.

Inquiry 753.

continued

Compact Keyboard Conserves Desktop Real Estate

By compressing row spacing, Mechanical Enterprises has designed an IBM PC AT– and XT-compatible 100-key keyboard that's 60 percent smaller than traditional AT-enhanced keyboards.

The microtype keyboard measures only 11 by 6 inches and weighs less than 2 pounds. Mechanical Enterprises says its studies show that touch typists achieve normal typing speed after a short familiarization period.
Price: $150.
Contact: Mechanical Enterprises, Inc., 461 Carlisle Dr., Herndon, VA 22070, (703) 435-9496.
Inquiry 754.

Space-saving 100-key PC-compatible keyboard.

End Those Scrolling Blues

A dual-page landscape monitor from Nutmeg Systems lets Macintosh desktop publishing aficionados view two complete pages when they write, edit, and prepare layouts.

The Nutmeg 19, available for the Mac Plus, SE, and II, has a 79-dpi resolution in a 1024- by 768-pixel paper-white phosphor display. The horizontal refresh rate is 63.65 kHz, and the vertical scan rate is 63.73 kHz.

The monitor measures 17 by 19 by 18 inches and weighs 42 pounds. Nutmeg also uses a proprietary video interface that lets you easily upgrade your monitor if you move up to a Mac II.
Price: $1899 for use with the Mac II; $1699 for use with either the Plus or SE.
Contact: Nutmeg Systems, Inc., 25 South Ave., New Canaan, CT 06840, (203) 966-3226.
Inquiry 755.

A Passport to Portable Data

Plus Development's latest technological innovation is called the Plus Passport. It's a removable hard disk system that lets you insert 1¼-inch thick, 3½-inch 20- or 40-megabyte hard disks into the company's custom chassis like you insert video cassettes into a VCR.

You then have an MS-DOS- and OS/2-compatible hard disk subsystem that works on all the IBM machines and compatibles, including systems with Micro Channel architecture.

The drives use 1-to-1 interleave for efficient data throughput and are rated for shocks of up to 150 g's. If you use the Passport for booting up other drives, you can back up as much as 40 megabytes of data in less than 5 minutes, says Plus Development.

The drive cartridges fit into a drive subsystem that fits into a standard 5¼-inch half-height bay.
Price: 20-megabyte PC version, $1250; 40-megabyte PC version, $1450; 20-megabyte Micro Channel version, $1350; 40-megabyte Micro Channel version, $1550.
Contact: Plus Development Corp., 1778 McCarthy Blvd., Milpitas, CA 95035, (408) 434-6900.
Inquiry 756.

Yes, We Have No DataDesk Keyboards

DataDesk International keyboards were incorrectly associated with EECO keyboards in the June What's New section on page 70 ("123-Key Keyboard Remembers Macros").

DataDesk is an independent designer and manufacturer of two popular keyboards: the Turbo-101 for IBM PC compatibles, and the Mac-101 for Macintosh computers.

The two keyboards together are compatible with just about everything on the market, including the Tandy 1000, AT&T PC 6300, and IBM PCjr. The two keyboards are 101-key units with firm keys that produce a definite "bounce feeling" that many users prefer over PC-clone and Macintosh keyboards.
Price: Turbo-101, $149.95; Mac-101, $169.95.
Contact: DataDesk International, 7651 Haskell Ave., Van Nuys, CA 91406, (818) 780-1673.
Inquiry 757.

continued

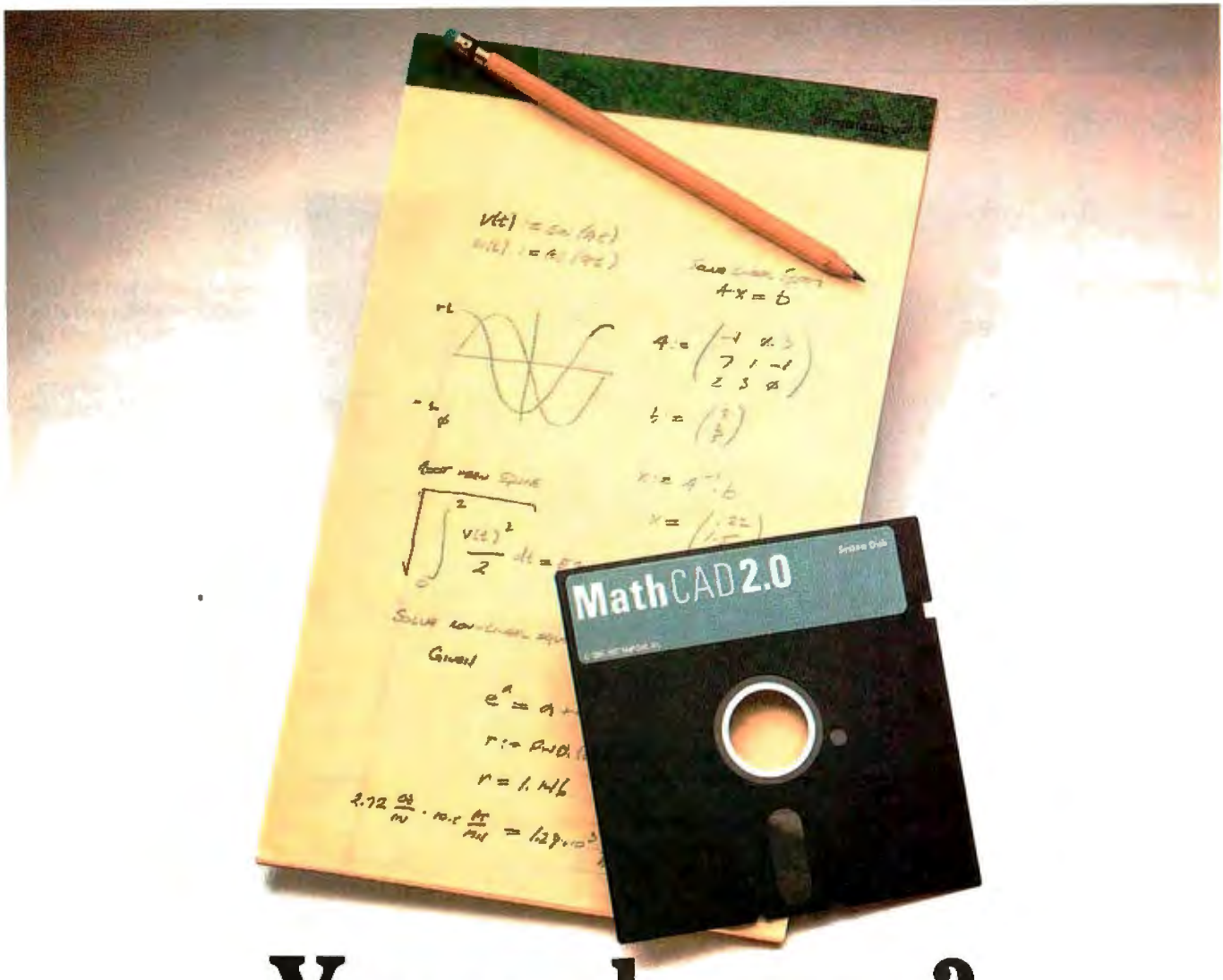
Put Up to 8.4 Gigabytes in the Palm of Your Hand

While the battle over digital audio tape (DAT) for recording music rages in both Congress and the music industry, a California company has adopted DAT technology for storing truly massive amounts of computer data.

Gigatape's Giga 1200 DAT subsystem writes from 1.2 to 8.4 gigabytes on a standard 4-millimeter digital tape cartridge. The company claims that the unit is compatible with all the IBM machines and compatibles, including the PS/2s, as well as with the Macintosh, MicroVAX, and other workstations.

The Giga 1200 uses helical scan technology, originally developed for the VCR industry, and the latest digital recording techniques. Helical scan technology involves using two read/write heads on a drum that rotates at 2000 rotations per minute.

The tape speed is 0.32 inches per second, and the data transfer rate averages 192K bytes per second. But read/write is sustained even through 1.5-megabyte-per-second bursts. That means an entire tape can be loaded with information in less than 2 hours. Error correction is handled with a proprietary code that the company claims keeps bit and burst errors to less than one in 10^{15}.
Price: $6500.
Contact: Gigatape, Inc., 5266 Hollister Ave., Santa Barbara, CA 93111, (805) 964-8990.
Inquiry 788.



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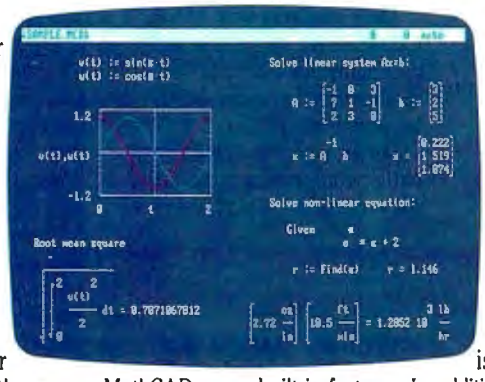

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Circle 138 on Reader Service Card

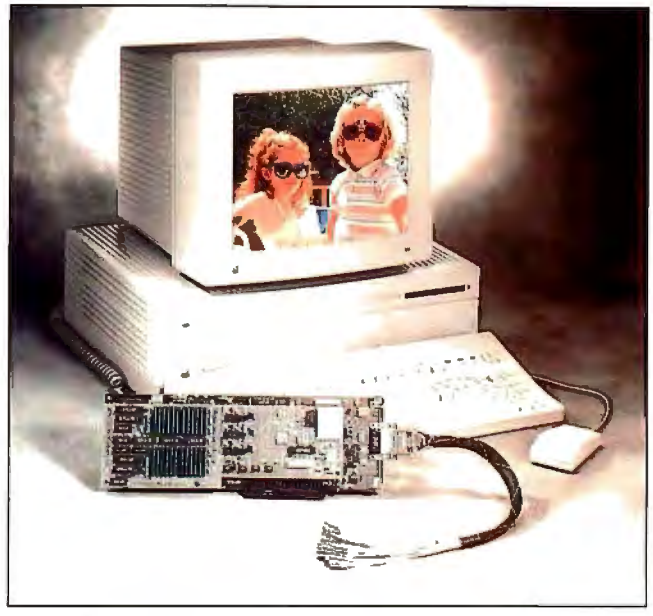
Manipulate Video on Your Mac II

Now you can use your Mac II to display video captured from standard video sources, then manipulate that image and add graphics with the ColorCapture board by Data Translation.

The board allows real-time video that's been captured on video cameras, VCRs, and still-video equipment to be displayed on the Mac II. Two versions are available—one for the National Television System Committeee (NTSC) standard in North America and Japan, and one for the Phase Alternate Line (PAL) standard in western Europe.

Once you capture the image, you can crop the picture, add text or graphics, export color images to other applications, sharpen and soften edges, adjust brightness and contrast, add or subtract images, print hard copies, animate, and output to a videotape.

Resolution is 640 by 480 pixels, and images can be displayed from a palette of 32,768 colors. The board fits into a single Mac expansion slot with a cable that extends from the board to plug into video cameras, VCRs, or electronic still-video equipment. For live display, you can attach composite or RGB monitors directly to the board.



Real-time Mac II video translation.

Additional specialized functions include a zoom/pan/scroll controller, which allows instantaneous magnification and close-up examination of image regions. There's also a graphics memory plane for merging text and drawing lines, arcs, curves, boxes, icons, and so on.
Price: $2995.
Contact: Data Translation, Inc., 100 Locke Dr., Marlborough, MA 01752, (617) 481-3700.
Inquiry 758.

Low-Cost, High-Speed Modem

The ATI Technologies 2400etc is a 2400-bit-per-second internal modem that allows for the equivalent of 4800-bps data transmission with its data-compression techniques.

Only modems with MNP Class 5 error correction will communicate with this modem at maximum speed, however. MNP Class 5 provides for what the company calls "100 percent error-free data transfer." This IBM PC–compatible unit fits into a standard half slot and also operates at 1200 and 300 bps.
Price: $239.
Contact: ATI Technologies, Inc., 3761 Victoria Park Ave., Scarborough, Ontario, Canada M1W 3S2, (416) 756-0711.
Inquiry 759.

Serial Mice Can Now Take the Bus

The Pointing Device Adapter (PDA) lets you convert your serial mouse to work on a standard PC bus, freeing up that serial port for other things.

This MicroSpeed product, a ½-length card with software for Microsoft, Logitech, Mouse Systems, and compatible rodents, is compatible with the IBM AT, XT, PS/2 Model 30, and compatibles.

The PDA's features are many. They include an I/O address that's the same as that for bus mice, and interrupt selection for IRQ 2, 3, 4, 5, or 7. MicroSpeed's MAP (multi-axis pointer) driver with ballistic gain support is included, allowing you to better control the pointer on the screen with the mouse. While the ballistic gain feature has been available on the Macintosh mice for some time, MicroSpeed says this is the first time you can buy a mouse for PC compatibles with variable speed control.

Finally, there's a device driver for Windows applications, an AutoDesk device interface driver for AutoCAD, and MicroSpeed's KeyMAP keyboard emulator software.
Price: $69.
Contact: MicroSpeed, Inc., 5307 Randall Place, Fremont, CA 94538, (800) 232-7888; in California, (415) 490-1403.
Inquiry 760.

continued

The ConoDesk 6000, a PostScript-compatible printer controller, outputs PostScript code 10 times faster than competing units, the manufacturer claims.

Scalable fonts for Ventura Publisher, PageMaker, and Windows let you scale every typeface to all standard PostScript point sizes and rotate them to any angle.

The controller uses a proprietary 32-bit microprocessor and 2.5 megabytes of RAM and works with the IBM XT, AT, Compaq 386, and compatibles. It supports Hewlett-Packard LaserJet and Canon-engine printers.

There are 13 typefaces with PostScript-compatible metrics and a 228-character set for Ventura Publisher and PageMaker. Optional software includes ConoScript, the interpreter that allows the printer to print PostScript files. Optional hardware includes HP LaserJet Series II and Canon LBP-8II video interface boards.
Price: $2995 for the base system with interpreters for Windows and PageMaker; $695 for the ConoScript interpreter; $100 to $700 for a floating-point processor.
Contact: Conographic Corp., 16802 Aston, Irvine, CA 92714, (714) 474-1188.
Inquiry 789.

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Features ● = Yes ○ = No	Sprint 1.0	WordPerfect 4.2	MS Word 4.0	WordStar 4.0	MultiMate Adv. 1.0
Maximum file size	Disk	Disk	Disk	4MB	128K
Thesaurus (integrated)	●	●	●	●	●
Windows Open (maximum)	6	2	8	1	1
Files Open (maximum)	24	2	8	1	1
Cross-Reference (dynamic)	●	○	○	○	○
Indexing Options	7	1	3	3	○
Columns: Parallel	●	●	●	●	●
Snaking (chg. # same page)	●	●	Not same pg.	○	●
H-P LaserJet Support	Full	Partial	Full	Partial	Full
PostScript Support	Full	Text	Full	○	Text
Mouse Support (integrated)	●	○	●	○	○
Dynamic Shortcuts	●	○	○	○	○
Alternative User Interfaces	●	○	○	○	○
Verify Spelling as you type	●	○	○	○	○
Programmable Macro lang.	●	○	○	○	○
Save File[1]	5.9	41.1	9.7	4.4	1.0
Top to Bottom[2]	7.5	7.5	49.4	8.1	21.0
Search and Replace[3]	1.6	6.6	4.6	17.1	13.4
Find Unique Word	3.3	6.2	7.0	13.8	20.6
Suggested List Price	$199.95	$495.00	$450.00	$495.00	$565.00

Time tests were performed on an Acer 286 (8 MHz), 640K RAM. [1]File size 103K. [2]1636 lines. [3]14 occurrences. Times shown are in seconds. (Benchmark details available upon request.)
Prices and specifications subject to change without notice.

*Customer satisfaction is our main concern: if within 60 days of purchase this product does not perform in accordance with our claims, call our customer service department, and we will arrange a refund.

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Circle 30 on Reader Service Card (Dealers: 31)

An Affordable and Expandable Fiber-Optic Network

Eight XT- or AT-compatible computers, eight printed circuit boards, one networking hub, and fiber-optic cabling constitutes the simplest form of the new Ethernet local-area network (LAN) from 10Net Communications.

But you can expand that with more fiber-optic cabling, more boards, and more hubs. Each hub supports eight computers. To form a 392-computer, 10-megabit-per-second (mbps) LAN with as much as 6 kilometers between any two nodes, you'll need 54 hubs, 392 boards, and lots of cabling.

To expand the network even further, you can add a regenerative repeater and link two 392-computer networks. A second repeater allows you to link more than 1000 computers. The boards use Intel's 82586 Ethernet controller chip and have Hewlett-Packard LED sources and positive-intrinsic-negative (PIN) photodiode receivers to transmit and receive 850-nanometer light pulses through 62.5-micron multimode fiber-optic cabling with recommended SMA or ST connectors. Total delay between two hubs on 392-computer clusters is 25 nanoseconds.

Repeaters, which restore amplitude (like the hubs) and retime the signals, add 750 ns to transmissions. Repeaters also allow connection of fiber-optic to coaxial or cheapernet (thin coaxial) cabling.

If you add two more full-length cards to one of the computers, you have a bridge that will link clusters of 10Net 1-mbps LANs with several types of networks, including Ethernet, Token Ring, and ArcNet. The networking software is 10Net's existing package, 10Net 4.0, which includes an electronic mail package called Network Courier from Consumers Software.

Price: PC board with software, $1295; hub, $2995; repeater, $1395. (Fiber cabling and installation not included.)
Contact: 10Net Communications, 7016 Corporate Way, Dayton, OH 45459, (513) 433-2238.
Inquiry 765.

Ethernet local-area network from 10Net Communications.

Ethernet Stalks the Twisted Pair!

If you're considering installing Ethernet but the hassle of running coaxial cable through the walls and floors is giving you pause, Hewlett-Packard has a simple solution. Its newest product, HP StarLAN 10 PC Link, uses the already-installed telephone wiring in your building to network your PC or compatibles at 10 mbps.

PC Link includes a half-length PC card and software called OfficeShare, which provide the transport mechanism between MS-DOS- or Unix-based systems, as well as the twisted-pair Ethernet network that HP introduced last year. With PC Link, you can locate as many as 12 PCs up to 100 meters from the networking hub. And those capabilities will increase when repeaters and bridges become available, since StarLAN 10 can support a total of 1024 PCs or Unix devices.

You can also connect your PCs using existing coaxial Ethernet networks with a device called the Twisted-Pair Media Access Unit. According to HP, before its all-twisted-pair products became available, such coaxial-to-twisted-pair devices were the only way to connect PCs to Ethernet.

Price: PC Link, $695; hub, $2995; Twisted-Pair Media Access Unit, $295.
Contact: Hewlett-Packard Co., Customer Information Center, Inquiry Fulfillment Dept., 19310 Pruneridge Ave., Cupertino, CA 95014, or call the HP sales office listed in your telephone directory white pages.
Inquiry 766.

Your PC or PS/2 Can Now Talk AppleTalk

The first IBM PC- and PS/2-based AppleTalk file server supports up to 30 machines at 230 kilobits per second (kbps). It consists of a board and software for the host and the clients.

The Tangent Technologies card, dubbed the Tangent-Share, eliminates the need for a dedicated Macintosh file server or for individual hard disk drives at each workstation. As a nondedicated file server, it allows you to store files and applications from any IBM PC, PS/2, or Macintosh on the AppleTalk network host, to use the host as a local disk drive, or to transfer files between incompatible systems.

TangentShare provides both "administrator" and "super user" privileges from any IBM or Apple machine on the network. Administrator machines can perform such management functions as adding users to the network and changing passwords. The super user machines, designated by the administrator machines, have complete access privileges to all directories in the network. There can be multiple administrators and multiple super users on each network.

Price: $700 for board and file server software; $325 for board and IBM PC client software; $400 for board and PS/2 client software.
Contact: Tangent Technologies, 5990-K Unity Dr., Norcross, GA 30071, (404) 662-0366.
Inquiry 767.

continued

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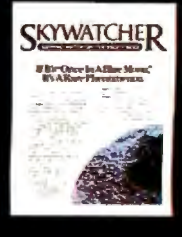

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Circle 129 on Reader Service Card (Dealers: 130)

Who Can Make a 4-inch Scan? The ScanMan Can

With 200-dpi resolution, ScanMan provides a way for you and your IBM PC, AT, XT, PS/2, or compatible to add graphics to desktop publishing, business presentations, and other documents. Then you can store the images in your personal database.

The ScanMan has a 4-inch-wide scanning window, and it can scan images that are up to 11 inches long. The scanner, interface board, graphics editor, and ScanWare software are included.

ScanWare allows for scanning directly into Microsoft Windows or to Logitech's Graphics Editor. The Graphics Editor allows many manipulations, including image sizing, cut and paste, color, reverse and rotate, insert, and magnify. Compatible application packages include Aldus PageMaker, Ventura Publisher, Logitech PaintShow, Logitech Publisher, PFS: First Publisher, and ZSoft PC Paintbrush.

Price: $299.
Contact: Logitech, Inc., 6505 Kaiser Dr., Fremont, CA 94555, (415) 795-8500.
Inquiry 761.

Logitech's 4- by 11-inch scanner.

More HP DeskJet Memory for Soft Fonts

Expansion memory cards for Hewlett-Packard DeskJet printers can expand your printer memory by 128K bytes with one cartridge or by 256K bytes with two cards.

Popular soft fonts such as Helvetica require as much as 256K bytes of memory. In fact, a single point size can use more than 50K bytes. These memory cards, therefore, provide for the necessary soft font memory. But in addition, the memory cards are compatible with hard fonts that fit into HP expansion slots.

Four 32K-byte by 8-bit static RAM chips are used in each 5- by 3-inch cartridge. Each cartridge is specifically designed for one of two option slots available on each HP printer.

Price: $129.
Contact: Pacific Data Products, Inc., 6404 Nancy Ridge Dr., San Diego, CA 92121, (619) 552-0880.
Inquiry 762.

Monitor Testing Made Simple

One tool now tests monitors and nothing else. It's called the Montest-A5D3, and it tests at least six types of standard personal computer monitors: IBM PC monochrome, Color Graphics Display, Enhanced Graphics Display, Mac II, IBM PS/2, and IBM Professional Graphics Display. You use it to set alignment, convergence, and color balance.

The Montest-A5D3 generates four patterns—color bars, cross hatch, full raster, and a window—and has all the hardware and adapters needed to directly drive either analog or digital monitors. The Montest-A5D3 measures 8 by 6 by 2 inches and weighs less than 2 pounds.

Price: $925.
Contact: Network Technologies, Inc., 19145 Elizabeth St., Aurora, OH 44202, (216) 543-1646.
Inquiry 763.

The IEEE 488 Controller That Stands Alone

A new IEEE 488 controller from IOtech lets you control instruments and store data in 32K bytes of nonvolatile memory.

Called the Macro488, it allows up to 100 macros, or instruction sets, to be loaded into the unit's memory from any computer with an RS-232C or RS-422 data port.

You can control up to 14 instruments simultaneously with the Macro488. It's ideal for applications, such as vehicle testing, where vibration, and excessive temperatures, and humidity can cause problems. Because it stands alone, its relative immunity to vibration problems places the Macro488 at an advantage over computers in the field. It also operates over a temperature range of between 0°C and 35°C and a relative humidity range of between 0 and 70 percent.

A built-in clock with time and date stamping lets you collect data at precise times or at regular or irregular intervals.

Price: $995.
Contact: IOtech, Inc., 25971 Cannon Rd., Cleveland, OH 44146, (216) 439-4091.
Inquiry 790.

Printer Ribbons That Won't Fade Away

Long after most printer manufacturers began concentrating on desktop publishing applications, one company decided to reinvent the ribbon.

Chronos Computers now offers Sta-Blk reinking printer ribbons for more than 350 popular printers, including the Apple Imagewriter I and II, the C. Itoh ProWriter, and two Epson models. The reinking technology makes the ribbons last at least 20 times longer than conventional ribbons, the company claims. Besides that, the ribbons don't fade.

Price: $49.95 for the Epson printer version; $39.95 for the Imagewriter or ProWriter versions.
Contact: Chronos Computers, 4186 Sorrento Valley Blvd., Suite H, San Diego, CA 92121, (619) 455-8200.
Inquiry 764.

continued

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[1] Revenue doubled in 9 of Oracle's 10 years. [2] Sales rate over $200 million in current fiscal year. [3] For PC development use only. Requires a 286/386 PC plus 1-MByte extended memory. Offer valid only in US & Canada. © 1988 by Oracle Corp. ORACLE® is a reg. trademark of Oracle Corp. dBASE is a reg. trademark of Ashton-Tate. Microsoft & IBM own numerous reg. trademarks. TRBA

Dell Releases OS/2

Dell Computer reports that its version of Microsoft's OS/2 is a single-user multitasking operating system for 80286 and 80386 systems. It supports VGA video adapters based on Chips & Technologies, Video Seven, and Cirrus Logic VGA controllers.

Dell's OS/2 lets you install Microsoft OS/2, MS-DOS, and Xenix on the same hard disk. Utility programs such as Etree and Speed are included. Etree displays a visual tree of the disk directory, and Speed lets you change the processing speed and keyboard repeat rate.
Price: $324.95.
Contact: Dell Computer Corp., 9505 Arboretum Blvd., Austin, TX 78759, (512) 338-4400.
Inquiry 770.

80386 C Compiler Creates Protected-Mode Code

The NDP C-386 C compiler from MicroWay is a globally optimizing compiler that was designed for the Intel 80386. It generates native 80386 protected-mode 32-bit code that runs under DOS or Unix V.

The compiler is capable of running with arrays larger than 64K bytes and can run programs as large as 4 gigabytes.

NDP C-386 is a full implementation of PCC, Bell Lab's Portable C Compiler, whose syntax is a superset of Kernighan and Ritchie C. The compiler includes all standard PCC extensions along with supersets of ANSI C and Microsoft C extensions. The new extensions include a set of graphics and BASIC-like screen handling functions, in addition to hooks to the operating system.

Coprocessors supported include the MicroWay/Weitek mW1167 and the Intel 80387 and 80287 coprocessors.

MicroWay's C compiler runs on any 80386-based computer or AT compatible with an Intel Inboard or other 80386 add-on board. A floating-point coprocessor is required, as well as 2 megabytes of extended memory. You'll also need a hard disk drive with at least 2 megabytes of free memory. DOS 3.2 or higher or Unix 386 System V Release 3 is also required.
Price: $595.
Contact: MicroWay, P.O. Box 79, Kingston, MA 02364, (508) 746-7341.
Inquiry 768.

Document It!

To simplify the process of documenting C programs, Software Blacksmiths designed C-DOC, a set of documentation tools for C programmers. The tools also modify your programs and can insert documentation as a part of each individual module header.

C-Call documents the caller/called hierarchy of a group of programs. It creates graphic tree diagrams that show the flow structure. It also produces a table of contents of files versus modules, processes functions and macros with parameters, and generates cross-references of function definitions and usages.

C-Ref analyzes and documents the use of local/global parameter identifiers. It also produces summaries for individual modules for use in headers, and it produces a module- or system-level cross-reference of all identifiers, definitions, and usages.

C-List analyzes and displays the flow structure within modules. It will reformat a source program and produce structure outlines of the flow structure.

C-Hdr uses outputs from C-List to generate and update module headers.

The program runs on the IBM PC, XT, AT, and compatibles with DOS 2.0 or higher and 256K bytes of RAM.
Price: $89.
Contact: Software Blacksmiths, Inc., 6064 St. Ives Way, Mississauga, Ontario, Canada L5N 4M1, (416) 858-4466.
Inquiry 769.

A Rascal for Pascal

A Pascal compiler for $19.67? Rascal (rhymes with Pascal) supports a 64K-byte code and a 64K-byte data segment, performs floating-point arithmetic with an 8087, and produces a `.COM` file in two passes. The company reports that the compiler is capable of compiling about 1000 lines per minute on an IBM PC and compares the object code produced to that of Turbo Pascal 4.0.

Rascal features 30 operators and 6 distinct classes. It also includes 156 standard procedures. The compiler recognizes explicit register references through standard identifiers, the company reports. It also recognizes explicit branches to labels, procedures, and functions.

Source code for the code generator and library is included. You can compile the code generator with either Turbo Pascal 4.0 or Rascal. The Rascal-generated code is about 50 percent faster, according to the manufacturer.
Price: $19.67.
Contact: Eugene Nelson, 1009 Vilas, Suite 3, Madison, WI 53715, (608) 257-7588.
Inquiry 771.

FaceIt Builds Menus

Instead of drawing a window, typing in the text, and positioning it on-screen, FaceIt automatically builds single windows and multimenu systems from your database and ASCII files. It determines the window size based on the amount of text to be displayed. It also automatically positions the window on-screen, configures the spacing between choices, and determines the correct number of columns.

Virtual windowing and built-in scrolling are other features of FaceIt. The program is compatible with dBASE III Plus, FoxBASE+, DBXL, Clipper, Quicksilver, and Borland and Microsoft languages. Language-specific modules are contained within FaceIt. It runs on PS/2s and compatibles.
Price: $99.
Contact: Black and White International, Inc., 23 West 88th Street, New York, NY 10024, (212) 787-6633.
Inquiry 772.

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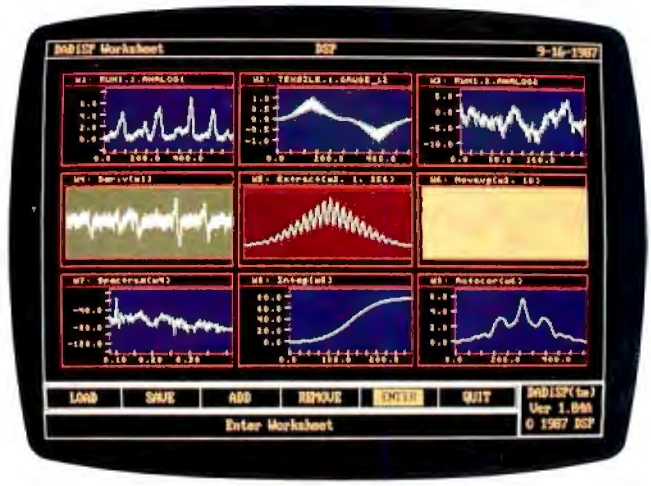
Data Analysis All Over Your Screen

DSP Development Corp. says the most difficult thing about DADiSP is pronouncing its name. It's pronounced "Day-Disp," and it stands for data analysis and digital signal processing.

You use the program after you've acquired data from a variety of instruments. DADiSP 2.0 is a package that lets you import ASCII and binary single or multichannel data files into the database as a data set. The program has a menu-driven interface and lets you analyze your data graphically and numerically. The waveforms are represented in windows that are treated as cells in a spreadsheet. When you make a change to a waveform in one window, the program makes the necessary alterations to others.

The worksheet can hold up to 64 windows, with each offering graphics operations such as scrolling, zooming, expansion, compression, and cursor movement.

The program has over 160 analysis routines, including signal arithmetic, signal calculus, waveform generation, Fourier analysis, frequency domain analysis, correlations, and trigonometric and statistical routines. DSP reports that the size of waveforms is unlimited, as the program pages large waveforms to and from your disk during calculations.



DADiSP waveforms are presented in multiple windows.

DADiSP runs on the IBM PC, XT, AT, and compatibles as well as on Sun and other workstations. It runs under DOS, Unix, and OS/2, according to DSP.
Price: DOS version, $795; Unix version, $2495.
Contact: DSP Development Corp., One Kendall Sq., Cambridge, MA 02139, (617) 577-1133.
Inquiry 773.

Go Solo!

Solo 101 is a statistical program that features fill-in-the-blank-type panels that give you your statistical-analysis options. If you need help knowing what to put into a panel, you move the cursor to the field and a help message pops up.

With Solo you can calculate the mean, standard deviation, and percentiles, and you can generate frequency tables and cross-tabulations. The program also performs multiple regression with residual analysis, stepwise regression, robust regression, weighted regression, and correlation analysis. You can store residuals, predicted values, confidence intervals, and other observation-type statistics in Solo's database. Forecasting techniques include trend analysis, single and double exponential smoothing, and seasonal adjustment. Analysis of variance procedures include general linear models, unweighted means, and repeated measures.

Solo includes a data-entry spreadsheet, database utilities, data import, report writing, and transformation capabilities. With the spreadsheet editor, you can cut and paste sections of the database, append data to existing information, and reorder columns for easier data entry and viewing.

The data-import facility lets you read and write ASCII files. You can also sort, merge, transpose, or make subsets of databases. A report writer also lets you output to a printer or ASCII file.

The program runs on the IBM PC, XT, AT, and compatibles with DOS 2.1 or higher, 512K bytes of RAM, and a VGA, EGA, CGA, or Hercules graphics card.
Price: $149.
Contact: BMDP Statistical Software, Inc., 1440 Sepulveda Blvd., Los Angeles, CA 90025, (213) 479-7799.
Inquiry 774.

Preview AutoCAD Drawings

Whether you're using AutoCAD or not, you can pop out of whatever program you're in and take a look at an AutoCAD (DWG) drawing with SoftWest Quick-See. Because it is a stand-alone program, you don't need AutoCAD to run it. The manufacturer reports that it displays a drawing at close to AutoCAD Redraw speeds.

SoftWest Quick-See runs on the IBM PC and compatibles with DOS 2.1 or higher, 256K bytes of RAM, and a Hercules monochrome display adapter, EGA, CGA, or VGA. A math coprocessor and a hard disk drive are not required.
Price: $99.
Contact: The Great SoftWestern Company, Inc., 207 West Hickory St., Suite 202, Denton, TX 76201, (800) 231-6880; in Texas, (817) 383-4434.
Inquiry 775.

continued

AutoCAD on the Mac II

AutoCAD Release 10 runs on the Mac II and adds three-dimensional wireframe construction and surface modeling capabilities, along with new drawing and editing features. These include user-defined coordinate systems, dynamic real-time zoom and three-dimensional rotation, and multiple view ports.

Release 10 is data-file-compatible with MS-DOS and Unix versions of the program, so you can read and write drawing files interchangeably between two different machines.
Price: $3000.
Contact: Autodesk, 2320 Marinship Way, Sausalito, CA 94965, (415) 332-2344.
Inquiry 776.

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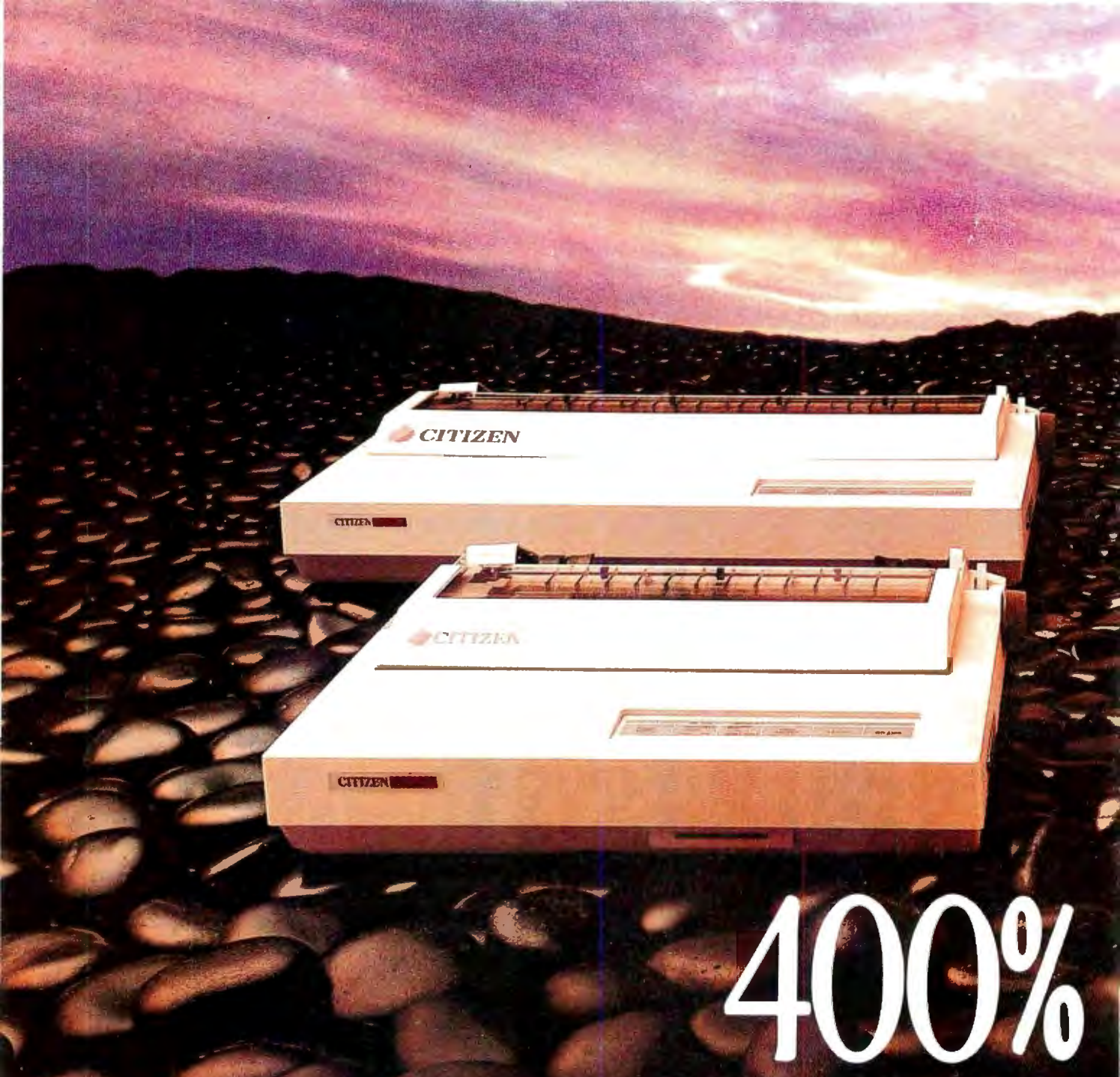

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All in all, the MSP series, with an 18-month warranty, represents an excellent value in precision-built printers. Which, considering Citizen's tradition, isn't all that new.

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Slideshow on the Desktop

Now you can create slides with access to 16.8 million colors on a Mac II to use in your desktop presentations. Microsoft has enhanced PowerPoint 2.0 with templates that have built-in color schemes, background effects, and fonts. Other added features include a spelling checker and a find-and-replace command.

To take advantage of the preselected color schemes, you select a background color, and the program suggests contrasting colors. If you merge slides into other presentations, you can choose different color schemes, with all elements of the slide converting to the new color scheme.

The spelling checker comes with a main dictionary that you can supplement with your own words. Word-processing features of the program include tabs and decimal tabs, variable line and paragraph spacing, and five outline-like levels for bulleted copy points.

The program also lets you import graphics from MacPoint, PICT, and EPSE file formats. Using the Macintosh Clipboard, you can incorporate graphics in any format, according to Microsoft. You can also incorporate black-and-white graphics and then color them.

PowerPoint 2.0 runs on the Mac Plus, SE, or II running System 4.1 or higher with 1 megabyte of RAM and two 800K-byte floppy disk drives or a hard disk drive. The software is compatible with AppleShare and MultiFinder.
Price: $395.
Contact: Microsoft Corp., 16011 Northeast 36th Way, P.O. Box 97017, Redmond, WA 98073, (206) 882-8080.
Inquiry 777.

Sample desktop presentation slide from PowerPoint 2.0.

Make Your Commodore 64/128 a Desktop Publisher

Create multiple-column page layouts on the Commodore 64 and 128 (in 64 emulation) with PaperClip Publisher from Electronic Arts.

You can create documents of up to 50 pages in length; manipulate text and graphics with ruler, margin, and column guides; enlarge pages with the magnify mode; and resize boxes and have text flow between them.

A text editor is included, and the font converter utility lets you convert fonts from popular word processors. You can also import text files from PaperClip II and other word processors.

The built-in graphics editor lets you import and edit graphics from other programs. You can also choose from a variety of box backgrounds and outlines, and you can work on pages from 3 by 3 inches to 8 by 14 inches with as many columns as you want. PaperClip Publisher also supports a wide variety of printers.

The program runs on the Commodore 64 and 128 with 64K bytes of RAM, a 1541 or 1571 floppy disk drive, and a mouse or joystick.
Price: $49.95.
Contact: Electronic Arts, 1820 Gateway Dr., San Mateo, CA 94404, (415) 571-7171.
Inquiry 778.

1-2-C Compiler

Compile 1-2-C converts your worksheets into C source code instead of BASIC. It also handles more than just Lotus files and will compile any .WKS files.

Once your worksheets are compiled, you don't need the original spreadsheet program, as the worksheets become stand-alone .EXE files.

Compile 1-2-C, formerly known as LTS2C, runs on the IBM PC, XT, AT, and compatibles with 640K bytes of RAM and a 1.5-megabyte hard disk drive. The program works with Lotus 1-2-3 releases 1A and 2.01 and works with all 1-2-3 commands except Graph and Window. The program is not copy-protected.
Price: $299.
Contact: Resource Analysis International Corp., 12581 Venice Blvd., Los Angeles, CA 90066, (213) 390-7661.
Inquiry 779.

A Helping Hand from Handi

The makers of Handi call it "information integration software." It's one program that combines a database manager, word processor, calendar, scheduler with alarms, and report generator. You can run it as either a stand-alone or a memory-resident program.

HandiBase is the database manager. Each database holds a maximum of 65,500 B-tree indexed records. Each record can contain up to 4090 bytes of structured and free-form data. Each database can support up to 20 structured fields.

HandiWord is a word processor that performs word wrap, text block manipulation, find/replace, cut/paste, import, export, and other test manipulation functions. It handles large documents of up to 60,000 characters.

The program's calendar module is called HandiScheduler, and it features an alarm that you can set to remind you of appointments or other events. When the alarm goes off, a small window pops up on the screen when you're in other programs, and some text reminds you of why the alarm has gone off.

HandiReport is the report generator, and it lets you print form letters, labels, business reports, invoices, and more.

Handi runs on the IBM PC, XT, AT, and compatibles with DOS 2.1 or higher and 74K bytes of free RAM.
Price: $49.
Contact: HandiCorp, Inc., 17080 142nd Place NE, P.O. Box 1263, Woodinville, WA 98072, (800) 451-3496; in Washington, (206) 481-7026.
Inquiry 780.

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There's no denying the availability of some outstanding dedicated terminals to access Digital,® Hewlett-Packard, and Data General® host systems. Which makes the task of precisely emulating the performance of those dedicated terminals on an IBM® PC or compatible a rather significant challenge.

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Every SmarTerm emulation is precise. So precise, in fact, that a dedicated terminal's SmarTerm counterpart fully emulates not only advanced performance features but also unique terminal quirks and bugs.

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Every SmarTerm emulation is easy to learn. These days, training costs are a hot topic. Software intended to boost overall system efficiency must recognize the value of learning speed. We have.

It's also easy to learn more about how SmarTerm emulations can help you shine. Your software dealer can supply all the details. Or you can contact us at (608) 273-6000 to request complete specifications and a demonstration disk of the SmarTerm emulation that precisely matches your requirements.

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he software, making it available for IBM Token Ring and Ethernet systems. Applications written for pre-

Price: $395
IBM Token
unbundled).
Contact: 10Net Communications, 7016 Corporate Way, Dayton, OH 45459, (513) 433-22
Inquiry 782.

Make Connections with Reunion

Reunion software lets you access and process information between an IBM PC, an asynchronous host mainframe, and minicomputers. It provides two-way communication between host computers and PC applications, terminal emulation, file transfer, multitasking, and program development. The program's multitasking ability lets you run it in the background of other application programs, transferring files, sending mail, or retrieving host information, while you continue to use the application program in the foreground.

The program is menu-driven and contains a dialing directory and help. To further simplify use of the program, you can redefine or remap any key on your PC keyboard. You can also create macros with Reunion, automating repetitive tasks so that one keystroke can perform a series of commands.

A Writer facility lets you create, modify, compile, and test scripts. It also imports any ASCII editor for use within Reunion. A Learn facility lets you automate communications sessions, allowing you to alter scripts. The Connect facility offers a modular structure for connecting to host computers and information services. It also includes a dialing directory.

Reunion's application language, Resource, contains about 75 commands that let you read and write to PC files, initiate and control other PC applications, call other scripts as subroutines, and let the host computer initiate PC applications.

Terminals emulated include the IBM 3101 Character Mode; DEC VT-220, VT-100, and VT-52; generic TTY; and PC7171 for protocol converters. Methods of file transfer include XMODEM and YMODEM, Kermit, Linkware, and nonprotocol ASCII.

To run Reunion you'll need an IBM PC or PS/2 with DOS 2.0 or higher and at least 384K bytes of RAM, with at least 512K bytes needed for Linkware file transfers. You also need an asynchronous COM1 port, a COM2 port, or a Net/One network adapter, and a CGA, EGA, VGA, or IBM monochrome adapter.
Price: $175.
Contact: Westford Harbor Co., 288 Littleton Rd., POB 240, Westford, MA 01886, (617) 692-9440.
Inquiry 781.

Networking with DataEase

DataEase, a database management program, is now available in a network version. Applications you've developed with single-user DataEase can run on DataEase LAN with a single keystroke, the company reports.

The LAN version provides three record-locking and two file-locking strategies for viewing and editing shared data. It also has a MultiView feature, which shows you multiple related files with one keystroke.

With DataEase LAN 1.1, you can have 26 databases per directory, up to 255 files per database, and up to 255 reports per database. It also provides B-tree indexing, wild-card searches, and 99 predefined choice fields. You can import DataEase, Lotus, dBASE II and III, DIF, ASCII, and mail-merge files, and you can export to Lotus, DIF, MultiMate, ASCII, mail-merge, and GrafTalk file formats.

DataEase LAN 1.1 runs on the IBM PC, XT, AT, 3270 PC, PS/2s, and compatibles with at least 640K bytes of RAM. You also need an interface card supported by the DOS 3.1 network interface or Novell Netware 86 or 286 version 2.0a or higher. The database management program runs with Banyan VINES 2.1, 3Com EtherSeries and 3+ 1.2, IBM PC LAN 1.1, Novell Netware 86/286 2.0a or higher, and the AT&T StarLAN.
Price: $700; $900 for the Workstation pack, which provides access for three additional PCs.
Contact: DataEase International, Inc., 7 Cambridge Dr., Trumbull, CT 06611, (800) 243-5123; in Connecticut, (203) 374-8000.
Inquiry 783.

Macintosh E-Mail System

Macintosh users can add the ability to communicate electronically over AppleTalk networks with QuickMail. This desk accessory offers an automatic log-in option, log-in/log-out, and password security.

With QuickMail you can have real-time private or public conferences; you can also generate a transcript of the conferences. A public bulletin board is included, and you can invoke a privacy feature for a specified length of time.

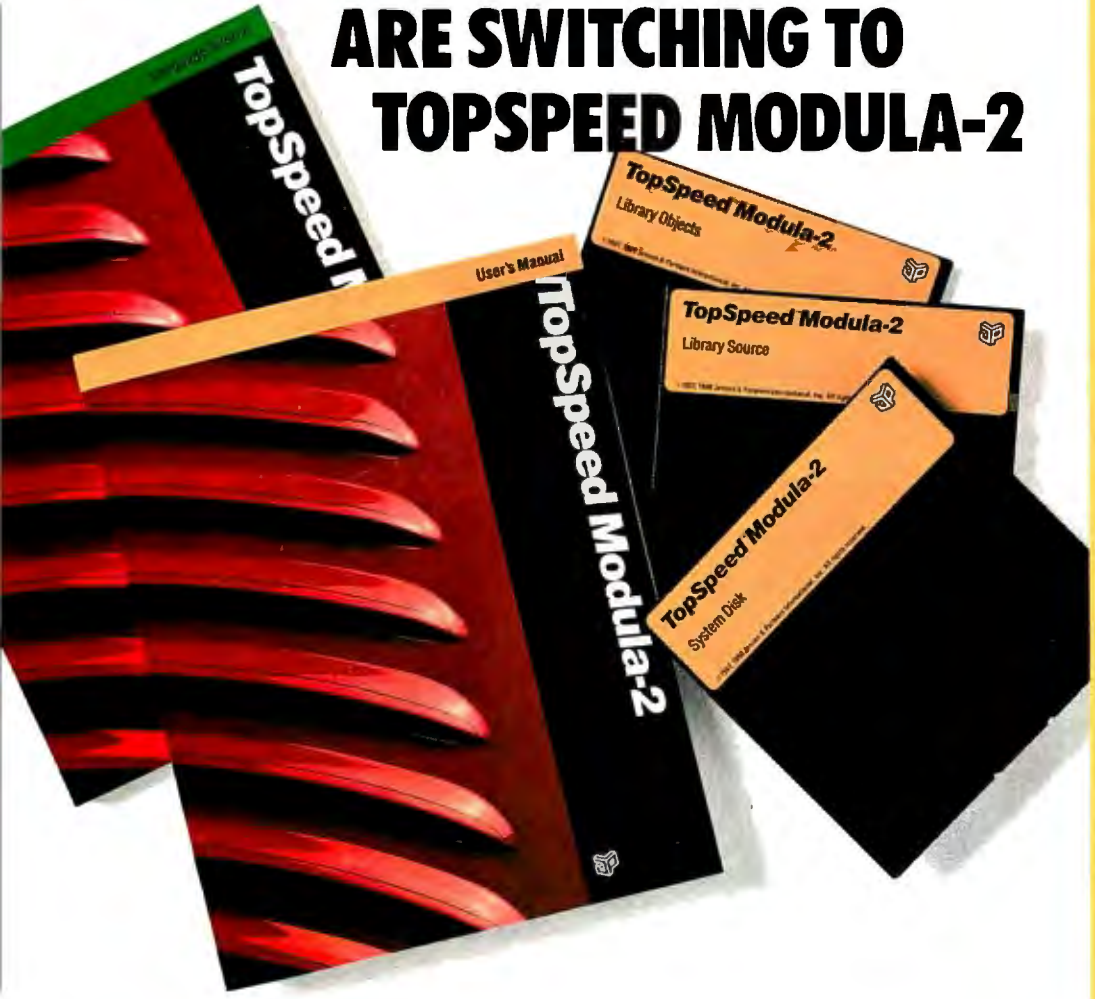
You can forward messages to other users, print them out, or save them to disk. You can also attach up to 16 files or clipboards per message and reply to or edit sent messages.

The program works on networks with the Macintosh 512KE systems and higher with at least one hard disk drive. It is compatible with AppleShare, TOPS, and MacServe networks.
Price: $300 per 10 users.
Contact: CE Software, 1854 Fuller Rd., West Des Moines, IA 50265, (515) 224-1995.
Inquiry 784.

continued

FACT:

MORE AND MORE PEOPLE ARE SWITCHING TO TOPSPEED MODULA-2



"JPI Modula-2 looks like another classic in the making. It generates code as good as or better than leading C compilers and the programming environment is a genuine pleasure to use. At the price it's a tremendous bargain, and with luck it just might do for Modula what Turbo has done for Pascal."
Dick Pountain
Byte Information Exchange
short.takes conference

"I liked all of the hard-disk space that was recovered after I deleted my BORLAND, MICROSOFT, and LOGITECH compilers, because with TopSpeed Modula-2 all the rest are obsolete."
Robert D. Randall
Donnelley Marketing

The successor of Pascal: JPI TopSpeed Modula-2 produces better code than Microsoft C, Turbo C, Logitech Modula-2, and Turbo Pascal 4.0.

JPI TopSpeed Modula-2 is a professional Modula-2 development system with full support of memory models, multi-tasking, long data types, structured constants, long and short pointers, 80X87 inline code and emulator, separate compilation, direct BIOS/DOS calls, etc. The comprehensive library includes CGA, EGA and VGA graphics support, math functions, sorting, file handling, window management, a time-sliced process scheduler and more.

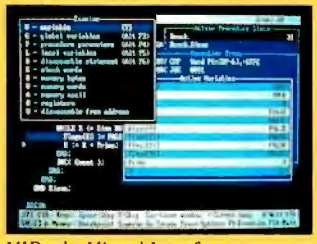
The Compiler Kit includes: High-speed optimizing compiler, integrated menu-driven environment with multi-window/multi-file editor, automatic *make*, fast smart linker. All Modula-2 sources to libraries included. BONUS: Complete high-speed window management module included with source. 258-page User's Manual and 190-page Language Tutorial.

The TechKit includes: Assembler source for start-up code and run-time library, JPI TopSpeed Assembler (30,000 lines/min), TSR module, communications driver, PROM locator, dynamic overlays, and technical information. 72-page manual.

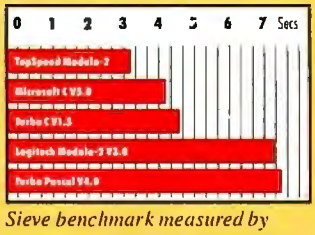
System Requirements: IBM PC or compatible, 384K RAM, two floppy drives (hard disk recommended).

Circle 115 on Reader Service Card

TopSpeed's seamlessly integrated environment.



VID, the Visual Interface Debugger, coming soon.



Sieve benchmark measured by the British Standards Institution (BSI)—25 iterations on an 8MHz AT.

Compiler Kit $99.95.
TechKit $59.95.

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Phone: (415) 967-3200

In England and Europe contact:
Jensen & Partners UK Ltd., 63 Clerkenwell Rd., London EC1M 5NP. Phone: (01) 253-4333. Compiler Kit £59.95, (add £4.69 for VAT & handling in the UK; £4.00 handling in Europe). TechKit £34.95 (add £4.03 for VAT & handling in the UK; £4.00 handling in Europe).

TopSpeed is a trademark of Jensen & Partners International. Other brand and product names are trademarks or registered trademarks of their respective holders.

Design Your Own Logo

Using an IBM PC with a TrueVision TARGA or VISTA graphics board and Flamingo's Logo Editor, you can create logos and illustrations.

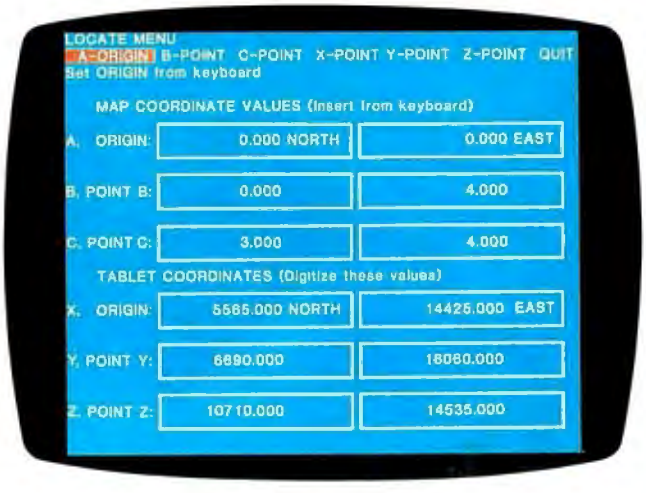
The object-oriented drawing program lets you trace or create illustrations with smooth antialiased edges. The Logo Editor comes with object types such as curves, ovals, arcs, circles, lines, rectangles, irregular polygons, and text. You can choose objects from pop-up menus and manipulate them with a mouse or graphics tablet. You can also group, ungroup, rotate, flip, move, copy, scale, stretch, delete, and undelete objects.

You can edit the text that comes with the cubic spline outline definitions and incorporate the text into your logos. Eight outline fonts are provided.

Layout tools include flat, gradient, or TARGA image background styles; and grids, resident color palettes, and color creation models. You can render your work on-screen through an antialiasing process that smooths the curves and lines. You can also store your designs as logos or as fonts. Logo files are read back into the Logo Editor and printed onto any TARGA image file. Font files are compatible with Flamingo Graphics' RIO.

Logo Editor runs on the IBM PC AT and compatibles with at least 640K bytes of RAM and a 10-megabyte hard disk drive. You also need a TARGA frame buffer and an analog RGB or composite monitor. The company also recommends Expanded Memory Specification memory and a math coprocessor.

An illustration created with Flamingo's Logo Editor.



HotDij matches digitizer data to other programs.

Price: $895.
Contact: Flamingo Graphics, 875 Main St., Cambridge, MA 02139, (617) 661-1001.
Inquiry 785.

Digitize Me

Place data from a digitizer tablet directly into your word processor, spreadsheet, or other programs with HotDij, a memory-resident utility.

HotDij contains preprogrammed control characters to match the digitizer data to your other programs. You can also define up to four additional sets of control characters. The program adds control characters to enter the data into columns on the monitor. It adjusts for drawing scale and corrects for drawing placement errors. HotDij keeps track of changes in scale or drawing location, as well as the application in use. Whenever you reboot, HotDij remembers your previous application and sets up for it. The program allows for keyboard input and accepts ASCII input to the digitizer.

HotDij is menu-driven. It also offers you a selection of 34 predefined digitizer interfaces. When you install the program, you must match the report format of the digitizer tablet to your computer.

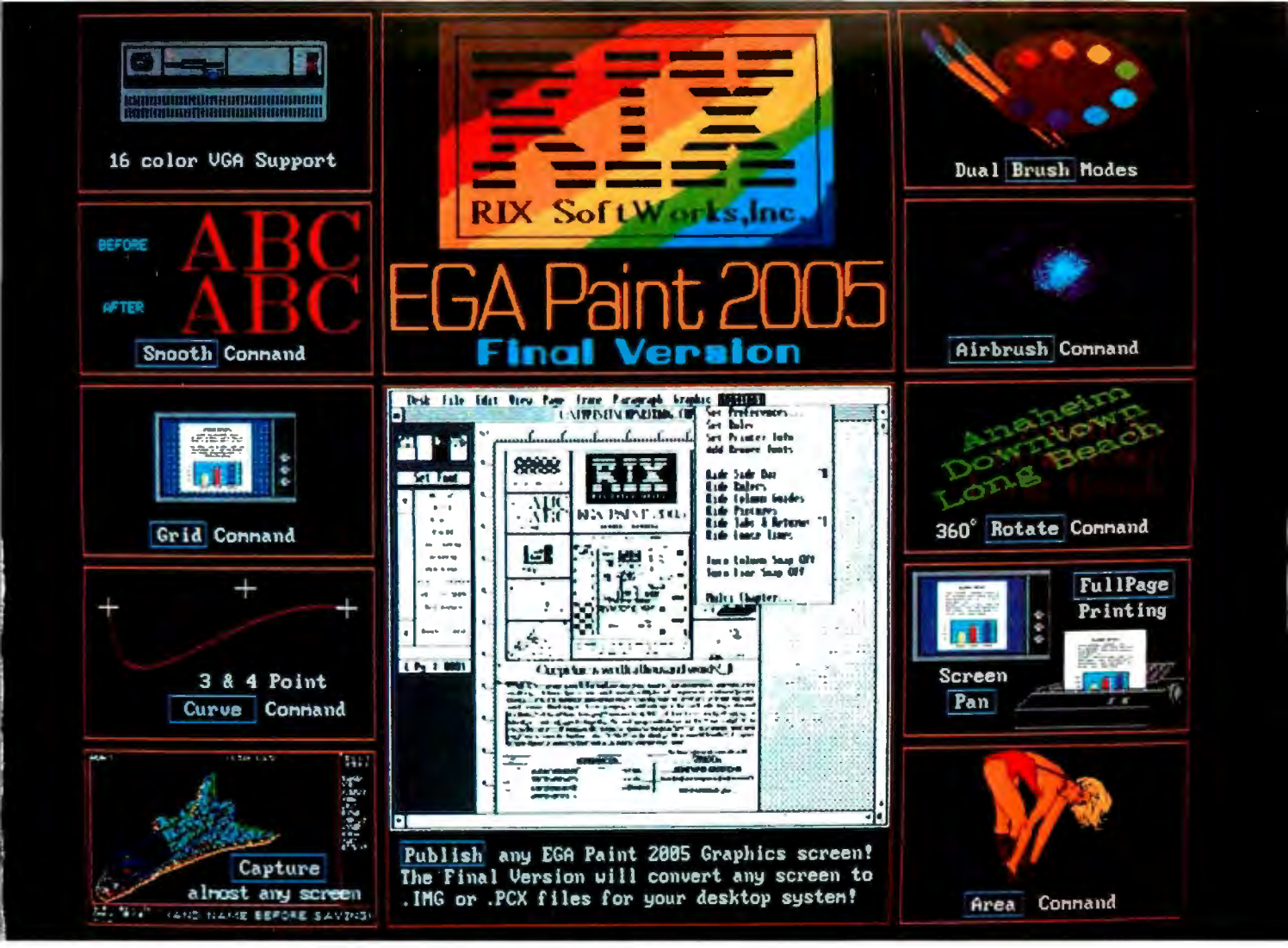
Designed to run on the IBM PC and compatibles, you'll need at least 64K bytes of free RAM and an asynchronous communications port. The program comes with a wiring adapter to connect your system with a digitizer. Geocomp reports that the program works with any digitizer that sends ASCII.
Price: $335.
Contact: Geocomp Ltd., 749 Van Gordon Court, Golden, CO 80401, (303) 233-1250.
Inquiry 786.

Perk Up Your Output

If your standard 9-pin dot-matrix printer produces dull-looking output, The Image Printing Utilities may be able to help. The program achieves higher-quality output by making three print passes over each line, with a different pattern of dots each time. The dot density is 216 dots per inch vertically by 240 dpi horizontally.

The program includes 16 fonts, and all except the Graphics font include the entire character set of an IBM Graphics Printer.

The program takes up 35K bytes of RAM for each font loaded. It runs on the IBM PC and compatibles with DOS 2.0 or higher and at least 128K bytes of RAM.
Price: $89.95.
Contact: Image Computer Systems, P.O. Box 647, Avon, CT 06001, (203) 678-8771.
Inquiry 787.



One picture is worth a thousand words!

Kiss those endless upgrade fees goodbye! After well over three years of development, RIX is pleased to announce the Final Version of our EGA specific graphics editor, EGA Paint 2005. RIX was the **first** (and still the only) graphics, software company to introduce an EGA specific graphics editor, the **first** to create a combination TARGA™ image translator and print package, the **first** to release a VGA specific hi-res graphics editor (in July), and now the **first to release a final version of any software program ... ever!** We at RIX had originally planned to release a separate package to implement desktop publishing capabilities but when the release date arrived, we felt our loyal users deserved a fully self-contained graphics package. Now RIX has made it possible for you to make a little history too with EGA Paint 2005 Final Version, At $129.00, surely the best value in graphics programs ever! Find out why. Order today! RIX SoftWorks, always the best ... for less!

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ColoRIX VGA Paint is the cat's meow for your Hi-Res VGA system! ColoRIX supports all modes of VGA, and has time saving features like: Automatic color graduation generation, block palette freeup, image drag for 3D effects, a completely self-contained presentation package which has animation capabilities, and much more. We'll be shipping in July, first come, first served so get your order in now! **Only $199.00!**

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Circle 420 on Reader Service Card (DEALERS: 421)

WHAT'S NEW

PACIFIC COAST

Data for Here, or to Go

The Disk Pack has two slots that hold removable hard disks (20 to 160 megabytes) and is fully compatible with Macintosh, Apple, IBM PC, XT, AT, and compatible computers, according to Mega Drive Systems.

The base, which contains the two slots for the removable hard disks, has a SCSI interface bus and a Mac-compatible connector. You can choose between several formatted capacities for the hard disks: 20, 45, 70, 120, or 160 megabytes. Each weighs about 2½ pounds, and you can daisy-chain disk packs to hold as much as 1 gigabyte of on-line data.

Disk Pack works with IBM PCs, Macs, and Apple computers.

Disk Pack connects directly to the Mac Plus, SE, and II through the SCSI port. A SCSI board is required to connect the Disk Pack to an Apple IIe, IIc, IIGS or Mac 128K, 512K, or 512Ke. SCSI connector kits ($469 for IBM PC, XT, AT, or compatibles and $749 for the PS/2 series) are also available.

Price: Base (two-slot), $699. Modules: $849, 20-megabyte; $1299, 45-megabyte; $1599, 70-megabyte; $1999, 120-megabyte; price not available for the 160-megabyte.

Contact: Mega Drive Systems, 1801 Avenue of the Stars, Suite 507, Los Angeles, CA 90067, (213) 556-1628 or (800) 322-4744.

Inquiry 835.

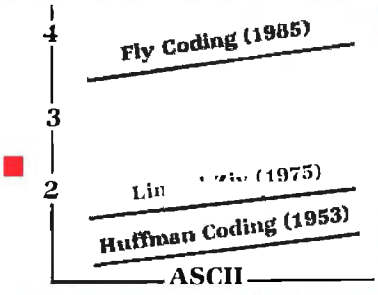
continued

It's the Dawn of the Information Age. . .

The new modem$ with built-in data compression are all the rage. Trouble i$, they use the Limpel-Ziv algorithm—something le$$ than optimal!

The centerpiece of the **FlySpeed Collection** is **st/exp,** the first commercial implementation of Fly Coding. st/exp compresses text files typically to 30% or less of their original size, at rates of over 1000 words per *second,* allowing you not only to communicate faster, but also save valuable disk space.

But now that you can communicate and store information so much more efficiently, you need a more efficient way of creating it. So we created **Typing Demon,** a spin-off of our work on communication aids for the handicapped. Typing Demon partially automates typing, speeding word-processing by 25% or more. Nothing revolutionary—just the difference between finishing the afternoon's word-processing at 4:45, versus 6:00 p.m.



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With **"d,"** FlySpeed's user-friendly directory program, you'll be able to look at your files sorted by file name, file date, etc. And you'll be able to page back and forth through long directories to your heart's content. (Say goodbye to directories scrolling off-screen.)

And when **Merlin,** the text-retrieval member of FlySpeed, debuts in January, you'll not only be able to create, communicate, and store information more quickly and efficiently, but you'll actually be able to find it later! *Instantly,* based upon any word or combination of words in a document. Because Fly Coding is inherently indexed.

You wouldn't expect computers of the 21st century to store and communicate information in the same inefficient format used in the 1950s. Now, for just 75 bucks, neither will yours.

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Take any disk listed in this ad - $2 each - when you join today! Offer expires August 31, 1988.

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- ☐ 499 PROCOMM: Extremely versatile telecommunications.
- ☐ 310,1022,1023 O-MODEM: A favorite. Let's your computer talk via phone.
- ☐ 212,334,621 RBBS-PC: Set up your own bulletin board.

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- ☐ 577, 578 C TUTOR: Learn C language.
- ☐ 965 PASCAL COMPILER: Full-screen editor, incremental compiler and more.
- ☐ 254 PC-DOS HELP: Gives you on-line help to remember those DOS commands.
- ☐ 105 PC-PROFESSOR: Learn beginning BASIC.
- ☐ 775-778 PSEUDOSAM: Macro assemblers & debuggers for many popular microprocessors, including 8088/86/286s.
- ☐ 481 STILL RIVER SHELL: Menued DOS commands. Makes life easier.
- ☐ 403 TUTOR.COM: Learn beginning DOS.

Databases

- ☐ 287,288 FILE EXPRESS: Customize, menu driven data base.
- ☐ 5, 730, 1015 PC-FILE+: The most powerful and popular data base.
- ☐ 830 WAMPUM: dBase III clone, but easier to use. (Hard disk req)

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- ☐ 844 ABC FUN KEYS: For ages 2-5. Teaches the alphabet.
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- ☐ 229 FUNNELS & BUCKETS: Fun game teaches younger children arithmetic.
- ☐ 320 PC-TOUCH: Typing tutor. (Color Req)
- ☐ 477 WORDGAMES: Stimulates the intellect.

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- ☐ 164, 773 CASHTRAC: Manage checking accounts, track investments.
- ☐ 151 FINANCE MANAGER II: Double entry bookkeeping.
- ☐ 469,470 MR. BILL: Itemize invoices, age accounts, etc.
- ☐ 331 PC-GENERAL LEDGER: Written by a top financial manager.
- ☐ 575 PC-STOCK: Track & evaluate stock trends. (Color req)

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- ☐ 452 AMULET OF YENDOR: Hack, a dungeons & dragons adventure game.
- ☐ 708 BACKGAMMON: You against the computer. Also, Wheel of Fortune.
- ☐ 780 BRIDGE PAL: Computer plays 3 hands.
- ☐ 228 CRIBBAGE: And a few other games as well.
- ☐ 457 GREATEST ARCADE GAMES: Flightmare, Jump Joe, Spacewar (Color req.)
- ☐ 476 PATRICK'S BEST GAMES: Bugs Centipede, 3-D Packman, Castle, Packgal, Spacevad.
- ☐ 557 PINBALL RALLY: 3 great games of dexterity and speed. (Color req.)
- ☐ 120 PC-CHESS: Your move...
- ☐ 791 POKER: Play draw poker head to head. Or try some Blackjack.
- ☐ 694 SLEUTH: A murder has been committed...
- ☐ 197 TWO TREKS: Beam me up, Scottie!
- ☐ 891 WHEEL OF MISFORTUNE: Spin the wheel, win or go bankrupt!

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(Most require CGA or EGA Card)

- ☐ 701-704 DANCAD 3D (4 disks): Create and animate 3d drawings. (Hard disk req)
- 828 EDRAW: Draw flowcharts, schematics, even printed circuits!
- ☐ 763 FINGER PAINT: A 3d wire frame modeling program. (Runs also with Hercules Card.)
- ☐ 870 HGCIBM: Run color graphics programs with your Hercules Card!
- ☐ 788 IMAGE 3-D (EGA ver.): Create, view, edit 3d objects.
- ☐ 762 IMAGE 3-D (CGA ver.)
- ☐ 1001 MAC PASTE: Read, save, edit and print Readmac or Mac Paint pictures.
- ☐ 344,345,1032 PC-KEYDRAW: Graphics and "slideshow" presentations.
- ☐ 244 SLIDE GENERATION: Create slides/transparencies.

Home & Hobbies

- ☐ 966 ASTROLOGY 94: Calculate and print charts.
- ☐ 361, 632 FAMILY HISTORY: Trace your family tree.
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Music

- ☐ 127 PC-MUSICIAN: Compose and play your song.
- ☐ 279 PIANOMAN: Plays your music or its own in chords.

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- ☐ 608 AUTOMENU: Create easy access menus for your hard drive.
- ☐ 824 DESK COMMANDO: Tools to tame your hard drive.
- ☐ 404 EZ-FORMS: Create your own business forms.
- ☐ 388 FORM LETTERS: Variety of business letter formats.
- ☐ 483 MAILMONSTER: Add, edit, sort and print labels by categories.
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- ☐ 517 IMAGE PRINT: Letter quality from your dot matrix.
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- ☐ 480 PC-OUTLINE: Like ThinkTank. Organize your ideas & thoughts.
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Circle 419 on Reader Service Card

Borland's Turbo Prolog 2.0

Prolog 2.0 features a database system with tools for developing and maintaining large databases and an interpreter that you can build into applications that require metaprogramming capabilities. You can also modify the interpreter to handle a new logic programming language, inference engine, or expert shell system.

Other new features include customizable interface, support for multiple internal databases, and mechanisms for handling error situations and controlling user breaks. A separate Turbo Prolog Toolbox ($99.95) includes support for menus, business graphics, communications, screen and report layouts, file transfer, and parser generators.

Turbo Prolog 2.0 requires an IBM PC, XT, AT, PS/2, or compatible, 384K bytes of RAM (640K bytes recommended), DOS 2.0 or higher, and two floppy disk drives (hard disk drive recommended). Video card support includes monochrome, CGA, EGA, MCGA, VGA, 3270, 8514, Hercules, and AT&T 400-line. Turbo Prolog Toolbox requires Turbo Prolog 2.0.

Price: $149.95.

Contact: Borland International, 4585 Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-8400.

Inquiry 836.

Page Preview Added to WordStar

WordStar Professional 5.0 features page preview capabilities that let you view up to 144 pages in thumbnail form on a single screen. You can also view single and facing pages in WYSIWYG format. A zoom view lets you look at font and linebreak details.

An optional menu-driven interface is compatible with IBM's Systems Applications Architecture. Footnoting, automatic reformatting, macro, undo, and automatic save capabilities are also added.

WordStar Professional 5.0 lets you create newspaper-style columns. You can edit two documents simultaneously. Brown Bag Software's PC-Outline, MailList, and Tel-Merge, a communications program, are also included.

WordStar Professional 5.0 runs on the IBM PC and compatibles with DOS 2.0 or higher, 384K bytes of RAM (512K bytes of RAM is required for page-preview and outlining capabilities), and two floppy disk drives or a hard disk drive. A graphics board is required for page preview.

Price: $495.

Contact: MicroPro International Corp., Customer Service, 33 San Pablo Ave., P.O. Box 7079, San Rafael, CA 94901, (415) 499-1200 or (800) 227-5609.

Inquiry 837.

Can you afford the time to build your own LaserJet Fonts?

Building your own fonts can be difficult and very time consuming. For Example: Building your own 24 point font could take as much as 59 minutes of your and your computer's valuable time, and that's just one font! To get the same typeface in a different weight (regular, bold, italic, etc.) will take you almost another hour, again, and again, and again. Most business people simply can't afford that much time. Can you?

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are affordable pre-engineered, easy to use, downloadable fonts for your **HP-LaserJet** or compatible printer. Our soft fonts are tried and tested, there's no guess work. You know what you're going to get. Best of all, they are ready to use as soon as you open their exclusive "pop-up" storage box.

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Chancelor Roman Garmon

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- Monochrome Monitor
- MS DOS
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- 1.2 Meg Floppy
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- Monochrome Monitor
- Graphic Card
- MS DOS
- GW Basic

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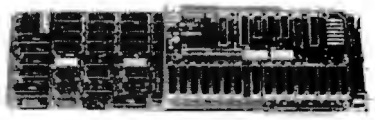

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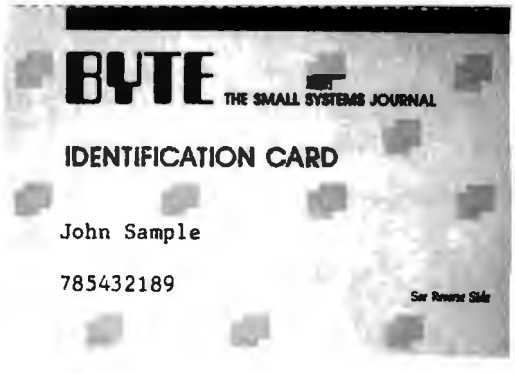

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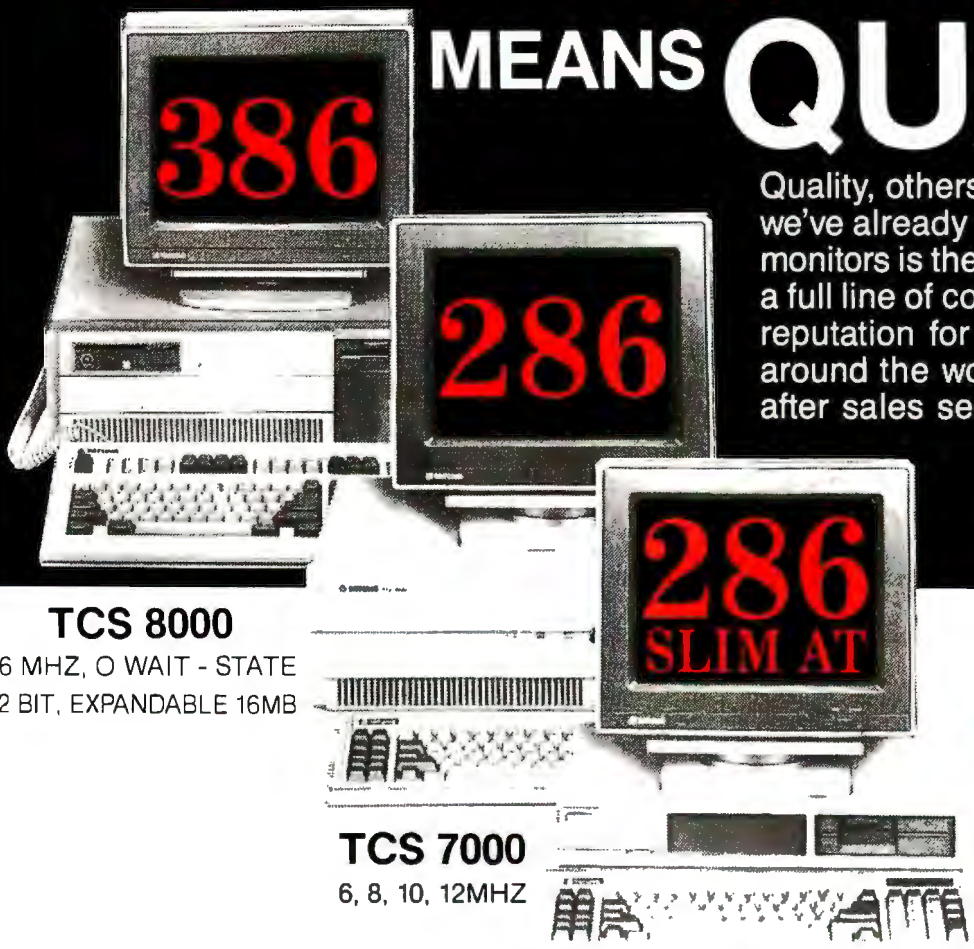

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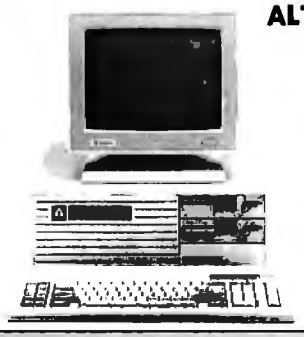

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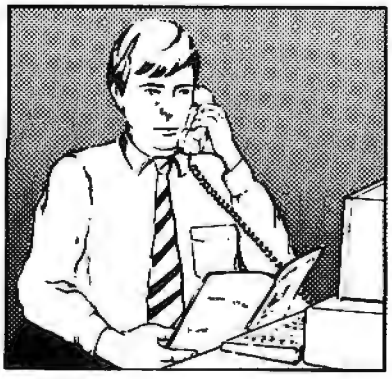

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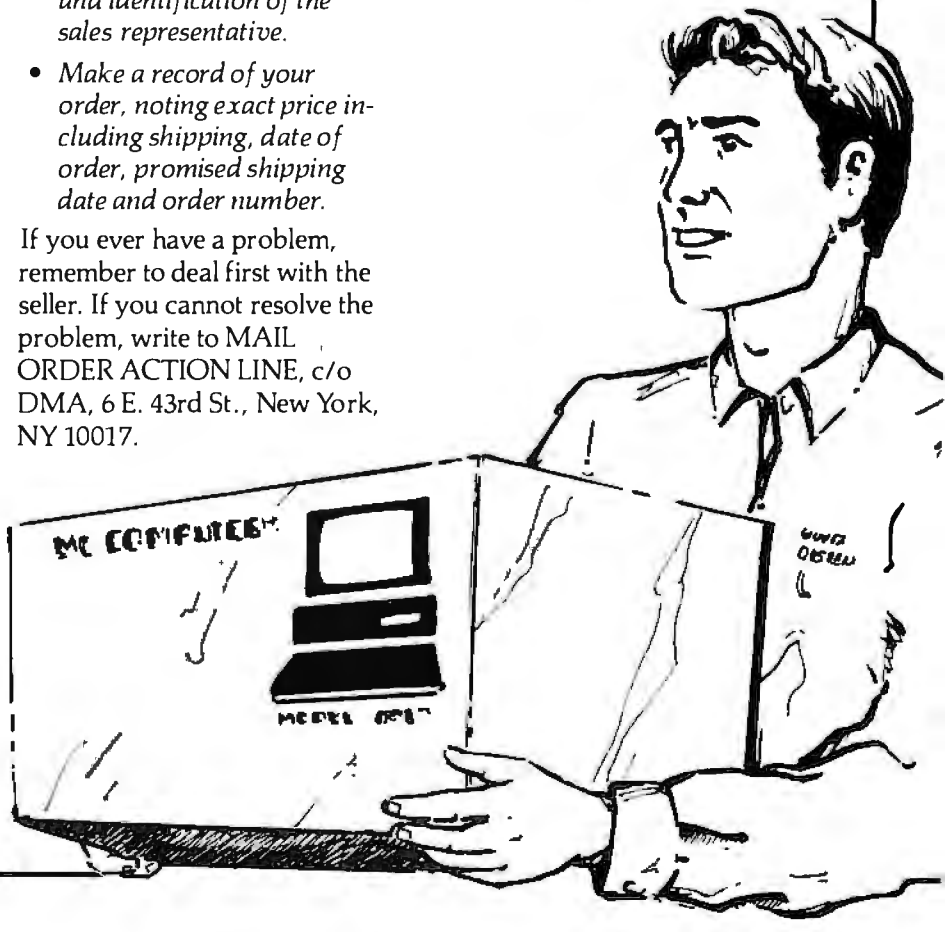

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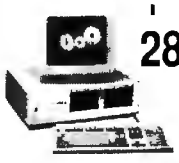

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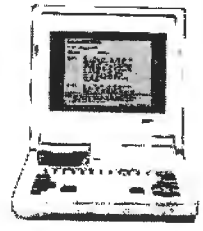

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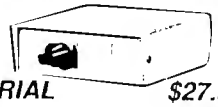

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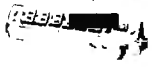

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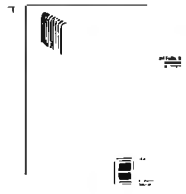

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COMPETITIVE BENCHMARK TESTING RESULTS

Based on in house testing, Everex Computer Systems Division has compiled the following benchmark test results:

			Mainstem
Everex Step 386/20	**4.91**	**35.0**	**24.3**
Compaq Deskpro 386 20	4.59	34.5	24.2
Everex Step 386/16	**3.93**	**27.3**	**19.5**
Everex Step286/16	**3.27**	**21.4**	**18.4**
AST Premium 386 20	3.04	[illegible]	
Wyse 386/16	2.96	[illegible]	[illegible]
Acer 386 16	2.99	[illegible]	[illegible]
Compaq Deskpro 386 16		26.0	[illegible]
IBM PS 2 Model 80, 16MHz		[illegible]	[illegible]
Everex Step 286/12	**2.46**	**15.9**	**13.7**
[illegible] 286 10		[illegible]	
Compaq Deskpro 286 12		11.7	
IBM PS 2 Models 50, 60	[illegible]	[illegible]	
[illegible]	0.90	[illegible]	[illegible]

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- Front panel LEDs for power-on, disk access and speed indication
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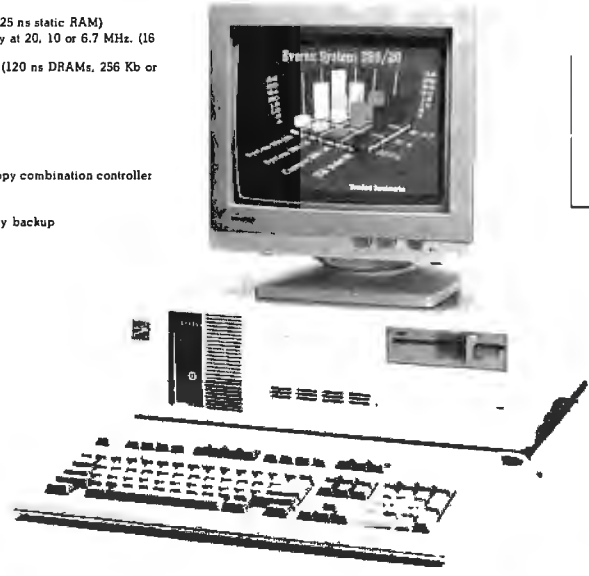

COMPATIBILITY TESTING RESULTS
The Everex System 386 has been evaluated by XXCAL, an independent third-party testing house. The test objective, as stated in XXCAL's report of February 16, 1988, was "to reveal any problems or inconsistencies relative to a selected group of off-the-shelf commercial software, networks, and peripheral products" on the Everex System 386. XXCAL's technicians "installed each application per documentation...[then] tested all functions, commands, and options directly related to a successful and thorough test of the product"

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SHORT TAKES

BYTE editors offer hands-on views of new products

Dell System 220

T-DebugPLUS 4.0

Z88 Portable

Grammatik III

Watcom C 6.0

Paradox OS/2

Dell Machine Sets 80286 Speed Records

You can sum up the new **Dell System 220** in three words: small, powerful, and affordable. The new unit is one of the smallest desktop systems around, as well as the fastest 80286-based system available. And at $1799, including a video graphics array (VGA) monochrome monitor, it is easily the best million-instructions-per-second-per-dollar value on the market.

The new system owes its prowess to a new 20-MHz CMOS 80286 processor, currently available only from Harris, and a high-speed chipset from Chips & Technologies that saves plenty of board space.

The System 220's small size—it takes up about as much space as a briefcase—can be misleading. Inside, there are three IBM PC AT–compatible expansion slots, laid horizontally front to back. There are also sockets for up to 8 megabytes of fast 80-nanosecond memory, a socket for an 80287 math coprocessor, two serial ports and a printer port, and space for a number of hard disk options.

My preproduction unit came with a lively 29-millisecond 40-megabyte hard disk drive and two 1.44-megabyte floppy disk drives. Inside was an 80287 and a megabyte of memory. The system also came with a Mitsubishi color VGA monitor. In normal use, the Dell System 220 seemed immensely faster than my usual 6-MHz AT clone with a 20-megabyte drive. Also, both the floppy and the hard disk drives on the 220 were surprisingly quiet. My impression of the 220's speed was backed up by our benchmarks, which rated the 220 at about 1 percent faster than an IBM Model 80.

With all its features, the only thing the 220 might possibly lack is an 80386 processor. This could become a factor in the future, when an 80386 with a 32-bit memory bus might be required for certain high-performance software. But the 220 also lacks an 80386 machine's high price tag. And for the foreseeable future, the 220 will probably be the best number-crunching bargain on the market.

—Rich Malloy

THE FACTS

Dell System 220
$1799 with one floppy disk drive and VGA monochrome monitor;
$1999 with color monitor;
$2699 with 40-megabyte hard disk drive and color VGA monitor

Options:
MS-DOS 3.3 with cache and disk utilities, $119.95.
1 megabyte of RAM, $500.
100-megabyte drive, $1700.

Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(512) 338-4400
Inquiry 851.

Squash Those Bugs

Whenever you write a program that does more than print "Hello World" on the screen, you're likely to run into bugs. When you have to squash those bugs, a good symbolic debugger like **T-DebugPLUS 4.0** for Turbo Pascal 4.0 can make your life much easier.

Add-on programs for the Turbo Pascal environment have always found themselves

continued

in something of a quandary, since one of the main strengths of Turbo Pascal is its integrated set of editing, development, and debugging tools. To convince users to turn away from one of the Turbo tools, a product has to be pretty impressive. I think this debugger could turn a few heads.

T-DebugPLUS begins by offering features found in most symbolic debuggers. You can examine and alter variables using the names you gave them (instead of addresses), set permanent and conditional breakpoints, set watchpoints, and single- or multiple-step through a program. In addition, T-DebugPLUS lets you open watch windows on up to 8 variables at a time (12 at a time with EGA or VGA graphics), switch between debug and output screens, switch between source code and assembly code views, and make use of expanded memory specification or extended memory to debug larger programs.

The instruction set in T-DebugPLUS is mnemonic to a good extent, and commands can be chained together in macros. Both when I worked through the example code provided with the package and when I used it on larger programs, I found that the features of the package were easy to learn and use, so that I was able to really use the software after a short time.

T-DebugPLUS comes with an installation program that patches TPC.EXE, TPMAP.EXE, and TURBO.EXE so that all will support local symbols. The patched versions of the programs create TPU and TPM files that are twice as large as those created by unpatched versions, but are otherwise compatible with normal Turbo Pascal files.

Using T-DebugPLUS is a simple matter. You compile your code to an .EXE file, using the /$T+ command-line option of TPC.EXE or by setting the "Turbo Pascal map file" option to On in TURBO.EXE.

After compilation, you must exit to DOS and run T-DebugPLUS as a separate program to debug your code. This marks a change from earlier versions of T-Debug, which ran as a part of the integrated Turbo Pascal environment. According to TurboPower Software, the change was made because of the increased memory requirements of Turbo Pascal 4.0.

Though the new version of T-DebugPLUS does not fit into the Turbo environment as seamlessly as older versions, I found it to be a valuable, easy-to-use tool in debugging programs. Given the price and utility of the package, the slight increase in inconvenience is most forgivable.

—Curtis Franklin Jr.

THE FACTS

T-DebugPLUS 4.0
$45; with source code, $90.

Requirements:
IBM PC, XT, AT, PS/2, or compatible with at least 256K bytes of RAM.

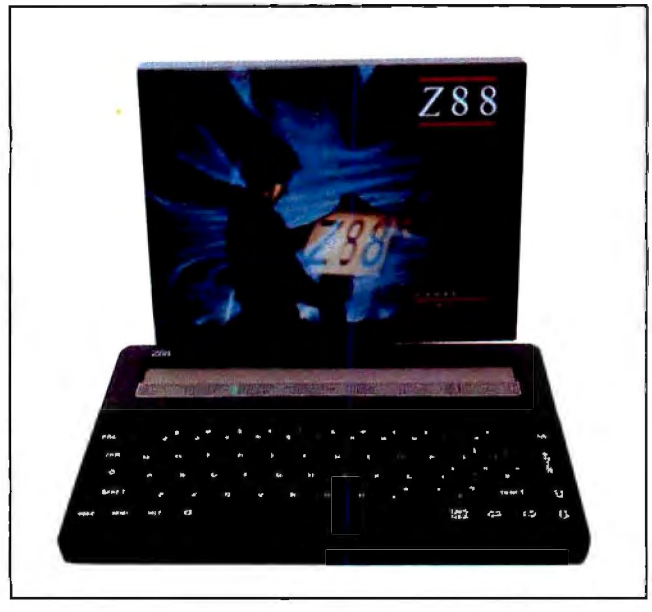
TurboPower Software
P.O. Box 66747
Scotts Valley, CA 95066
(415) 322-3417
Inquiry 852.

A Z88 Portable to Go

The Cambridge Computer Z88 is a laptop portable that weighs less than 2 pounds and is scarcely larger than a copy of BYTE. Achieving this compact size involved compromises: the Z88 has no disk drives but uses RAM for mass storage; it has only an 8-line liquid crystal display rather than a 25-line one; and it's not IBM PC–compatible but comes with a complete suite of applications software in ROM, like the Tandy Model 100.

The processor is a CMOS Z80 with 32K bytes of internal RAM and 128K bytes of ROM. The 9-pin serial port works at speeds up to 38,400 bps. Power is supplied by four Walkman-size disposable dry cells that last about 20 hours. There are three slots at the front for memory cartridges.

My test machine came with 128K bytes of extra RAM and 128K bytes of EPROM. A built-in PROM programmer lets you use the EPROM as nonvolatile, write-once memory for semipermanent data like address lists; an optional ultraviolet eraser lets you reuse EPROM packs. 512K-byte RAM cartridges will be shipping soon, allowing up to 1.5 megabytes of RAM. The company is also promising 1-megabyte cartridges soon.



THE FACTS

Cambridge Computer
Z88 Portable Computer
$549.00

SSI Computer System Inc.
424 Cumberland Ave.
Portland, ME 04101
(207) 761-3700
Inquiry 853.

Options:
32K-byte EPROM cartridge, $45; 128K-byte RAM or EPROM cartridge, $110; PC Link software and cable, $75; serial printer cable, $14; parallel printer cable, $65; modem, $225.

The keyboard is molded from a single sheet of black rubber and looks like a chocolate bar. Recent history has given rubber keyboards a bad name, but this one is different. It has a surprisingly positive action, and you can quickly begin to touch-type on it. The 64-key layout is of standard typewriter pitch, with a full-size space bar and four cursor keys.

The display is a supertwist LCD with dark blue characters on pale yellow. It shows 8 lines of 100 characters; the middle 80 are used for text, and each side is reserved for menus and indicators. It's deeply recessed to avoid damage, and the top edge throws a shadow that hinders viewing in some lightings.

continued

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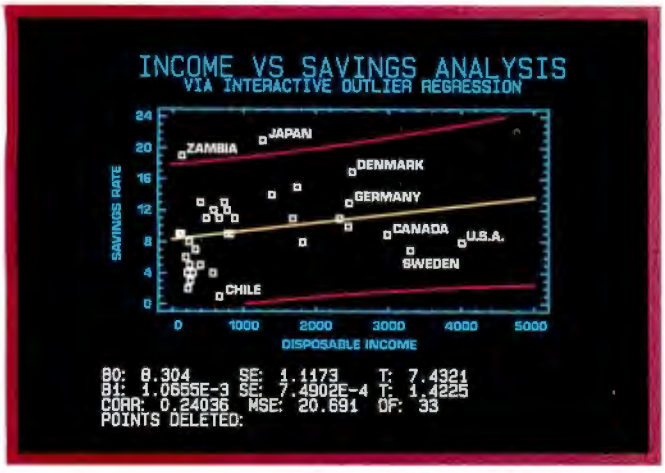
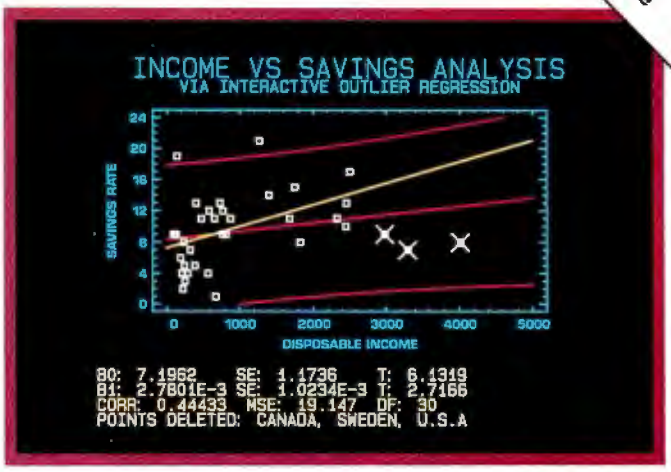


Select the points you want to remove from your regression model . . .



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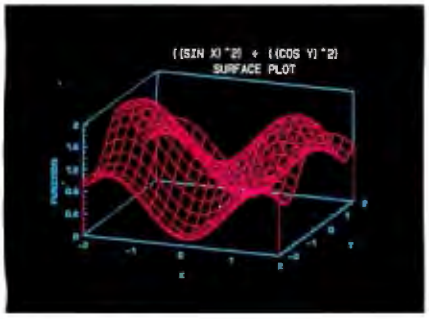

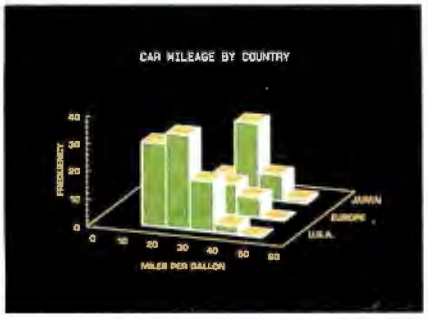

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The ROM software is powerful and cleverly integrated. A combined word processor/spreadsheet called PipeDream works like Lotus 1-2-3, using spreadsheet cells to hold document text, and acts as a simple database.

PipeDream is easy to use and permits quite sophisticated layouts. It supports underline, italic, and boldface, which are visible on the WYSIWYG bit-mapped display. To the right of the text area is a window that shows a 1-pixel-per-character page preview; as well as verifying layout, this helps you find your place in long documents.

You can interrupt any program and pop up another, and you may run as many copies of PipeDream, working on different files, as memory permits. The other programs include a good appointment diary/calendar, a calculator (with built-in unit conversions), a clock/alarm, a terminal program, and BASIC. There are also pop-up system services, including a file manager, setup options, and Printer options. When you switch off the Z88, it saves the whole environment and starts back up where you left off.

The operating system supports hierarchical directories, I/O redirection, and proper batch files with an auto-execute option. RAM cartridges are treated as separate devices, like disk drives. You can print files directly to serial or parallel printers, but the best way to use the Z88 is to upload files to a desktop PC at your office or home. The PC Link package consists of a plug-in ROM, a cable, and a disk of PC software; uploading is controlled entirely from the PC screen via menus. The communications package consists of a 1200-bps matchbox-style modem plus a communications program in ROM.

Don't disdain the Z88 just because it lacks an 80386 or a hard disk drive; the clever software makes it a match for many a larger machine. And when you have to carry it around all day, small really is beautiful.

—Dick Pountain

An Analyst for Your Writing

Grammatik III is a new version of Reference Software's IBM PC-compatible program for analyzing documents for grammatical and stylistic errors. Unlike Grammatik II, which checked documents against a fixed phrase dictionary, Grammatik III uses parts of speech and suffix analysis to provide more comprehensive grammar checking.

Not only does Grammatik III find possible errors, but it also offers suggestions for improvement. Grammatik III scans your document and finds basic errors like double words, unbalanced punctuation, or improper capitalization, as well as more subjective problems like use of the passive voice, pretentious expressions and cliches, wordiness, and split infinitives. In addition, Grammatik III checks for subject-verb disagreement, double negatives, incomplete sentences, and other incorrect usages. Since writing "errors" are often subjective, you can customize Grammatik III to ignore certain types of phrases.

While Grammatik II worked best with ASCII files (it had problems with word-processing control codes), Grammatik III is designed to work with most major PC-compatible word-processing programs. When you first install the program, you select from a menu of word processors and text formats. You then run your document through Grammatik III, either interactively or in batch mode. When in interactive mode, it flags suspected problems on the

continued

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The best reason to buy DesignCAD 3-D is not the low price, the performance or the compatibility. The best reason is the amazing ease of use. DesignCAD 3-D's powerful commands mean that you can produce professional 3-D drawings in less time than you thought possible. In fact, we think you'll agree that DesignCAD 3-D is easier to learn and easier to use than any 3-D CAD system for IBM PC, at any price!

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PC Resource Magazine has listed DesignCAD 3-D as one of the six new computer products worth watching in 1988.

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screen. You can edit the problem phrase or sentence, ignore it, or instruct Grammatik III not to flag this type of problem in the future. After you've finished checking the document, Grammatik III saves the edited version and makes a backup of the original.

Grammatik III also provides a statistical summary of the document (number and type of errors found, a "readability index," and other statistics).

In batch mode, Grammatik III marks your document without your intervention, saves the marked file, and creates a backup of the original. You can then work with the marked document using your word processor. Grammatik III includes an optional spelling checker, but spelling checking more than doubles the grammar-checking time. If your word processor has a separate spelling checker, it's probably better to use it.

I tested a beta version of Grammatik III using an IBM PC XT with an Orchid 286 accelerator card (TurboEGA). In batch mode, a 10,000-word document took about 4 minutes to check. I tried the process using both a hard disk and a RAM disk and got about the same results (the CPU is the bottleneck rather than the disk access speed).

In my tests, Grammatik III found a lot of errors but also missed some blatant ones. For example, it missed "many friends of mine lives in New York" and the incomplete sentence, "So should be fun." It did find "their going to have a party," and gave the message: [the context of "their" indicates you may have meant "there" or "they're."] Although it missed some errors and also flagged some correct grammatical phrases, the program is helpful in identifying possible stylistic or grammatical problems.

—Nick Baran

THE FACTS

Grammatik III
$99.00

Requirements:
IBM PC, XT, AT, or compatible, 128K bytes of RAM, DOS 3.0 or higher, one floppy disk drive.

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You now have all the underpinnings of **Watcom C 6.0**. And most of the other C compilers that have hit the ground in the last year.

Now give it a price: $495. A little steep? Not for what amounts to two compilers.

Here's where Watcom C begins to part company with the crowd. It actually consists of WCC, which operates with a 64K-byte data area; and WCGL, which makes use of all available memory (up to 640K bytes). The idea is that, though WCGL is slower than WCC, it can compile all the monstrous programs that would overflow WCC's memory allotment.

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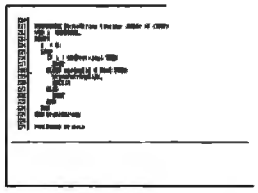
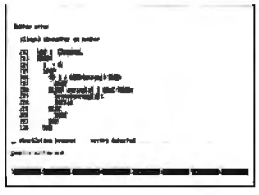
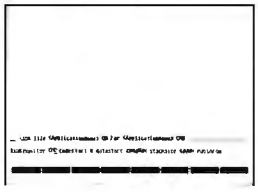
Program development system for Series 32000 based embedded systems running on IBM-PC/XT/AT and PS/2-30







Description:

- Add-in board consisting of Series 32000 chip set and ROM-resident EDITOR, COMPILER, LINKER, DECODER and MAKE UTILITY

Host Hardware:

- IBM PC/XT/AT or compatible with free half card slot

Host Software:

- DOS 2.0 or later

Target Hardware:

- Any Series 32000 based embedded system

Target Software:

- Runtime support is supplied in source form

Key Product Features:

- This compiler enables you to use all the features of Modula-2 as described in Nicklaus Wirth's *Programming in Modula-2* (3rd edition).
- The target runtime support module, supplied in source form, includes a floating point package which emulates the NS32081 chip, if necessary.
- The system's command-line-based user interface is on-screen supported and leads the user through the command entering process.
- The information display makes constant reference to a manual unnecessary by providing the user with the information needed to run the system.
- Only a single command line is needed to convert a set of source modules into an executable file.
- Any individual application can consist of up to 400 modules written entirely in Modula-2.

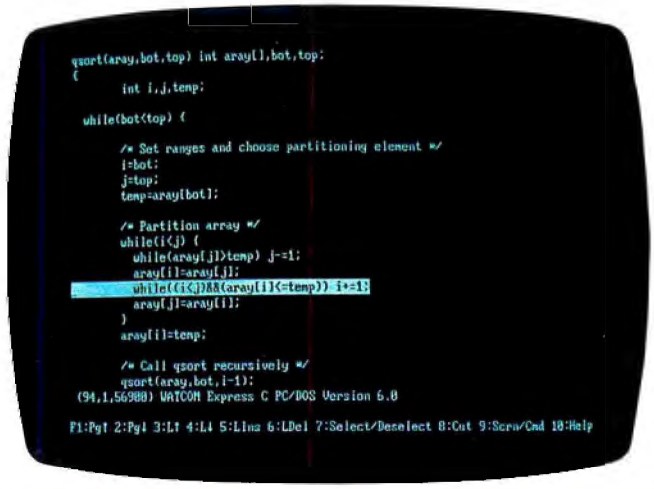
Key Product Benefits:

- Manual-free use
- Programs can be written entirely in Modula-2
- Easy handling of very large program packages
- Convenient transfer of Modula-2 programs written for other processors to Series 32000 environment
- Reasonably priced development system for the entire family of Series 32000 microprocessors

Product Vendor:

Alois Schönbächler, Freischützgasse 14, CH-8004 Zürich/Switzerland

Tel.: 41-1-241-0514



```
qsort(array,bot,top) int array[],bot,top;
{
        int i,j,temp;

  while(bot<top) {

        /* Set ranges and choose partitioning element */
        i=bot;
        j=top;
        temp=array[bot];

        /* Partition array */
        while(i<j) {
          while(array[j]>temp) j-=1;
          array[i]=array[j];
          while((i<j)&&(array[i]<=temp)) i+=1;
          array[j]=array[i];
        }
        array[i]=temp;

        /* Call qsort recursively */
        qsort(array,bot,i-1);
 (94,1,56988) WATCOM Express C PC/DOS Version 6.0

F1:Pgf 2:Pgi 3:Lf 4:Li 5:Lins 6:LDel 7:Select/Deselect 8:Cut 9:Scrn/Cmd 10:Help
```

THE FACTS

Watcom C 6.0
$495 (includes Express C)

Requirements:
IBM PC, XT, AT, PS/2, or true compatible, DOS 2.0 or higher, and 512K bytes of memory recommended.

Options:
Watcom Express C, $125 (if purchased separately)

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I performed some informal tests on the Watcom compiler, stacking it up against Microsoft C 5.0 on my 10-MHz AT clone. I modified our new Sort benchmark to create an array whose elements were in reverse order, and I hand-timed the execution speed of the result. (I used small models for both compilers and set no compile switches—I handed identical copies of the source code to each compiler.) The Watcom compiler's version completed in 11.3 seconds, while Microsoft's took over 15 seconds. However, the executable file Watcom created was over 12K bytes in size, while Microsoft C created an 8K-byte executable file. I figure it's the same old equation: speed at the cost of space.

And, yes, you'll find yet another editor supplied with the Watcom disks. The editor is simple enough to use, allows you to work on more than one document simultaneously via multiple workspaces, can operate in either line mode or screen mode, and supports editing macros.

Watcom's answer to Turbo C and Quick C is Express C. As you might guess, you can operate Express C with Watcom's editor in an integrated environment so that all development functions—compiling, linking, editing—occur in memory.

What you might not guess is that Express C also includes a memory-resident source-level debugger that allows you to trace program execution, view and modify variable contents, set breakpoints, and display your program's output. If you launch Express C with the /d option, the debugger automatically fires up when you compile and run your program. While experimenting with the debugger, I stumbled onto a bug in the benchmark program I was creating. But that's what it's there for, right?

When I pitted Express C against Turbo C (using yet another variant of the Sort

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benchmark with a smaller array size), I found that Turbo C chalked up a compile-and-execute time of 9 seconds against Express C's 28 seconds. I thought I could attribute Express C's poor showing to the fact that it performed array- and pointer-bounds checking unless told otherwise. But even when I told it otherwise, it still hit the wire at about 27 seconds.

Watcom delivers a high bang-for-the-buck ratio when compared to Microsoft C 5.0. Watcom C is a class act, and the source-code debuggers for both the high-end C 6.0 *and* the integrated Express C make the whole package a real possibility for doing heavy-duty development work.

—Rick Grehan

Paradox Takes on OS/2

If you've used the MS-DOS version of Paradox, **Paradox OS/2** will be immediately familiar. Except for the OS/2 line on the opening screen, the actual user interface is identical, and it works *exactly* the same; it is compatible with files, scripts, and reports from earlier versions.

The differences showed up when I started doing some actual work. Because Paradox OS/2 runs in 80286 protected mode, it directly addresses all your system memory. That eliminates the time-consuming disk reads and memory swapping that take place under the MS-DOS version.

This immediately translates into speed. Database access, moving around tables, and doing usual work like sorting and generating reports is noticeably faster, though your mileage will vary depending on the type of database you're using and what you're doing with it.

You can run multiple Paradox OS/2 sessions at the same time, and even share data and utilities among them. This is heady stuff for those of us used to the one-task-at-a-time limitation of MS-DOS.

Paradox OS/2 uses the same concurrency controls to coordinate multiple sessions that Paradox 2 uses to coordinate multiple users on a network. There are, of course, some limitations. You can't physically make changes to two sessions concurrently, so Paradox OS/2 has the same abilities as its MS-DOS brother to lock tables and set what the program calls "private directories."

If you're new to OS/2, you'll soon find that there's a boundary to the apparent magic, especially if you have limited memory. Each session you start exacts its cost in processing time and RAM. While Paradox OS/2 can use up to 16 megabytes of RAM, my PC AT clone had only 3 megabytes, the minimum you need to run the program. Things started to slow down appreciably by the time I started the third Paradox session.

Paradox OS/2 is far from the ultimate OS/2 application. It's really just a sophisticated port from the MS-DOS version, which already had its own multiple-session hooks in its network support. But it's a tantalizing glimpse of the possibilities that OS/2 will offer.

—Stan Miastkowski

THE FACTS

Paradox OS/2
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Requirements:
IBM AT, PS/2 or compatible, 3 megabytes of RAM, OS/2 Standard Edition 1.0 or higher, and a hard disk drive.

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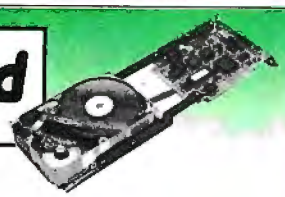

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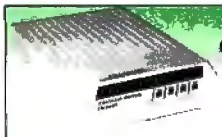

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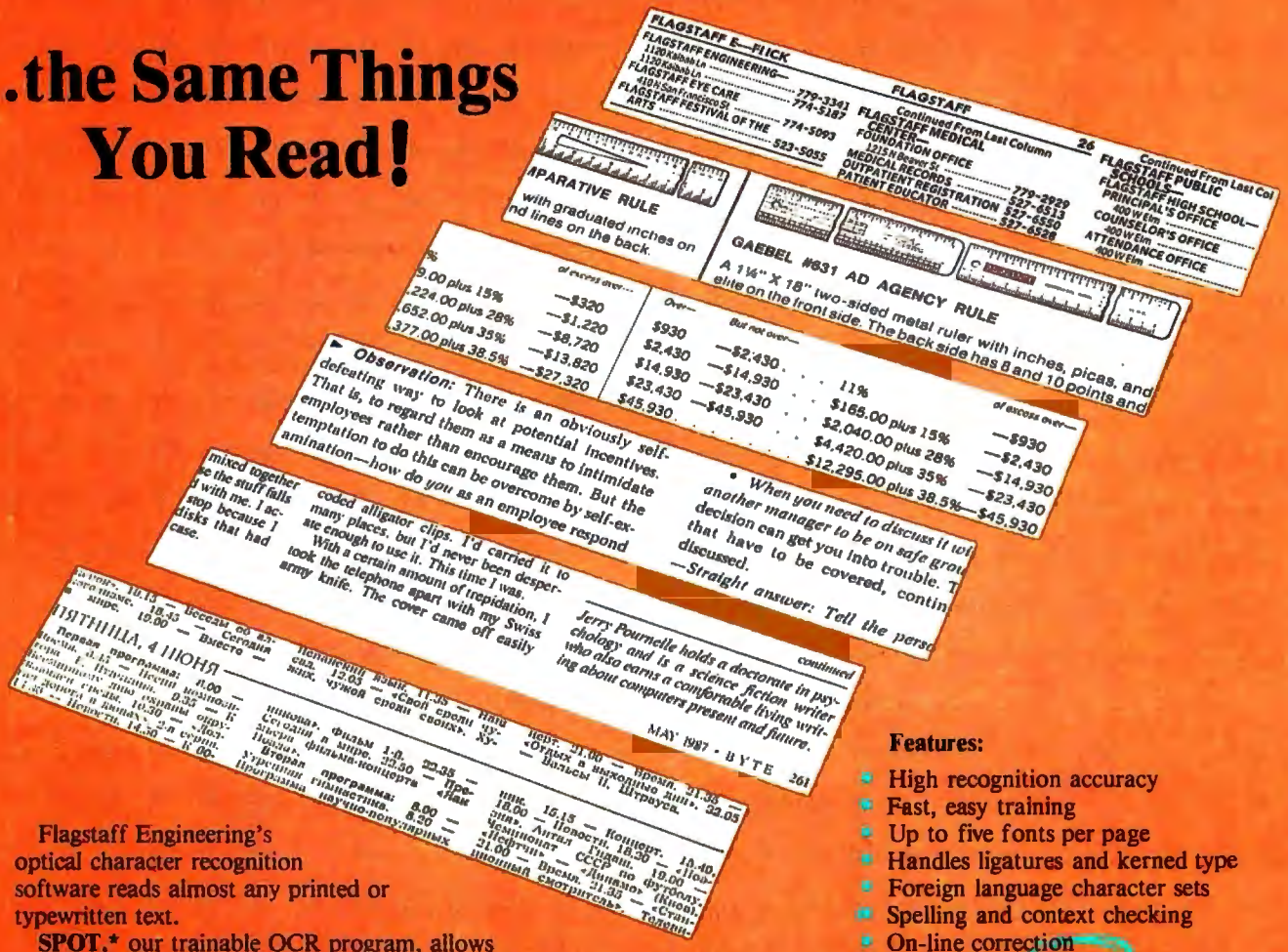

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A FOND FAREWELL

Is Jerry's old friend Zeke II retiring to greener pastures?

This is a shameless commercial. As I write this, *Legacy of Heorot* by Larry Niven, Jerry Pournelle, and Steve Barnes is on the best-seller list in England. About the time you read this, the paperback version will be out from Pocket Books. If every BYTE reader goes out and buys one, it will hit the best-seller list here. If you all buy another for a friend—

Well, anyway, it's a good book about the first interstellar colony (sent out by the National Geographic Society), it has a nice computer in it, and you can buy the book at your favorite bookstore. Meanwhile, there's a lot happening at Chaos Manor.

Writers are superstitious about all kinds of things. Goethe had to have a drawer full of rotten apples. Schiller wanted cats in the room. Some need a particular brand of coffee or a favorite coffee mug.

Not all writers worry about furniture, but many do. I confess I'm one of them. Of course, I don't think of it as superstition, just good organization.

What I want is a big desk, the bigger the better, that I can get right up close to, and high enough for drafting work. For years, I used a 4- by 8-foot piece of half-inch mahogany plywood screwed to the top of an ancient student desk that stood on little feet to raise it; the result was overhangs on all four sides deep enough that I could scoot a chair right up to the desk. It was a little odd getting to the drawers, but the system worked.

Of course, I didn't do my writing on that structure, because it was too high to set a typewriter on. Instead, I set my Selectric on a regular typing table, one large enough to hold not only the typewriter, but pages to be retyped or a few books. The typing table was at right angles to the desk, so I had only to swivel around to get at it. That way, I could lay out notes and research work on the big desk, turn left to the Selectric when I was writing, and turn back to the desk to review notes.

When I got Ezekial, my old friend who happened to be a Cromemco Z80, I set things up the same way, with Zeke taking the place of the Selectric. Of course, an S-100 system with 8-inch disk drives wouldn't fit on a normal typing table, and I ended up building a furniture system that had the computer itself near the floor, the disk drives on a counter, and the 15-inch monochrome Hitachi monitor on top of the disk drives.

The keyboard first went on the Selectric's old typing table; later, I got a larger table that would hold the keyboard and a bunch of notebooks and stuff. The monitor was at eye level and 30 inches away, just far enough that I didn't need the reading element of my bifocals to read the large text put up by the Processor Technology VDM board. There were only 16 lines of 64 characters, but that was enough.

I wrote on that system for years. Ezekial himself evolved into Zeke II: a CompuPro S-100 "boat-anchor" box and CompuPro 8-inch disk drives, but the same Hitachi 15-inch monitor driven by the same VDM memory-mapped video board. Larry Niven bought an exact duplicate of Zeke II. We wrote a number of books on those two machines. I also wrote these columns and everything else I did, a total of several million words.

I tried the IBM PC when it first came out. I even bought one, but for research only. I had no temptation to use it to write books. PC text editors weren't good enough. Their only advantage was that a PC would put up 24 lines of text as opposed to Zeke's 16, but against that the PC was *very* slow compared to Zeke. In particular, it scrolled slower. With Zeke I could instantaneously flip back and forth by pages, which more than made up for the 16-line limitation. Also, it took a lot longer to read and write IBM 5¼-inch disks than 1.2-megabyte CompuPro 8-inch disks. For the first 5 or 6 years after the PC came out, there was just no incentive to change over from Zeke.

Slowly, though, PCompatibles got faster and better. EGA video put up readable text in color. New PCompatible thesaurus and spelling programs came out—although Oasis Systems' The Word Plus was for a very long time the best spelling program around (it's still the basis for the spelling checker in many well-known word processors). Writing utilities like Grammatik II (and now III) and the Readability program would work only with PCompatibles. Editor programs sprouted features not available for my old CP/M system. I found I was using the PC more and more.

Eventually, the only things I was writing on Zeke II were books in collaboration with Larry Niven. When we brought in Steve Barnes to work on *Legacy of Heorot*, we had another problem: Steve was using WordStar on a Kaypro PCompatible, and his files had to be translated from PC-DOS to CP/M.

Fortunately, we had the means to do it: the Golem, my big CompuPro Dual Processor (80286 master, Z80 slave board), can read and write 360K-byte 5¼-inch DOS disks, and it also sports a pair of 8-inch floppy disk drives (as well as a 40-megabyte Priam hard disk drive). We could feed Steve's disks into the Golem, run his files through a filter, and write them out on 8-inch disks that Zeke II could read into our CP/M text editor.

When we finished *Legacy of Heorot*, I decided enough was enough. Niven was working on a new book with David Drake, and Drake uses a Toshiba T1000 PCompatible with 3½-inch disks. Getting Drake's stuff onto the CP/M system

continued

and Larry's onto Drake's Toshiba was no easy job. It was time for a change.

Niven was persuaded to go buy a PCompatible: a Zenith Z-386 with a hard disk drive, a 19-inch Electrohome monitor, and both 5¼- and 3½-inch floppy disk drives. That took care of the Drake collaboration. I converted our latest stuff over to PCompatible format. Now I was doing all my writing on PCompatibles.

I had long since set up a PCompatible on the opposite side of my desk from Zeke; swivel left to the PCompatible, swivel right to Zeke (and also to a terminal that controls the Golem). Which PCompatible it was changed from time to time: first Big Kat the Kaypro 286, then Fast Kat the Kaypro 386, and now Zanna Lee the Zenith Z-386. Zeke II sat there watching in silence. He had nothing to do, and we turned him on only when a visitor wanted to see him.

Then BYTE wanted a column for the special Macintosh edition. Apple sent a Mac II. About then, Cheetah put together the Big Cheetah, a 20-MHz 80386 with a Priam 330-megabyte internal hard disk drive and a Maximum Storage APX-3200 WORM (write once, read many) drive. Commodore sent the Amiga 2000. Atari sent a Mega ST. Every one of those machines had to be set up on test stands far away from my desk, making it very inconvenient to *use* them—and after all, the point of this column is to write about stuff I've used for practical work.

Something had to be done, and I did it.

Three weeks ago, Zeke II retired. We had a little ceremony and wheeled him out.

At the moment, the poor old fellow is sitting in the storeroom. All his parts are there—disk drives, Hitachi monitor, keyboard, and all the cables—but they aren't assembled. I haven't really had the heart to do it. As far as Zeke knows, he was turned off one day and hasn't been awakened again. Suppose I connect him up and he sees where he is? Unthinkable.

I confess I don't really know what to do with him. What I'd like is to find him a good home. Oh, sure, there are some mad hobbyists who'd like to have all his parts, but I can't allow that. What I want is someone who will *use* him—but who? Who, after all, is likely to want an ancient Z80 machine that's physically larger than a two-drawer file cabinet, has 8-inch disk drives that spin all the time, and has a 16-line by 64-character display driven by the world's last operating Processor Technology VDM board? He's a wonderful old guy, but he's also a museum piece.

I know from my mail that I have very clever readers, and some seem as devoted to old Zeke as I am. I've decided to have a contest: I'm soliciting the best suggestion as to what to do with Zeke, the CompuPro S-100 Z80. I'm not sure what the prizes will be. Something appropriate, like dinner at a COMDEX or West Coast Computer Faire for the best half dozen letters, and something a bit more special for the winner.

The rules are simple: I'll consider any suggestion provided that Zeke will be kept intact and there's some chance of implementing it. If you want to tell me why Zeke ought to be given to you, or your family, or some favorite institution, feel free. If you think he belongs in the Smithsonian, you'll have to show me some evidence that the Smithsonian would be interested. If you think he ought to be sent to the center of the galaxy, you'll have to explain how that could be accomplished.

The Mac has a well-deserved reputation for being easy for utter beginners to use.

The decision of the judge—me—is final, all entries become part of the general chaos in Chaos Manor, and some will be returned but others won't be because they're lost or the dog ate them. Contest closes on Thanksgiving Day.

The Furniture Dilemma

When I first got Zeke, there wasn't any commercial computer furniture. In those days, you either made do with typing tables or designed and built your own "workstation." In the early 1980s there was a flood of the stuff, most badly designed. Gradually, evolution and the market took care of the situation, so that now you can get quite a bit of computer furniture designed for PCompatibles. There's also some for the Macintosh.

Alas, there is absolutely nothing satisfactory for the Mac II; and what has evolved for PCompatibles isn't going to be useful much longer. The problem is mice.

Until recently, PCompatible users didn't need mice. You couldn't operate a Mac without one, but many considered a mouse for the PC to be a pretentious bit of luxury. Slowly, though, PC users began to change their minds. Some programs require mice—it's possible to use Microsoft Word without one, but you won't like it much. Others weren't designed for mice but work better if you have them: WordPerfect with either Mouse Perfect or a properly written script for Logitech's Menu mouse support package is a good case in point, being much easier to use with a mouse.

Also, the Mac has a phenomenal (and well-deserved) reputation for being easy for utter beginners to use, and much of the Mac's design philosophy is drifting over into PCompatible software designs. The upshot, in my judgment, is that mice are taking over the computer world, and pretty soon none of us will feel at home without them.

That's where the furniture problem comes in. With the exception of a few special items jiggered for the Mac and dependent on the old Mac's small footprint and weird keyboard, there isn't any computer furniture designed for mouse users.

One of the best kinds of computer desk starts with a more mundane item—office desk or credenza or even a solid countertop—and puts a keyboard drawer underneath. There are a number of keyboard drawers, and while many of them are overpriced, all the ones I've seen work quite well and are easy enough to install. All the keyboards I've used fit well in the drawer tray, and the system is solidly built so things don't wobble when I type. However, every one of those keyboard drawers, without exception, is too narrow to hold both a keyboard and a mouse.

I suppose it's only a matter of time until someone gets smart and makes a computer desk with a keyboard area large enough for both keyboard and mouse, but that hadn't happened by Spring COMDEX; I looked at every computer furniture display in Atlanta, and except for one desklike system that's a full 4 feet wide, there wasn't a thing. Sigh.

Amiga Progress

One of my high points of COMDEX was a demonstration of new developments for the Amiga given by Dr. Harry Rubin, chief operating officer of Commodore America. Rubin's enthusiasm for the Amiga is unmatched; he reminds me of some of the company executives back in the early days of microcomputers.

One thing they showed me was Unix

continued

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running on what appeared to be an Amiga 2000. This was full System V Unix, no compromises, and, even loaded down with several simultaneous tasks, it certainly looked fast enough. Fair warning: this is a show report. I'll have more on it when it's running here at Chaos Manor and I can turn Alex loose on it. I can only say that what I saw at COMDEX impressed the heck out of me.

Meanwhile, at the Amiga developers' conference held just before COMDEX, they distributed new ROM chips for the 2000. Joanne Dow was given a copy for installation in my machine, and about an hour ago she came over and did the job.

ROM installation in the Amiga is simple but tedious. You have to remove about eight screws so that you can move the hard disk drive, floppy disk drive, and power supply. The good news is that they're all mounted on a rigid frame that moves as a unit, so once the screws are removed, the whole assembly lifts off to expose the ROM chip. After that, things are simple.

AmigaDOS is not simple. I watched Joanne do her magic for a while, but I soon lost track. What I can say is that after about half an hour of work she had set up the Amiga 2000 so that on power-up you must boot it with a floppy disk—it still won't entirely boot from the hard disk drive—but that process is considerably faster than it used to be. The good news is that once that's done, the Amiga can be reset and rebooted from a RAM disk. That takes only a few seconds.

I don't know of any other computer that can boot from its own RAM disk.

There are other developments. There's a new version of the Amiga operating system, which is said to speed up disk operations. There were certainly plenty of software developers at the COMDEX Amiga booth. A number of "standard" PC programs, including WordPerfect, have been ported over to the Amiga and work fine there.

All in all, the Amiga seems to be improving steadily. More when I learn more. I'm supposed to have Unix for the Amiga coming in the next week or so.

Scanners Live in Vain

Spring COMDEX wasn't very exciting if you were looking for something new. There were almost no new products, and not much more new technology. There was, however, considerable excitement among dealers, a general feeling that the doldrums are over and the computer industry is ready to take off again.

The most exciting new hardware product I saw was the Logitech ScanMan. This is a small hand scanner that interfaces with a Logitech printed circuit board. You run the scanner over text or pictures or whatever, and it makes a bit-mapped image similar to a PC Paint file.

Meanwhile, over in the Apparel Center—where all the newcomers to COMDEX are sent—Flagstaff Engineering was exhibiting a program that takes scanned text images and turns them into machine-readable files. I suppose I'd better explain that.

Computers can store text in two different ways. The most familiar way is as actual text files, in which the machine "knows" what's there. Each letter, number, and punctuation mark is stored as a uniquely recognizable binary number, so that the machine can not only reproduce the text, but also manipulate it in orderly ways. It can make alphabetic sorts, look at words and compare them to dictionaries, and in general act as though it

continued

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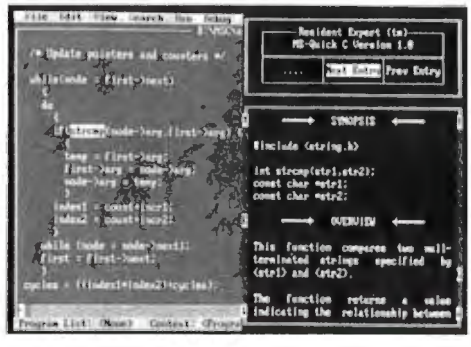

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"knows" what the files contain.

The other way machines can store text images is as bit-mapped images. In this case, the computer doesn't know that what it has stored is text; as far as the machine is concerned, this may be a picture of the planet Jupiter, a random drawing made with a paint program by a 3-year-old, a line drawing of the Washington Monument, a Gary Larson cartoon, or anything else. The machine isn't expected to know anything about the image: its only obligation is to faithfully reproduce it when called upon. The fact that this particular image happens to be a picture of a page of text is completely irrelevant.

As an example: Mrs. Roberta Isdell Pournelle's father, the late Frank Isdell, was one of the early union organizers in the copper mines in Idaho. Those were rough times: his house was dynamited by the Pinkertons in retaliation for his union activities. Frank Isdell kept a journal, handwritten on yellow lined paper. It makes fascinating reading. Mr. Isdell died long enough ago that most of his grandchildren don't remember him well, and Mrs. Pournelle and I have decided to use our considerable computer resources to publish that diary so the kids will know just what their grandfather was like.

The first part of that job is easy. We simply use an image scanner to make copies of his manuscript pages. Once we have those, we can reproduce them in any way we like, on paper with a laser printer or even as page images to be stored on a CD-ROM. What we'll have is the electronic equivalent of photocopying or photographing those pages.

The problem with that is, you can't do anything with the images other than reproduce them. Since the machine can't read those notes, it can't do spelling correction. It can't index. We can't search for key words. Like a camera, it can only produce a new image copy; and that's not quite what we had in mind. Our intent is to produce an annotated work embedding Frank Isdell in his times, with notes and maps. To properly do what we want, we'll need true text files. The only way to get those is to have someone type them in. No computer is smart enough to take handwritten text and turn it into machine-readable text.

The Trouble with Kerning

If Frank Isdell had typed his notes, we wouldn't have such a problem. There are hardware scanners with programs that recognize typescript letters, one letter at a time. If they encounter a typeface they haven't seen before, they can be taught that one, too. These machines are called optical character readers (OCRs).

When an OCR sees the symbol ';', it is clever enough to recognize that as a semicolon and store it in memory as the binary equivalent of number 59. Similarly, an *A* is assigned the number 65, *a* is stored as 97, and so forth. The numbers are ASCII. ASCII is an arbitrary scheme that assigns a unique number to every letter, number (from 0 to 9), and punctuation mark. ASCII isn't the only such scheme—IBM sometimes uses a system called extended binary-coded decimal interchange code (EBCDIC), which assigns quite different numbers to each letter and punctuation mark—but it's the one used by all microcomputers.

OCRs have been with us for a long time, and they're quite good for what they're intended for, which is typescript. The trouble arises with printed text. Whereas typescripts (with exceptions like the IBM Executive, but let's not complicate matters) allow the same width to each letter—the *i* takes up just as much room as the *m*—printed text doesn't work that way. Not only is the space allocated to the *i* less than that given the *m*, but some letters actually overlap, as for example when they typeset the letter combination *WA*. This process is known as kerning, and it has been around for centuries, because kerned text is more readable and just plain looks better than typescript. The trouble is that kerning confuses the computer.

For years, we've heard announcements of OCR scanners that could read kerned text, and every now and then one comes out; but none of them has been worth much. At COMDEX, Flagstaff Engineering was demonstrating the Spot program that can take image-scanned text from either the Hewlett-Packard or the Panasonic scanner and turn that into machine-readable ASCII files.

The program isn't perfect. It has to be taught each typeface, and every time it runs into a kerned pair it has never seen before, it complains until you teach it what it means. You have to tell it that the symbol *WA* is to be interpreted as two ASCII characters rather than one. Once it learns that, it remembers. Eventually, it will know all the kerning pairs in that particular book, after which it can read the book.

I have a bunch of books I wrote on a typewriter before I got old Zeke. I either don't have the typescripts of those books, or they were so marked up in editing as to be unscannable; in any event, I have no

continued

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machine-readable copies of my early works, and no easy way of making any.

That's all changing. Flagstaff Engineering has enough confidence in their programs that they're arranging to get me the loan of a Hewlett-Packard scanner, which they say will work with their software so that when we put printed copies of my old books in, we'll get machine-readable language out.

I can't wait to try that.

Traveling Strikes Again

Mark Eppley of Traveling Software doesn't seem to know the rules: he held a press conference (his first ever) at COMDEX to announce a product they're actually shipping. I understand that seven different PR agencies were so horrified they tried to straighten him out: you hold press conferences to announce stuff that you're going to ship Real Soon Now, not something that you've actually got out the door.

Anyway, Traveling has a small memory-resident program for laptops that keeps track of battery use. By doing Shift-Alt-B, you get a "fuel gauge" display that estimates the time remaining before the batteries in your particular laptop (you tell it which one you have during setup) go dead.

This is one of those utilities Traveling developed largely for their own use, then partway through decided it was a salable product. You can live without it—I have for several years—but it's certainly a convenience if, like me, you have a faulty memory. I have several times got on an airplane with a partially charged Z-183 and run out of juice before the flight was over. My fault, but very annoying. Traveling's Battery Watch program would have prevented that.

I can't testify to its accuracy for all laptops, but I did test a prerelease version on my Z-183, and it's pretty good on that: it reported I had 2 hours left when in fact the machine ran for 2 hours and 10 minutes. An hour later it reported 1.1 hours remaining, so it was in fact updating its prediction by watching my use pattern.

Battery Watch has a "deep discharge" option designed to really run down your nickel-cadmium battery. Running it down until it's complete discharged and then recharging it maintains the capacity and increases the life span of the battery. Otherwise, the battery develops a "memory"; if not completely discharged, it only partially recharges. The deep discharge option may be useful for some laptops, but it certainly isn't needed for the Z-183. When I tried the program, it did continuous reads on both the hard disk and floppy disk drives.

Moreover, after I'd been running the deep discharge option and listening to it grind my hard disk and floppy disk drives for a while, the backlit screen turned itself off. The prerelease version of Battery Watch didn't know how to take control of that, which is odd, because you set the time-out constant (how long the screen will stay lit between keystrokes) in software, meaning that number has to be stored somewhere in the machine's memory. The backlit screen uses plenty of power, and if you can keep it on, that surely would be the most harmless way to deep discharge your battery. As it happens, Norman Spinrad discovered a way to do just that on the Z-183: simply give the machine the SHIP command.

SHIP is supposed to park the hard disk drive head in a landing zone, after which you turn off the computer. If you don't turn it off after issuing SHIP, the Z-183's screen backlighting stays on until the battery is gone, which is surely a more benign way than grinding the disk drives.

Mark Eppley says that the production version of Battery Watch does keep the backlight on during a deep discharge. And, although using SHIP is a gentler method to discharge the batteries, using the deep discharge option speeds up the entire discharge/recharge operation.

The fuel-gauge part of Battery Watch works fine, and anyone who does a lot of traveling with a portable will be better off for it.

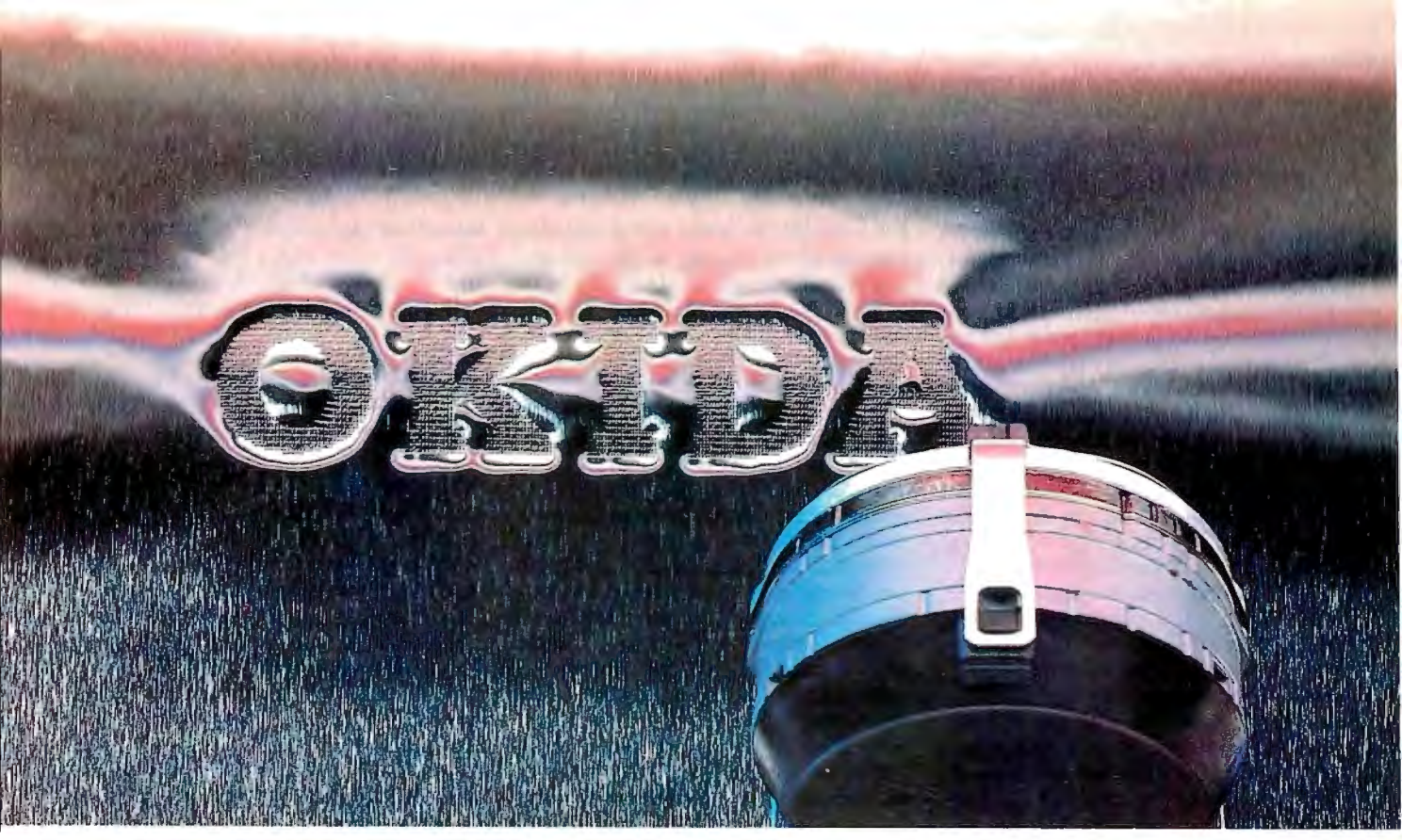
Peep Shows

One reason COMDEX wasn't very exciting was that about half the new stuff on display has been vaporware for a very long time: products announced but not yet demonstrated, much less shipping. No matter how exciting a product is, after you hear about it long enough you lose interest.

Some companies know this, and they have a policy of not making public announcements until they've really got a product. On the other hand, they also know that writers have an insatiable appetite for new things to write about, which presents them with something of a dilemma.

One way out of that is what's known in the trade as a peep show: your booth on the show floor has only shipping prod-

continued



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ucts, but you also have a hotel suite where you bring selected distributors, dealers, and customers for private showings; and if there's any time left over in your schedule, you bring in reporters and columnists you can trust to respect information-release embargoes. As an example, I saw the Zenith laptop computers almost a year before they were announced to the public—I'm rather proud that they incorporated a couple of my suggestions into the final product—and the Zenith Flat Technology Monitor long before it was shown to the industry in general.

When I first began writing for BYTE, there was a full 4-month delay between my draft and the actual publication. Over the years, they've whittled that down a lot: I'm writing this on May 20, just before the Science Fiction Writers of America's annual Nebula Awards banquet, and it will be in the August issue, meaning that it will be on the stands in mid-July. Of course, I should have had this in a week ago....

Anyway, one of the COMDEX peep shows was held by Intel, and I have their permission to say this much: Intel has a new PCompatible communications system, hardware and software, that will knock your eye out. I've been saying for years "one user, at least one CPU," and Intel has taken that to heart. I guarantee you'll hear more about this one.

ForComment:

I first saw Broderbund in San Francisco's Brooks Hall at one of the early West Coast Computer Faires. They had a tiny booth over against one wall, and they were showing the best computer games I'd ever seen. The next year they had a larger booth, and the year after that they had one of the biggest in the show, all built around computer games.

If you know computer games, you're likely to know something about computer graphics, and the temptation for games companies is to use that expertise in an attempt to penetrate the business market. Sometimes that doesn't work—few even remember the name of Infocom's business programs—but sometimes it works spectacularly, as witness Broderbund's Print Shop low-end desktop publishing programs and utilities for the IBM PC.

I recently received a report that Print Shop was the best-selling PCompatible program of 1987, and I've no reason to doubt that. I've covered it in other columns; in the unlikely event you don't know about it and you have the slightest interest in using a PC for simple bread-and-butter print work, check it out. It's not as elegant as some of the high-end programs, but it's easy to get into and good enough for a heck of a lot of jobs.

Anyway, Broderbund hasn't abandoned games, but they have become a serious contender in the business and education markets.

One of their better efforts is ForComment: (despite the cutesy-pie name). This is a program that lets from a few to a whole bunch of people take text files, examine them, and make editorial comments complete with date and initial stamps. The commented version can then be sent on to someone else, either by disk or through a local-area network (LAN). Either way, there are simple ways for the final editor to collate the comments and either implement or remove them. One of the neatest features is selectivity: if one of the people making comments turns out to be a complete idiot, you can set the system so that you'll never see those remarks.

Despite the fact that Niven and I are about the most successful writing team since Nordoff and Hall, I'm no great fan of collective writing; realistically, though, most corporate documents are necessarily collaborative efforts. Policy memos have to be vetted by several departments. Letters often must be reviewed by a number of specialists. All this can be expensive, especially if it's done in face-to-face meetings.

ForComment: can take up some of that burden. It's easy to learn and easy to use, and it's not overdeveloped for the job it's supposed to do. It supports about a dozen word-processing programs (including, of course, straight ASCII text files). My only complaint about ForComment: is that it doesn't recognize Q&A Write, which is the editor Niven and I are using for our next novel.

SideKick Plus

Readers of this column will know that I'm a longtime addict of SideKick; indeed, one of the reasons I abandoned old Zeke was that there was nothing like SideKick for CP/M. I can't imagine there's anyone out there who doesn't know what SideKick is, but just in case: it's a memory-resident program that gives you instant access to a notebook, calendar/datebook, desk calculator, phone book and dialer, and ASCII conversion table. It's a program you can get totally dependent on, as Mrs. Pournelle discovered after I installed a copy on her AT&T 6300 Plus machine.

The only real problem with SideKick was that it ate too much memory; and since it was one of the earliest of the memory residents, it didn't cooperate too well with other such programs. If you loaded it last, though, it worked quite well; and if you used it in its own DESQview window, the memory requirements were no problem at all. Consequently, although I've had SideKick Plus for some time, I was in no hurry to install it. Better is the enemy of good enough, and SideKick was good enough....

That was foolish of me. SideKick Plus does a lot more than address SideKick's problems.

It does take care of those. True, it uses *more* memory than SideKick did, but unlike its predecessor, SideKick Plus knows how to load most of itself into Lotus/Intel/Microsoft EMS 4.0 expanded memory. Of course, you must have an expanded memory board, but that's no problem: a whole bunch of vendors will be happy to sell you one. Alas, that will be expensive. A year ago, memory was essentially free. Now, given the U.S. Department of Commerce's success in creating and enforcing a memory chip cartel—I guess the government thought Japan, Inc., was at a competitive disadvantage and wanted to level the field—I don't know what a good expanded memory board will cost.

The important thing is that SideKick Plus has a whole bunch of new features, including an outline processor that competes with Ready!. For the past couple of years, I've used both SideKick and Ready! (Ready! has always had the ability to stuff most of itself into expanded memory, so it doesn't take up too much prime memory space); now, I'll probably eliminate Ready! entirely.

There are also alarm clocks, lots of enhancements to the calculator, real improvements to the calendar/scheduler, and enough more that it's pointless to go on. If you liked SideKick, you'll love SideKick Plus. If you don't use SideKick, you probably ought to rethink your situation. It was that good, and SideKick Plus is even better.

Strongly recommended.

Developer's Dreams

There's been a recent spate of news about a design defect in the Intel 80386/80387 chip combination; sometimes when doing 32-bit calculations, the two chips get into an Alphonse/Gaston situation, each expecting the other to do something first, and the system is locked up.

The latest major system here is a big 20-MHz Cheetah 386, with a Priam 330-megabyte hard disk drive. The neat thing about the Cheetah 386 motherboard is

continued

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Dr. Robert Atwell, a leading defense scientist, calculates that NDP Fortran-386 is currently saving him $12,000 per month in rentals of VAX hardware and software while doubling his productivity!

Fred Ziegler of AspenTech in Cambridge, Mass. reports "I ported 900,000 lines of Fortran source in two weeks without a single problem!" AspenTech's Chemical Modeling System is in use on mainframes worldwide and is probably the largest application to ever run on an Intel processor.

Dr. Jerry Ginsberg of Georgia Tech reports "My problems run a factor of six faster using NDP Fortran-386 on an mW1167 equipped 386/20 than they do on my MicroVAX II."

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that the Cheetah designers saw the 80386/80387 lockup problem in advance, and they are pretty sure they've designed around it. This kind of hardware arcana is a bit out of my league, but I do know this much: I've got a program said to invoke the Intel lockup bug, and it certainly doesn't do anything to the Cheetah. Since the bug is probabilistic, it could be that I just haven't run the lockup program long enough, or, who knows, there may be a bug in the bug program. But I don't seem to be able to do *anything* to that Cheetah that can hurt it.

In fact, this machine is a developer's dream. It's blindingly fast. The Priam hard disk drive is large enough to store nearly every program I have. I have both 1.2-megabyte high-density and 360K-byte "standard PC" floppy disk drives. The Cheetah links to everything else through a serial port: so far, I've tried Brooklyn Bridge, Traveling Software's LapLink and DeskLink, and ArtiSoft's LANtastic. All work fine, so I've had no problems transferring data into and out of the system.

The real kicker is the Maximum Storage WORM drive. I seem lately to have developed a love affair with this thing.

I talked about WORM drives last month. Now I'm ready to make a flat statement: any software developer or serious writer who doesn't have a WORM drive has rocks in his head.

Well, OK, I know better than to say things like that. There are probably circumstances I don't know about. However, for serious software developers, money is *not* a good reason to avoid getting a WORM. If you're really serious about your software development or your writing, you can't afford not to have one. If your work is worth money, it's worth a good backup system; and the WORM is darned near the ultimate in backups.

A WORM drive lets you save—and recover—every version of your work. A WORM cartridge holds between 200 and 300 megabytes, and it costs a bit more than $100. You won't need more than one per software project. (Two if you're really a worrier: use them on alternate days, and keep one in a safety deposit box well away from your house or office. That way, a fire can't do you in.)

I've used half a dozen WORM drives in the last couple of months; of those, the Maximum Storage WORM drive has been the simplest to install and easiest to use. One caution: WORM drives and the DOS program XCOPY do not work well together. I've had problems with it, and when I was out to Colorado Springs I found that the Air Force Academy computer science people had the same difficulty.

XCOPY sometimes does not save subdirectory information, even though it reports that it did. Later on, when you try to recover the files and can't find them, the tendency is to blame the WORM drive; but in fact the fault lies with XCOPY, which sometimes just plain gets lost in subdirectories. Microsoft says they're aware of this and will fix it.

Enough about WORMs. What I'm really gushing about is the big Cheetah machine. Back in S-100–bus CP/M days, Dr. William Godbout's CompuPro machines dominated the development market: the major software developers had CompuPro machines, and most of those who didn't, wished they did.

There's no similar situation in the PCompatible world. There may never be. I will say this: Cheetah has the potential. Their machines are reliable, fast, simple, and well designed. Combine a Cheetah 386 motherboard, Priam 330-megabyte hard disk drive, and Maximum Storage WORM, and you've got something approaching a software developer's dream machine.

Winding Down

Once again I'm out of space, and there's still a huge pile of stuff on my "ready" table. One of the most important items is ArtiSoft's LANtastic, which is just possibly good enough to make 1988 the year of the LAN.

The game of the month is FTL's Dungeon Master for the Atari ST. I warn you: this game is addicting.

The book of the month is *Infinite in All Directions* by Freeman Dyson (Harper and Row). In 1887, Adam Gifford left a bequest to establish a series of lectures on natural theology. Since then, Gifford lecturers have included William James and Alfred North Whitehead. The 1985 Gifford Lectures were given by Dyson. I certainly don't agree with him on many of his points, but Freeman Dyson is one of the sanest people I've ever met. ■

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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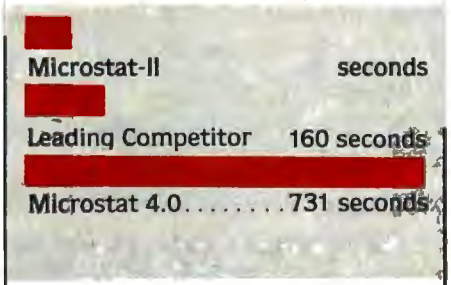

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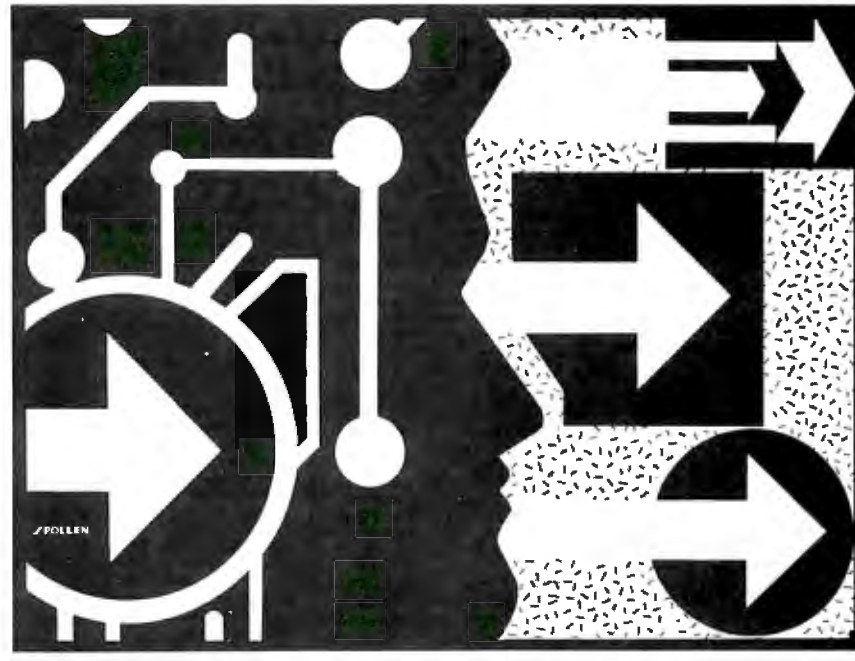
NEW DIRECTIONS

The column and a shareware classic get a "Plus," and GrandView defines a new class of software



Understanding why we've changed the name of the column from "Applications Only" to "Applications Plus" requires a little historical perspective. When I began writing it, BYTE had no equivalent of today's Short Takes, and application reviews in general were in short supply. The name "Applications Only" was a signal to readers interested in software that here, at least, they could find reactions to lots of programs.

Times change, and BYTE's coverage of software has expanded noticeably. There is no longer quite the pressing need for short reviews. I've also found that the name has caused me grief when I've found myself writing about hardware or—heaven forfend!—programming. Every time I've digressed into those areas, I've had to concoct some strained rationale for the excursion.

So we've borrowed a gambit from the software business by giving the column a "Plus." It sounded better than "Enhanced." The major change will be a little breathing room for the author, yours truly. The core material will remain software-oriented, but I won't feel sheepish if I write about industry issues or trackballs. I'm also hoping to add more head-to-head comparisons of products and maybe a few application projects. Expect any changes gradually, and let me know if they work.

Beyond ThinkTank

When I first heard about GrandView (Symantec, $295), I had no idea what to expect. The name sounded more appropriate for a street, or possibly a suburb, than it did for software. Also, I had been betting that the next product from the Living Videotext Division of Symantec would be an MS-DOS version of More, the state-of-the-art Macintosh outliner. So when I plugged in GrandView, I was wondering whether I would find More . . . or less.

In fact, GrandView could probably be called "too much of a good thing." It's billed as "Desktop Planning, Writing, and Information Management," and there's a lot to it. It is not merely an upgrade to ThinkTank. This is a new type of software, and on first glance it combines aspects of an outliner with solid word processing, project tracking, and categorization. It strikes me as being a comprehensive blend of ThinkTank, Q&A Write, InstaPlan, and possibly SideKick Plus, though it does not borrow all the features of each of those products.

If you're familiar with the long development history of Living Videotext outline packages, you've noticed a steady movement from pure outlining to, well, information management (for want of a more precise term). The company has done a superb job of listening to its customers, and GrandView represents the latest attempt to serve the needs of the business executive. ThinkTank users have been crying for better word processing, and they have slavered at More. They've used the outliners to develop to-do lists, plan projects, store databases of names and addresses, develop agendas, and so on.

Living Videotext staffers have been amazed at the odd tasks their programs have been forced to perform. And gradually, the sample files included with the rest of the product line have changed to reflect this trend, to the point where the examples could be called "A Manager's Guide." If you were to develop generic documents by sweeping all the paper off

continued

ILLUSTRATION: CHRIS SPOLLEN © 1988

an executive's desk and analyzing the contents, you'd get the idea.

Anyway, you start by developing an outline, but you can switch instantly to a document view with full-power word processing (and spelling checking, I might add), or to a category view, where you can attach keywords and priorities to items. Thus, you can produce a more personally styled output document than you could with ThinkTank, and you can easily home in on important tasks.

The outliner, which can be seen as the organizing spine of the program, lets you perform all the usual Living Videotext operations: cloning, hoisting, marking and gathering, time stamping, and so on. You've got keyboard macro capacities, and GrandView lets you construct installable templates so you can quickly zap a preset form into your outline.

Aside from a few minor annoyances, such as the fact that once you've asked the installation program to set up a second printer you can't back down from that decision, the program is as solid as Living Videotext's other offerings, and the company has one of the best records in the business for shipping hassle-free products. I encountered no oddities, but the 3 weeks I've been testing have been far from enough to hit all the options.

But I have found the program rather Byzantine. You can't just plug it in and go; gotta read the manual or you're lost. Good documentation and on-line help provide a big assist, but you won't learn the program without a few hours of hard study. While the integration is smooth and painless—you can switch quickly among the various views—it's also confusing at first go. Once they've mastered it, GrandView enthusiasts will spend most of their time living in the software, only coming up for air to fiddle with a spreadsheet or database.

For the quick-and-dirty outline person, like me, who likes to have Ready! around so that I can jot quick notes, GrandView is simply overkill. But I have to say that this is a first impression. I'm still flustered by the category view, and I need to experiment in depth.

One of the problems facing people who evaluate software is the need to write about new products as soon as possible after they hit the street. GrandView demands much more study. I suspect that, as with any complicated piece of software, I'm going to have to ease into it and work with it for a while before passing final judgment. Think of WordStar, XyWrite, dBASE, or most spreadsheets; you can get the rudiments in a few weeks, but the programs seem tough at that point. It's not until you've explored the nooks and crannies that you appreciate their real power.

Though my first reaction is somewhat negative, I'm positive that the product will succeed in management applications and that anybody who is looking for a tool that goes beyond simple outlining will be delighted by GrandView. So I'm going to hold off, take some time, and give you an extended-use report in a few months. GrandView is intriguing and important enough to demand at least that much attention.

A Way with Words

It certainly isn't the greatest word processor ever sold, but Professional Write 2.0 (Software Publishing, $199) is without question a solid and workable MS-DOS program. There's something comfortable about the Software Publishing interface; you know what you're

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- The Data Exchange System, Model 24, allows high speed exchange of data between computers, printers and other peripherals.
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- Optimum flexibility: Select the right combination of serial and parallel ports, and set *any* of these ports as a peripheral port or as a computer port.
- Basic unit expandable to 24 ports by 4-port modules offered in serial/parallel combinations.
- Standard 512KB buffer expandable to 4½ megabytes, to handle big print/plot jobs and many small ones.
- Buffer memory dynamically allocated to maximize buffer utilization.
- Simultaneous data input and output on *all* ports, so no devices are kept waiting.
- Computer-to-computer communication concurrent with all other operations.
- Full duplex communication allows file transfer capability with many communications software packages.
- Compatible with virtually all computers, printers, plotters, modems and other peripherals.
- Pop-up RAM resident PC support software allows peripheral selection via hot key.
- Super fast throughput allows data to pass through with no apparent processing delays.
- Many user-definable parameters including separate baud rates, flow control and parity for each port.
- Internal serial-to-parallel and parallel-to-serial conversion.
- Cascading capability to increase available number of ports.
- Unlimited hotline tech support.
- Designed and manufactured in the U.S.A.

Circle 23 on Reader Service Card

doing from the start, and you rarely have to consult the excellent manual.

I had almost forgotten how pleasant it is to work with this company's products. Software Publishing is another of the few big companies that rarely releases buggy software, and it aims at the businessperson who's intent on getting to work rather than the computer guru who's in love with technicalities.

By now, the interface itself has become something of a standard. You've seen it in PFS:Write, Q&A, and a host of imitators. Function-key menu bar across the top of the screen, boxed center area for your typing, ruler and two status lines across the bottom. Hit one of the function keys, and a longer menu pops down. Default selections in menus are always highlighted, and the default choices make sense.

Most commands can be selected either from the menus or by hitting a Control sequence (Alt combinations are reserved for macros). Nothing fancy, and good correlation with printed output. It will probably offend the purists who prefer an absolutely blank screen, but the rest of us will find it unobtrusive. You've got three pleasant color schemes to choose from, and all of them are easy on the eyes (especially on an EGA monitor or better).

Here's what you get with Professional Write 2.0: a spelling checker with a 77,000-word main dictionary and a 5000-word personal dictionary. A 20,000-word thesaurus. A built-in calculator and column math. An address book for mail merge that has a nice entry screen and room for 2000 entries. Automatic envelope printing (nice, if your printer can handle it). Macro recording. Line drawing, and access to the extended character set. Support for expanded memory. File encryption. A wide selection of printers and multiple font capability, including PostScript. Context-sensitive help.

Nothing spectacular in that list, but Professional Write does offer a couple of tricks worth mentioning. Not only can you save a 40-character description of each file, but you can search the complete text of all your Professional Write documents, directory by directory, looking for a specific search string. And the program imports files from major word processors, Lotus 1-2-3, and dBASE III without any headaches.

Using the program takes absolutely no brains, and I couldn't break it as hard as I tried. My quibbles with it are relatively minor: I'd prefer a larger user dictionary, and the 2000-entry limit on address books seems low, even though you can create as many as you require.

I do, however, question the use of the word "Professional" in the program's name. This product strikes me as a basic word processor, fine for everyday use but probably not the best available for industrial-strength applications. You could probably write a book with it, but I wouldn't want to use it for a doctoral dissertation in math or physics. Likewise, it lacks legal line numbering and multiple-column printout. So it's not really a top-echelon package.

Professional Write 2.0 is a good answer to Q&A Write, with a few features not available there, but I do recommend checking out the Symantec product if Professional Write sounds interesting to you. In fact, you probably ought to get demonstrations of a few other midlevel word processors at the same time. You won't be disappointed with Professional Write, but it's kind of a Ford. Depending on taste, you might do just as well with a Chevrolet.

Items Discussed

GrandView.....$295
Symantec Corp.
Living Videotext Division
117 Easy St.
Mountain View, CA 94043
(415) 964-6300
Inquiry 934.

Procomm Plus..... $75
Datastorm Technologies, Inc.
P.O. Box 1471
Columbia, MO 65205
(314) 449-7012
Inquiry 935.

Professional Write 2.0 .....$199
Software Publishing Corp.
P.O. Box 7210
Mountain View, CA 94039
(415) 962-8910
Inquiry 936.

Shareware to Commercialware

This column is not the only thing to add a "Plus" to its name; Procomm, that venerable shareware workhorse, has gone commercial and has become Procomm Plus (Datastorm, $75). The only way to get your hands on this new revision of the product is to buy it from a dealer or order it directly; you won't find the Plus version on your local bulletin board. Tom Smith and Bruce Barkelew, the authors of the program, are two of the nicest guys in the business, and I hope the change in the program's status lets them earn a decent living at last.

Procomm was definitely one of my favorite telecommunications packages: full-featured, clean, and fairly easy to understand. Procomm Plus adds some new stuff: support for more file-transfer protocols than I knew existed (including Kermit and a couple for error-correcting high-speed modems), emulation of any terminal you'd ever want to emulate, split-screen mode for CB-style on-line chat, host mode for interactive dial-in operations, and a simple text editor.

The neatest addition is a decent script language that can be mastered easily; the team's earlier efforts required you to write in gibberish. The program already had a good interface for setting keyboard macros, exit to DOS as a shell operation, automatic session logging if desired, and a one-keystroke screen capture.

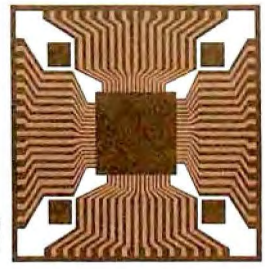
There are two other advantages to buying the private version. The first is the printed manual. Procomm Plus has some complex aspects, and step-by-step documentation is a big help. The second advantage is the support files you get in the package, which include scripts for every major on-line service and widespread bulletin board software; and dialing directories for bulletin boards in Atlanta, Austin, Boston, Chicago, San Francisco, and Washington, DC. The package also includes long lists of both U.S. and international bulletin boards. This is the kind of nicety that is almost never provided with shareware.

The program is certainly the equal of many packages already on the market, and it can legitimately compete with the category leaders. Note, however, that there is no provision for background operation, and that the script language falls short of some of the more extensive packages, like Mirror II, the latest Crosstalk, and Framework.

But on the whole, you won't go wrong purchasing and using Procomm Plus unless your requirements are sophisticated in the extreme. For day-to-day telecommunications, this is highly recommended. ■

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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More and more, programmers and workstation builders are using DESQview 2.0 as a development tool. The reason is simple. They can create powerful, multitasking solutions today for the millions of DOS PCs in use today. Solutions comparable to those promised for tomorrow by OS/2.

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80386 programmers can take advantage of the 80386's protected mode for large programs, yet run on DOS and multitask in DESQview–side by side with other 80386 and DOS programs. The breakthroughs that make this possible: DOS Extenders from PharLap Software and AI Architects and DESQview support of these DOS extenders.

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STAKING OUT THE TERRITORY

What's best for your office? This new column offers real-world answers.

In many ways, business users of small computers are just like any other user. We have the same problems with hardware that breaks, software that isn't shipped when promised, and salespeople who know less than we do about the machines they sell.

But there are differences. We may buy hundreds of computers, risking hundreds of thousands of dollars if we make the wrong decision. We may have an office floor with 60 people who need to share the same information. Or we may have a VAX in the basement that we need to connect our personal computers to.

This is why I'm writing a business column about small computers for BYTE. It will approach personal computers from a business viewpoint, but without the bias you find in the "single machine" magazines. No one type of computer is the solution to all problems, so no one computer will dominate this column.

That's not to say that I won't write about IBM and clone machines or about Macintoshes. They are the most heavily used by the BYTE readership, and I will devote a lot of space to them. On the other hand, I won't ignore the Unix world or the less popular, specialty machines either. All these areas show great promise, and the future of your business may lie with one of these machines.

The PC Guru

If you're reading this magazine, there's a good chance that you're the person in your organization who is the "Corporate Techie," or the "PC Guru." While you may or may not be in the organization chart as a computer staff resource, you serve as one. When people find out that they can't format a floppy disk, or that they *did* format their hard disk, you're the person who gets the call. You're also the person who seems to have a constant stream of visitors to your desk, all asking the same question: "I've been thinking about getting a personal computer. What kind should I get?" In many companies, you're also the person who wields a lot of the influence about what the company buys and how it uses small computers.

One of the best ways to decide what will work in your office is to look at the experiences of others. It's a lot cheaper to let someone else take the risk while you learn from their experiences. Sometimes you can't do that, though, so the next best thing is to read about them.

For this reason, I'll try to illustrate my examination of the business small computer user with case histories where they're appropriate. I'll also tell you about trends I see that are important to business users, and I'll report on hardware, software, and services that might affect your business. What I won't do is give conventional, safe answers where another answer is better, nor will I deal with information you can find out from a quick read of the manual.

Networking

One question that inevitably crops up each week or so concerns networks. Now that local-area networks (LANs) are known to exist, everybody wants one. Usually, the rationale is as simple as, "We have to be able to talk to each other." This means that there is a need for some portion of an organization to share some common data. Normally, the first application that comes to mind involves a database, although word processing tends to follow closely.

Often, the request for a LAN comes without a full understanding of whether that is the correct solution. Your colleague or client has read about these wonderful networks and thinks a LAN is the answer to the organization's information flow. It can be, of course, but it can also do a lot to impede that flow.

The software you choose can play a big role in making the LAN work properly—especially when many users on the LAN need to use the same database. Choosing the wrong database can make your network seem to come to a stop.

I ran across an example of this problem with a network that was using dBASE III Plus on a number of workstations to access a single large database on the file server. At the same time, other users were trying to use WordPerfect. As soon as more than three or four people began to use the database, performance dropped drastically.

This happened, of course, because all the database users were trying to use the file server's disk at the same time. The first user to try got control, and the others waited in a queue. Since many single-user databases running on a network, including dBASE, treat the LAN as a disk channel, all the work for all the stations was being done by a single drive. The drive churned away, searching and indexing, while the other users waited. Of course, the repeated disk accesses added to the network traffic, slowing things even more. Response time was well over a minute on some screens.

Clearly, a number of actions can be taken to improve response time when using a database on a network. Some network operating systems, including Novell NetWare, allow very flexible arrangements of hard disks. Likewise, adding more network server cards to the file server can help improve throughput. Probably the best solution, though, is to pick a DBMS that's designed as a multiuser system in the first place.

The Database Server

Network performance problems with databases that were originally designed for single users have led a few manufac-

continued

turers to develop new solutions. One of the best is the database server. This is a database engine that resides on a CPU dedicated to database use. Queries come to the database engine, and results are returned to the users. Ashton-Tate, developer of dBASE, has announced that, with Microsoft, it will develop just such a database server, but it has yet to deliver.

Meanwhile, a few other companies have said that they will bring out server-based database engines. XDB Systems of College Park, Maryland, has one.

A server database engine such as XDB works by dividing the DBMS into a front-end processor and the data engine itself. The front-end processor resides on the user's workstation. It provides the user interface and translates the user's actions into SQL commands. These commands are then sent to the database server.

When the database server receives an SQL command from a workstation, it performs the requested operation and returns the result. The constant traffic of disk accesses is removed from the network, and the file server is freed from the need to support the database as well. As a result, functions not related to database management continue unimpeded, and your file server can be smaller.

Powerful Engine

There is a down side to all this, of course. In the first place, XDB requires that you dedicate at least one CPU as the database server. Although you can use any IBM PC clone as the server, the capability of the server directly affects the speed of the database operations. Dr. Bing Yao, president of XDB, told me that an 80286-based machine should be considered for serious database use, and that he would tend to recommend an 80386.

There's also the need for disk space. In addition to buying a large-capacity disk for the file server, you also need one for the database server. Because this disk will be doing all the network's database work, it should be pretty fast. If performance gets to be a problem with a single database server, XDB allows you to add additional servers.

Fast and Easy

There is a silver lining. XDB uses industry-standard SQL to communicate with its database engine. This means that you can move your mainframe data to your microcomputer and take along the queries that you used with DB2 as well. You can also go in the other direction, using queries from XDB to extract information from a mainframe database.

Setting up most applications is quick and easy. XDB provides a fourth-generation query language for writing custom applications. In addition, there is a forms manager that allows you to define the database as you design the forms. Experienced developers can make use of C and COBOL libraries for creating applications that can't be developed in other ways. Finally, experienced SQL users can enter queries directly into an interactive SQL system.

Once the applications are developed, the user has no way of knowing whether the system is using the database engine on the network, or a single-user database on the local workstation. Indeed, XDB will work equally well in either case without changing the applications. That way, you can create an application for all your users without worrying whether it will ultimately find itself on a network or a stand-alone computer.

If you've already made the decision to invest in the hardware, software, physical plant, and personnel necessary to operate a LAN that carries a significant database processing load, the additional server and disk capacity you need to assure adequate performance is worth the cost. When you couple its fast operation and industry-standard query language, XDB is a good deal for the serious database installation.

Products Mentioned

XDB Server $1995
XDB-SQL
Developers $495
Run-time $195
XDB Forms
Developers $295
Run-time $95

XDB Systems, Inc.
7309 Baltimore Ave., Suite 220
College Park, MD 20740
(301) 779-6030

Inquiry 846.

What's New for Business?

The network version of XDB was one of the pieces of good news at Spring Comdex. In some ways, though, this does not look to be an exceptional year for innovation in the world of IBM-compatible computers. When I checked with the firms claiming to have OS/2 products at Comdex in May, only 22 products were shipping. A few more were due out this summer, but many will not arrive until after Comdex in the fall, or even into 1989. If you use IBM PCs or compatibles and need software, you probably should plan on looking to the DOS world instead. There, products seem to be gaining maturity and functionality.

A number of Comdex vendors told me they were still waiting to see what would happen to the market before they committed resources to OS/2. Hardware development likewise seems stunted, with most manufacturers simply creating new versions of add-on boards that already exist for PCs or PC ATs and clones. There were some significant efforts demonstrated to give the PC/AT world the same capabilities as the PS/2. These included VGA cards and hard disks and controllers with 1-to-1 interleave.

The Macintosh II continues to woo business buyers away from manufacturers of IBM and compatible machines. Informix promised that its new superspreadsheet, Wingz, would finally make it to market. WordPerfect for the Macintosh finally shipped just before Comdex. Autodesk announced a version of its AutoCAD for the Mac. Bolstered by the widespread belief that the Mac is faster and easier to use, these products are gaining interest from executives, especially now that Presentation Manager for OS/2 seems to be so far away.

Unix is making a push as the business standard for microcomputers. While at Comdex, I watched as Commodore's chief operating officer Henri Rubin used a mouse to click open windows on Unix, MS-DOS, and Amiga DOS on his Amiga 2000 equipped with a 100-megabyte disk. Dr. Rubin told me that the Amiga would soon be available with additional ports to support multiuser operation. He also showed me an Amiga with a screen resolution of 1008 by 800 pixels. I wonder if Commodore is aiming at the lucrative workstation market.

On the IBM side of business, things have slowed down a little just now. Perhaps this is the time for a breather. On the other hand, perhaps it will give some of the other architectures a chance for a little more market share. ■

Wayne Rash, Jr. is a member of the professional staff of American Management Systems, Inc. (Arlington, Virginia), where he consults with the federal government on microcomputers. You can reach him on BIX as "waynerash."

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

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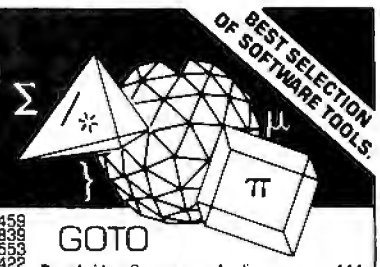

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AZTECC-Commercial, Manx	$ CALL
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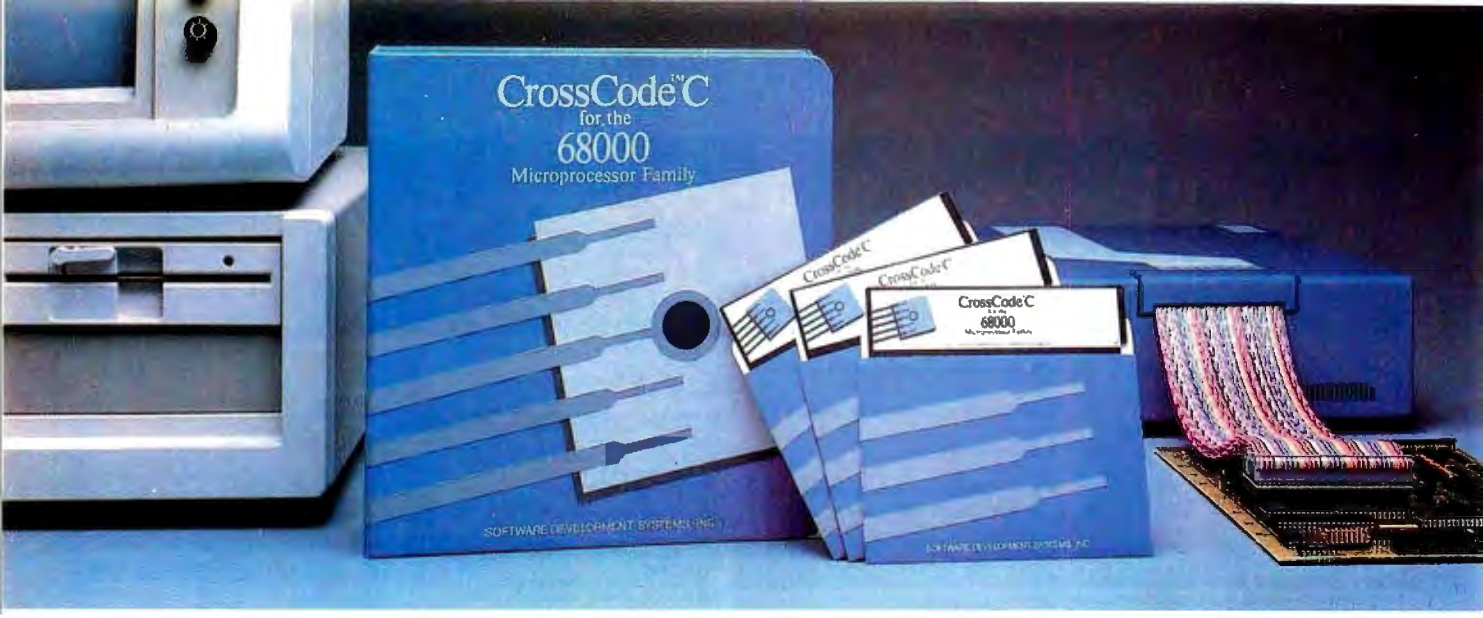

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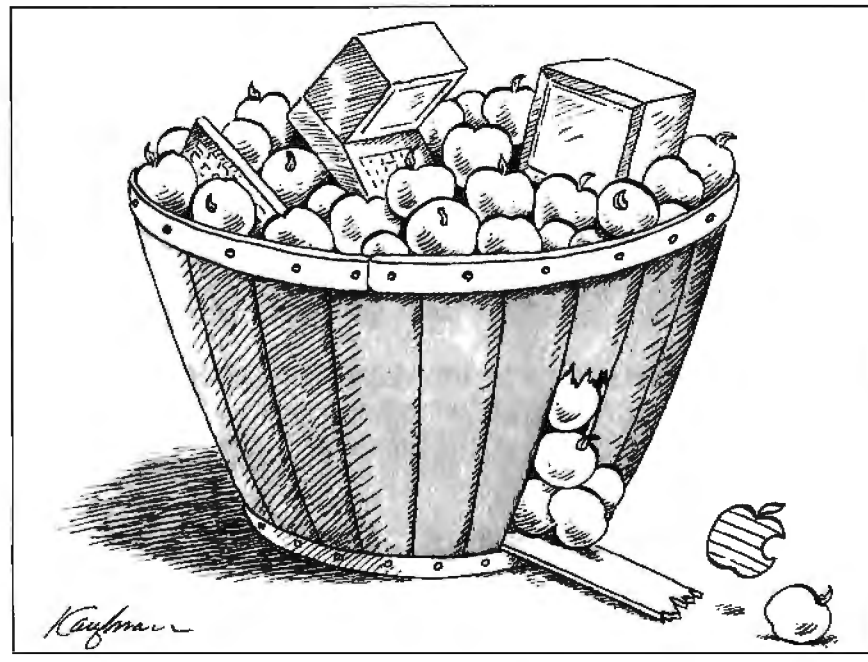
WHAT'S UP WITH APPLE?

Late shipments, abandoned products, and blown promises are driving the rest of us crazy



As I write this column, it is the third week of May. I am still waiting for Apple to release its System Tools 6.0 software for the Mac. I had hoped to report on the updated released versions of the System, Finder, and MultiFinder. Apple promised members of the Apple University Consortium (AUC) in March that the revised System software would be available on AppleLink, CompuServe, GEnie, MacNET, and elsewhere by the end of April, with complete shrink-wrapped kits (à la System Tools 5.0) and printed documentation soon after.

Late, incomplete, and confused distribution has plagued the release of Mac system software since the first update in 1984. In the last year, though, the confusion and problems have spread to other Apple software products, growing almost in parallel with Apple's impressive fiscal performance. As Apple has grown from an entrepreneurial enterprise to a more traditionally managed technology company, several important products have either fallen between management cracks or been released woefully incomplete.

The fact is, Apple has blown a lot of promises lately. Two more examples will serve to clarify my point: MacPascal and A/UX.

MacPascal

Ever wonder what happened to MacPascal? Did you know that you can't currently buy it from Apple (or anyone else)? I first discovered the "MacPascal problem" in January. It was then that I had Apple's new System Tools 5.0 software installed on our laboratory Macs. One of the primary uses for these machines is to teach introductory programming. Because of its friendly interface and novice-centered development environment, along with its multiple-window approach to interpreted execution and debugging, MacPascal is a perfect environment for learning. It's safe to say that MacPascal helped sell a lot of Macs to universities.

Almost as soon as the System Tools 5.0 was installed, we started having serious problems with MacPascal 2.1 (the latest version). Program files became corrupted, printing failed, working programs refused to run, and so on. To make an excruciating story short, after considerable effort I found that Apple had simply dropped MacPascal. No more versions. No bug fixes. No more MacPascal. Nothing. Apple recommended that we either run MacPascal 2.1 with old system software or migrate to another Pascal. What was even more frustrating was that no one at Apple could point to whose decision it was to drop MacPascal.

It's now 5 months later, and the only good news is that Apple is near an agreement with Symantec/Think Technologies (the original authors) to take MacPascal back into its fold for an eventual rewrite and rerelease next fall. Are they kidding? People who are using MacPascal can't put their work on hold until the autumn of 1989. Most Pascal users will probably adopt our strategy: migrate to Think's Pascal compiler, Lightspeed Pascal, even though it's not as good a product for learning programming.

A/UX

Apple's much-ballyhooed Unix for the Mac II, A/UX, is another of Apple's software mistakes. The product missed its initial ship date (August 1987) by more than 6 months. When it finally shipped in February of 1988, Apple had not done its homework in addressing one

continued

ILLUSTRATION: ROBERT KAUFMAN

of its largest groups of potential A/UX customers: users of System V and BSD 4.2/4.3 Unix.

As announced, A/UX was simply not competitive with Unix offerings from Sun, Apollo, and AT&T. It was too expensive, and could be purchased only on an Apple 80-megabyte hard disk; tape distribution was not available. Apple had made no provisions for distributing the source code for A/UX. Dedicated Unix users simply *must* have the source code. And despite earlier promises to the contrary, A/UX deflated the hopes of a large segment of its intended market by being mostly plain vanilla System V. A/UX definitely was *not* Unix for the rest of us.

To be fair, we should be able to forgive Apple for this last failing, especially since A/UX 1.0 is its first Unix release. Apple got a lot of technical things right with 1.0. It also broke new ground by making it easier to recover from Unix file-system errors and install new devices. But the other A/UX problems point to a larger management problem: an inability to announce and deliver software on schedule and as described. Apple's spin-off company, Claris, will help somewhat (by taking applications like MacWrite away from Apple), but the management difficulties remain for Apple's languages and system software.

Apple's mistakes make a disturbingly long list; I hope the folks there are learning from the errors. All the lawsuits in the world won't help retain or increase market share if the way it has handled A/UX, MacPascal, and system software becomes a trend.

System Tools 6.0

I've worked with a beta version of System Tools 6.0 for several weeks. About all I can say is that it lives up to its beta designation. It didn't work properly on the Mac II, SE, or Plus I used for testing. Whether I copied the files to clean hard disks or used the Installer to update an existing System, the stuff just didn't work right. Screens froze for no reason, the mouse went dead, and bombs with just about every ID number known to *Inside Macintosh* cropped up. Since this is labeled an "early beta," I hope the problems are fixed before release.

The new software included a couple of interesting new features worth remembering: a notification manager and a new font format. The notification manager is supposed to notify foreground applications running under MultiFinder when a background application (e.g., a telecommunications program) needs direct attention. As it stands now, the notification manager should be useful if you expect to upload or download several files in the background while working on something else in the foreground. I hope software publishers will take advantage of this capability to allow other functions that need occasional attention to operate in the background (e.g., program compilation or hard disk backup).

The new font format, NFNT, allows up to 16,000 fonts to be loaded into a system, up from the 256 you can load now (without using a third-party DA/font manager like AlSoft's Font DA/Juggler Plus). You can also install up to 32,000 individual fonts in your system with the new format. The increased limits come from NFNT assigning font numbers to entire font families rather than to individual fonts. Unfortunately, NFNT fonts are not compatible with the existing ones, and Apple does not yet have any software to convert the old fonts to the new format

continued

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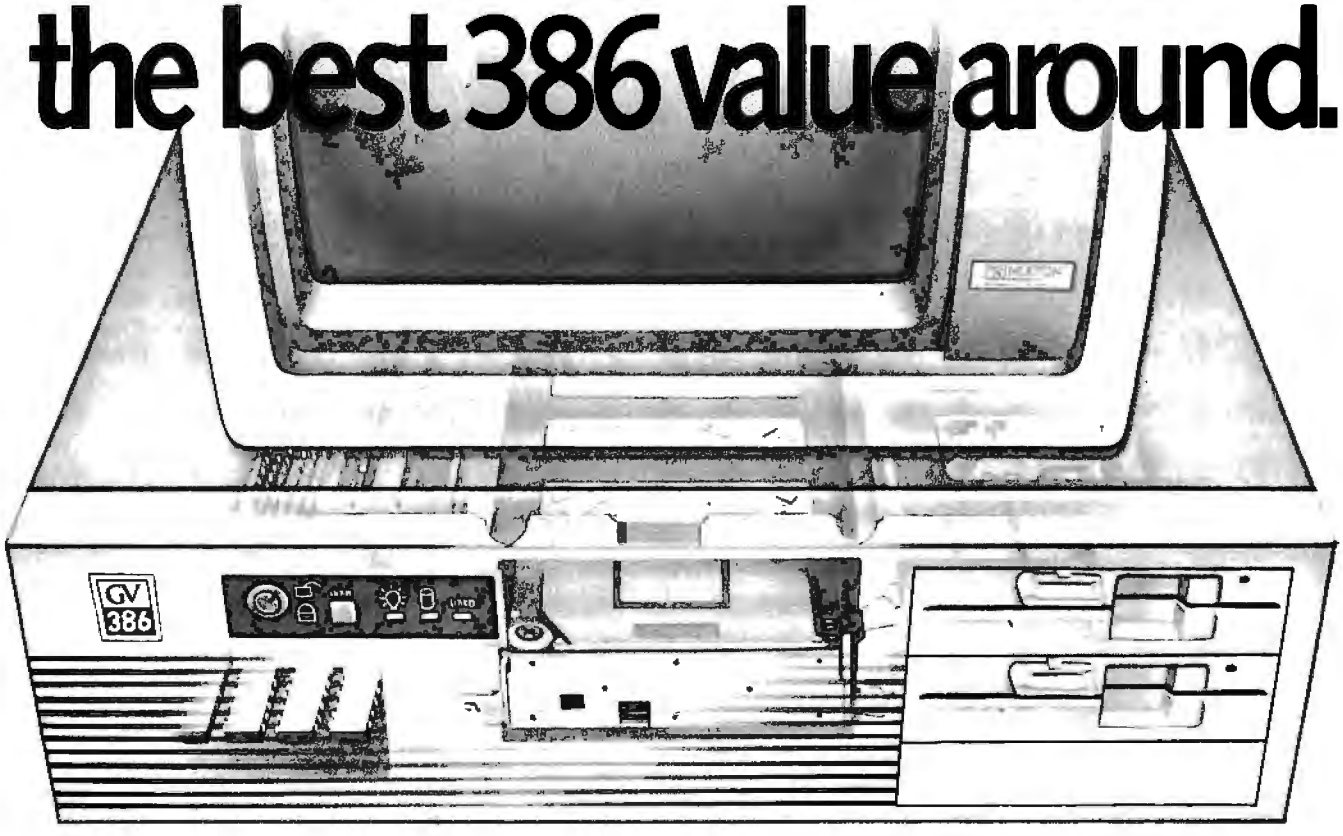

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(the beta version of the Font/DA Mover 3.8 that I tested in the System 6.0 package lacked a conversion feature).

The beta 6.0 System disks I tested, despite taking up four 800K-byte disks, also lacked any NFNT fonts. Still, Apple would not have created the new font format if it didn't plan to use it, so NFNT utility software and fonts might appear as early as the Boston '88 MacWorld Expo. I expect that vendors like Adobe, who have substantial investments in existing libraries of typefaces, will eventually convert some or all of their fonts to the new NFNT format.

FoxBASE+/Mac

I've been working with FoxBASE+/Mac, a relational database, since December 1987, when it was a low-numbered beta. I've had the initial released version (1.0) for about a month now, and I'm impressed. FoxBASE+/Mac is *fast*. Not just a little bit fast, but a lot fast. In the 1000-, 10,000-, and 50,000-record flatfile tests I've run, it's faster than any other Macintosh database, relational or not. The same blazing speed held up in the limited multifile relational tests I tried (relating 3 files of 10,000, 5000, and 2500 records each). FoxBASE+/Mac outruns 4th Dimension, McMax, dBASE Mac, FileMaker Plus, Reflex Plus, Omnis 3 Plus, Double Helix II, and others at the basic tasks of creating, importing, modifying, sorting, retrieving, and deleting database information.

FoxBASE+/Mac is a dBASE III Plus-compatible database for the Mac. It can run any dBASE III Plus code directly (once you've ported it over to the Mac using TOPS, or through a serial connection, or by using the Apple File Exchange software and a PC-compatible Mac disk drive). It can also read dBASE data files without modifications. FoxBASE+/Mac also read the PC FoxBASE files I tried.

FoxBASE+/Mac, however, is not the first software to offer complete dBASE III Plus compatibility on a Mac. The dMacIII program, first published by Format Software (a West German company), and rewritten and rereleased in 1987 by Nantucket Software as McMax, claims that honor. McMax is fast too, although slower than FoxBASE.

If FoxBASE+/Mac were just a faster version of McMax, its market would be limited primarily to developers who want to port their dBASE III applications over to the Mac. Happily, speed is just part of the appeal of FoxBASE+/Mac.

Unlike McMax, FoxBASE+/Mac includes a set of command extensions and additional features that go way beyond

dBASE. FoxBASE can build applications that incorporate many familiar Macintosh software features, such as pull-down menus, radio buttons, scrollable and editable text windows, dialog and alert boxes, resizable and scrollable output windows, font and font-size control, icon-style menus, and color on the Mac II. These features give FoxBASE+/Mac much more utility as a Macintosh-only database applications development system than McMax. FoxBASE+/Mac's direct competition is Acius's 4th Dimension. It easily beat 4D 1.04 in my benchmark speed tests (4D 1.04, the current release as of May 1988, suffers from a number of speed problems), and I suspect that even the improved 4th Dimension, version 1.1, will still be drubbed by FoxBASE in speed testing.

FoxBASE+/Mac also costs $300 less than 4D. But speed and price are not the only concerns for database developers and users. The total development and user environment is just as important as any performance and value rating based only on speed and list price. In this more complete comparison, FoxBASE still has a lot of catching up to do. 4D provides more features, more development aids, and a better overall environment than does FoxBASE+/Mac. 4D also offers a run-time version for developers, and it supports multiple users (with proper file and record locking) over AppleShare.

Fox Software expected to release a run-time version of FoxBASE+/Mac in June for $300. By that time, the company should also have released a LAN version compatible with the file and record locking utilities of AppleShare and 3Com's 3+Share.

Given how rapidly Fox Software has gotten a serious Mac relational database into the market, I'd keep a close eye on it. I expect version 2.0 will keep its speed and add more development tools.

FullWrite Professional

Here's a program that looked like quintessential vaporware. First announced at the January 1987 MacWorld by Ann Arbor Softworks (the FullPaint people), its release was repeatedly postponed. Ashton-Tate finally bought it in February and began shipping it at the end of April. I've tried version 1.0 for a week and have some initial impressions.

At $395 it's competitively priced with Microsoft Word 3.02, although Microsoft's aggressive volume and educational discount purchase program often drops Word's price to less than $90. In contrast, I paid $219 for my copy of FullWrite Professional from a local Chicago computer store (not a chain franchise).

Version 1.0 is slow. In fact, as a basic editor, it is annoyingly slow. I tried writing this column using FullWrite but gave up because the screen scrolled too slowly, and search-and-replace operations creeped along (I finished the column using MindWrite 1.1). I used a 1-megabyte Mac Plus in these tests. Brief testing on an 8-megabyte Mac II showed that FullWrite performed well. Therefore, on a fully configured Mac II, FullWrite is a good editing choice.

I'm impressed. FoxBASE is not just a little bit fast, but a lot fast.

There's no question about FullWrite's credentials as a high-end word processor, though. It surpasses Word's desktop publishing (DTP) features by adding page-layout and drawing functions (although it's no match for the page-layout capabilities of a complete DTP program like PageMaker 3.0). Besides the basic DTP capabilities, FullWrite has a slew of editing and formatting features just like Word: a spelling checker, an outliner (yes, a usable integrated outliner, unlike Word's useless one), automatic hyphenation, automatic indexing and table of contents creation, and floating footnotes. FullWrite also has some nice editing features that Word lacks, such as review notes and revision journaling.

Like many beta testers, I had problems with FullWrite reading Word files, but my system didn't crash. Instead, the file would open with corrupted text. The released version doesn't have this problem.

Despite FullWrite's slowness compared to Word and MindWrite, I still liked the program. It's very easy to figure out and use. If I was in the habit of creating long structured documents with some graphics elements in them, I'd probably choose FullWrite over a combination of PageMaker and Word, because it would be simpler to learn and use and still produce an acceptable result.

As a basic full-screen editor/word processor, though, FullWrite Professional is just too slow on a 1-megabyte Mac Plus, and it requires too many machine resources (at least 1 megabyte of memory, preferably 2 megabytes, and as fast a hard disk drive as you can afford). For my basic writing needs, I'll stick with MindWrite 1.1 and Word 3.02, because I don't need all the DTP features of FullWrite. MindWrite's wonderful outliner is reason enough for me to rely on it, while Word's scrolling speed and global updating acumen more than make up for its other flaws. ■

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Don Crabb is the director of laboratories and a senior lecturer for the computer science department and the college at the University of Chicago. He is also a consulting editor for BYTE. He can be reached on BIX as "decrabb." The views expressed are his own.

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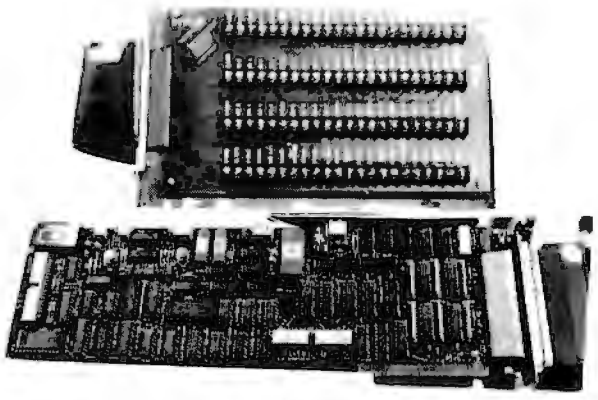

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INPUT RANGES	
unipolar	0 TO ±10 volts user-selectable
bipolar	±5 and ±10 volts user-selectable
OUTPUT MODE	
unipolar	straight binary
bipolar	offset binary
INPUT IMPEDANCE	>100megohms with 100 picofarads
INPUT CURRENT	limited to less than ±4 mA
INPUT VOLTAGE	
Normal mode	±30 volts maximum without damage power on or power off
Common mode	±11 volts maximum
COMMON MODE	
Rejection ratio	72 db
Integral linearity error	±1 LSB maximum
DIFFERENTIAL Linearity	
Error	± ½ LSB maximum
Stability	±5 ppm/degrees C of FSR (max)
GAIN	
Error	±0.1% between ranges (max) any range adjustable to 0
Stability	±32 ppm/degrees C of FSR (max)
OFFSET	
Error	adjustable to 0
Unipolar stability	±24 ppm/degrees C of FSR (max)
Bipolar stability	±24 ppm/degrees C of FSR (max)
MONOTONICITY	0 to 50 degrees C
THROUGHPUT to memory	15,000 conversions/second min

The analog output functions of the adapter operate in programed I/O mode. The analog output functions provide 12-bit relative accuracy

RESOLUTION	12-bits
Number of output channels	2
OUTPUT modes	unipolar or bipolar, user-selectable
OUTPUT ranges	
Unipolar	0 to ±10 volts user-selectable
Bipolar	±5 and ±10 volts user-selectable
INPUT CODE	
Unipolar	straight binary
Bipolar	offset binary
OUTPUT Current	±5 milliamps, min with normal loading and protection from damage with the output shorted to common
OUTPUT impedance	2 ohm, max
CAPACITIVE loading	0.5 microfarads max
GAIN	
Error	0.1 between ranges (max) any range adjustable to 0
Stability	± ppm/degrees C of FSR(max)
OFFSET	
Error unipolar	±3.25 millivolt max
Error bipolar	adjustable to 0
Unipolar stability	±8 ppm/degrees C of FSR (max)
Bipolar stability	±24 ppm/degrees C of FSR(max)
MONOTONICITY	0 to 50 degrees C
SETTLING TIME	10 microseconds max to within 0.1% FSR for a 10 volt step with 1000 ofload
PROTECTION	Protected for short to common
OVERSHOOT	±1% of FSR max
THROUGHPUT from memory	25 000 conversion/second

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Mark Minasi

WHY OS/2?

It was the El Dorado of DOSes, lying beyond multitasking, beyond 640K bytes. This new column takes a practical approach to understanding—and living with—the reality of OS/2.

One of the big selling points of the original 1981 IBM PC was its large (for the time) 256K-byte memory and greater speed. Several microcomputers in the PC's price class, like the North Star Horizon II and the Altos machines, offered multiuser and multitasking capabilities. These capabilities were offered on machines with slower CPUs and less memory, so multitasking capabilities seemed (to me and to other IBM PC buyers at the time, that is) a reasonable feature for the PC's operating system. In fact, at the time, Digital Research offered a multitasking version of CP/M for the PC. DOS 1.0 *wasn't* multiuser or multitasking, but at $40 it was the cheapest available operating system, so 96 percent of the early PC owners chose it over the other options, CP/M or the p-System.

By late 1982, everyone at the local PC user's group had heard of a rumored DOS 2.0. Some of the rumors said that it would be multiuser and multitasking.

DOS 2.0 arrived, *sans* multiuser and multitasking. Ah, well, we told ourselves, the next version would redress these deficiencies. In 1984, IBM fired our hopes by offering a new and more powerful computer. The initial press releases showed a computer with dumb terminals on it and made reference to a 4-megabyte memory capacity. The new "multiuser" AT had powers and abilities beyond that of the PC, we were told. A new DOS, version 3.0, came with it, but it didn't really do anything new save take up an extra 10K bytes or so. IBM said that a DOS to exploit this new machine's powers would be released "soon."

The rumors continued. DOS 4.0 would be bypassed altogether for DOS 5.0, the El Dorado of DOSes: Beyond multitasking, and memory *beyond 640K bytes*—the once-monstrous 640K bytes had become a straitjacket. The trade rags said Microsoft figured that it could knock it out by early 1986. DOS 5.0 then tried to go undercover, assuming new names seemingly each week: CP-DOS, A(dvanced) DOS, 286DOS. We didn't care *what* they called it. We wanted more memory and multitasking.

Finally, on April 2, 1987, IBM announced a whole slew of new hardware and software. DOS 5.0 was finally announced, calling itself OS/2.

The attractive features of OS/2 are multitasking, access to larger memory, a graphical user interface, an improved local-area network manager, legal terminate-and-stay-resident programs, better harmony among programs, a rich system interface, and compatibility with many familiar DOS commands, and, with the Presentation Manager, OS/2 provides a device-independent platform. I'll examine the first three this month and take the rest up next month.

Multitasking

OS/2 is designed to be a single-user, Unix-like operating system for 80286 and 80386 PCs. A dozen or more (12 for OS/2 1.0, 17 for OS/2 1.1) programs can run at the same time, all loaded into memory and executing.

This *concurrent* multitasking goes beyond many simple systems currently available under DOS that load several programs into memory but give actual CPU attention only to the one that you are currently interacting with. In these simple systems, no background processing occurs. Such systems' main values are that they let you cut and paste between applications and that they eliminate the time required to load and unload a program. A good and inexpensive example of these programs is Software Carousel from SoftLogic Solutions.

Gordon Letwin, Microsoft's chief architect of OS/2, says that it is fundamentally different from minicomputer operating systems like Unix. Multi*user* systems, he says, must appear to fairly allocate computer resources among multiple users. OS/2, on the other hand, need not appear fair to the multiple programs running in the system. In fact, Letwin argues, you really want to give the lion's share of the CPU time to the program in the foreground—the one the user is currently interacting with. Letwin claims that OS/2 does this.

OS/2 has a relatively sophisticated task-switching algorithm, incorporating a 189-level priority scheme and a dynamic adjustment algorithm for those priorities that takes into account things like how long a task has been CPU-starved and whether or not the task is just waiting for I/O. In a future column, I'll show you how to manipulate these priorities for optimum performance.

Large Memory

"Breaking the 640K-byte barrier" has become a cliché, but OS/2 does it. The 80286 and 80386 have, of course, always had the ability to address large amounts of memory, but not while in the "real mode" (are the other modes "unreal"?) that DOS requires. Access to more memory is allowed under "protected mode"-16 megabytes of memory, in fact.

OS/2 even goes beyond 16 megabytes. It can use extra disk space where there is insufficient RAM. If you try to run, say, a 3-megabyte program where only 2

continued

megabytes of RAM are free, OS/2 will transparently store 1 of the 3 megabytes on disk, treating it as if it were RAM. This scheme, called "virtual memory," is OK in a pinch, but access to disk is so much slower than access to memory that you'll want to avoid this one where possible.

Another reason to avoid virtual memory under OS/2 is that the virtual memory manager is buggy. The process of moving memory blocks temporarily to disk and back is called "swapping." The swapper program will use *all* the free space on your hard disk drive—you can't tell it to use only *x* megabytes for swapping. The swapper under 1.0 is moderately stable, although I've crashed it a few times. The swapper under the current 1.1 beta release is very fragile. If you want a stable OS/2 platform for your programs, disable the swapper by adding `MEMMAN=NOSWAP,MOVE` to your `CONFIG.SYS` file. Bugs like this are fairly common in a new system, and they will no doubt be fixed in a future release.

As the largest disk addressable by OS/2 is the familiar 32 megabytes (yes, the old DOS limitation on disk size is still with us), and the maximum RAM addressable by OS/2 is 16 megabytes, a program using *both* RAM and virtual memory could theoretically be as large as 48 megabytes.

The virtual memory scheme could be very useful were it not for the fact that OS/2 seems unable to swap *itself*. An IBM PC AT with 2.5 megabytes of RAM cannot boot the Presentation Manager code that Microsoft shipped to developers in April, as it must have at least 2.7 megabytes to boot. Apparently, *all* of OS/2 must reside in RAM.

Another disappointment about OS/2's use of large memory is not Microsoft's fault, but Intel's. Even in protected mode, the 80286/80386 chips are designed to address the 16 megabytes in terms of 64K-byte segments. Going across segments requires more code and is slower. Many compiler writers, dismayed at how much more slowly a program runs when doing a lot of segment swapping, have simply limited static data areas to 64K bytes—one segment.

It would be a real shame if inexpensive compilers maintained this now antediluvian constraint. There are, of course, no inexpensive compilers for OS/2 currently. But an expensive one, the BASIC compiler, *still* has the 64K-byte limitation on static data.

For OS/2 to get beyond the 64K-byte segments, it would have to put the chip in a different, incompatible mode, the "32-bit" protected mode, but this is only available on the 80386 chip.

Items Discussed

Microsoft OS/2 System Development Toolkit..... $3000
Microsoft Corp.
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Inquiry 945.

Software Carousel..... $60
SoftLogic Solutions
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Manchester, NH 03103
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Inquiry 946.

Graphical User Interface

Whether you like them or not, WIMP (windows, icons, mice, and pointers) interfaces are chic these days. The Mac has established a solid market, and the well-dressed PC these days looks like a Sun engineering workstation with a small screen. The hardware for WIMP is now in place—VGA is as good as Mac graphics, and the PS/2 comes with a rodent interface built right in. OS/2 supports EGA and VGA, as well as a variety of mice. Unfortunately, the current OS/2 releases do not support Hercules graphics.

The "point and click" ease of a graphical user interface makes using applications easier and reduces training time. The Mac can be described as not an application platform, but rather an application *funnel* in the sense that all Mac applications not only *can* look the same, but pretty much *must* look the same. The downside of this uniformity is that it grinds programmers' gears: All of us who have ever touched a compiler to code fancy ourselves artists in the field of user interface design.

The graphical user interface is handled by an optional program called the Presentation Manager (PM). The PM is to OS/2 as Windows is to DOS: Windows is not necessary under DOS, and the PM is not necessary under OS/2. Including Windows/PM, however, opens the doors to some interesting applications.

It's hard to say too much good or bad about the PM, as the current beta code (early June 1988) is very, well, unstable. In his letter to developers, Microsoft's Steve Ballmer basically said, "Here's what we've got so far, it's not reliable, better stuff is coming. . . ."

I can't see how Microsoft will have a shippable final product by October—the date Microsoft and IBM have promised release to the general public—but I wish them luck. It's easy to take potshots at Microsoft for everything being so late, but I don't see how it *couldn't* have been late. According to Microsoft, it took 35 programmers 4 years to write OS/2. That's a mighty large programming project to manage—larger, I'd guess, than anything the company has tried before.

If you know Windows, you'll spot a lot of it in the PM. The Control Panel is the same, the Alt-spacebar character does similar things, and, as in Windows 2.0, it can be managed without a rodent by using Alt keys. Applications can still communicate via the Clipboard.

However, you'll also miss a few things. As of this writing, Microsoft does *not* provide the desk accessories that Windows has—the clock, calculator, Reversi game, notepad, paint program, and terminal. This is a serious flaw, and it points to a major deficiency in OS/2: The frills are gone. Where DOS generally came with a BASIC interpreter and the all-purpose `DEBUG`, neither is supplied with OS/2 despite its $400 price tag. Come on, now. Would giving us `DEBUG` and GWBASIC really hurt sales of those $500 compiler/CodeView combinations?

OS/2 Tip of the Month

If you're going to use a serial printer under OS/2, OS/2 won't talk to the printer if it doesn't see some activity on the CTS line of the serial port, line 8 on an AT's 9-pin port or line 5 on a standard 25-pin port. The following minimum cable worked to let me "print" from my desktop OS/2 machine with a 9-pin serial connection to my 9-pin laptop (a sneaky way to capture screens for use in text):

```
Side 1        Side 2
  2-----------3
  3-----------2
  5-----------5
  7           7
  |           |
  8           8
```

■

Mark Minasi is a managing partner at the firm of Moulton, Minasi & Company, a Columbia, Maryland, which specializes in technical seminars. He can be reached on BIX as "editors."

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

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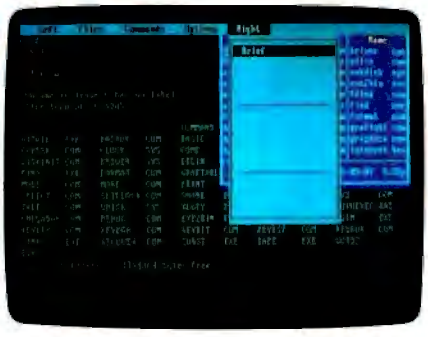

Pull down a menu for quick, easy access to the full power and features of the program.

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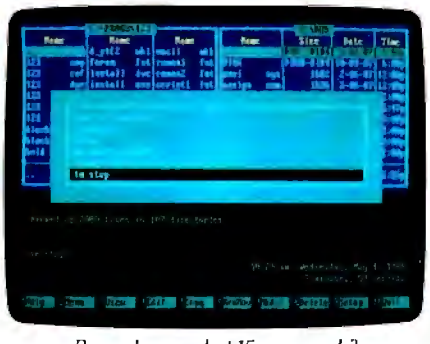

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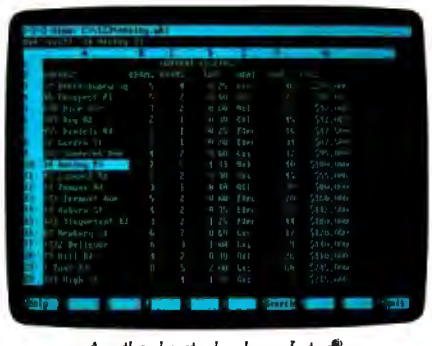

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See DOS run like you've never seen it before. Like you won't see it run with any other DOS enhancement shell. See version 2.0 of the Norton Commander™—a dramatically advanced version of the program *Infoworld* called "tops in its class...a new level of convenience for MS/DOS users." The new Norton Commander combines the functions of a hard disk manager with all the features you need to support and enhance the DOS command line. Yet it's flexible enough to get out of your way when you don't need to see it. Novice or expert, you'll want to see your dealer right away. And see how fast DOS can run.

Peter Norton COMPUTING

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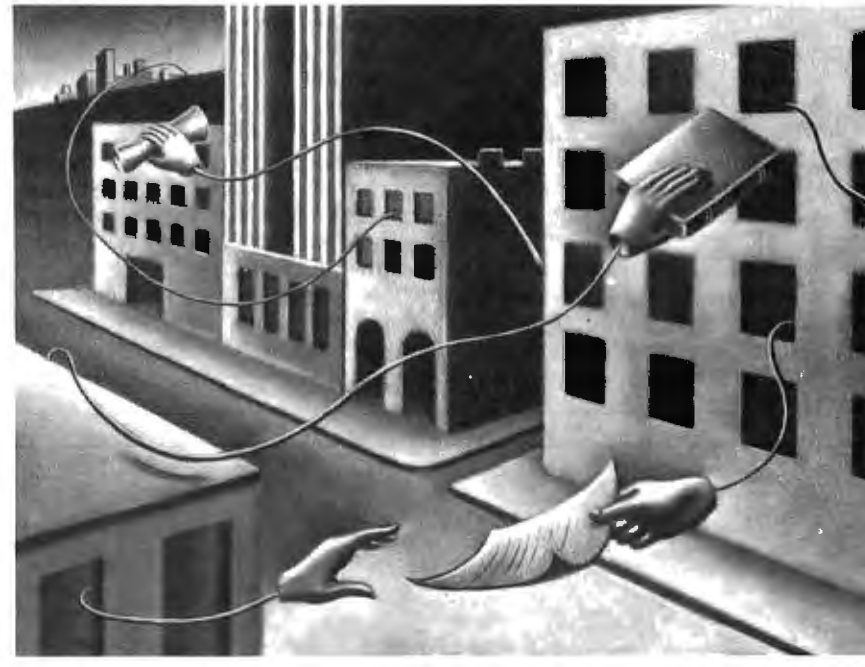
THE WIRED SOCIETY

Surveying the electronic communications landscape



Cyrus Field never imagined in his wildest dreams the global effect of his accomplishment in 1866: the laying of the Atlantic cable. Ten years later, Secretary of State William Evarts spoke the following words at a ceremony commemorating that event:

"Columbus said, 'There is one world, there shall be two.' Cyrus W. Field said, 'There are two worlds—there shall be one.' "

Welcome to the wired society.

Telecommunications is the infrastructure of the computer industry, the lifeline of a wired society. Whether you're pushing binary files across the country on a dedicated line or simply typing in a comment on BIX over voice-grade telephone lines at 1200 bits per second (bps), some form of communication is taking place.

Consider this electronic communications landscape: Local-area networks (LANs) are the city streets; computer conferencing systems are the interstate highways; packet-switched networks are the global trade routes; and bulletin board systems are the rambling country roads that stitch communities together.

A Technological Misfit

The world's economy flows across an electronic global highway every day, much of its information base at the beck and call of a simple carrier tone. Yet, for all its importance, telecommunications is a bastard child: merely acknowledged, begrudgingly accepted, never quite fitting in.

For example, a BYTE survey shows that 60 percent of you own a modem and 18 percent plan to buy a modem in the near future. However, use of communications software ranks a distant fourth behind the "big three" of applications: word processing, spreadsheets, and database programs.

My love affair with PC-based communications began with a Commodore Vic-20, a 9-inch black-and-white TV, and a 300-bps direct connect modem. After some 6 years on-line, half of that spent writing about telecommunications topics ranging from pirate bulletin boards to security issues to governmental attempts to strangle free access to public information, my blind love affair has matured into a clearer understanding of and a healthy respect for telecommunications.

A good friend and fellow communications writer, Art Kleiner, told me he hit a "curmudgeon stage" with the technology a couple years back. This stage entailed an uneasy satisfaction with the overall environment of "being on-line." So, instead of merely defending the technology to critics, he began asking questions. And demanding answers.

Why is the technology so difficult to understand? Why is it so difficult to get a modem and communications software package to successfully dial a remote computer? Why, why, why?

My own curmudgeon stage shortly followed Art's. But this isn't a bad thing. As Art told me, "It's made me look for answers and explore ways to push the technology, instead of just accepting whatever came along as well and good." His philosophy is an information-age extension of the old dictum "Question authority."

So I'm a bit skeptical when I hear that telecommunications is just about to take off, poised to become the "next wave" of computer productivity. It hasn't happened, folks. And for good reasons.

For example, people still oversell the technology. It's good for some things, but bad for others. And there are built-in

continued

ILLUSTRATION: PAUL COZZOLINO © 1988

problems with every application, but that should come as no surprise; few things more technologically advanced than a disposable lighter work dependably.

For all the above grousing, however, I believe the real advancements and advantages of telecommunications are indeed just around the corner (the trouble comes in defining just how far up the street that corner lies).

In this column I'll look at the complex factors driving the communications industry today and tomorrow. To do that, I'll examine three broad areas of the industry: technology, issues, and effects.

Technologies

For the purposes of this column, communications technology deals with the nuts and bolts of pumping bits and bytes from the desktop to other intelligent devices. Access may be via a direct connection, a local-area network, or dial-up communications.

My discussions will focus on topics such as modem technology. Modems are becoming more sophisticated, capable of pushing data faster and more efficiently. How is this being accomplished, and why isn't it being done on a larger scale?

The burgeoning modem market is beginning to demand dial-up 9600-bps modems, and the industry is starting to respond. One small catch, however, is compatibility, the plague of the computer industry. For example, many 9600-bps modem manufacturers use the Microcom Networking Protocol (MNP) for error correction, but each implements it in a slightly different way.

The telecommunications environment, as a whole, is no different. The drive for faster, faster, faster creates a fractured marketplace with incompatible implementations of "standards" in a kind of free-market "to each his own" mentality.

There are signs of a "coming together" on these issues, however, and I'll keep a close watch on those developments. One good sign is the growing acceptance of the X.400 electronic message exchange standard among providers of electronic mail services.

Then there's communications software, which is like any other piece of software: The one you're reared on is the one you'll most likely die for. Trying to get people to change their brand of communications software is like trying to get the Dalai Lama to change his religion.

When are communications software developers going to learn that the quintessential user isn't the quintessential programmer? And that the user doesn't want to learn a programming language that may as well be Urdu, just to write advanced script files?

For telecommunications to become as indispensable as the word processor, programmers are going to have to concentrate on truly seamless approaches to telecommunicating. The program should take care of most of the work so you can just boot up and go on-line.

I'll be looking at the best and brightest of the future communications packages here. I don't expect miracles right away, but I'm impressed with rumblings I hear coming just over that horizon.

Another aspect of the technology is the systems—the networks and information services—with which the modems and communications software interact. These include computer conferencing systems like BIX, consumer information

continued

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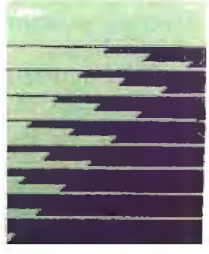

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utilities like CompuServe, LANs, electronic mail (E-mail), and international packet-switched networks. It's in these "hot spots" of telecommunications that the technology comes alive, or should come alive.

Tom Mandel, a futurist and senior analyst at the Stanford Research Institute in Palo Alto, California, is completing a landmark study entitled *Interactive Telecommunications Services: Precursors of the Wired Society*. He says, "Direct consumer access to information through electronic means is going to grow dramatically in the next 5 years. I think we'll see a growth rate, in terms of users, of anywhere between 25 and 30 percent."

Although Mandel is optimistic about the growth of interactive systems like BIX, CompuServe, and E-mail, he says, "We won't see a true mass market emerge." Instead, several niche markets will spring up and profit.

Such niche markets include services like NewsNet, which offers the full text of some 300 specialized newsletters and publications; on-line services like BIX, which cater primarily to a more technical crowd; or Quantum Link, an on-line entertainment service for owners of Commodore computers. In essence, there isn't likely to be one service for all people in the near future.

"To create sufficient demand for a mass market, people are going to have to be given a reason to go outside their normal media requirements: TV, the newspaper, and magazines," says Mandel. "To create sufficient demand for new services at levels attractive to the everyday Joe, the design, delivery, and pricing of consumer services will have to improve significantly."

Here, I'll examine these "niche markets"—what's hot, what's not, and why.

Issues

Congress, in grappling with the effects of new technologies on today's society, has issued several reports out of the Office of Technology Assessment (OTA). The bottom line for the OTA is that any kind of electronic communications systems, with the possible exception of E-mail services, is actually a publishing medium. When you place something on-line, you become an author; the system becomes the publisher.

This author/publisher relationship raises issues of copyright, intellectual property rights, free speech, and the rights of privacy. A 1986 OTA report states, "Electronic dissemination creates some very complex issues with respect to the public interest, and involves the intellectual property system in other issues such as communications, antitrust, and freedom of speech." A broad brush, indeed.

I've had students from around the world take my class, and I've never set foot in a classroom.

Beyond these thorny issues are those of governmental regulation and legislation. Earlier this year, the Federal Communications Commission (FCC) withdrew a proposal that would have dramatically increased the rates that on-line service subscribers would have to pay. The FCC withdrew it, in large part, because of a tremendous grass-roots coalition between service providers and their subscribers: you and me.

It was an issue near and dear to all users of on-line services. And they won. But only because the entire issue was hashed out on every imaginable system from the basement BBS to BIX.

In 1986 Congress saw the need to pass the Electronic Communications Privacy Act, an amendment to the Wiretap Act of 1968. This landmark legislation gave at least some basic privacy rights to private electronic correspondence. And earlier this year, the first lawsuit under the ECPA was filed in an Illinois court.

Such issues can't be separated from discussions about communications, because after the smoke of technological advancement clears, the issues are still smoldering. I'll look at these, too.

Effects

Any technology that directly affects the way humans interact creates unexpected results. A historical example is the telephone. Thought of as merely a business tool when first brought into the public, a way for the boss to stay in touch with the remote worker, it quickly became a social tool and has largely remained so, relegating its original intent to a secondary level.

Electronic communications change the way people work, how they work, and the very structure of organizations that implement such systems (ask Oliver North—who destroyed paper documents but didn't understand that deleted E-mail messages on a PROFS system are archived—about the effects of electronic communications). For example, communications technology is changing how educational systems accomplish tasks, and new methods of teaching are springing up.

I teach graduate-level courses for Connected Education, a program for the Media Studies department under the auspices of the New School for Social Research in New York. And although I've had students from around the world take my courses, I've never set foot in a classroom; the courses are all taught via the EIES conferencing system located on the campus of the New Jersey Institute of Technology.

Nonprofit organizations are beginning to use computer communications to extend their effectiveness—and their budgets. And the presidential candidates are relying on telecommunications to help them coordinate campaigns and keep statewide campaign offices informed of new strategies.

These effects are crucial to the success of communications because they offer tangible results that you can point out to the critics of the technology.

This column will also highlight noteworthy applications of communications and keep you informed on how they affect various segments of the world.

Future Stock

In the coming months, I'll take a look at aspects from each of these various areas. From the bumpy back roads of BBSes to the superhighways of computer conferencing systems, the global highway will be well traveled.

My regular "watering holes" are: BIX ("brock"), MCI Mail ("bmeeks"), and CompuServe (7036,1355). For those of you who are hooked into the more esoteric Usenet (you know who you are), I can be reached on the WELL via the pathway "ihnp4!ucbvax!cogsci.berkeley.edu!well!brock."

As well-traveled as I am across this electronic landscape, I don't stop everywhere. If there's an issue, a topic, or a technology that you think deserves a stop along the way, let me know. ■

Brock N. Meeks is a San Diego–based freelance writer who specializes in high technology. You can reach him on BIX as "brock."

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

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Circle 65 on Reader Service Card

25-MHz Computing Buzzsaws

She Canna Go Much Faster Than This, Captain!

The 80386 system builders have cranked the dial up another notch. And from Compaq, Everex, Intel, and SimpleNet, here they come: the first of the 25-MHz 80386-based AT clones. Several other companies, including IBM, Advanced Logic Research, and Everest Computer have also announced 25-MHz machines.

Judging from the preproduction systems I just looked at, "AT clone" is not a precise term. It's probably more accurate to say that these machines have AT parts grafted onto them. Like the Six Million Dollar Man, with his frail, biologic human parts stitched together with superhuman bionic limbs, these machines marry a significant portion of an 8-MHz AT that limps alongside a high-speed, 32-bit 80386 system. Each machine accomplishes this dual personality in different ways, yet there are striking similarities—at least on the surface.

All four machines have a number of 8-MHz AT-compatible expansion slots that you can feed from the market's never-ending supply of peripheral boards. Each machine also has a 32-bit expansion bus for a high-speed memory board supplied by the company (sort of a similarity and a difference—since each machine's 32-bit expansion bus is proprietary). This leaves you in a predicament: If you want to upgrade memory beyond what you can place on the motherboard, you can either buy a slow, less-expensive AT-bus memory board from any number of sources, or a fast, more expensive 32-bit memory board from the company that made your machine.

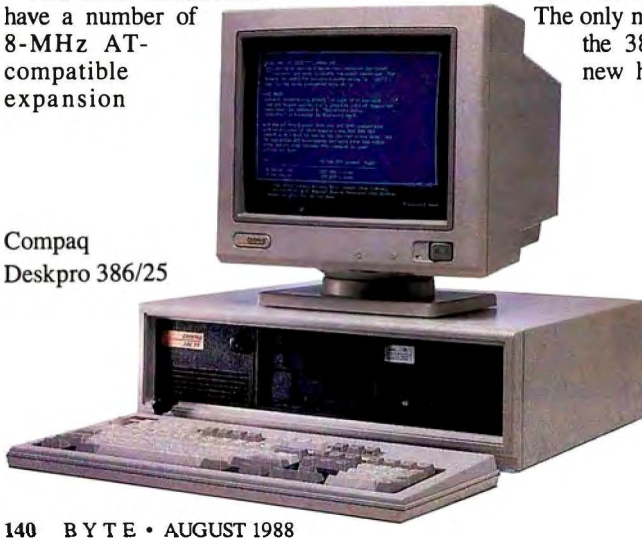
Compaq Deskpro 386/25

Compaq's Deskpro 386/25 looks so much like the Deskpro 386/20, you'd swear all the company did was jack up the CPU to 25 MHz and jack up the price to over 10 grand. But if you examine the motherboards, there has been some redesign: Most of the remaining dual in-line package (DIP) chips have been replaced with surface-mount technology.

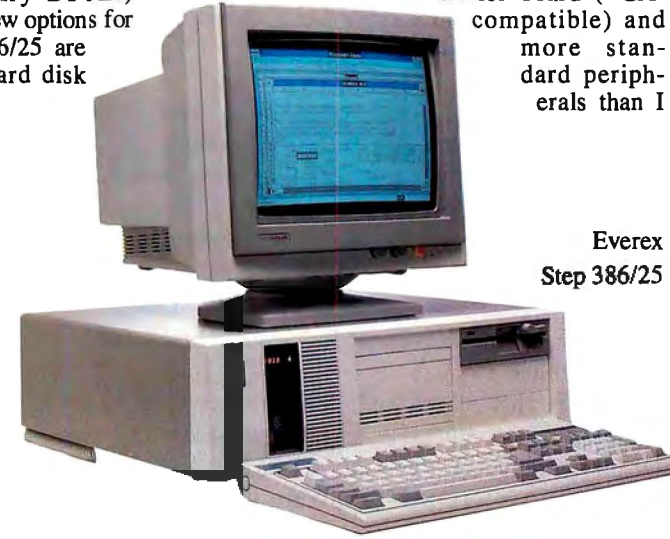
However, Compaq refers to most of the design and options of the Deskpro 386/25 as "current technology." Current, that is, with respect to the 386/20. (For a review of the Deskpro 386/20, see the February BYTE.) The only new options for the 386/25 are new hard disk drives (up to 600 megabytes in an expansion unit), a new 80386 hardware technical manual, and sockets for the new 25-MHz versions of the 80387 and Weitek 1167 coprocessors. Interestingly, you can install both coprocessors in the same machine. They will coexist peacefully, and your software can choose between them. (A 25-MHz Weitek processor was not available at the time I was writing this. I did, however, benchmark the machine with a 25-MHz 80387).

The Flex architecture is still there (see the February review for details), only now it's running at a higher clock speed. As with the 386/20, you can download the BIOS (including the video BIOS) to RAM for faster execution. The CPU and math coprocessor sit on a local high-speed bus with cache memory and are managed by an 82385. Compaq continues to deliver the high level of quality the company is famous for. The chassis is well built, with plenty of attention to radio-frequency-interference shielding.

My test system was loaded: a 300-megabyte ESDI (enhanced small device interface) hard disk drive, 3 megabytes of RAM, a 1.2-megabyte 5¼-inch floppy disk drive, a 135-megabyte tape backup unit, Compaq's Video Graphics Controller board (VGA-compatible) and more standard peripherals than I



Compaq Deskpro 386/25



Everex Step 386/25

have space to mention. You can purchase the Deskpro 386/25 in one of two models that differ only in mass storage. The Model 300 has a 1.2-megabyte 5¼-inch floppy disk drive and a full-height 300-megabyte hard disk drive and sells for $13,299; the Model 110 has a half-height 110-megabyte hard disk drive and a price tag of $10,299. You can add combinations of 1- and 4-megabyte memory-expansion boards to bring the system's total memory up to 16 megabytes.

Everex Step 386/25

What really attracts me to the Everex is the tinted-glass window on the front panel that slides open to reveal a miniature starship's control panel. This 2½ by 5-inch area is a tiny paradise of switches and lights. Across its top is an amber alphanumeric LED panel that keeps you abreast of equipment checks at boot-up (it says things like "DMA OK") and which disk, cylinder, and head is accessed during normal operation ("C:0017 0" means drive C, cylinder 17, head 0). Beneath the LED is a power light and a hard disk access light. Farther down is a three-position toggle switch beside three lights, one each for 8-, 12-, and 25-MHz operation. The next panel down holds the turnkey lock for locking your keyboard, and moving lower you come to a pair of push buttons: one for shutting off the speaker and another for rebooting the system.

Inside, the Everex is all business. It houses eight expansion slots: six AT-style, one 8-bit "drop-slot," (for 8-bit boards that have added to their real estate by extending below the lip of the connector) and one 32-bit slot. The 32-bit slot in the review machine held a 2-megabyte RAM card. On the motherboard were eight 256K-byte single in-line memory modules (SIMMs) (filling all the SIMM slots available) and 256K bytes of high-speed static RAM (SRAM) for the cache. The review system also had an 80-megabyte full-height hard disk, a 1.2-megabyte 5¼-inch half-height floppy disk drive, and a 1.44-megabyte 3½-inch floppy disk drive. For video, Everex supplied one of its EGA boards and an Eversion MN-200 monitor.

Everex also provides extensive utility software, including a hard disk utility package and RAMdisk software. The hard disk utility software includes an extensive diagnostic section, as well as software for creating either Extended DOS partitions, which allow you to create logical drives of up to 32 megabytes each on a single physical drive, or Super DOS partitions, which allow you to create a single partition of up to 285 megabytes on one drive.

You must be careful about one thing on the Everex, though: The configuration program (you get to it by a hot-key sequence—I stumbled into it via a bug in the ROMs that an engineer at Everex assured me would be eliminated on future machines). The program asks you a lot of questions. Unless you have the manual to explain what they all mean, and unless you are intimately familiar with the options you have tacked onto your system, you can really bunge things up.

The cost for a minimum Everex 386/25 system—case, power supply, motherboard, keyboard, 1 megabyte of memory, DOS 3.3, and a 1.2-megabyte floppy disk drive and controller—is $5999. The configuration I tested has a price tag of just over $9500.

Intel SYP302

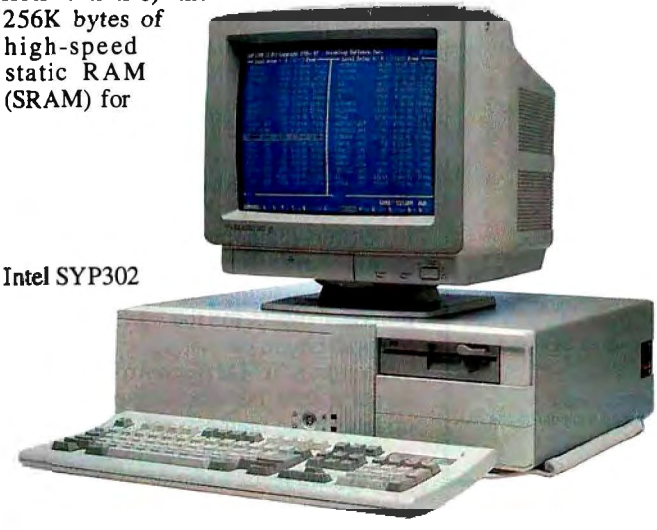
Here's a machine for OEMs only. I've included it here because it will show up on the shelves as the basis for systems from other manufacturers. The System SYP302 from Intel's OEM Platform division gets you a motherboard (populated with a range of memory amounts), power supply, and hard and floppy disk drives (optional). The OEM has to supply the frivolities of computing . . . such as a keyboard, video boards, CRTs, and whatever additional peripherals you need. (For a motherboard with 2 megabytes, a chassis, and a power supply, an OEM can expect to pay $6449.)

My Intel system came with a half-height 44-megabyte hard disk drive, with a pop-out to either add another one or replace the current one with a full-height drive. It also had a 1.2-megabyte 5¼-inch floppy disk drive and pop-outs for three more half-height drives under that. Between the power supply and I/O sockets, I found 4 megabytes of memory in 4 SIMM packages, with room for 4 more. (You can take the machine to 24 megabytes with plug-in memory cards.) Hidden somewhere on the motherboard (I looked, but couldn't find it—I suspect it was in the darkness beneath the drives) is 64K bytes of 35-nanosecond SRAM used as processor cache memory. There's also a socket for a 25-MHz 80387. Fortunately, the socket was occupied on the machine I tested.

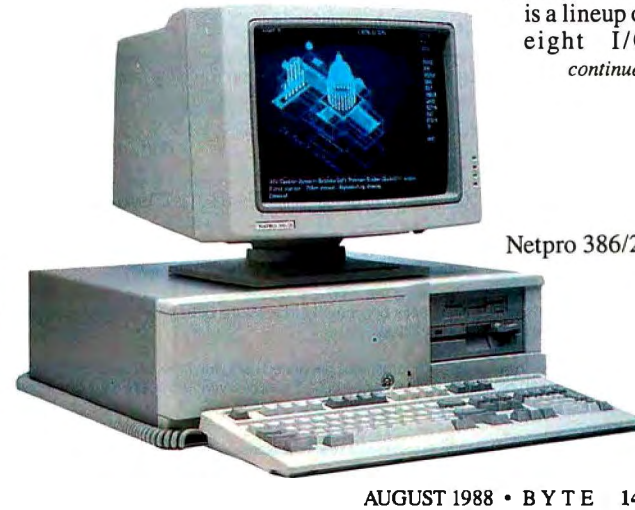
There is no Intel 82385 cache controller chip on the SYP302, though I fully expected to see one. In conversation with an Intel engineer, I was told that this is because at the time the engineers were designing the SYP302 system, Intel was unsure that a 25-MHz version of the 82385 would be available in time for the SYP302. Consequently, the engineers of the 302 set about creating a cache controller from discrete components. The caching system is posted write-through (more on this later) and uses a direct-mapping scheme; that is, there is no sophisticated algorithm—such as a least-recently used formula—used to update main memory from the cache.

Arranged along the back of the motherboard is a lineup of eight I/O

continued



Intel SYP302



Netpro 386/25

connectors. You can use seven of these as 16-bit AT slots (they operate as though attached to an 8-MHz AT machine), and the eighth as an 8-bit drop slot. Two of the seven AT-compatible slots are lined up with 86-pin AT32 32-bit expansion slots that operate at full 25-MHz processor speed. Currently, the AT32 slots will accept only an Intel AT MEM8 8-megabyte expansion board.

The Intel SYP302 uses the Phoenix BIOS. You can have the BIOS downloaded to RAM at boot-up time (the BIOS routines execute faster out of RAM than out of ROM), and a jumper on the motherboard chooses either DOS or Unix operation. Unix operation maps the ROM to the very top of the physical memory-address space so that Unix sees a large contiguous RAM space.

The Intel machine has to take the prize for being the most unattractive of the group. Its left front panel juts out in a way that suggests either a design afterthought or an engineering kludge and is actually an artistic attempt to hide the intake vents that span the front underside of the chassis. Keep in mind, however, that this is an OEM machine. Anything that might be even remotely mistaken for a frill took a back seat to function.

Netpro 386/25

SimpleNet's Netpro 386/25 is one of the first systems based on the Intel SYP302 box. On the outside, the Netpro 386/25 looks just like the Intel system. When you remove the cover and look inside, the Netpro 386/25 looks just like the Intel system. Then, when you run the benchmarks, the Netpro 386/25 performs—if you allow for statistical errors in timings—just like the Intel system.

The only possible performance differences you will see depend on the peripherals you plug in. In the case of my Netpro machine, I received an Orchid Designer VGA board and a combination hard/floppy disk drive controller hooked to an 80-megabyte hard disk drive, a 1.2-megabyte 5¼-inch floppy disk drive, and a 1.44-megabyte 3½-inch floppy disk drive.

At the time of this writing, the Netpro 386/25 is available in two models: The Model 1 is a 4-megabyte monochrome system with an 80-megabyte hard disk drive, a 1.2-megabyte 5¼-inch floppy disk drive, an EtherLan adapter, and a retail price tag of $12,499; the Model 2 sports a VGA display, an extra 3½-inch floppy disk drive, a 102-megabyte hard disk drive, and a price of $13,499.

As an aside, the monitor I received with the Netpro was an RE5515 multiscan monitor from Relisys. For the most part, it worked quite well, but during the benchmarking, the BYTE Lab personnel noticed that whenever the system changed graphics modes, they had to adjust the horizontal width of the display. This did no damage to the hardware or program execution, but the effect was unbearably annoying.

Table 1: *Speed differences between 20- and 25-MHz 80386-based systems range from about 50 percent improvement to more than double, when running such standard tests as BYTE's Matrix inversion.*

CPU	IBM PC AT	IBM PS/2 Model 80	Compaq Deskpro 386/20	Everex Step 386/25	Compaq Deskpro 386/25	Intel SYP302	Netpro 386/25
Matrix	11.69	4.75	3.06	2.44	2.47	2.25	2.56
String Move							
Byte-wide	80.41	39.51	26.11	16.02	25.01	21.59	21.57
Word-wide:							
Odd-bnd.	80.41	39.09	31.01	20.01	25.65	23.64	23.60
Even-bnd.	40.26	19.66	13.07	8.02	12.51	10.80	10.80
Sieve	73.65	29.11	23.18	15.25	15.25	16.33	16.34
Sort	84.39	33.11	26.89	11.44	11.45	12.19	12.19
CPU Index:	**1.00**	**2.27**	**3.13**	**5.08**	**4.20**	**4.44**	**4.35**
FLOATING-POINT[1]							
Math	46.46	10.77	7.01	5.71	5.64	5.86	5.82
Error[2]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sine(x)	20.05	4.61	3.29	2.65	2.58	2.64	2.66
Error	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09	2.00E-09
e^x	17.20	4.50	3.06	2.54	2.47	2.56	2.57
Error	1.00E-09	1.77E-02	1.77E-02	1.77E-02	1.77E-02	1.77E-02	1.77E-02
FPU Index:	**1.00**	**4.15**	**6.10**	**7.47**	**7.64**	**7.40**	**7.38**

[1] The floating-point benchmarks use 8087-compatible instructions only.
[2] The errors for the floating-point benchmarks indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

All times are in seconds. All figures were generated using the 8088/8086 version of Small-C (16-bit integers). Figures for 80386 machines do not use 80386-specific instructions. For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE.

All the Difference in the World

These machines' claim to fame is speed. Caching obviously plays an important role in this area; when I inadvertently disabled the cache on the Intel machine, its performance dropped to what I would expect from a 16-MHz AT. Many manufacturers of these (and other) high-speed systems spend much of their time touting their caching system's high "hit rate" and low "effective wait states." What about these systems?

The Everex uses a proprietary Advanced Memory Management Architecture (AMMA) that—according to the company—gives the system a performance boost beyond standard cache systems. First, AMMA permits you to expand the cache memory from 64K bytes (the minimum) to 256K bytes as your system memory expands. Second, processor cache systems based on the Intel 82385 cache controller chip—the Compaq uses the 82385—are *write-through*, which means that as the processor writes data into the cache memory, it also writes the data to the system memory so that system memory is kept up to date with cache memory. A write-through cache will experience a performance reduction during write operations that access the slower main memory. (To be specific, Intel refers to the 82385's cache implementation as *posted write-through* and claims that a posted write-through allows the 80386 to issue a write to the cache and proceed with the next operation without having to wait for the update to slower main memory. However, if multiple write operations occur back-to-back, the system can bottleneck as the processor waits for the cache controller to update main memory.)

Everex's AMMA controller implements a true buffered-write cache that updates main memory only when necessary (e.g., when the direct memory access system reads a section of main mem-

ory that corresponds to memory updated in the cache) and does so in blocks of up to 128 bits at a time.

Is the AMMA worth its salt (or silicon)? My guess is that the best indicator of the AMMA's speed advantage over an 82385-based cache would be the String Move benchmark (see table 1), and in fact the Step 386/25 does turn in times that are noticeably faster than the other systems for that benchmark. Whatever the reason—larger cache size or smarter cache management—the Everex does seem to be able to move data between the CPU and memory more quickly than the other machines. For the other benchmarks, the Everex shows no clear win over the Compaq, and only a marginal lead over the Intel and Netpro.

A Dual Personality

As sophisticated as these machines are, I cannot help pointing out how similar their philosophy is to that of the Apple IIGS. The IIGS used the 65816, a processor that was an upgrade to the 6502, with larger registers and a wider address range. Compare this with the 80386's improvements over the 80286/8086. The IIGS had internal fast RAM, but the system was slowed to 1 MHz during access to the IIe-compatible I/O slots. Compare this with how these machines must reduce execution speed during access to the AT-compatible slots. Finally, the IIGS had a special fast-RAM/ROM memory-expansion slot. Compare this with each of the 25-MHz machines' proprietary 32-bit high-speed memory expansion slots. It seems that compatibility plagues the hardware engineers of the PC world as well as the Apple world. Are these dual-personality machines the only possible response in the demanding face of compatibility? And how much trouble are we getting into with all the proprietary 32-bit buses?

My personal choice among these machines is a toss-up between the Everex and the Compaq. The Everex does appear to have a leg up on the Compaq and the Intel-based machines in terms of raw speed, but the Compaq comes from a fine heritage of dependable workhorses, and there's certainly plenty of Compaq peripherals to draw from.

Ultimately, you have to ask yourself whether or not the extra speed is worth the extra cost. Is there enough software out there that makes use of the 80386 that you need right now? The 80386 should begin showing its real power as more multitasking applications appear, and a serious Xenix or Unix user might have no other choice. For those who use these machines as MS-DOS applications boxes, it may well be that a specimen from the apparently endless supply of faster-and-faster AT clones will do. Still, it's nice to put on your goggles, black flight jacket, and Red Baron scarf and sit down in front of all those megabytes and megahertz to whip through an application in a morning instead of a whole day. ■

The Compaq 386s

Though not a 25-MHz machine, I find the new Compaq 386s to be more interesting than the other ones reviewed here. Why? Because the Compaq 386s uses the new Intel 80386SX processor, a 16-MHz CPU that is related to the 80386 in the same way the 8088 is related to the 8086.

Internally, the 80386SX and 80386 look identical, externally the 80386SX uses a 16-bit data bus. For the manufacturer, this translates to simpler board design, lower chip cost, and smaller package size. For us, it means we can get a good 80386 system for less money.

Another attraction of the Compaq 386s is its integration of much of the peripheral hardware onto the motherboard. Not only will you find the expected: real-time clock and calendar, parallel printer port, and serial port; there's also the unexpected: VGA controller (with a 16-bit data path that software may one day take advantage of), and a mouse port. Compaq also throws in some welcome utilities: their expanded memory manager (CEMM) package for support of the Lotus/Intel/Microsoft Expanded Memory Specification (LIM/EMS) and Compaq's own disk-caching software.

Compaq serves the 386s in a variety of flavors. You have your choice of no internal hard disk drive (the Model 1 at $3799), a 20-megabyte hard disk drive (the Model 20 at $4499) or a 40-megabyte hard disk drive (the Model 40 at $5199). All three models include 1 megabyte of memory, a 5¼-inch 1.2-megabyte floppy disk drive, and 4 AT-style expansion slots as standard. If backup is one of your sensitive areas, you might check into their tape backup systems: 40 or 135 megabytes. Be careful when exploring the memory-upgrade paths for the Compaq 386s, though. There are four memory expansion options available in a variety of permutations that take the system to a maximum system memory of between 4 megabytes and 13 megabytes. Inside the Compaq 386s are four AT-style slots and one high-speed memory expansion slot.

I'm also giving the Compaq 386s high marks for external appearance—particularly when placed next to the Bauhaus design of the Intel box. It has a smaller footprint than an AT (15 by 16 inches), so it fits nicely onto typing tables that the other 80386 systems would topple.

	Compaq 386s
CPU	
Sieve:	32.73
Sort:	27.04
Matrix:	5.38
String Move:	
Byte-wide:	52.24
Word-wide:	
Odd-bnd.:	44.05
Even-bnd.:	26.14
Doubleword-wide:	
Odd-bnd.:	29.42
Even-bnd.:	19.70
Floating Point	
Math:	11.12
Error:	0.0
Sine(x):	4.63
Error:	2E-9
e^x:	4.53
Error:	1.77E-2

For an idea of the machine's performance, the table above shows the benchmark results for our 80386 low-level tests. The Compaq 386s runs at about half the speed of it's bigger brother (the Deskpro 386/20) for the CPU and FPU tests. The Compaq 386s is not a barnburner in the speed category, but if your plans include a solid 80386 machine it's worth a closer look.

Rick Grehan is a BYTE senior technical editor. You can reach him on BIX as "rick_g."

The Dell System 220. Once again the critics stole the words right out of our mouth.

"The Dell System 220 runs most PC Labs system benchmark tests at speeds that would make you think you're running a 386."
—PC MAGAZINE

"the Dell machine is renewed evidence that the price of 286-based desktop equipment continues to drop rapidly, making such machines very attractive for daily work under MS-DOS even as they hold out the promise of running OS/2 in the future."
—WILL FASTIE, PC WEEK

"...includes a year's on-site support...in the price of the computer. This is the sweetest support deal offered by any computer vendor in the industry."
—ERIC KNORR, PC WORLD

"The hot item from a technical point of view is the System 220. This machine runs a 286 processor at 20 MHz, which is its major claim to fame."
—WILL FASTIE, PC WEEK

"the System 220 has more going for it than just speed."
—PC WORLD

The reviews are beginning to pour in.

And they read like a wish list for every power user looking to exceed the ordinary limitations of a 286 computer.

The computer everyone is praising in such glowing terms is the Dell System 220.

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System 310	With Monitor & Adapter		
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- Real-time clock.
- Three full-sized AT† compatible expansion slots.
- Socket for 80287 coprocessor.

Options:

- 3.5" 1.44 MB diskette drive.
- Intel 80287 coprocessor.
- 1 MB RAM upgrade kit.

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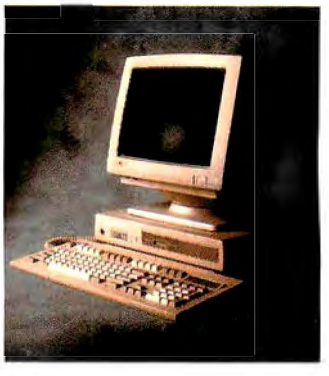
System 220	With Monitor		
	VGA Mono	VGA Color	VGA Color Plus
One Diskette Drive	$2,299	$2,499	$2,599
40 MB – 29 ms Hard Disk	$2,999	$3,199	$3,299
100 MB – 29 ms Hard Disk	$3,799	$3,999	$4,099



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- Dual diskette and hard disk drive controller.
- Enhanced 101-key keyboard.
- 1 parallel and 2 serial ports.
- 200 watt power supply.
- Real-time clock.
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- Socket for 8 MHz 80287 coprocessor.

Options:
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- 8 MHz Intel 80287 coprocessor.

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40 MB – 40 ms	$2,299	$2,499	$2,699	$2,799
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90 MB – 18 ms ESDI	$3,299	$3,499	$3,699	$3,799
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AD CODE NO. 11EH8

Communications

The BYTE Lab tests communications programs that can go to work when you go home

Steve Apiki and Stan Diehl

Carbon Copy Plus
Crosstalk Mk.4
Crosstalk XVI
HyperACCESS
Instant Terminal
MaxOnline
Mirror II
Move-It
PC BLAST II
Procomm Plus
Relay Silver
Smartcom III
Softerm PC

If you were stranded on an island with a bottle of aspirin, a personal computer, and a modem, what communications package would you most like to have along? Make the wrong decision and you're likely to need the aspirin. Finding software that lets you use your modem may be easy, but the package with the speed, automation, and flexibility to let you make the most of your system is a rare find indeed.

Data communications is often the same procedure from day to day. But say you just got a new 19,200-bit-per-second modem and you need to find a package that can handle it. You may want something that can run in the background without a multitasking operating system. Or maybe you're just tired of running through the same log-on procedure by hand, over and over again. The best thing about new software is the performance increase you can get for a relatively small amount of money.

The subjects of this month's product focus are MS-DOS-based, stand-alone communications software packages that have a script language—a feature that can relieve you of hours of tedium and hours of connect time. Generally, a script language lets you program your system to handle a communications session unattended. Programmed with a sophisticated script, your computer can recognize prompts from the host systems and act accordingly—say, sending queries or transferring files.

The packages we reviewed vary, however, in their ability to save you from sinking that saved time back into learning a cumbersome script language or a difficult command sequence. They also range in maximum transfer speeds from 2400 to 115,200 bps, and in price from about $70 to about $250—but you don't always get what you pay for.

System requirements are generally the same: Most run under DOS 2.0 on a single 3½-inch or 5¼-inch floppy disk drive and in 192K bytes of RAM. All the packages let you use BIX, CompuServe, or other information services, and they let you upload and download files from your company's mainframe. However, many of them will perform at their top transfer rate only when they're talking to a computer running the same software. We'll highlight differing requirements in the individual sections that follow (also see table 1).

Carbon Copy Plus 5.0

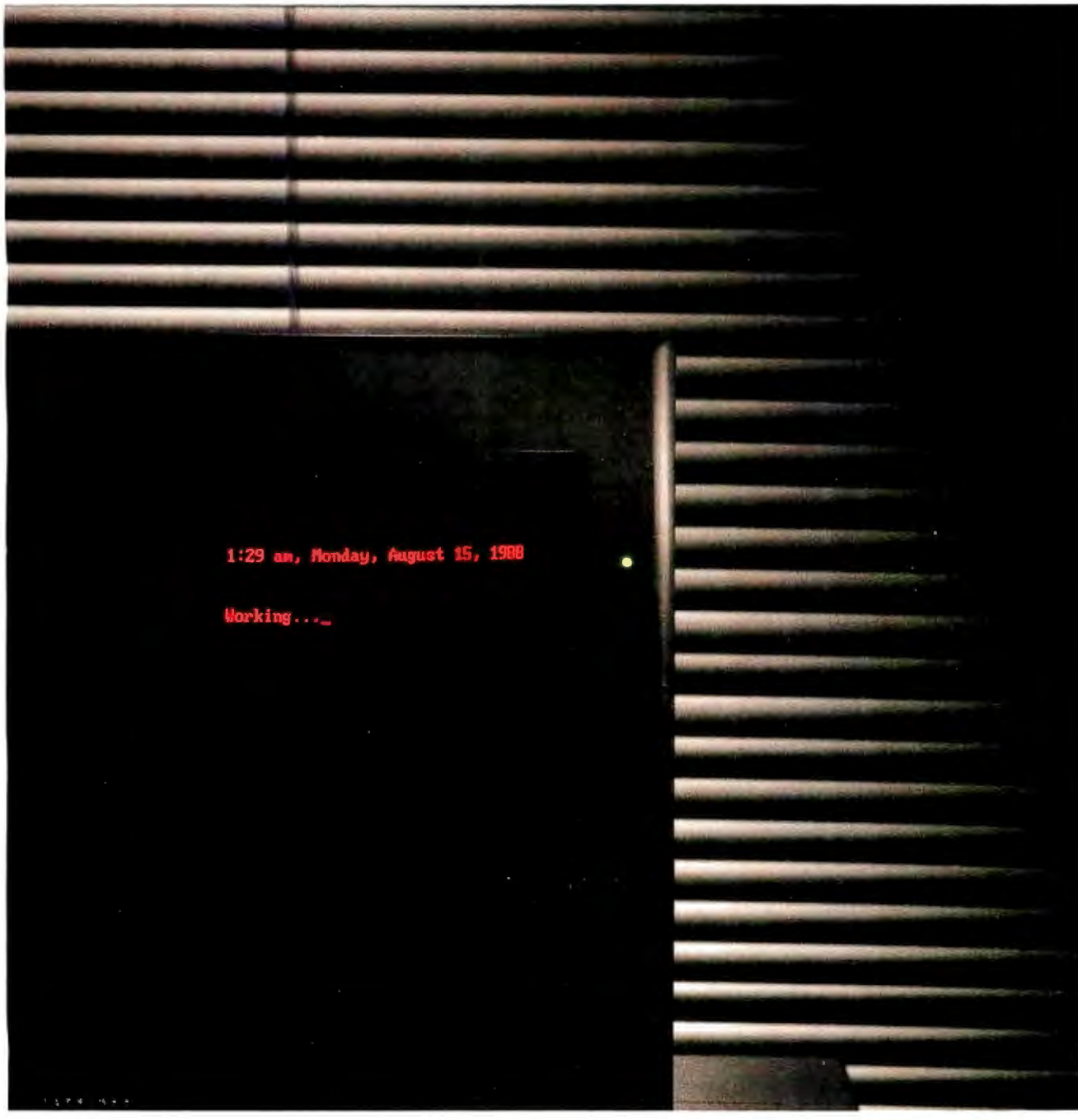
Meridian Technology's Carbon Copy Plus 5.0 is a good example of a package that is strong overall and provides unique features for specialized needs. It requires an unusually large (256K-byte) section of memory, but it exchanges code size for speed by loading its configuration program directly into memory. It includes 224 pages of documentation.

Carbon Copy is more than a utility for communicating with mainframes—it's also a remote PC control package. Because of this, it is broken down into two executable programs, `CC` for the host and `CCHELP` for the remote side. The remote user can access host command files to read or write, control the host's graphics screen, and send output to the host's printer. Disk access is made possible through CCDOS, a DOS look-alike that gives host file control to the remote user through an almost transparent additional program layer. For example, `CCHELP` is able to specify the host's drive C by entering `HC:`. Actual file transfers are accomplished with a simple `COPY` command and are conducted using Carbon Copy's own error-checking protocol.

The host can limit file access by disabling CCDOS. As an added security measure, the host can dial a preset callback number upon receipt of a valid password from an inquiring computer. CC can also be run in a resident (background) mode so the host user can continue to run applications while file transfers are taking place.

continued

According to Script



PHOTOGRAPHY: PAUL AVIS © 1988

Table 1: *Features and price are unrelated in the packages we tested (● = yes; ○ = no).*

Package name	Price	Copy-protected[2]	Documentation	Minimum RAM (bytes)	Maximum data transfer rate (bps)	Learn mode	Text editor	Background operation
Carbon Copy Plus 5.0	$195	●	224 pages	256K	38,400	○	○	●
Crosstalk Mk.4 1.01	$245	○	424 pages	256K	115,200	●	●	○
Crosstalk XVI 3.61	$195	○	199 pages	96K	115,200	○	○	○
HyperACCESS 3.28	$149	●	232 pages	192K	57,600	○	○	○
Instant Terminal 1.1	$ 95	○	71 pages	192K	19,200	○	○	○
MaxOnline 2.4	$ 70	○	222 pages	256K	19,200	●	○	○
Mirror II 3.6.12	$ 70	○	368 pages	192K	115,200	●	●	●
Move-It 4.02	$150	○	155 pages	128K	19,200	○	○	○
PC BLAST II	$250	○	322 pages	256K	38,400	○	●	○
Procomm Plus 1.1A	$ 75	○	340 pages	192K	115,200	●	●	○
Relay Silver 1.0[1]	$150	○	591 pages	192K	19,200	●	●	●
Smartcom III 1.08	$249	○	218 pages	512K	115,200	●	●	●
Softerm PC 3.0	$195	○	728 pages	256K	115,200	●	●	●

[1] Requires two floppy disk drives.
[2] Disks can be copied, but duplicates will not work together.

All this host mode power doesn't come at the expense of terminal-emulation capability. Carbon Copy can hold its own against dedicated mainframe links, with transfer speed that puts it right up with Crosstalk Mk.4, support for the most common transfer protocols, and emulation support for five popular terminals.

The terminal commands are clear and efficient, mostly Alt-key combinations. In fact, Carbon Copy was the best at our manual keystroke benchmark, and, though the commands are short, they are by no means cryptic. The compilable script language is similarly tight, although it does not contain the advanced decision-making structures of some packages.

If you're interested primarily in MS-DOS-based communications and need a package that will enable very intimate data sharing over the telephone, then this may be the one you're looking for. Keep in mind, however, that all the specialized features require at least two copies (one for the host and one for the remote terminal) at nearly $200 apiece.

Crosstalk Mk.4 version 1.01

A real communications software Cadillac, Crosstalk Mk.4 version 1.01 from Digital Communications Associates (DCA) is a hefty package that requires two 360K-byte floppy disk drives and the assimilation of a 424-page user's manual. It includes a comprehensive script language and a top-drawer price of $245. The list of terminals it can emulate is as long as your arm (see table 2); you can edit text with a built-in editor; and, in addition to supporting every major file-transfer protocol, it introduces one of its own, called DART.

DART is essentially an upgrade of the older Crosstalk protocol, with new features that include crash recovery and time and date stamping. Crash recovery enables file transfers to continue after an error is corrected, appending new data onto that already sent.

If, despite all the protocol options available, you still must do an ASCII transfer, you won't have to worry about speed. With a rate of 115,200 bps supported and the ability to send and receive with only limited line waits, Crosstalk turned in an excellent time on our file-transfer benchmark.

The command mode is built on the Crosstalk system of loading command modules for making preset calls. The modules can contain connection settings, protocols, and terminal emulations. This system is relatively easy to use once you get familiar with it, although keeping track of all the two-letter commands often requires hunting through the manual. Crosstalk Mk.4 had an average showing on our keystroke benchmark; it suffered from the need to send an attention signal before any commands.

Most outstanding of all its features is its CASL script language. CASL uses multiple decision loops, has specialized disk-access commands, and can create much more than script files. Because of its command specialization and its size (over half the manual is dedicated to CASL commands), writing simple scripts like our script benchmark can be difficult for those unfamiliar with the language. Fortunately, Crosstalk Mk.4 provides a learn script that lets you record a session into a script file that can simply be edited. With the learn script, what would have taken nearly 500 keystrokes to program by hand was reduced to the 197 indicated in table 3.

Although Crosstalk Mk.4 is a very powerful package, its price puts it in a range (shared by Smartcom III, as discussed later) reserved for only those in real need of its most advanced features.

Crosstalk XVI 3.61

Crosstalk XVI, though the standard by which other communications packages are measured, falls short of the mark itself in our tests. Version 3.61 requires only 96K bytes of RAM and costs $195.

The software emulates nine popular terminals, but it supports fewer protocols and is more difficult to learn than most modern packages. The common way to run command mode is to load command files containing directory information. You can supplement this by following script menus or by entering two-letter commands. As with Crosstalk Mk.4, the process takes some getting used to but can be efficient once you are familiar with the language. There is a status table that you can access with a single key to find your connect options; however, finding the table with less commonly used information (like the modem commands) can take several commands. The system had an average score on our

continued

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Table 2: *You should check a package carefully to make sure it supports the protocols and emulations you need (● = yes; ○ = no).*

	Protocols															Emulations		
Package name	CrossTalk	CompuServeB	Hayes	IMODEM	Kermit	Proprietary	SuperKermit	SeaLink	Telink	WXMODEM	XMODEM	XMODEM1	XMODEMBatch	XMODEMw/CRC	YMODEM	YMODEMG	ADDS Viewpoint	AMPEX D80	ANSI TTY
Carbon Copy Plus 5.0	○	○	○	○	●	●	○	○	○	○	●	○	●	●	●	○	○	○	●
Crosstalk Mk.4 1.01	●	●	○	○	●	●	●	○	○	○	●	○	●	●	●	●	●	○	●
Crosstalk XVI 3.61	●	○	○	○	○	○	○	○	○	○	●	○	○	○	○	○	●	○	●
HyperACCESS 3.28	○	○	○	○	●	●	○	○	○	○	●	○	○	●	○	○	○	○	●
Instant Terminal 1.1[4]	○	●	○	○	●	○	○	○	●	●	●	○	○	●	●	○	○	○	●
MaxOnline 2.4	○	○	○	○	●	○	○	○	●	○	●	○	●	●	●	○	○	○	●
Mirror II 3.6.12	●	○	●	○	●	○	○	○	○	○	●	○	●	●	●	○	●	○	●
Move-it 4.02	○	○	○	○	○	●	○	○	○	○	●	○	○	●	○	○	○	○	●
PC BLAST II	○	○	○	○	○	●	○	○	○	○	●	○	○	●	○	○	○	●	●
Procomm Plus 1.1A	○	●	○	●	●	●	○	●	●	●	●	○	○	●	●	●	●	○	●
Relay Silver 1.0	○	○	○	○	●	●	○	○	○	○	●	○	○	●	○	○	○	○	○
Smartcom III 1.08	○	○	○	○	●	○	○	○	○	○	●	●	○	●	●	●	○	○	●
Softerm PC 3.0[5]	●	○	●	○	●	●	○	○	○	○	●	○	○	●	○	○	●	○	●

[1] Character mode only.
[2] Requires additional hardware (e.g., IRMA and SmartAlec).
[3] Requires 7171 protocol converter or equivalent.
[4] DEC emulators included; 40 others available at additional cost.
[5] Supports 33 additional terminals not listed here.

manual keystroke test.

Writing a script file is simply a matter of listing commands, and there are no shortcuts except for abbreviated command strings. Decision loops based on received strings must be implemented using the when construct—a technique that can lead to errors with unexpected input.

Only the XMODEM error-checking protocol is supported in addition to Crosstalk's own. Data transfer rates are supported to 115,200 bps, but our ASCII transfer test shows the severe performance hits that you get when flow-control characters and character waits are necessary for error-free transmission. Crosstalk XVI was one of the few packages we tested that took longer to send a file to a faster machine than to receive it—a clear indication of high software overhead.

Overall, Crosstalk XVI is an average package at an above-average price. Crosstalk look-alike programs are easy to come by, but many of them have added features and flexibility that Crosstalk has not.

HyperACCESS 3.28

Hilgraeve's HyperACCESS is a versatile communications package with solid file-transfer ability and unique features that make it useful for widely varying applications. Version 3.28 sells for $149.

HyperACCESS supports XMODEM, Kermit, and its own Hyper protocol. Despite its moderate maximum transfer rate, HyperACCESS compared favorably to higher-rated packages in our throughput tests, with low overhead and flawless XON/XOFF synching. The software features optional data compression capability for both XMODEM and the Hyper protocol.

But speed is not HyperACCESS's only asset. It also has a powerful host mode that allows remote control over DOS and DOS programs. Remote user access can be limited to read only, DOS only, or one program only.

One weakness in an otherwise good package is its use of a menu-driven command mode. Although the manual keystroke score was average, the commands involve constant flipping through layers of menus. Transferring files is especially taxing.

HyperACCESS features Hyper Pilot, a compilable script language that lets you check for syntax errors before you're actually on-line. Unfortunately, the script language itself does not allow many shortcuts, and it fared poorly on the programming keystroke test. In addition, if you're used to other software's script languages, which are all similar, you'll find that learning Hyper Pilot requires some adjustments.

Instant Terminal 1.1

Take our advice: When the Instant Terminal manual mentions that a little file on the supplemental disk is intended only for a "computer engineer, technician, or programmer," don't listen. Print the file. Using the sparse 55-page reference manual that came with the package, we assumed Instant Terminal was a cheap Procomm clone. In fact, the sign-on screen tells you that Datastorm Technologies, the Procomm people, licensed the software to Softronics. But with a little digging, we found a full scripting language and features that are only hinted at in the published documentation.

Instant Terminal even ran a Procomm script, including GOSUBs and conditionals, without an edit or a hitch. Still, it's not a full implementation, the most notable omission being a learn facility.

One other problem with the "cheap Procomm clone" assumption: Procomm costs less. With a single emulation, Instant Terminal will run you $95.

As the name suggests, Instant Terminal touts its terminal-emulation features. Our review copy included a software module and documentation supplement

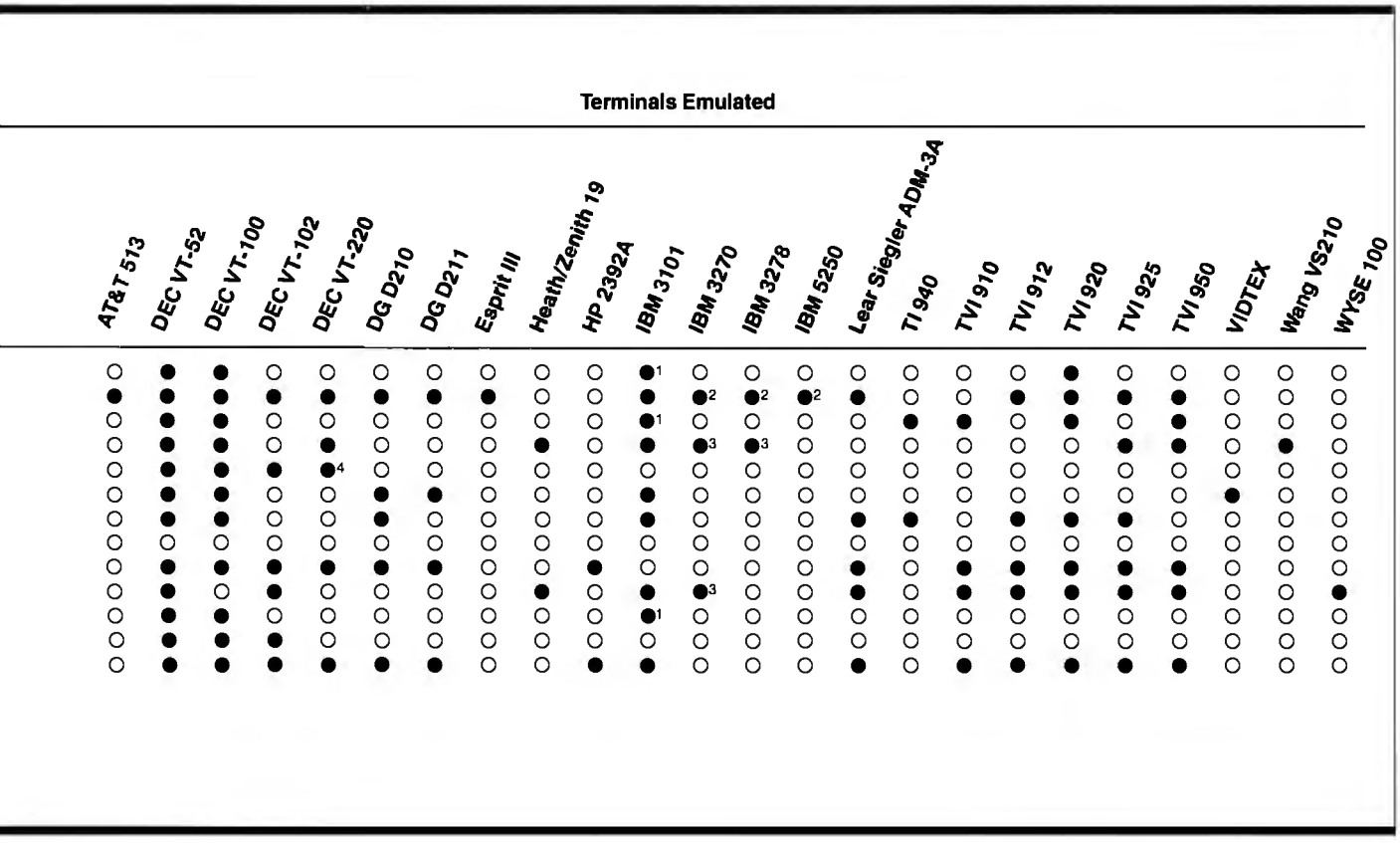

Table 3: *The packages varied widely in ease of programming and thoughput. (All times are in seconds.)*

Package	Keystrokes to create BIX script	Keystrokes for manual BIX session	1-megabyte send at highest bps	1-megabyte receive at highest bps	Perfect-line 1200-bps send	Perfect-line 1200-bps receive	Typical-line 1200-bps send	Typical-line 1200-bps receive
Carbon Copy Plus	286	19	310	722	590	588	592	589
Crosstalk Mk.4	197	26	318	770	595	592	589	591
Crosstalk XVI	237	24	873	618	592	591	588	589
HyperACCESS	479	26	296	770	589	592	593	597
Instant Terminal	343	19	885	884	596	597	596	595
MaxOnline	158	26	579	549	619	597	606	598
Mirror II	117	25	475	926	594	598	597	597
Move-It	145	44	1653	1660	589	590	587	593
PC BLAST II	419	38	435	1259	596	592	600	594
Procomm Plus	142	22	452	542	587	587	590	588
Relay Silver	117	30	740	656	593	592	594	595
Smartcom III	162	23	98	262	582	584	587	585
Softerm PC	195	33	950	954	667	665	655	661

for DEC VT-220 emulation. An order form enclosed with the package lists 40 additional emulator modules. Although most of the telecommunications packages reviewed here include a variety of common emulations, documentation was almost invariably poor. Instant Terminal fills this gap. So if you need to emulate an obscure terminal, or if you have a specific application on only one or two terminals, look into Instant Terminal. However, if you access multiple hosts, take note: The first emulation goes for $15; after that, they're $50 a shot.

MaxOnline 2.4

Though sometimes bogged down by multiple menus, this $70 package offers abundant features for its price. The menus are well designed, making MaxOnline a very easy package to use, especially for novices. The operations you need most show up on the first screen. And if anything's missing, you can add new functions by editing USER.MNU.

MaxOnline reaches a maximum data

continued

Circle 131 on Reader Service Card (DEALERS: 132)

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transfer rate of only 19,200 bps, but it scored credibly on our benchmarks, timing under 10 minutes on both 1-megabyte transfers. Adequate scripting and a functional learn mode combine for easy automation, while the 222 pages of documentation include plenty of instructive programming routines and command examples. The distribution disk also contains demonstration scripts.

MaxOnline touts a windowing feature that supports simultaneous file transfer from two COMM ports. It falls short of true background mode, but it can speed up extensive file-transfer tasks. While one window downloads from a remote host, the other port can process files over a direct line. You can customize each window and easily jump back and forth. Remote operation excels for a program in this price category. Simple commands set passwords, restrict log-ons to specific users, allow varying levels of access, and trigger an interactive chat mode. Easy file management is also available.

The compact scripting language handles most basic commands. It would not, however, support an `IF WAITFOR` statement, counting instead on a time-out error to break from the mail loop. Parameters are easy to change, with an overview screen and menus available for most entries. MaxOnline illustrates how far communications software has come: A little money buys a professional package with plenty of power.

Mirror II 3.6.12

Being accustomed to a given command system and script language may be your only reason for sticking with an otherwise weak communications product. SoftKlone's Mirror II 3.6.12 solves that problem by letting you use the familiar Crosstalk system while adding a learn command, background mode, text editor, strong terminal emulation, and some friendly screen displays. All this, including 368 pages of clear documentation, will run you a mere $70.

Although the command structure is virtually identical to Crosstalk's and is not any easier to learn, Mirror II's screen displays present your connect information clearly and let you scroll through all the parameters you have set. It performed at Crosstalk's level in the manual keystroke test, the only difference being an added stroke to get past the initial screen display without waiting it out.

Running Mirror II in the background is easy, requiring only a hot-key toggle to switch between itself and another application. It can handle the difficult task of simultaneously receiving a file and doing disk-intensive operations with only about a 5 percent performance hit, and without errors. Be warned that Mirror's 192K bytes plus your operating system take up a big chunk of a 640K-byte memory, and you may be severely limited as to the other applications you can run.

If you're not used to the Crosstalk script language, there is a learn facility to help get you started. Using it enabled us to cut the programming keystrokes down to an excellent 117, including editing. Mirror adds the ability to access a command completion register to the standard Crosstalk command set, which makes possible decision loops based on 22 separate conditions.

The software supports all common protocols, including Crosstalk. It scored very well in our ASCII send test, but lower than average on our ASCII receive. In this case, the flow control necessary to properly send the file from the Compaq 386/20 to the AT at 115,200 bps was unusually sluggish.

Mirror II is a very good, strong, and flexible package for less than half the price of Crosstalk. Those comfortable with the Crosstalk command file format may well find a new favorite here.

Move-It 4.02

When you boot up Move-It, all you get back is an asterisk. After delving through so many programs with reams of overlapping menus and multiple keystrokes for one simple command, that lonely command prompt was refreshing. Of course, you have to rely on the 155 pages of documentation—without an index—and a few help screens to get you through the learning phase. The stark screen display disguises a powerful program with a full scripting language.

Though simple in concept, the program's price tag ($150) puts it in a class where it must match the performance of some tough competition. Unfortunately, it lacks the basic features required to meet that goal. Take the phone book, for example: It is a raw ASCII file, where each line contains an entry, and a comma separates each argument of an entry (e.g., phone number, data transfer rate, and parity). Again, the simplicity appealed to us, but for the price of this package, you should not have to exit the program and run up a word processor each time you add a phone entry. And during XMODEM transfers, you should get more of a status update than just a row of dots across the screen.

Move-It's elegant scripting almost makes up for the lack of a learn facility. Even without automatic generation of

code, it took only 145 keystrokes to program the full BIX session. Move-It handles the BIX mail loop with typical efficiency. It first looks for the read/action prompt (meaning mail is in the box), then jumps to one label if the prompt is encountered, or to another label if it is not; thus:

```
MA read/action:
                JU no_more_mail FALSE
                JU more_mail
```

Unlike many of the programs we reviewed, you don't have to wait for a timeout to fall through the mail loop. This structure not only produces efficient code but also handles a variety of complex chores.

Still, when the program drifts away (an affliction all too common during telecomputing), you start to miss the menus and status prompts so common in the other packages. And this program drifts off more than others. It hung when it couldn't detect a dial tone, it hung when connected to a Hayes-compatible modem it didn't think was compatible enough, and it even hung when an invalid data transfer rate was entered. There's nothing more infuriating than a hung program that stares back at you with only that lonely asterisk.

PC BLAST II

In a category with Smartcom III and Crosstalk Mk.4, the $250 PC BLAST II faces some brutal competition. Even with 300-plus pages of documentation and some powerful features, it just doesn't achieve top-of-the-line status. The manual lacks coherent organization, and the sparse index skips the first two sections. BLAST scripts handle complex chores, but they run erratically—a fatal flaw when automating on-line procedures. BLAST also comes up short on maximum data transfer rate (38,400 bps) and number of protocols supported (only XMODEM and the functional, though nonstandard, BLAST protocol).

BLAST reverts to some cryptic scripting language. Unfortunately, the documentation covering the command structure doesn't help much. While most programs use the `Wait For` standard to await specific prompts, BLAST uses a `TTRAP` command. Still, even after employing numerous traps and delays, BLAST insisted on flooding BIX with a burst of commands. Although BIX handled it, some services won't. For protocol transfers, you've got to access the on-line menu and then send local keystrokes to automate the menu selections. This inefficient method invites trouble. The `TUPLOAD` and `TCAPTURE` commands support only text transfer. On top of that, BLAST lacks a learn facility.

The setup file enhances automation by triggering script files and loading variables such as `@logfile` and `@password`, but this doesn't make up for the inefficiencies. A keystroke count exposes the problem: The manual session took 38 keystrokes to complete, while the command script required 419. For the price BLAST demands, it should be doing more of your work. Other programs in BLAST's price category deliver elegant scripting, full features, and smooth operation—an enviable standard, and one that BLAST simply does not meet.

Procomm Plus 1.1A

Procomm Plus offers the best of both worlds: cheap yet powerful, easy to use yet rich with features. At first glance, it appears plain enough for public domain, and yet it supports almost any telecomputing application: 11 standard protocols, 14 terminal emulations, every common configuration up to 115,200 bps, host mode, split-screen chat mode, an automated phone book, macros, and a surprisingly powerful script language. In the old price ($75) versus performance ratio, Procomm leads the field.

Procomm employs the familiar PC-Talk key sequences to get the job done. The key combinations are, for the most part, logical; and for those that aren't, one keystroke calls a comprehensive overview screen. The 340-page manual, well-organized and indexed, does not leave you ripping out pages with one hand and hair with the other. Page references at the beginning of each chapter supplement a detailed table of contents and a complete index.

Although some compatibility quirks are to be expected in the world of telecommunications programs, Procomm did better than some. A few of the packages could not handle the POPCOM modem, a purported Hayes compatible, but Procomm had no trouble with it at all. Another Hayes compatible incessantly reported Carrier Detect High, and most of the programs had problems with this. Some dealt with it on boot-up by flashing a warning or initiating a reset. Some even dropped into terminal mode, fully on-line, refusing to believe that no one was home. Procomm Plus simply ignored it. Perhaps this exposes a lack of sophistication, but it can be a blessing. Telecomputing causes enough headaches without your program getting picky.

continued

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The Tests

Our tests seek to evaluate communications software performance in two broad categories: throughput and ease of use. To this end, we devised benchmarks to pinpoint performance ability in eight separate areas.

The first is our manual keystroke test, where we record the number of keystrokes necessary to carry out a defined session on the BIX conferencing system. It provides a quantitative measure of the relative complexity of using the command mode. The session consists of logging on, filing and downloading mail, filing and downloading messages, and logging off. Keystrokes that are used for commands in terminal mode (i.e., commands for BIX's use only) are not counted. We made every effort to use keyboard shortcuts where these were available. The count begins on the first stroke after the program is started and ends when we have returned to DOS.

For our second test, we wrote a script language program to automate the same BIX session, and we determined the keystrokes needed to enter and execute the script. Since BIX's mail subsystem requires that you file memos individually, and the amount of messages can vary from day to day, the program must have some kind of input-based decision structure to work properly.

We chose to use the language's best structure, not necessarily its most compact, for handling unexpected conditions. If abbreviated commands were possible, we used them. If the package had a learn facility, we counted only the keystrokes needed to use the learn mode and to edit the resulting script.

Throughput was measured using two data files (a 64K-byte file and a 1-megabyte file), transferred between a standard IBM PC AT and a Compaq Deskpro 386/20 under fixed conditions. The terms *send* and *receive* are always referenced to the AT. The 1-megabyte ASCII transfer test times the send and receive timings of one million *A* characters via a null modem connection and using no error checking. We pushed for the greatest error-free transfer rate we could get, which is not merely a function of data transfer rate; it often meant adjusting flow control and line or character wait parameters. At 115,200 bps, we should see 1-megabyte transfer times of about 90 seconds (1 megabyte/(115200/10)), but typical times were more on the order of 10 minutes, which was the fastest transfer time the software (and the disks) could correctly handle.

To determine how the software reacted under everyday conditions, we measured the transfer rate of a 64K-byte data file at 1200 bps over two simulated phone lines. The first line, simulated by our modem testing equipment, was a "perfect" line, with virtually no noise and no line impairment. The connection was made using two 1200-bps Hayes-compatible modems. The second line simulated was a "typical" line, with typical noise, attenuation, and phase jitter. These parameters were determined by the preliminary draft of EIA-496, a specification for universal communication equipment tests.

As for the script language, Procomm boasts a complete command set: `if...then...else` looping, case structures, a Shell command for DOS operation, subroutines, and advanced screen handling. This power does not come at the cost of simplicity. For instance, Procomm handled the BIX mail loop with ease:

```
WAITFOR "read/action" ;BIX prompt
                      ;when you have mail
IF WAITFOR            ;if you have mail,
 GOTO more_mail ;go get it
ENDIF
```

Sure, it looks obvious; but few packages handle the loop so easily. For all but the most complex programming projects, Procomm scripting will do the job. Only the lack of a true background mode dampens our endorsement. The Shell command allows you to escape to DOS while still on-line, but file transfers will not proceed until Procomm returns to the foreground.

Procomm meets a software designer's most stringent standard: Pack in the features, but keep the interface simple. It doesn't intimidate, but it can still handle complex applications. Above all, it strives for invisibility, flashing menus at you only when asked and remaining as unobtrusive as possible. A noble achievement, and a goal all too often neglected.

Relay Silver 1.0

Relay Silver 1.0 is a fully featured communications software package that requires 192K bytes of RAM and two floppy disk drives. It includes two manuals with over 500 pages of well-referenced documentation, and it sells for $150. Relay Silver is weak in throughput, ease of commands, and terminal emulation, and the unusual extra features it adds are not enough to make up for these basic lacks.

Among the added features are a sophisticated background mode, a text editor, and a script language learn facility. The background mode allows Relay Silver to run as a true terminate-and-stay-resident (TSR) program, always accessible through a hot-key combination. Unfortunately, background file transfers were quite slow when running a disk-intensive application in the foreground.

ASCII transfers were quick enough, but hard to get going. At high speeds, the software occasionally locks when using XON/XOFF, apparently because the receiver doesn't catch all the data and never sends the next XON. For hard-wired connections, Relay Silver needs a null modem cable configuration that differs from that of almost every other package.

The command mode is menu-driven beyond reason, and to accomplish any file transfers with the menu, you must edit an entire directory specification. A command entry mode of sorts is available through an attention key, but that handy bit of information is buried well within the documentation. Once you find it, you can enter script commands directly from the keyboard. Even with this shortcut, Relay Silver had a lower-than-average score on manual key counts.

On the plus side, Relay has a powerful script language and a good learn facility. Relay also finished with an excellent keystroke count in our programming test. The commands are simple and intuitive, and editing a learned script can take remarkably little effort. In addition, Relay includes an application program interface—software hooks that let you easily incorporate Relay scripts into your own programs. The manufacturer says a new release of Relay Silver with script enhancements and additional terminal emulations will be available this fall.

Smartcom III 1.08

For elegant scripting, full features, and pure telecomputing power, you just can't

continued

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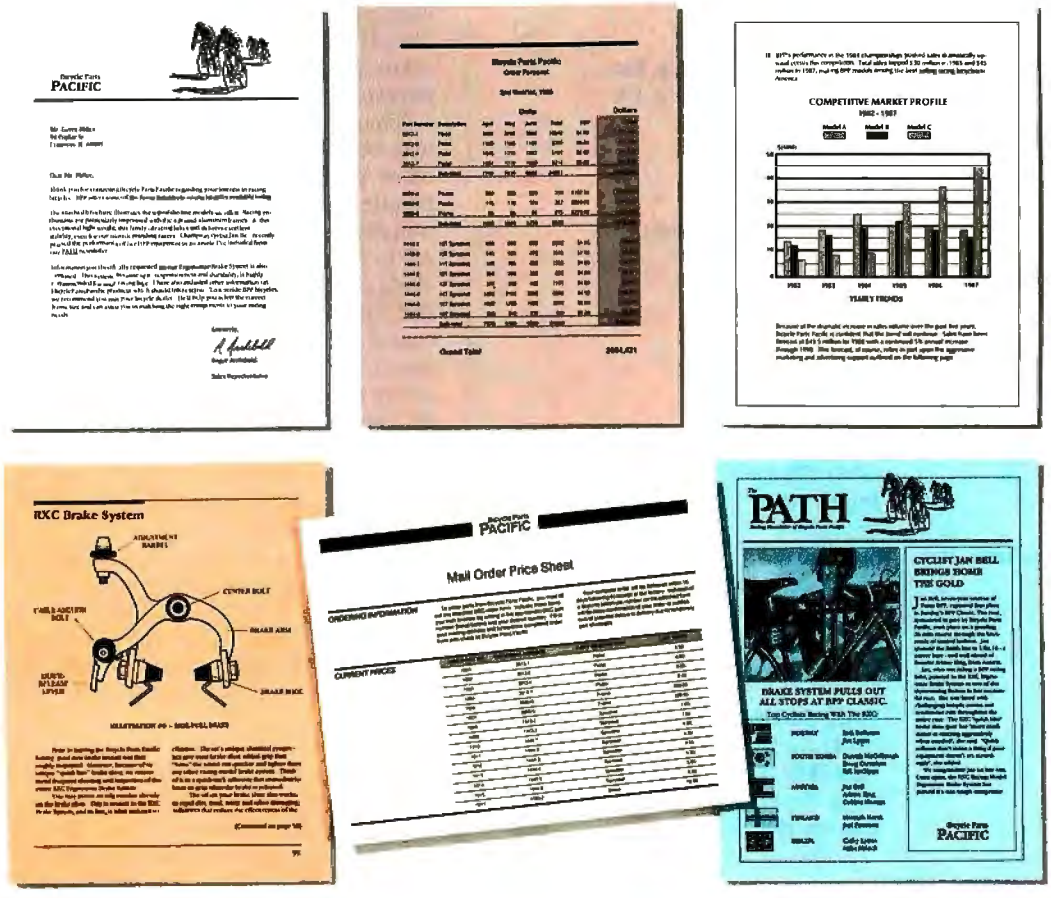

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West Hills, CA 91307
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beat the Old Guard. Smartcom III requires a hefty 512K bytes of RAM, an 80-column display, and a hard disk drive, but the package includes everything: a full-functioned editor, file compression and data encryption, on-line disk management, a complete command set, an integrated compiler, simultaneous sessions, remote access capability, and an excellent learn facility. The four-disk set is not for the casual user, as the $249 price tag attests, but if you have heavy-duty uses in mind, Smartcom III will do the job.

Multiple menus and excessive help screens can be annoying and inflexible, but Smartcom III's implementation of those features works. You can find your way around the system and experiment with only occasional glances at the ample (218-page) documentation.

The editor, unlike many integrated editors, is fairly painless, and, when editing script files, it offers some helpful debugging tools. Debugging the scripts of other packages can become tiresome because most errors are only discovered on-line. The Smartcom compiler, accessible from within the editor, catches many errors; and when problems do arise, you can avoid the headache of switching from one module to another or, worse, from one program to another. After Smartcom detects a compilation error, it puts you right where you need to be: back in the editor.

Hayes has included a complete programming environment with multiple conditional structures, windowing, speed optimization, and full error trapping. The language is verbose (even with a learn facility, it took 162 keystrokes to edit the automated session). But the selling point here is power. With the less expensive packages, you usually employ a generic routine and hope all unfolds as expected, but Smartcom lets you pick the right command for each application. Start the learn facility and watch Smartcom create your script in an upper window as the session churns along on the main screen. It even scrambles your password. Slick.

Smartcom blazed through our 1-megabyte benchmarks. Unlike almost every other program, Smartcom could truly handle its advertised maximum data transfer rate. Sending the file from the AT to the Compaq, Smartcom scorched along at 115,200 bps with no delays at all and broke the tape in 98 seconds. Of course, the AT can't capture that fast, but Smartcom let us know about character errors right up front. Instead of waiting for the 1-megabyte transfer to complete, only to find errors in the file, we simply aborted the process, popped down to 38,400 bps, and sent the file to the AT in a record 262 seconds.

If you need a full range of features, or if you plan an extensive programming project (such as a bulletin board system or a complex sequence of unattended sessions), the Smartcom investment pays off quickly.

Softerm PC 3.0

Although Softerm did not excel at our benchmarks, registering 954 seconds on the important 1-megabyte receive test, it did run through them with admirable ease. The configuration parameters were not only comprehensive but easy to find and modify. When a problem did occur, the excellent documentation (over 700 pages packed in two manuals) covered it. And there's lots to cover: a complete script language, learn mode, background operation, direct remote access, six popular protocols, queue scheduling, and a text editor.

For terminal emulation, Softerm breaks away from the pack. Chapter 4 of the reference manual lists 45 terminals, and each is well documented. That chapter alone runs 200 pages. In an area where most of the packages come up woefully short, Softerm deserves special accolades.

Unique resident features are also noteworthy. Softerm's Communication Agent, coupled with an unattended host mode, enables true background operations. A hot-key toggle lets you queue a script file containing the `MONITOR` command, turning control to the remote terminal while the local computer runs DOS operations or application programs. Resident menus also offer disk management and sophisticated host ac-

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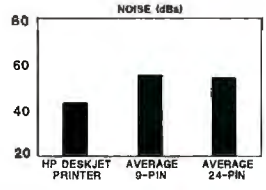

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cess. The File Agent uses configurable device specifiers, letting you access remote computers as if they were local disk drives.

Softerm's learn mode creates only macros; you've got to enter script code manually. The editor saves you some keystrokes by generating commands and by catching entry errors, but it can be inflexible. In fact, the script language itself suffers from a rigid structure. Not an open programming environment, but the kind you may appreciate at debugging time or when coding complex sessions.

The menu structure is somewhat confusing. For instance, F4 from the Softerm Functions menu, labeled File Transfer, does *not* let you transfer files; for that feature, you must call the Utility Functions menu. A better design would save keystrokes and enhance clarity.

With so many features and admirable power, Softerm deserves its place alongside the expensive communications packages. It can do the job, but it's not a program you can go to work on right out of the box. A steep learning curve, annoying rigidity, and poor performance in our benchmark tests thwart the promise of this full-featured package.

The Big Picture

Today's communications software has come a long way. Learn modes, easy macro definition, and context-sensitive help make telecomputing simpler than ever. With powerful scripting and abundant features, the best programs don't sacrifice sophistication. If you have a quick and easy session to run, complex features stay out of your way; but if you need more power, it lies in wait. By gleaning the features and checking benchmarks, you should pick a package that is most closely aligned to your application.

For instance, if you have limited hardware and perform long file transfers, background operation becomes vital. It frees your local keyboard and enhances productivity. It also limits your choices considerably: While most programs can access DOS without logging out, they lack true background. On the other hand, if you desire simultaneous transfers, a program like MaxOnline or Mirror II can do the job by accessing both COMM ports.

Our line simulator benchmarks show all packages performing XMODEM transfers equally well. Clearly, though, with 1-megabyte transfer rates ranging from over 20 minutes to less than 2 minutes, software affects throughput. And a high data transfer rate does not necessarily ensure performance; software over-

Circle 45 on Reader Service Card

head and line waits can significantly hamper transfer speed. Crosstalk XVI and Smartcom III both tout maximum data transfer rates of 115,200 bps, yet their 1-megabyte transfer times differ by as much as 13 minutes—very significant when tying up a valuable resource.

Proprietary protocols can make a difference. Carbon Copy compressed our file of 64,000 *A* characters and sent it in 12 seconds. The BLAST protocol handles noise exceptionally well. Each package emphasizes specific features, but a couple of them bring it all together.

Top of the Line

For overall performance, Smartcom III leads the field. It set the standard for 1-megabyte transfer, the most telling of our benchmarks. It includes all necessary features and throws in all those little extras that make the job easier—such as recalling filenames from the first couple of keystrokes, encrypting files and scrambling passwords for added security, and allowing simultaneous on-line sessions.

Smartcom's scripting also sets the pace. When faced with ever-changing prompts and the vagaries of on-line communications, you need a language that has full error trapping and can handle all the anomalies. You'll still run into programming limits, but, for an application language, Smartcom attains the state of the art.

Price vs. Performance

Here Procomm Plus wins our endorsement. Unobtrusive and easy to use, it still includes all major features and supports an enviable set of protocols and terminal emulations. It achieves simplicity with standard Alt-key combinations and with a comprehensive menu that's a single keystroke away. Its power comes from a surprisingly strong scripting language. And it's highly flexible—an indispensable feature for telecomputing tasks. Although it lacks the sophistication of Smartcom III or Crosstalk Mk.4, Procomm Plus does the job admirably well at a reasonable price.

Generally, we were impressed by the overall quality of all the packages tested. Once lagging behind the telecomputing revolution, communications software has filled the gap with full programming capability and creative proprietary features. Going on-line has never been easier. ■

Steve Apiki and Stan Diehl are testing editors for the BYTE Lab. They can be reached at One Phoenix Mill Lane, Peterborough, NH 03458, or on BIX as "apiki" and "sdiehl."

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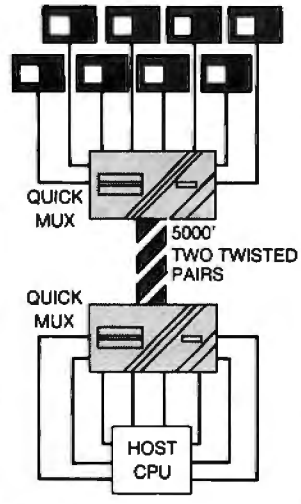

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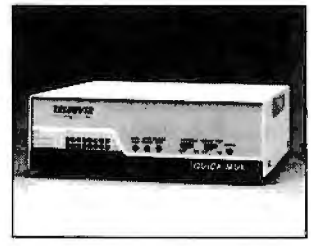

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Variations on the 20-MHz Theme

The Tatung TCS-8000, Proteus 386A, and Everex Step 386/20 take different paths to high performance

Ed McNierney

As more 80386-based computers become available, you'd think they'd be as similar as peas in a pod. But that's not the case. As computers based on the 80386 move beyond the initial 16-MHz wave to 20 MHz, design variations between different systems become more prominent. Those variations show up clearly as differences in performance.

The 20-MHz systems reviewed here—the Tatung TCS-8000, Proteus 386A, and Everex Step 386/20—follow different design philosophies. The three systems show a remarkable range of performance and operational capabilities for a set of machines that are superficially so similar. Each couples its CPU with an enhanced AT-style keyboard, a reasonable-size hard disk drive, and an EGA display subsystem. Yet on closer inspection and testing, each shows unique performance features, and the group as a whole shows a variation in performance of more than 100 percent on some of the benchmarks.

Fast Cache

The most prominent factor in an 80386-based system's performance is the memory architecture. Since the 20-MHz 80386 is an exceptionally memory-hungry processor with a instruction prefetch queue to keep filled, its demands on memory access are severe. Unfortunately, memory costs are such that the several megabytes of sub-50-nanosecond static RAM (SRAM) required to give the 80386 unimpeded memory access would make any system prohibitively expensive. But that much fast memory isn't necessary; good performance can be obtained for a fraction of the cost by using a well-designed memory system. Each of the three systems reviewed uses a different approach to memory architecture.

The Tatung TCS-8000 takes the simplest approach. The CPU accesses all the 80-ns memory through a 16-bit data path and requires no proprietary 32-bit extension bus. The resulting system runs with two wait states at all times, and you can add more memory with any conventional memory-expansion board. Unfortunately, this simple solution almost always results in a performance penalty that puts the TCS-8000 at the bottom of this three-system heap in memory-intensive operations. However, that fast RAM makes the Tatung TCS-8000 almost as fast as the Compaq Deskpro 386/20, which uses 100-ns RAM.

The Proteus 386A takes an intermediate approach with a motherboard that can support 4 megabytes of 100-ns memory with a 32-bit data path. This dynamic RAM (DRAM) is supplemented by a 64K-byte 45-ns SRAM cache. Since most applications do not require more than 4 megabytes of RAM, this system provides a reasonable performance compromise. This system also does not use a proprietary 32-bit expansion slot, so if you add more memory, it must be accessed through a 16-bit bus. The cache system caches all memory, however, not just the memory on the motherboard; as a result, the performance degradation that the 16-bit memory produces is moderated. Testing showed that this caching had little effect on the performance of the system, which ran memory-intensive operations just slightly faster than the Tatung TCS-8000.

The Everex Step 386/20's memory system is perhaps the most unusual of the

Not peas in a pod: From left to right, the Tatung TCS-8000, Proteus 386A and Everex Step 386/20 travel different paths to improved performance.

group, but it produces the best overall performance. You can install up to 8 megabytes of 120-ns DRAM on the system board, with another 8 megabytes available in a full 32-bit expansion slot. To boost the performance of this DRAM, a 64K-byte SRAM cache (expandable to 256K bytes) is also used—but with a twist.

Most PC cache systems are the write-through type. If data is in the cache, it's read from there; otherwise, it's read from main memory. But when data is written, it's always written to the cache first and then "through" the cache into main memory. As a result, the cache offers little benefit on memory writes. However, since the bulk of a CPU's work consists of reading instructions to execute, this write penalty does not seriously affect performance.

But Everex, deciding to squeeze all possible speed out of its system, has implemented a write-back cache instead. In this cache system, if a data write occurs to a memory location in the very fast 25-ns cache, that write occurs only to that memory and not to main memory. It then marks the cache location as "dirty" because its value differs from the main memory location it is caching. When that same location is read again, it is read directly from the cache until a new memory access causes that cache location to be overwritten. When new memory is moved into the cache, the current contents of the cache are checked to see if they are dirty. If so, those contents are written out to main memory before they're overwritten. Thus, a memory location that is frequently written to gets written much more quickly than in a conventional "write-through" system.

Tatung TCS-8000

The TCS-8000 as reviewed lists for $5288, not including a math coprocessor. The system supports a 10-MHz 80287 or 80387 coprocessor, neither of which Tatung supplies; the review system was equipped with a 10-MHz 80287. You can't vary the coprocessor speed, but you can switch the system CPU speed between 20 MHz and 8 MHz from the keyboard using the Ctrl-Alt-Minus keys. The system always powers up in the slower 8-MHz speed. If you really get into trouble, a convenient hardware reset switch is provided on the front panel of the system unit.

The motherboard of the review unit held 2 megabytes of 80-ns RAM on SIMM (single in-line memory module) chips, with sockets for up to 4 megabytes. You can add more memory with an AT-style memory card. There are eight slots: two 8-bit and six 16-bit. The serial/parallel card and the EGA card take up both 8-bit slots, and the floppy/hard disk drive controller takes one 16-bit slot, leaving five 16-bit slots free.

The review unit had one 1.2-megabyte 5¼-inch floppy disk drive and one full-height hard disk drive. There is room for two other half-height devices. The MiniScribe 6053 40-megabyte hard disk drive performed well and reliably, but it fell behind the performance expected of a drive in this class. According to the Coretest, it had a data transfer rate of 169.9K bytes per second, an average seek rate of 33.7 milliseconds, and a track-to-track rate of 5.7 ms. As a result, all the Tatung's disk-based benchmark results were the poorest of the three machines.

Although a disk support software package was included with the system, it did not include a disk-cache utility, as the other two systems did. Disk-cache utilities are becoming standard equipment on 80386 machines, and one could improve the Tatung TCS-8000's general performance.

The display adapter is an ATI EGA-compatible short card with additional support for Hercules graphics modes and several enhanced EGA modes, including 800 by 560, 640 by 480, and 752 by 410 pixels. Tatung supplied its own EGA CM-1480 monitor, which features an additional monochrome mode: When the monitor is operating in text mode, a switch can change the normal white-on-black display to amber on black, green on black, or bright white on blue.

The Tatung system suffers from a poor keyboard. Although the feel of the keys is similar to that of many of the softer keyboards, the lack of a firm touch is overshadowed by the poor layout. The layout resembles the new IBM Enhanced 101-key layout at first glance, but there are

continued

Everex Step 386/20, Proteus 386A, Tatung TCS-8000

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	Everex 386/20	Proteus 386A	Tatung TCS-8000
XyWrite III+ 3.52	Med/Lrg	Med/Lrg	Med/Lrg
Load (large)	:14	:13	:13
Word count	:02/:16	:02/:17	:03/:22
Search/replace	:04/:20	:05/:22	:05/:23
End of document	:02/:13	:01/:13	:02/:14
Block moves	:10/:10	:10/:10	:11/:11
Spelling check	:07/:47	:07/:50	:09/1:02
Microsoft Word 4.0			
Forward delete	:11	:11	:14
Aldus PageMaker 1.0a			
Load document	:11	:05	:16
Change/Bold	:21	:23	:28
Align right	:16	:20	:21
Cut 10 pages	:16	:17	:19
Place graphic	:04	:05	:05
Print to file	1:40	1:44	2:02
Index:	**3.06**	**2.73**	**2.31**

SPREADSHEET	Everex 386/20	Proteus 386A	Tatung TCS-8000
Lotus 1-2-3 2.01			
Block copy	:02	:03	:03
Recalc	:01	:01	:01
Load Monte Carlo	:15	:16	:16
Recalc Monte Carlo	:04	:03	:03
Load rlarge3	:04	:04	:04
Recalc rlarge3	:01	:01	:01
Recalc Goal-seek	:03	:03	:03
Microsoft Excel 2.0			
Fill right	:04	:04	:05
Undo fill	1:26	1:28	2:01
Recalc	:01	:01	:01
Load rlarge3	:20	:22	:26
Recalc rlarge3	:01	:01	:01
Index:	**3.37**	**3.20**	**2.98**

DATABASE	Everex 386/20	Proteus 386A	Tatung TCS-8000
dBASE III+ 1.1			
Copy	:51	:50	1:42
Index	:19	:19	:23
List	1:52	2:56	3:44
Append	1:40	1:35	2:03
Delete	:02	:02	:03
Pack	1:19	1:36	2:30
Count	:17	:16	:19
Sort	1:16	1:15	1:23
Index:	**1.55**	**1.45**	**1.06**

SCIENTIFIC/ENGINEERING	Everex 386/20	Proteus 386A	Tatung TCS-8000
AutoCAD 2.52			
Load SoftWest	:38	:57	2:01
Regen SoftWest	:26	:45	:47
Load StPauls	:10	:19	:15
Regen StPauls	:05	:09	:09
Hide/redraw	8:48	14:37	15:22
STATA 1.5			
Graphics	1:27	1:17	2:17
ANOVA	:14	:23	:28
MathCAD 2.0			
IFS 800 pts.	:12	:22	:23
FFT/IFFT 1024 pts.	:13	:26	:25
Index:	**3.68**	**2.26**	**1.94**

COMPILERS	Everex 386/20	Proteus 386A	Tatung TCS-8000
Microsoft C 5.0			
XLisp compile	3:33	4:20	4:51
Turbo Pascal			
Pascal S compile	:04	:05	:06
Index:	**2.75**	**2.22**	**1.92**

All times are in minutes:seconds. Indexes show relative performance; for all indexes, an 8-MHz IBM PC=1.

LOW-LEVEL PERFORMANCE[1]

CPU	Everex 386/20	Proteus 386A	Tatung TCS-8000
Matrix	3.04	3.19	3.54
String Move			
Byte-wide	20.05	31.25	29.42
Word-wide			
Odd-bnd.	25.05	25.29	29.59
Even-bnd.	10.00	15.65	14.74
Sieve	19.10	20.00	22.50
Sort	14.29	21.48	25.00
Index:	**4.07**	**3.22**	**3.01**

FLOATING POINT[2]	Everex 386/20	Proteus 386A	Tatung TCS-8000
Math	7.18	32.52	27.99
Error[3]	0.00E+00	0.00E+00	0.00E+00
Sine(x)	3.30	14.37	11.17
Error	2.00E−09	2.00E−09	2.00E−09
e^x	3.19	12.10	9.76
Error	1.00E−09	1.00E−09	1.00E−09
Index:	**5.96**	**1.42**	**1.74**

DISK I/O	Everex 386/20	Proteus 386A	Tatung TCS-8000
Hard Seek[4]			
Outer track	3.33	3.28	3.31
Inner track	3.31	3.33	3.30
Half platter	10.00	6.64	13.29
Full platter	12.56	8.35	16.64
Average	7.30	5.40	9.13
DOS Seek			
1-sector	11.97	8.25	18.47
32-sector	41.90	41.82	64.30
File I/O[5]			
Seek	0.11	0.13	0.11
Read	1.09	1.16	0.98
Write	1.01	1.14	1.14
1-megabyte			
Write	6.89	7.33	8.55
Read	7.03	7.66	8.22
Index:	**1.41**	**1.44**	**1.17**

VIDEO	Everex 386/20	Proteus 386A	Tatung TCS-8000
Text			
Mode 0	9.12	16.53	22.02
Mode 1	9.09	16.51	22.01
Mode 2	8.59	16.55	21.68
Mode 3	8.57	16.55	21.68
Mode 7	N/A	16.87	N/A
Test average	8.84	16.60	21.85
Graphics			
CGA:			
Mode 4	1.70	1.56	2.00
Mode 5	1.65	1.54	2.01
Mode 6	1.67	1.65	2.01
EGA:			
Mode 13	3.48	3.35	3.98
Mode 14	3.59	3.65	4.27
Mode 16	3.70	3.70	4.12
Graphics average	2.63	2.57	3.06
Index:	**1.59**	**1.17**	**0.94**

N/A = Not applicable; mode not supported by graphics adapter.

[1] All times are in seconds. All figures were generated using the 8088/8086 version (1.1) of Small-C (16-bit integers). Figures for 80386 machines do not use 80386-specific instructions.

[2] The floating-point benchmarks use 8087-compatible instructions only.

[3] The errors for the floating-point benchmarks indicate the difference between expected and actual values, correct to 10 digits or rounded to 2 digits.

[4] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100).

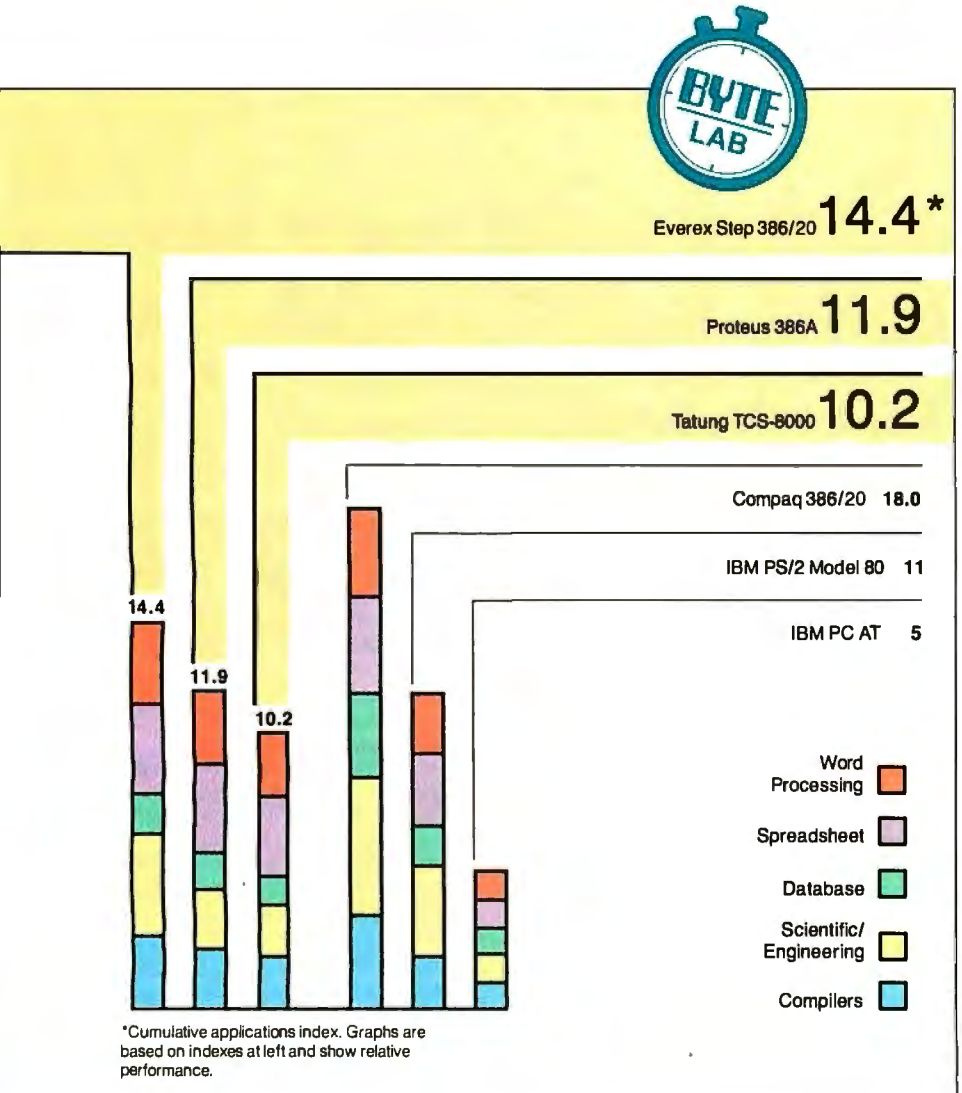
[5] Read and write times for the File I/O benchmarks are in seconds per 64 Kbytes.

[6] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.

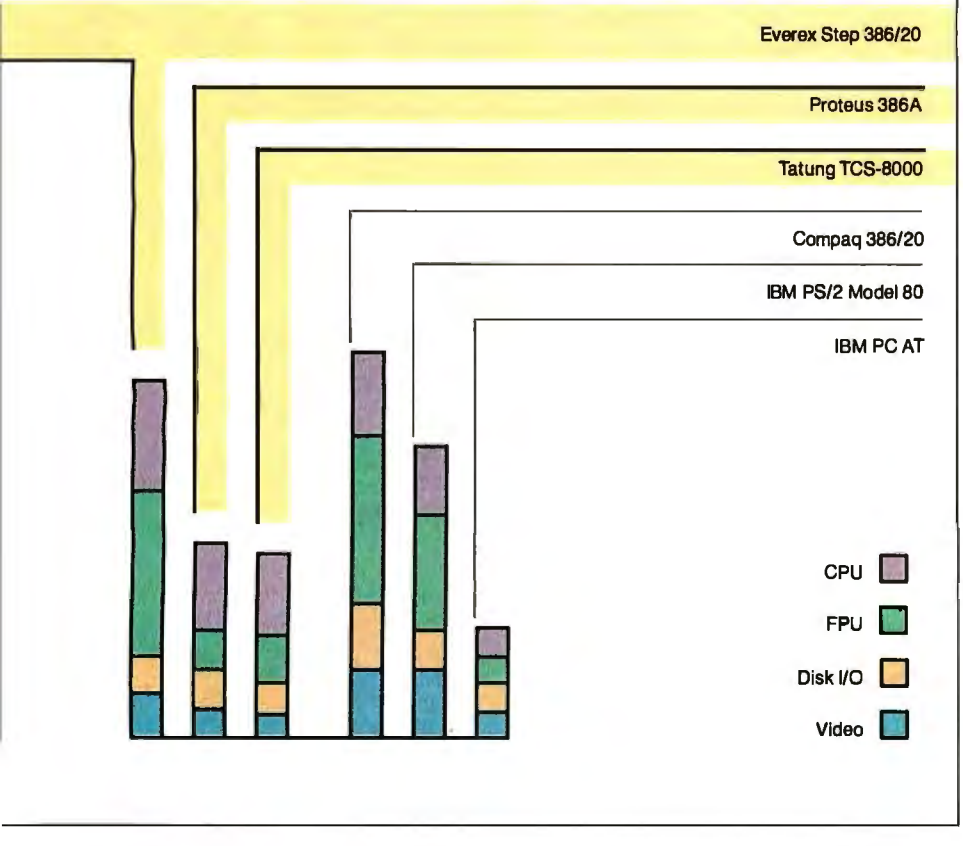
CONVENTIONAL BENCHMARKS

	Everex 386/20	Proteus 386A	Tatung TCS-8000
LINPACK	172.03	623.40	507.90
Livermore Loops[6] (MFLOPS)	0.17	0.04	0.05
Dhrystone (MS C 5.0) (Dhry/sec)	6793	5945	5291

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE.



*Cumulative applications index. Graphs are based on indexes at left and show relative performance.



some variations in key positions.

The system's documentation includes four binders of material, two of which are supplied by Microsoft for the Tatung version of MS-DOS 3.21 and for GW-BASIC. The other two manuals are the Tatung user's guide and technical reference; these two suffer severely from confused English, spelling and grammatical mistakes, and poor organization and indexing. Information is scrambled throughout the manuals, and not much effort was spent keeping complex and technical information separate from the standard user information required to set up and operate the system.

A poor set of documentation makes it difficult to take a computer system seriously. The cost of writing documentation is small compared to developing and distributing an 80386-based computer system, yet better documentation would produce a big benefit for both the manufacturer and the user.

The TCS-8000 has a 1-year parts and labor warranty; service is provided by Tatung.

In general, while the Tatung system did not fail or break down, it didn't have any outstanding features. Its quirky keyboard and generally ordinary performance put it near the bottom of the list when compared to the other systems available. A new manual, better support software, and a new keyboard could make the system a reasonable, if unremarkable, 20-MHz 80386 choice.

Proteus 386A

The Proteus approach to personal computers is to be a hardware supermarket. Its catalogs include a wide variety of hardware options, and you order them in whatever combination you want. Proteus offers support and service with a 15-month on-site warranty with each of its systems. For users who don't have the courage or the time to take the cover off their system units every time something goes wrong, a comprehensive support system like Proteus's can be very welcome.

The Proteus 20-MHz 80386 system comes with a socket for an optional 80287 math coprocessor. The keyboard controls the system's operating speed and cache memory controller. The Ctrl-Alt-Plus and -Minus keys switch the operating speed between 20 MHz and 6 MHz, and the Ctrl-Alt-Left-Shift-Plus and -Minus keys enable or disable the SRAM cache memory when the system is running at 20 MHz. The cache is always disabled at 6 MHz, because at that speed

continued

	Tatung TCS-8000	Proteus 386A	Everex Step 286/20
Company	Tatung Co. of America, Inc. 2850 El Presidio St. Long Beach, CA 90810 (213) 979-7055	Proteus Technology Corp. 377 Route 17 Airport 17 Center Hasbrouck Heights, NJ 07604 (201) 288-8629	Everex Computer Systems Division 48431 Milmont Dr. Fremont, CA 94538 (800) 356-4283
Components	**Processor:** 80386 running at 20 MHz, switchable to 8 MHz; socket for optional 10-MHz 80287 or 80387 math coprocessor **Memory:** 1 megabyte of 16-bit two-wait-state DRAM standard on motherboard, expandable to 16 megabytes **Mass storage:** 1.2-megabyte 5¼-inch floppy disk drive; optional 40-megabyte 5¼-inch hard disk drive **Display:** Optional Enhanced EGA card with Hercules emulation; optional Tatung CM-1480 EGA monitor **Keyboard:** 101-key Modified Enhanced keyboard **I/O interfaces:** One DB-25 parallel port; one DB-9 serial port; six 16-bit and two 8-bit expansion slots **Other:** Phoenix Technologies BIOS with ROM-based Setup utility; hardware reset switch	**Processor:** 80386 running at 20 MHz, switchable to 6 MHz; socket for optional 10-MHz 80287 math coprocessor **Memory:** 4 megabytes of 32-bit zero-wait-state DRAM on motherboard, expandable to 16 megabytes; 64K bytes of 45-ns SRAM cache memory **Mass storage:** 1.2-megabyte 5¼-inch floppy disk drive; optional 720K-byte 3½-inch floppy disk drive; optional 320-megabyte 5¼-inch hard disk drive **Display:** Optional Everex EVGA enhanced EGA with Hercules emulation and high-resolution EGA display modes; optional NEC MultiSync II display monitor **Keyboard:** 101-key Modified Enhanced keyboard **I/O interfaces:** One DB-9 and one DB-25 serial port; one DB-25 parallel port; six 16-bit and two 8-bit expansion slots **Other:** American Megatrends BIOS with ROM-based Setup utility; hardware reset switch	**Processor:** 80386 running at 20 MHz, switchable to 10 or 7 MHz; optional 20-MHz 80387 math coprocessor **Memory:** 2 megabytes of 32-bit zero-wait-state DRAM on motherboard, expandable to 16 megabytes; 128K-byte 25-ns SRAM cache memory, expandable to 256K bytes **Mass storage:** 1.2-megabyte 5¼-inch floppy disk drive; optional 80-megabyte hard disk drive **Display:** Optional Everex EGA card; optional Everex EGA monitor **Keyboard:** 101-key Modified Enhanced keyboard **I/O interfaces:** 1-to-1 interleave floppy/hard disk drive controller; one DB-9 serial port; one DB-25 parallel port; six 16-bit, one 8-bit, and one dual 32-bit or 8-bit expansion slot **Other:** Front-panel LED status display; hardware reset switch; speaker disable switch; Everex Enhanced American Megatrends BIOS with ROM-based Setup utility
Size	6¾ × 22½ × 18⅓ inches; 59½ pounds	6¾ × 21⅓ × 17⅓ inches; 54 pounds	7 × 22 × 17½ inches; 58 pounds
Software	MS-DOS 3.21; GWBASIC 3.2; Tatung display drivers; MiniScribe disk management and diagnostic software	MS-DOS 3.30; GWBASIC 3.3; Everex EVGA utilities; SpeedStor disk caching and utility software	MS-DOS 3.3; GWBASIC 3.3; Everex Magic I/O support software; Everex EGA display adapter support software
Options	Monochrome display adapter: $99 Hercules/EGA card: $189 VGA card: $595	720K-byte 3½-inch floppy disk drive: $98 20-megabyte to 320-megabyte hard disk drives: $261 to $2895 Everex EGA card: $139 Everex EVGA card: $269 14-inch monochrome monitor: $129 EGA monitor: $375 NEC MultiSync II monitor: $675	80387-20 coprocessor: $1495 Weitek 1167 math coprocessor board: $1995 40-megabyte hard disk drive: $550 80-megabyte hard disk drive: $795 Everex EGA card: $169 Everex EGA monitor: $399
Documentation	Tatung TCS-8000 User's Manual; Tatung TCS-8000 Technical Manual; MS-DOS User's Guide; GWBASIC Manual	MS-DOS User's Guide; GWBASIC Manual; Everex Magic I/O Adapter reference; Everex EVGA Display Adapter reference; SpeedStor disk utility software reference; Proteus User's Guide	Everex System 386 User's Guide; NEC Everex Magic I/O operating manual
Price	Standard system with 1 megabyte of RAM, 1.2-megabyte 5¼-inch floppy disk drive, and floppy/hard disk drive controller: $3500 System as reviewed: $5288	Standard system with 1 megabyte of RAM, 64K-byte cache, floppy/hard disk drive controller, and 1.2-megabyte 5¼-inch floppy disk drive: $3190 System as reviewed: $8522	Standard system with 1 megabyte of RAM, 64K-byte RAM cache, floppy/hard disk drive controller, and 1.2-megabyte floppy disk drive: $4399 System as reviewed: $6437
	Inquiry 883.	**Inquiry 884.**	**Inquiry 885.**

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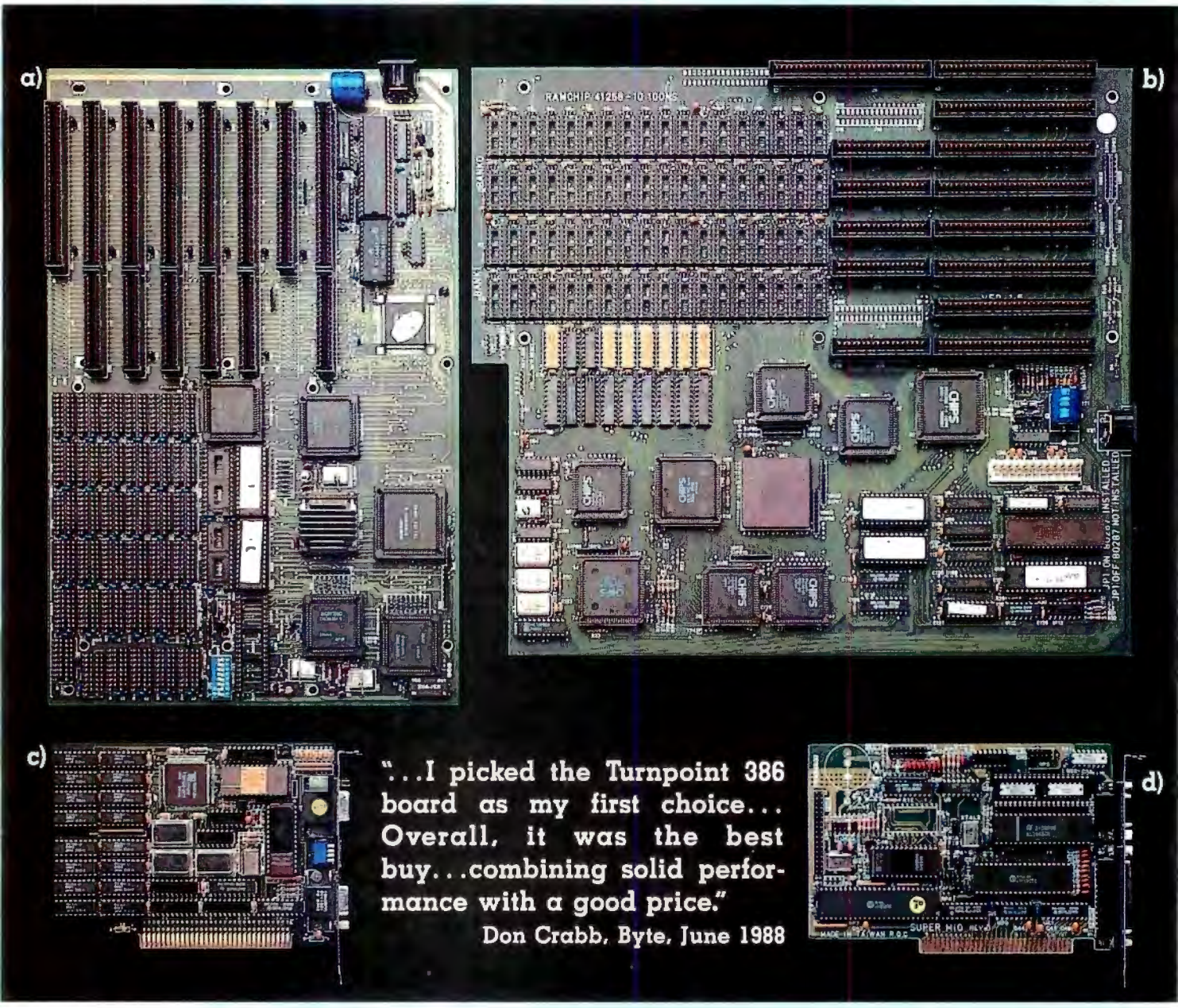

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TRADEMARKS and REGISTERED TRADEMARKS: IBM - International Business Machines

the standard DRAM is fast enough to keep up with the processor at all times. The front panel features a hardware reset switch for desperate moments. The system Setup program is in ROM and can be accessed during boot-up.

In the review system, the Proteus motherboard came with 4 megabytes of 100-ns DRAM for the main memory and 64K bytes of 45-ns SRAM for the cache memory, both in DIP chips installed in sockets. Additional system memory requires an AT-style expansion card. The motherboard has eight slots: six 16-bit and two 8-bit. The EGA/VGA and parallel/serial cards take both 8-bit slots, and the floppy/hard disk drive controller card takes a 16-bit slot. This leaves five 16-bit slots free. As configured, the review system lists for $8522.

The computer has space for five half-height disk drives. The review unit included a standard 1.2-megabyte 5¼-inch floppy disk drive and an optional 720K-byte 3½-inch floppy disk drive. The hard disk drive was a full-height Maxtor XT-4380E 320-megabyte ESDI (enhanced small device interface) drive. The Coretest rated this drive as having a data transfer rate of 212.5K bytes per second, an average seek rate of 13 ms, and a track-to-track rate of 3.7 ms.

Although the Proteus 386A uses a hardware cache memory system, its performance on memory-intensive benchmarks is not appreciably different from the Tatung system, which does not have a cache. Disk-intensive tests, however, show excellent performance due to the high-performance ESDI hard disk drive. This disk comes with SpeedStor disk management and caching software, which allows the entire disk to be split up into only three DOS partitions, two of which are larger than 32 megabytes.

With the SpeedStor software cache installed in extended memory, the disk benchmark times dropped dramatically, some running as much as 25 times faster; but even without the cache, the disk's 13-ms average access time greatly boosted system performance. For someone investing in a 20-MHz 80386 system, a high-speed hard disk drive is an essential, and the disk drives that Proteus supplies are more than worth the money.

The Proteus 386A uses an Everex EVGA card that can generate either TTL (EGA-style) or analog (VGA-style) output signals and is an extremely flexible display device. In addition to the standard device drivers, the EVGA software utilities include a wide selection of installable font files that replace the EGA's standard fonts with either more attractive, more decorative, or more compact fonts, including one suitable for 132-column text displays. The card comes with device drivers to support a variety of high-resolution display modes for AutoCAD and Microsoft Windows. Proteus supplied a very nice NEC MultiSync II monitor with the review unit.

The Proteus User's Guide comes in a small three-ring binder and is well organized and easy to read. It includes a "New Users" section for beginners and a "For Advanced Users" section for more experienced owners.

The Proteus keyboard is another "clone keyboard." Its layout resembles the IBM Enhanced keyboard, except that the Backspace and backslash/vertical bar keys assume their older AT positions. The keyboard offers no tactile feedback at all, and the keys offer so little resistance to pressure that it's a wonder they spring back again. A better keyboard design would help this system a lot.

If it's used with a replacement keyboard or as a file server on which the keyboard gets little use, the Proteus 386A is a reasonable performer with a solid backing of warranty support and repair service. It is worthy of serious consideration in disk-intensive operations, provided you can tolerate the minor annoyances in the system.

Everex Step 386/20

In several respects, the Everex Step 386/20 is the outstanding member of this group of machines. Its appearance sets it apart right from the start, with a flashy front-panel LED text display, speed and control switches, and a collection of indicator LEDs all protected by a sliding transparent cover. The text display tracks the progress of the system's power-on self-test and boot procedure, and from then on it continuously displays the disk drive, cylinder, and head most recently accessed by the disk drive controller system.

The front panel provides three control switches for selecting the system's operating speed at power-up, turning the system speaker on or off, or causing a hardware reset to occur. The system can operate at either 20, 10, or 7 MHz, and the Ctrl-Alt-Plus and -Minus key combinations allow you to speed up or slow down the processor. The system includes an optional 20-MHz 80387 math coprocessor whose speed matches the CPU and which is synchronized with it at all times.

The review system has a list price of $6362; it came equipped with 2 mega-

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bytes of 120-ns DRAM on SIMMs and 64K bytes of 25-ns SRAM in socketed DIP chips for the cache memory. You can add additional memory via a proprietary 32-bit expansion slot; up to 16 megabytes of memory can be added at exactly the same performance level as the original system-board RAM. The motherboard has eight slots—six 16-bit and two 8-bit. The floppy/hard disk drive controller uses a 16-bit slot, and the Everex EGA and parallel/serial cards both use 8-bit slots. One 8-bit slot shares space with the 32-bit memory-expansion connector.

The system uses a very fast SRAM cache, and the resulting performance shows a noticeable improvement over the other two systems (which were quite close to each other in system speed). The benchmark results show clearly superior performance across the board. The Everex memory system definitely makes a difference.

The Step 386/20 has room for five half-height devices. Data storage in the review system consisted of a standard 1.2-megabyte 5¼-inch floppy disk drive and a Toshiba MK-56FB 72-megabyte hard disk drive with an RLL (run-length-limited) controller. The Coretest indicated that the Toshiba drive had a data transfer rate of 490K bytes per second, an average seek time of 27.5 ms, and a track-to-track time of 5.6 ms.

Video display was handled by an Everex EV-659 EGA/parallel card. I used an NEC MultiSync II monitor with the review system.

The system came with a number of utilities, but without an operating system; I used the MS-DOS 3.3 shipped with the Proteus system. The company says that it is now shipping DOS 3.3 with the system. The utility software includes test and diagnostic programs and a RAM disk and disk-cache utility. The system Setup program is in ROM and is accessed during boot-up.

The keyboard itself appears to be identical to the one used by Proteus, with the same soft feel and poor tactile feedback.

The Everex Step 386/20 comes with a 1-year on-site warranty for parts and labor. Service is handled by National Computer Service and covers the U.S. and Canada.

The manual for the system was available only in a prerelease photocopy form, but it was a well-organized document. A printed version is now available. The manual contains little extraneous material and gets to the point clearly and quickly. Additional documentation supplied for the monitor (from NEC) and the I/O adapter card was also up to the same standard.

On the Bench

I tested all three computers with a variety of software: Microsoft Windows 1.03, SideKick 1.56, Turbo C 1.0, Quick C 1.0, and BRIEF 2.0. For hardware tests, I used my Everex Evercom 1200-bit-per-second modem and the Microsoft Bus Mouse. Everything worked fine with each computer.

The Small-C and Application benchmarks tell the whole story. The Everex Step 386/20 took the honors in the CPU test. This speed difference can be attributed to the SRAM cache combined with the fast 100-ns main memory. The Proteus 386A put in a good second-place performance, with the Tatung TCS-8000 showing a respectable third.

The FPU tests went hands down to the Everex Step 386/20—not surprisingly, since it was equipped with a 20-MHz 80387 while the other machines were running 10-MHz 80287 coprocessors. The File I/O test went to the Proteus 386A. It was running a 320-megabyte Maxtor with a very fast (13-ms) access time. The Video test gives the relative speed of the video cards; in this case, the Everex Step 386/20 (running—what else—an Everex card) was the leader.

The Application tests ranked the three in this order: Everex Step 386/20, Proteus 386A, and Tatung TCS-8000. The Everex Step 386/20 pulled ahead with the combination of its SRAM cache, fast math coprocessor, and efficient hard disk drive. The Proteus 386A placed a close second, with the Tatung TCS-8000 trailing the pack.

Everex Step 386/20 Pulls Ahead

If you're comparing machines by price, the Proteus 386A and Tatung TCS-8000 offer good value. The Proteus 386A has the advantage of a superior warranty, and you can order the computer with the options you want. But if you're betting on a performance and value horse race, the Everex Step 386/20 wins by several lengths. It features good performance and a convenient front panel, and it is manufactured and supported in the U.S. As these early entries into this high-speed market show, a careful selection of well-coordinated components can produce a true high-speed powerhouse system. ■

Ed McNierney is a principal engineer at Lotus Development Corp. and lives in Groton, Massachusetts. He can be reached on BIX as "mced."

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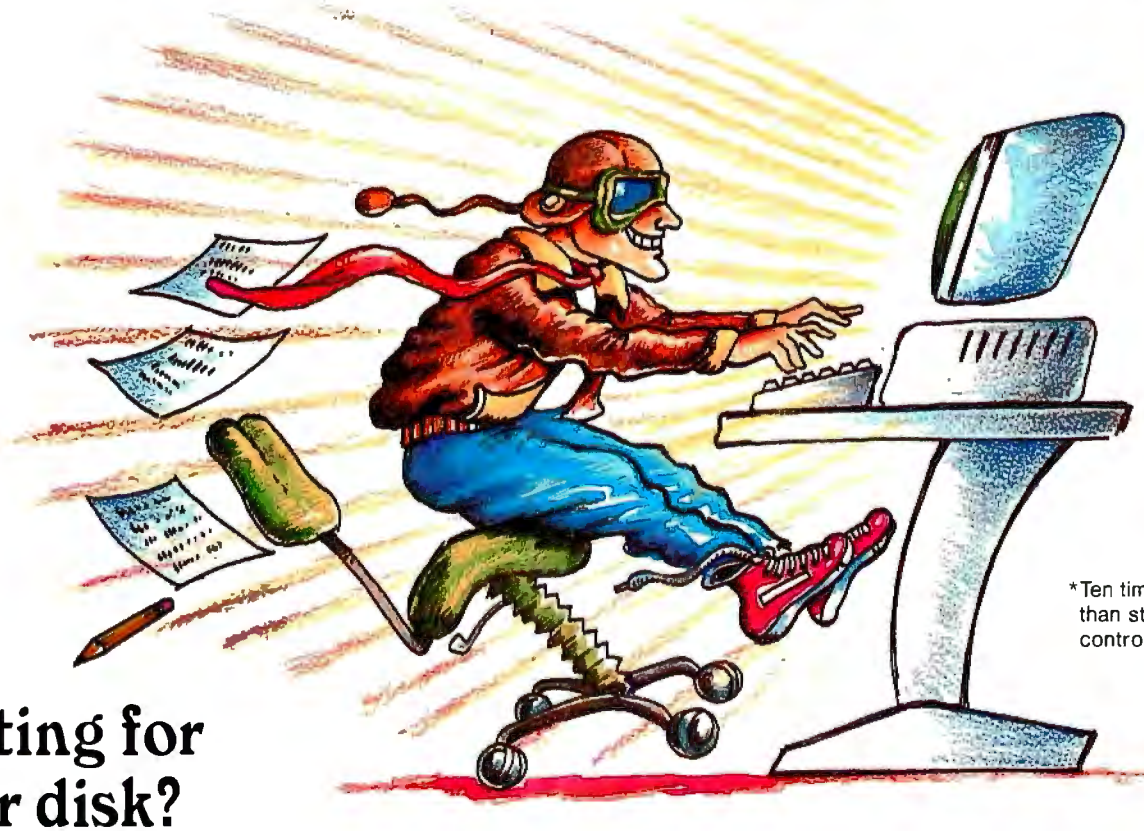

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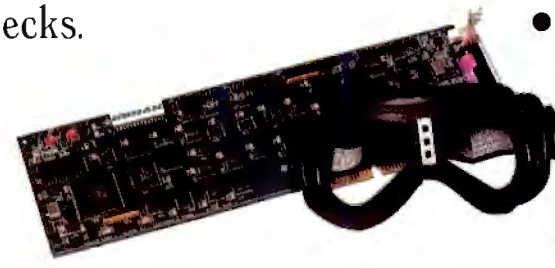

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Four Surrogate Mice

Trackballs and trackwheels are becoming common for manipulating text and data

Jeff Holtzman

Clockwise from top left: the MicroSpeed PC Trac, MicroSpeed FastTRAP, Fulcrum Trackball Plus, and Lightgate Felix.

Intrigued by graphic interfaces but hate mice? Then you might try one of the following four pointing devices to get the functionality of a mouse without the hassle. PC-Trac, FastTRAP, and Trackball Plus utilize optomechanical trackball technology; the fourth, Felix, employs a new optical data-tablet technology. I tested serial versions of these four devices on IBM and compatible equipment; PC-Trac and FastTRAP also come in bus versions, and a Macintosh version of Felix is available.

Generally speaking, mice have some advantages over trackballs, including smaller size and, often, better bundled software. Trackballs, however, are usually easier to control, so you may like them better than mice for more detailed operations. If you're used to a mouse, it may take a while for you to get used to a trackball. But after overcoming your initial resistance, chances are you'll enjoy using it.

MicroSpeed, the company that got its start in the DOS world with a clock-speed-enhancement accelerator, designed and manufactures both PC-Trac and FastTRAP (which stands for fast triaxis pointer). These two devices are similar internally and externally—and they even use the same CMOS microcontroller. PC-Trac combines an optomechanical trackball with three buttons; to that configuration, FastTRAP adds an additional vertically oriented wheel, called a trackwheel, that also drives an optomechanical system. PC-Trac and FastTRAP sell for $119 to $169, depending on the version you choose.

The Fulcrum Trackball Plus, put out by Fulcrum Computer Products, is the Volkswagen of trackballs for personal computers. It combines low price ($95) with many mouse and digitizing pad emulations, and less-than-perfect support for text modes. Budget-conscious buyers and those who require multiple emulations will find this a satisfactory, if uninspiring, product.

Cats hate mice, and Lightgate's electronic Felix is supposed to be a mouse killer. The documentation is full of near-religious fervor about Felix's merits. Hype aside, it turns out that Felix works acceptably for navigating text and graphics screens. Its software is a little rough, however: Depending on the application you're running, you must load various RAM-hungry drivers via a large batch file. And the documentation does little to help you figure out how to streamline the process of loading the drivers. But you will like the fact that Felix comes with a special Lotus 1-2-3 driver that makes it practical to use a pointing device with that program.

PC-Trac and FastTRAP

The serial version of PC-Trac is available for $119, the bus version for $139. Fast-

continued

Name	PC-Trac	FastTRAP	Trackball Plus	Felix
Type	Trackball	Tri-axis pointer	Trackball	Pointing device
Company	MicroSpeed, Inc. 5307 Randall Place Fremont, CA 94538 (415) 490-1403	MicroSpeed, Inc. 5307 Randall Place Fremont, CA 94538 (415) 490-1403	Fulcrum Computer Products 459 Allan Court Healdsburg, CA 95448 (707) 433-0202	Lightgate 6202 Christie Ave. Emeryville, CA 94608 (415) 596-2350
Features	Microsoft Mouse emulation in hardware, three buttons, ballistic-gain-control software, 200-dot-per-inch resolution; 10K bytes of memory used	Microsoft Mouse emulation in hardware, 2- and 3-axis operation, three buttons, ballistic-gain-control software, 200-dpi resolution; 10K bytes of memory used	10 mouse and digitizing tablet emulations, six buttons, power pack, 100-dpi resolution; 8K bytes of memory used	Two emulations, one button, 1-to-1 pointer-to-screen mapping, 1-2-3 and AutoCAD support, power pack, 320-dpi resolution; 40K bytes of memory used
Size	7½ × 4¼ × 2½ inches; 12 ounces; 6-foot cord	7½ × 4¼ × 2½ inches; 12 ounces; 6-foot cord	4½ × 5¾ × 1¾ inches; 4½ ounces; 4-foot cord	6 × 6 × 1 inches; 12 ounces; 7-foot cord
Hardware Needed	IBM PC, XT, AT, PS/2, or compatible with one floppy disk drive	IBM PC, XT, AT, PS/2, or compatible with one floppy disk drive	IBM PC, XT, AT, PS/2, or compatible with one floppy disk drive and a serial port	IBM PC, XT, AT, PS/2, or compatible with one floppy disk drive
Software Needed	MS-DOS 2.0 or higher	MS-DOS 2.0 or higher	MS-DOS 2.0 or higher	MS-DOS 3.1 or higher
Documentation	PC-Trac User's Guide; KeyMap User's Guide; "50 Things to Do with a Used Mouse"	FastTRAP User's Guide; KeyMap User's Guide; "50 Things to Do with a Used Mouse"	3-page installation instructions; 30-page technical manual	15-page installation guide; 17-page Lotus 1-2-3 guide
Price	Serial version: $119 Bus version: $139	Serial version: $149 Bus version: $169	$95	IBM version: $199 Macintosh version: $149
	Inquiry 889.	**Inquiry 890.**	**Inquiry 891.**	**Inquiry 892.**

Note: The Macintosh version of Felix does not include Hot Spots. Versions for the Mac II and SE were due in July.

TRAP costs $149 for the serial version; the bus version is $169. Both devices use the same case, which is about 2½ inches high at the highest point. The feel of the trackball in both PC-Trac and FastTRAP is smooth and solid. I wish, though, that the FastTRAP trackwheel had more resistance and its switches required less pressure; these alterations would give it a more consistent overall tactile sense.

Because of their overall similarity, I'll discuss the two devices as one, distinguishing between them only when necessary.

When you rotate the trackball, in either the text or graphics mode, the position of a special on-screen cursor varies accordingly. When the cursor moves to a menu title bar or icon, you press a button to make the functions represented by that menu or icon available for use. Further trackball movement lets you traverse the list of menu items; pushing a button then executes the currently selected function.

Text-mode programs seldom include drivers for pointing devices, so many pointer vendors include programs that enable their devices to at least emulate cursor-key motion. MicroSpeed, for example, includes a utility called `KEYMAP.COM` that allows trackball motion to send the cursor up, down, left, and right. This utility also lets you program each of the device's three push buttons to deliver a single keystroke. Each button can also be used alone or in combination with the Shift, Alt, or Control keys, giving you a total of 12 programmable button combinations to provide functions such as traversing the menu system of your spreadsheet. However, there aren't enough button combinations to map every function of your word processor or spreadsheet. `KEYMAP.COM` would be much more useful if you could program multiple keystrokes for each button-key combination.

An editor also lets you define as many as 32 named sets of programmed key substitutions, which are maintained in `KEYMAP.COM`. To define more than 32 templates, you can create and save programs under different names, such as `KEYMAP1.COM`, `KEYMAP2.COM`, and so forth. MicroSpeed supplies key sets for WordStar, Lotus 1-2-3, Turbo Pascal, and several others.

You can operate both PC-Trac and FastTRAP either in a Microsoft Mouse–

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emulation mode or in native mode. With native mode, you can utilize FastTRAP's tri-axis capabilities. Microsoft mode is the default, but you can alter a DIP-switch setting to force booting in native mode. In Microsoft mode, you can program the middle button to emulate simultaneous depression of the two outer buttons.

Both devices provide an emulated drag mode. Without this feature, you might find it hard to drag a trackball, pressing the button with one finger while you rotate the ball with others. For example, to choose a block of numbers for formatting in Excel, you position the cursor at one corner of the desired range, initiate drag mode by pressing the middle button, move the trackball to select the desired spreadsheet cells, and terminate drag mode by pressing the middle button again.

The trackball is handy for navigating even a standard text-mode spreadsheet, such as VP-Planner. You can move by row or column much faster with the trackball than even by holding a cursor key down. And with FastTRAP, you can use the trackwheel to page up, down, left, or right, very quickly.

If you use WordStar 4.0, the trackball cursor movement is somewhat jerky. You will have better luck with other editors, such as the one in Turbo Pascal that allows the cursor to roam freely about the screen.

You can use FastTRAP's trackwheel in several ways. You can traverse menus without moving the cursor from the current position, traverse the third (z) axis in a CAD program, or, in conjunction with a utility supplied by MicroSpeed, page up and down in a spreadsheet or word processor.

Even if you're not doing three-dimensional CAD work, the trackwheel can come in handy. In AutoCAD, for example, to get at the command menus, normally you must move the drawing cursor (cross hairs) from wherever you are to the far right edge of the screen, make your selections, and then move the cross hairs again to wherever you need the cursor. With FastTRAP, simply rotating the trackwheel activates the menu; you can traverse it by using more rotation, selecting items as usual with the left button. When you move the trackball again, you pick up where you left off with the cross hairs. You must load a separate driver, however, to use AutoCAD and Windows in this mode.

Software Drivers

You can install either device easily since they both emulate the Microsoft Mouse in hardware. If you have a Microsoft or compatible mouse, you just unplug the mouse and plug in FastTRAP or PC-Trac; the existing mouse driver will allow you to use it just as you would your mouse.

For best performance, you should take advantage of MicroSpeed's software drivers. You can load the drivers via `CONFIG.SYS` using `MAP.SYS`, or via `AUTOEXEC.BAT` using `MAP.COM`. With either driver, you can specify which serial port the device is connected to, among other parameters.

Driver versions 2.0 and higher allow ballistic gain control, a feature that provides dynamic speed and distance management. For example, when you rotate the trackball slowly, the pointer traverses only half the screen. But if you rotate the ball quickly over the same distance, the pointer traverses the whole screen.

FastTRAP's documentation consists of a well-written, well-organized 40-page manual that contains both an index and a table of contents. Beginners will find the information presented clearly and logically; advanced users will not find it insulting. Approximately half the book contains technical information on how FastTRAP works, software protocols and functions, and even a wiring diagram for 9-pin and 25-pin serial ports. (Microsoft charges $25 for this type of optional technical information.) A separate manual discusses how to use `KEYMAP.COM`.

Documentation for PC-Trac was not complete when I wrote this review. The review device came with the FastTRAP manual and semifinal PC-Trac–specific documentation. MultiSpeed says the finished version will be shipping by the time you read this review, and it will not include the FastTRAP manual.

A booklet of cartoons called "50 Things to Do with a Used Mouse" is sent free to PC-Trac and FastTRAP owners when they send in their warranty registration card.

Trackball Plus

Although Trackball Plus is about the same height as the MicroSpeed devices, it has only about half the footprint. The device has a grand total of six push buttons, only some of which are available in any given emulation mode. You change modes by pressing various combinations of buttons, or by using `STB.COM` from the DOS command line.

Emulations include: mice from Microsoft and Mouse Systems; graphics tablets from Houston Instruments, Retrographics, Tektronix, Hitachi, and Summagraphics (ASCII and binary); and the USI Optomouse. Separate software drivers provide the proper program interface for the Microsoft and Mouse Systems emulations; for the others, the target application must have a built-in driver.

The Trackball Plus plugs into an RS-232 serial port; versions are available with both 9-pin and 25-pin connectors. A separate cable runs from the serial port connector to a wall-mount transformer that supplies the unit with power. After plugging in the hardware, you set the desired mode and then (if necessary) install the Microsoft or Mouse Systems driver. Both `.COM` and `.SYS` drivers are supplied for these two emulations. Fulcrum's drivers are unlike most mouse drivers that load at the DOS command line: You cannot remove them from memory without rebooting. When you try to install a different driver, you receive a `Driver already installed` message.

The trackball itself functions fairly well in graphics applications. It has a good feel, and on-screen motions are smooth. However, there is no way you

continued

Test Setup

I tested each device in this review on two machines: an AST Premium/286 (10 MHz, zero wait states) with 1.5 megabytes of Expanded Memory Specification (EMS) 3.2 memory, a 40-megabyte hard disk drive (ST-251), an Orchid Designer VGA card, and an NEC MultiSync monitor; and an IBM PC XT with 1.5 megabytes of EMS 4.0 memory, a 20-megabyte hard disk drive (ST-225), a Hercules monochrome graphics card, and a Microsoft Mach 20 accelerator board.

On the AST, I used the following software to test each device: AutoCAD 9.0 (VGA mode), Windows 2.0 (in Orchid's proprietary 800- by 600-pixel, 16-color mode), and AutoSketch (EGA mode); under Windows, I tested several of the desktop accessories, as well as PageMaker 1.0a and Excel. On the IBM, I tested each device with VP-Planner, AutoSketch, and WordStar 4.0, all running under DESQview 2.01. I also tested compatibility with DESQview itself.

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Inside the Trackballs

Both PC-Trac and FastTRAP use 24-pin CMOS microcontrollers from National Semiconductor's COPS (Controller Oriented Processor System) family. They contain the program, data, and temporary storage, as well as system timing and I/O control. Inputs to PC-Trac include three push buttons and two slotted optical encoders; FastTRAP is similar but has a third encoder plus a trackwheel and a shaft-mounted encoder wheel. The devices have identical cases, but a panel covers the unused trackwheel slot in PC-Trac.

Four transistors on a printed circuit board interface the input devices to the microcontroller; except for the push buttons, all the electronics are mounted on one other small printed circuit board. The two boards are interconnected by a four-conductor flex circuit. All subassemblies—the PC boards, encoder shafts, switch caps, and cable—are press-fit into the base of the case. Everything is nicely arranged, and the overall impression is one of quality design and manufacture.

Because of the devices' low power requirements (a few milliamperes), they do not need a separate power transformer; as with most mice, they draw the power they require directly from the control lines of the port to which they are connected.

The COPS microcontroller is not interrupt-driven; rather, it continuously scans the six input ports. When it detects a switch opening or closure, or a trackball or trackwheel motion, it formats a message that it sends to the host computer via the serial port. In mouse mode, it sends a standard 3-byte message that contains button status and an 8-bit relative x,y displacement. In native mode, it adds a fourth byte that allows the transmission of third-button status and z-axis information from the trackwheel.

At the programming level, interface with the mouse driver is accomplished via the standard interrupt 33 hexadecimal. MicroSpeed's driver recognizes the standard Microsoft function calls (0 to 19), and it adds 11 extended functions of its own (64 to 74).

A look at the inside of Trackball Plus showed that it was built with less elegance and economy than the MicroSpeed devices. The PC board is hand-soldered, and traces of flux were evident all over the board. An Intel 8051 running at slightly over 7 MHz provides the unit's intelligence. A separate 2764 (8K-byte) EPROM contains the control program and data. Like the MicroSpeed devices, the 8051 works on a polled (not an interrupt-driven) basis.

Lightgate was notably tight-lipped about Felix's internal operation. However, by both inspecting the device and talking with technical-support personnel, I was able to gather some information. Two orthogonal plastic slides with precision-etched slots serve to interrupt the beams between a pair of orthogonal optical encoders. A proprietary microprocessor then processes that information, formats it, and sends it to the host computer. The microprocessor senses changes in the pointer's velocity and alters the outgoing message rate, thereby varying on-screen response.

Layout, materials, and construction in Felix are all first-rate.

can adjust sensitivity, nor can you use ballistic gain control.

In the Microsoft mode, I found the sensitivity satisfactory under Windows and AutoCAD, but unsatisfactory under AutoSketch. In addition, in the Summagraphics Bit Pad One mode under the version of AutoCAD (9.0) used for testing, I got no results from operating the alternate cursor button, which should allow you to move the cursor between two locations. According to the manufacturer, this version of AutoCAD precludes the efficient use of the alternate cursor button. Like the MicroSpeed devices, the Fulcrum Trackball Plus supports a drag-emulation mode.

A separate program, SETCUR.COM, is supposed to allow the trackball to emulate cursor keys in text applications, but I found this emulation erratic when used under WordStar. It did work with XyWrite, however. The installation document states, "Use of this function with word-processing programs, where precise horizontal control is needed, may be unsatisfactory." It is. On the other hand, when I used just the supplied Microsoft-emulation driver, I had no trouble navigating DESQview's menus with Trackball Plus.

Ergonomically, the buttons aren't up to today's standards. They are awkwardly located and definitely biased toward right-handed users. In fact, I can't see how a left-handed person would be able to use them at all. You also have to use too much pressure to activate them.

A 30-page technical manual and a 3-page installation guide are included. Neither is written or produced in the style of most of today's manuals, and nontechnical users may have trouble finding the necessary installation information. However, the company says the documentation and the packaging are being redone, and by the time you read this, the updated documentation and packaging should be available.

Felix

Protruding through the Felix low-profile hardware case is a single button mounted on a moving shaft. This button normally functions as the left mouse button; the right button is simulated by moving the shaft to the upper-left or upper-right corner and double-clicking. Right-handed and left-handed users will find it easy to use Felix since both corners are provided. When you double-click in the lower-right corner, Felix enters a "precision" mode in which cursor movement is restricted to just a portion of the screen. However, you have to press the button farther down compared to similar devices, and there is no tactile feedback to inform you when contact has been made. Thus, I found double-clicking under Windows to be slightly tiring.

Felix's software lets you change the button assignments and even move the buttons to the keyboard (i.e., using Felix just for positioning, and using keyboard keys to perform button functions). The software is supplied in both 5¼-inch (360K-byte) and 3½-inch (720K-byte) formats.

Felix's chief claim to fame is a 1-to-1 mapping with the screen (in nonprecision mode). When you move the pointer shaft to the upper-left corner of the 1.1- by 1.1-inch active portion of the device, the cursor will be in the upper-left corner of the screen. When you move the pointer to the lower-right corner, the cursor follows suit. In precision mode, a smaller portion of the screen is mapped to Felix, thereby allowing more accurate positioning in that portion of the screen.

Felix's secondary claim to fame is a feature called "Hot Spots." Hot Spots

continued

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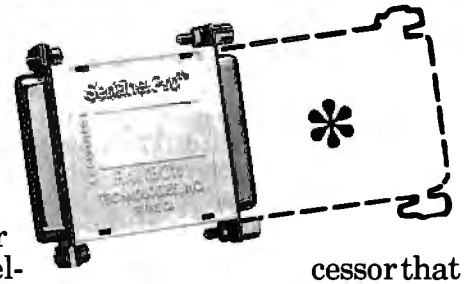

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are locations at the perimeter of the pointing area that provide keyboard macro functions. By moving the pointer to a Hot Spot and clicking, you can insert a number of keystrokes into the currently running application.

There are 12 Hot Spots. You can activate each alone or in combination with the Control, Alt, or left or right Shift key, for a total of 60 Hot Spots. Felix comes with a number of predefined sets of Hot Spot macros, an editor for creating your own, and a print utility for displaying and printing them. The Lotus and AutoCAD Hot Spot macros are extremely useful for getting at often-used functions quickly.

You can utilize Lotus macros remarkably well, so it is practical, and even desirable, to use Felix with the spreadsheet. For example, moving the pointer into the upper-right corner sends a slash (/) keystroke, activating 1-2-3's familiar horizontal menu.

Other Hot Spots let you move to the beginning or end of the spreadsheet, scroll by row or column, or make large jumps to distant areas of the spreadsheet. Hot Spots that you activate in conjunction with the Alt key let you execute common Lotus functions (e.g., learn and recall modes, and paging up, down, left, and right). You can add 36 custom macros to the other Hot Spot layers.

According to the manufacturer, cursor positioning is erratic under DESQview and programs running under it, so I ran my test software directly from DOS. Lightgate is presently working on drivers for Microsoft Windows/386.

Except for the less-than-desirable tactile feedback for the push button, Felix's overall feel is quite nice. The pointer slides easily, and I had no trouble positioning it accurately on the 800- by 600-pixel enhanced VGA screen. Lightgate is correct when it says that the 1-to-1 pointer/cursor mapping can aid productivity.

Running an Application

To run an application with Felix, you move to the application's subdirectory and load Felix drivers, followed by the application itself. For example, to load AutoCAD, you would move to its subdirectory and type `C>FELIX ACAD`. This Felix command actually invokes a fairly lengthy batch file—more than 100 lines in the version tested—that does conditional testing to determine which application you're loading, and then loads the appropriate drivers.

`MOUSE.EXE` is used for most applications, but `FLXACAD.EXE` loads drivers for AutoCAD and AutoSketch, and `FLX-123.EXE` loads the Lotus (or 1-2-3) driver. Another program loads the Hot Spot macro file for the selected application. Then the application itself is run.

Processing a long batch file is inefficient; a shorter batch file for each application would be an improvement. To speed things up, you can move the appropriate lines for your application to a separate batch file. To avoid unnecessary waiting, Lightgate should have either supplied separate batch files to load each application or written a single software driver that supports all—or at least most—applications. The supplied drivers generally occupy about 40K bytes of memory, about 3 to 5 times as much as most mouse and trackball drivers use.

You install Felix by plugging the cable into your 25-pin serial port (or into the supplied 9-pin-to-25-pin adapter, which is then inserted into the port), plugging a small power transformer into an AC outlet, and then inserting the coaxial power plug into the rear of the 25-pin connector.

An installation program copies files to a subdirectory called `\FELIX` on the user's disk. The program also adds that directory to the path statement in your `AUTOEXEC.BAT` file. The old version is saved as `AUTOEXEC.OLD`.

According to the manufacturer, a new version (1.05) is due out by the time that this article is in print. Lightgate says the new version will feature support for relative mode, for programs such as Dr. HALO.

The quality of the documentation is not as good as the quality of the device itself. Here's an example of the gibberish that permeates the main manual: "Felix buttons use an innovative technology which is about to change your pointing life. Their operation is based on the kinesthetic space created by the little square which is Felix's travel area. The implementation is our ergonomically informed solution to the challenges and hazards of input device use."

Even the sections in which the company really is trying to present useful information are difficult because of the verbose, self-conscious writing style. To get the device working, I found the `READ.ME` file and the `FELIX.BAT` file to be more useful. All in all, the manual needs to be thoroughly reworked to make it easier to understand how to set up and use Felix.

A separate manual covers using the special 1-2-3 driver software. You will find it more informative and less filled with rhetoric than the main manual.

Trackball versus Mouse

If you need a pointing device, first you must choose between a mouse and some other device. The main disadvantage of a mouse is that you must have some clear space on your desk on which to operate it. All the devices discussed here overcome that problem. A trackball can also be advantageous for fine, detailed work, because it's easy to control the ball with your fingertips. Some mice, however—the new Microsoft Mouse in particular—are light enough to make fingertip control possible. Overall, I prefer a mouse because it's smaller and easier to handle.

If you decide against a mouse, Fulcrum's Trackball Plus is easy to set up and use, and it is the least expensive device of its type. A developer desiring information on the software protocols of the emulated devices might buy one for the documentation alone, because software protocol data regarding the various devices is all conveniently collected in this one manual. However, Trackball Plus suffers from its lack of support for text modes, its nonergonomic buttons, and its right-handed bias.

Despite its problems, Felix is an intriguing device. Its positioning system and Hot Spot macro system are top-notch. You will find the push button less than perfect, however, as is the collection of software drivers. With more compact and elegant drivers, rewritten documentation, and some form of tactile feedback on the button, Felix will be a product to contend with.

Currently, however, the MicroSpeed devices are my favorites. Both are well designed, engineered, and manufactured, and neither requires a bulky and inconvenient external power transformer. The documentation is excellent, the plug-in-and-go Microsoft emulation makes it easy to get started, and the ballistic-gain-control drivers provide a long-missing capability for MS-DOS machines.

FastTRAP costs $30 more than PC-Trac. Viewed simply as a mouse replacement, it may not be worth the extra expense. But if you are working with AutoCAD or want a fast way of paging through your word processor or spreadsheet, it is worthwhile. Other developers are working on FastTRAP drivers that may also justify the extra expense. ■

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 as "editors."

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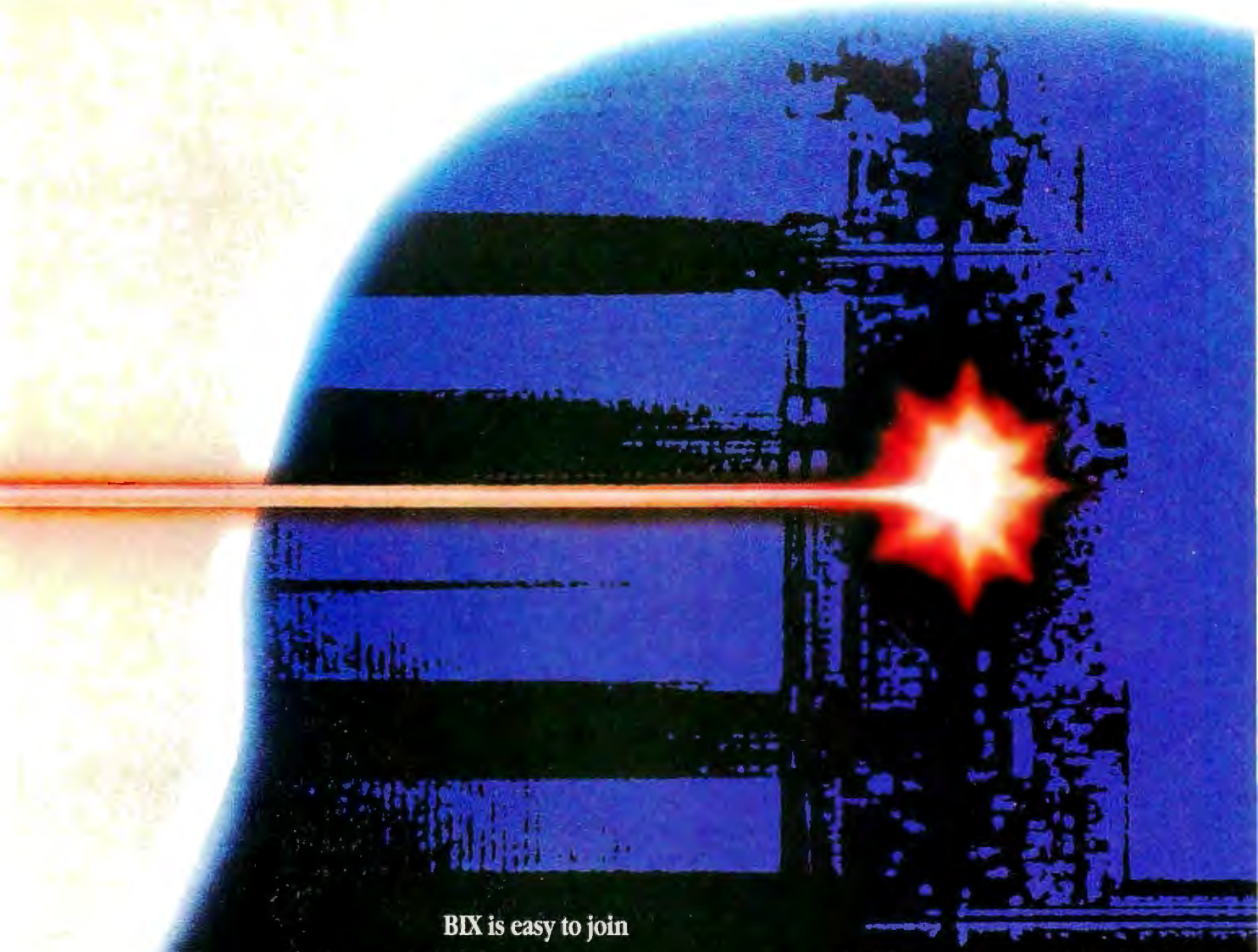

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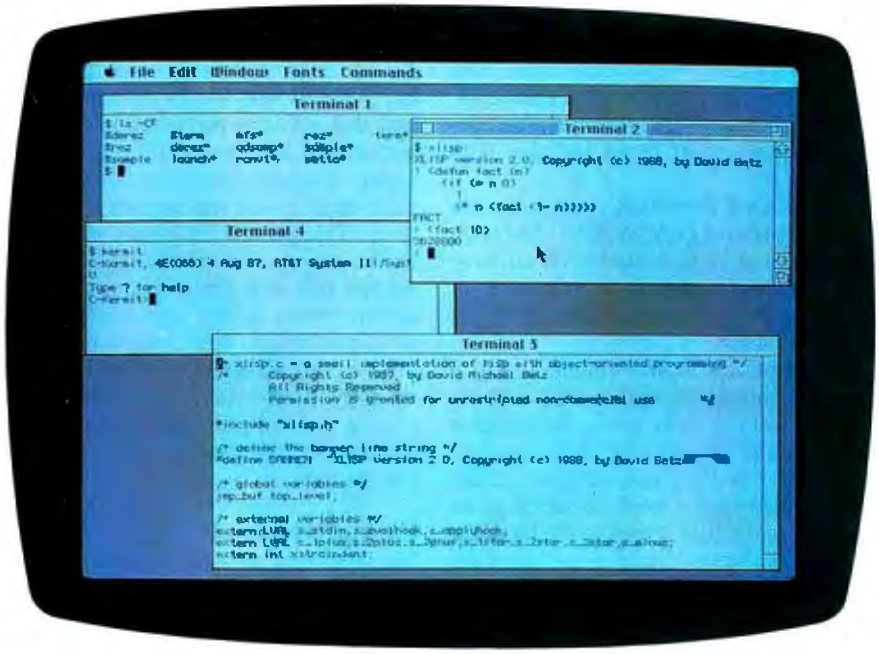
Unix for the Mac II



With A/UX, the Mac II becomes a low-end workstation

David Betz and Eva M. White

Sure, the Macintosh II's hardware is as powerful as some workstations, and it even uses a 16-MHz 68020 like the Sun and Apollo workstations. But before you call the Mac II a real workstation, you need to add a powerful operating system that supports multitasking, virtual memory, and networking to a variety of machines: one like Unix, for instance.

That's exactly what Apple's A/UX 1.0 is all about. It's a port of AT&T Unix System V Release 2 for the Mac II. However, A/UX differs from most other workstation versions because it is based on AT&T System V instead of Berkeley 4. To maintain compatibility with other workstations, A/UX includes important Berkeley Standard Distribution (BSD) 4.2 and 4.3 extensions, such as signals and sockets.

A/UX supports up to two additional users (using the Mac II's serial ports) and the ability to network across an Ethernet using NFS (Network File System) and TCP/IP (Transmission Control Protocol/Internet Protocol).

What really makes A/UX different from most other versions of Unix is that it gives you the ability to run Mac applications and to access the Mac's user interface Toolbox ROM routines. With these routines, you can write a Unix application with a Mac windowing interface. Unfortunately, this initial release does not provide a point-and-click windowing interface to Unix similar to that of the Mac operating system. In A/UX 1.0, you can run only one Mac application at a time, and the Toolbox routines don't yet support the Finder, desk accessories, or the printing manager (see "Unix and the Mac Interface" by Rick Daley on page 89 of the *Macintosh Special Edition*.)

To run A/UX, you need a Mac II with a minimum of 2 megabytes of memory and a paged memory management unit (PMMU). A/UX comes installed on an Apple 80SC 80-megabyte hard disk drive. You can get it on either an internal ($4879) or external ($4979) drive. If you buy it on an external drive, you'll also need an Apple small-computer-system-interface cable system to attach it to the Mac. Also, if you plan to use A/UX as a multiuser system, Apple recommends adding 2 megabytes of memory for each additional simultaneous user. You will also need an EtherTalk card.

The 80-megabyte hard disk drive comes preformatted into five partitions: a small Mac Hierarchical File System (HFS) start-up partition (2 megabytes), a large (56-megabyte) partition that comprises the root (/) and user (/usr) Unix file systems, and a 14-megabyte partition that Unix uses as swap space. The remaining two 3-megabyte partitions hold duplicate copies of the eschatology file system, which are used by the auto-recovery utility.

Using A/UX

Starting A/UX involves booting the Mac operating system from the start-up partition and then launching the sash stand-alone shell application. You can choose to either make sash the start-up application or just double-click on the sash icon. Sash opens a window and starts a countdown timer that, if allowed to complete the 10-second count, will then start the Unix boot sequence. Interrupting the counter will drop you into the stand-alone shell.

While the main function of sash is to

continued

A/UX 1.0

Type
Multitasking operating system

Company
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

Format
Apple 80SC 80-megabyte hard disk

Language
C and assembly

Hardware Needed
Mac II with a minimum of 2 megabytes of memory and a 68851 PMMU

Documentation
Getting Started with A/UX
A/UX System Overview
A/UX Installation Guide
A/UX Command Reference (A-L)
A/UX Command Reference (M-Z and Games)
A/UX Programming Languages and Tools, Volumes 1 & 2
A/UX Programmer's Reference
A/UX Local System Administration
A/UX System Administrator's Reference
A/UX Text Editing Tools
A/UX Text Processing Tools
A/UX Communications User's Guide
A/UX User Interface
A/UX Toolbox: Macintosh ROM Interface

Price
Monochrome system: $9297
Color system: $9897
Internal upgrade: $4879
External upgrade: $4979

Inquiry 904.

load Unix, you can also use it to manipulate the files in the A/UX file systems, or the files in either of the two eschatology file systems. Sash provides a subset of the standard Unix file manipulation tools, including `mv`, `cp`, and `ed`, as well as the file system checker `fsck` and the file system debugger `fsdb`. Other uses for sash are to partition hard disks, to build A/UX file systems, and to change kernel-tuning parameters.

Standard Unix

A/UX comes with all the standard Unix tools for software development, text processing, and communications. The software development tools include compilers for C and FORTRAN, an assembler and linker, a source code control system (`sccs`), a program maintenance utility (`make`), a parser generator (`yacc`), and a lexical analyzer generator (`lex`).

The text-processing tools include the `vi` text editor and the `nroff` and `troff` text formatting utilities. Apple also includes a utility license from Adobe to convert the output of `troff` to PostScript.

For communications, A/UX provides `uucp`, the Unix-to-Unix copy program, and its associated utilities, which allow multiple Unix systems to communicate through ordinary dial-up connections as well as by hard-wired serial links. The `uucp` software is the basis of the worldwide Usenet network. However, the Usenet software itself is not included with A/UX.

The system comes with public domain software source code for GNU EMACS, Kermit, and Unix compression utilities. This software takes up 9 megabytes of disk space, and you can delete it if you need the space.

A couple of features unique to A/UX are the auto-configuration and auto-recovery utilities. The auto-configuration utility simplifies the normal Unix procedure for installing new devices. Under Unix, installing a new device requires editing make files, copying the required drivers, and rebuilding and installing the kernel. To install an A/UX-supported device, you need to shut down A/UX, power off the Mac, install the hardware, bring the system back up using the device's installation disk, and run the installation program on the disk. This installs the driver software and reboots A/UX. When A/UX comes back up, the auto-configuration utility rebuilds the Unix kernel to add the new device driver software and then reboots again with the newly created kernel.

The auto-recovery mechanism is intended to guarantee that you can boot Unix into multiuser mode even after fairly severe file system damage has occurred. This mechanism uses the eschatology file systems to maintain backup copies of all critical Unix files. If, during the boot process, the recovery program detects that any of these files are missing from the main Unix file systems, it replaces them with copies from the recovery file systems. The auto-recovery program also checks for bad blocks on the disk and fixes file protection and ownership on critical files.

The sash utility handles the auto-recovery features of A/UX. If sash has trouble performing the Unix boot sequence, it invokes an auto-recovery procedure. The full auto-recovery takes about 45 minutes, but you can reduce this time significantly by disabling the block check portion of the auto-recovery process. Even in the case of an abnormal shutdown, like a power failure, the Unix `fsck` utility that runs as part of the startup sequence can usually fix most problems without having to resort to the lengthy auto-recovery process.

To test the auto-recovery utility, we renamed the kernel (`/unix`) to `/unix.save` and attempted to reboot the system. When the reboot failed, we invoked the auto-recovery program, which restored the kernel from one of the recovery file systems. We found out the hard way that any time you rebuild the kernel, you should be sure to run the two programs `/etc/eu` and `/etc/eupdate` to update the files on the recovery file systems. This procedure is only mentioned in the `ReadMe` file on the hard disk. We missed this step the first time, and the auto-recovery utility was unable to restore the kernel. Also, somehow in the process, we managed to delete the backup copy. Fortunately, we were able to use the sash copy utility to move the kernel manually from one of the recovery file systems.

Backup strategies

The auto-recovery mechanism is not a substitute for making regular backups, since it can restore only critical system files. It makes no attempt to restore user data files or programs. Auto-recovery is intended only to get the system back up and running after serious failures so that you can use normal backups to reconstruct the complete system.

Another good reason for making a backup is that when A/UX boots for the first time, it starts out in what is known as single-user mode. In this mode, all the Unix file protection is disabled, and it is very easy for an inexperienced user to do significant damage to crucial files. The safest approach would be to make a backup copy of the 50-megabyte Unix file system using one of the several Unix backup utilities supplied, such as `CPIO`.

Unfortunately, performing a backup isn't easy. The only backup medium A/UX 1.0 supports is the 800K-byte floppy disk drive (version 1.0 does not support the cartridge tape drive). Since there are about 45 megabytes of files on the system as distributed by Apple, a full backup requires approximately 56 800K-byte floppy disks.

continued

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RESOLUTIONS 8 bits/pixel	1024 x 1024	2048 x 1024	2048 x 2048	2048 x 1024	2048 x 2048
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Macintosh Toolbox Support

Apple supplies several tools with A/UX to support developing applications that use the Mac interface. You use a utility called `mfs` to move files between the Mac operating-system environment and A/UX. This utility is not capable of handling HFS floppy disks, so you must format 800K-byte floppy disks as Macintosh File System (MFS) volumes. The launch utility runs applications that were built in the Mac operating system and moved over with `mfs`. You can debug Mac applications using the standard Unix debuggers `adb(1)` and `sdb(1)`.

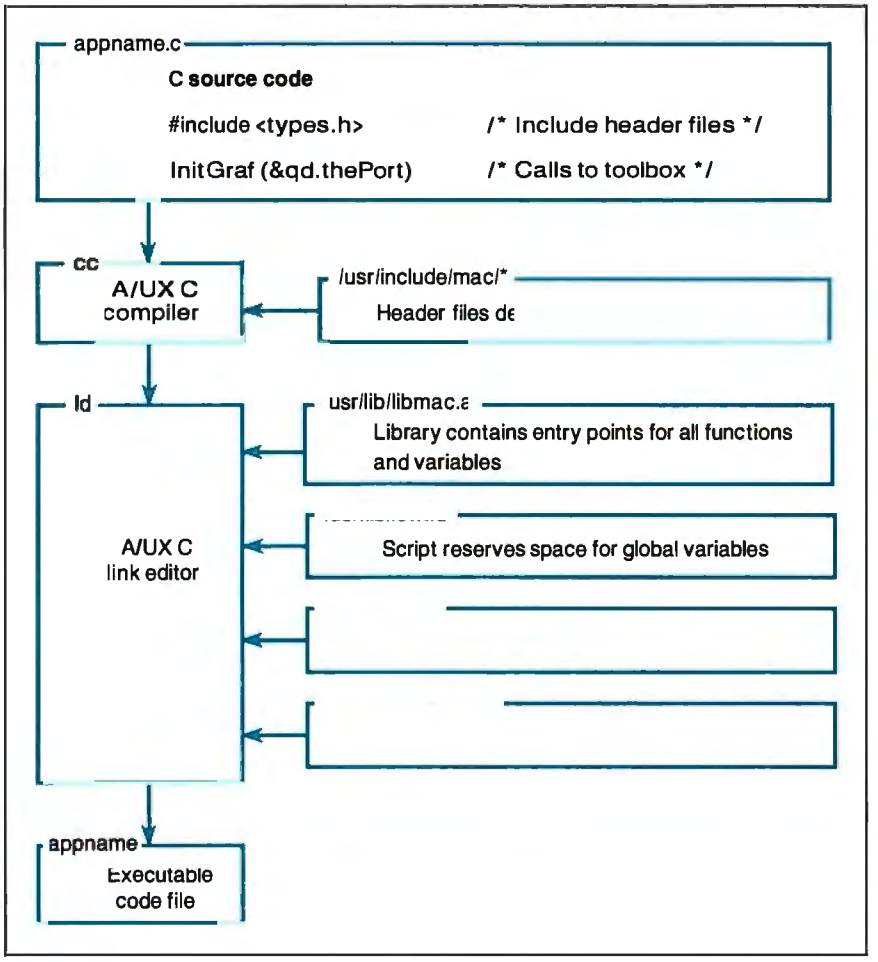

Figure 1: *The steps involved in creating an A/UX application that uses the Mac ROM.*

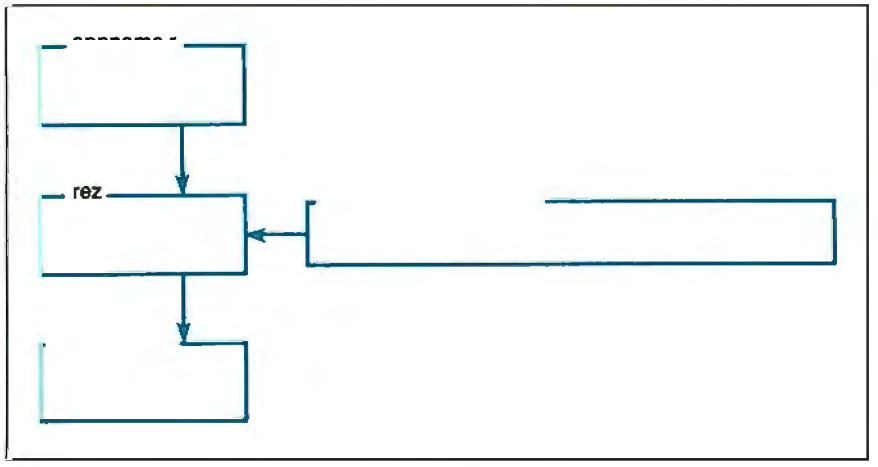

Figure 2: *The steps involved in creating a resource file.*

The launch utility successfully ran MacPaint 2.0 and MacDraw 1.9.5, but MacWrite 5.0 bombed, giving a memory-fault error. However, the error didn't disable the machine in any way.

A/UX comes with a resource compiler (`rez`) and decompiler (`derez`) whose source files are compatible with their counterparts in the Mac Programmers' Workshop (MPW). The `rez` utility translates resource description files to binary files that resource-manager functions in the Toolbox ROM can use. These resources describe the windows, menus, and dialog boxes that are familiar parts of all Mac applications. The decompiler translates binary resource files back to source form. It is useful for making alterations in existing resource files without having to reconstruct the entire file from scratch if no source is available for it.

There are two approaches to developing A/UX applications that use the Toolbox. You can develop them under the Mac operating system using the tools there, transfer them to A/UX using `mfs`, and run them using the launch. Or, you can develop, debug, and run them using A/UX tools. Figure 1 shows the library and header files that make up the Toolbox and, graphically, how you construct the code portion of an application under A/UX. Figure 2 shows how you construct the resource file. (Under the Mac operating system, the code portion and resource portion are stored together; under A/UX, these two pieces are in separate files.)

To build an A/UX application, you must include the appropriate header files in your program source and then link with the Toolbox files `libmac.a`, `low.ld`, `low.o`, and `maccrt0.o`. The library `libmac.a` contains the entry points for the Toolbox functions and variables; `low.ld` and `low.o` arrange access to the Mac low-memory globals; and `maccrt0.o` initializes the Toolbox interface and the trap dispatch tables and then invokes the main routine of the application.

The initialization code also opens a special device driver, called `/dev/uinter0`, that sets up access to the screen buffer, handles events in a manner similar to the event manager in the Toolbox ROM, tracks the cursor, and sets up the A-line trap handler.

Applications access the Mac Toolbox ROM by issuing A-line trap instructions. A/UX handles these trap instructions by

continued

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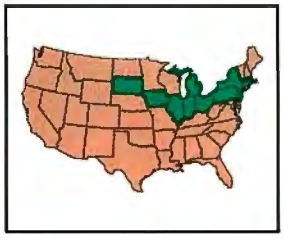
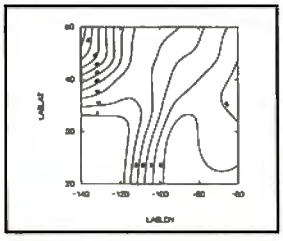
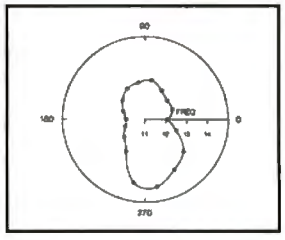
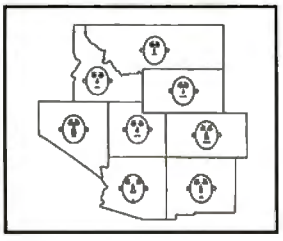
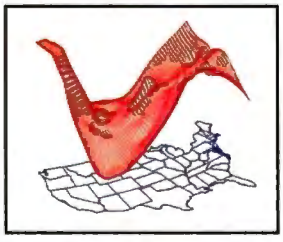
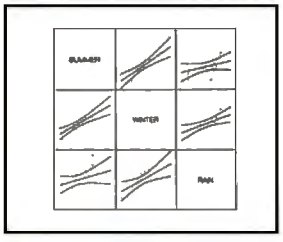
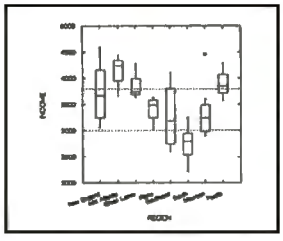
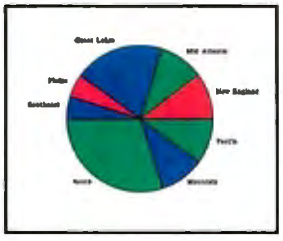
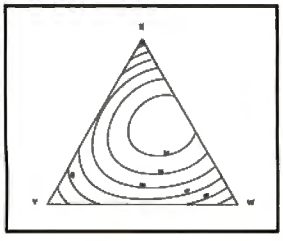
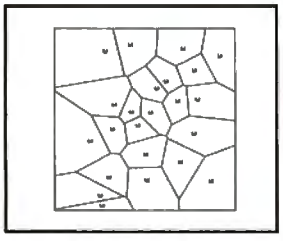
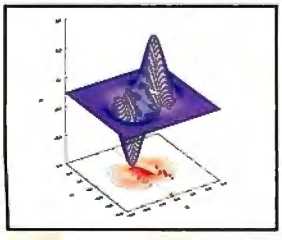
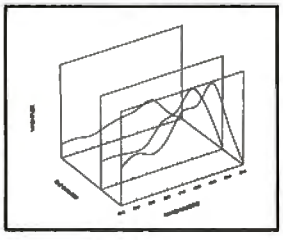

Statistics Basic statistics, frequencies, t-tests, post-hoc tests Multiway crosstabs with log-linear modeling, association coefficients, PRE statistics, Mantel-Haenszel, asymptotic standard errors Nonparametric statistics (sign, Runs, Wilcoxon, Kruskal-Wallis, Friedman two-way ANOVA, Mann-Whitney U, Kolmogorov-Smirnov, Lilliefors, Kendall coefficient of concordance) Pairwise/listwise missing value correlation, SSCP, covariance, Spearman, Gamma, Kendall Tau, Euclidean distances, binary similarities Linear, polynomial, multiple, stepwise, weighted regression with extended diagnostics Multivariate general linear model includes multi-way ANOVA, ANOCOVA, MANOVA, repeated measures, canonical correlation Principal components, factor analysis, rotations, components scores Multidimensional scaling Multiple and canonical discriminant analysis, Bayesian classification Cluster analysis (hierarchical, single, average, complete, median, centroid linkage, k-means, cases, variables Time series (smoothers, exponential smoothing, seasonal and nonseasonal ARIMA, ACF, PACF, CCF, transformations, Fourier analysis Nonlinear estimation (nonlinear regression, maximum likelihood estimation, and more).

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Table 1: *While the Sun 386i/250 is significantly faster than the Mac II running A/UX, in this configuration, the Sun costs about twice as much.*

	Number of Tasks			
	1	2	4	8
Mac II with A/UX	2.9	4.9	8.2	15.7
SUN 386i/250	2.0	3.0	6.0	12.0

Note: In both cases, the real execution time is reported. The SUN 386i uses a 25-MHz 80386, and the Mac II uses a 16-MHz 68020.

switching to supervisor mode and dispatching to code within the A/UX kernel. Once this code determines that the trap was a Toolbox ROM call, it invokes the trap handler and switches back to user mode. The user-mode trap handler then uses the dispatch tables to call either a ROM-based routine or a RAM-based patch. RAM-based patches update ROM code, as in the standard Mac operating system, and redirect Mac operating-system calls to routines that translate them to equivalent Unix calls.

You must then create the resource file containing definition objects such as windows, menus, and dialogs, and compile it with the `rez` resource compiler.

Finally, to run any programs under A/UX that use the Mac interface, you must have the program `toolboxdaemon` running as a background process. This program is responsible for setting up the shared memory structures that all Toolbox applications use. It is also responsible for cleaning up after a Toolbox process when it exits. This includes removing shared memory structures and windows from the screen. In version 1.0, the shared memory contains mostly cursor data.

Missing Mac User Interface

In A/UX, there is no facility like the Mac Finder to launch applications and manage files. A/UX provides three different shells (command interpreters)—the traditional Bourne shell (`sh`), the Berkeley C shell (`csh`), and the Korn shell (`ksh`). Each of these shells uses a command-line interface.

The closest A/UX comes to having a windowing interface is a sample program, called Term, that lets you open multiple windows, each running the Unix command-line interface. Since this is a sample program, full source code is provided so that you can modify it to suit your own needs.

As you would expect with a Mac application, Term lets you move or resize each window. One nice feature is a history mechanism that makes it possible to scroll back through a session to review output that has already scrolled out of the window. Unfortunately, you cannot cut and paste in these windows.

Each window acts as a terminal emulator implementing a subset of the DEC VT-100 control codes. You can also select the font and size of the text in each window.

Since A/UX allows only one Toolbox application to run at a time, it isn't possible to run any other program that uses the Toolbox from within the Term program. This means that to run another Toolbox program, you need to close down whatever is going on in each of the windows and exit from the Term program. This

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limits the usefulness of the program as a standard interface to A/UX.

Expanded Networking

If you want to go beyond the three users that can be accommodated by the console and the two serial ports, you can buy an Ethernet card and use the networking software that comes with A/UX.

A/UX supports Sun Microsystems' NFS, which allows a Mac II running A/UX to participate in a network of workstations and hosts and to share files. NFS makes it possible to treat files on other systems as if they were resident on your local machine.

There is also support in A/UX for the TCP/IP network protocol. This protocol and a number of utilities included with A/UX let you copy files between nodes on a network and establish remote log-in sessions with other nodes.

AU/X doesn't support AppleTalk, so if you want to connect a LaserWriter printer, you have to use an asynchronous link to one of the serial ports.

Even though the system comes with networking software, the documentation does not include the A/UX Network Administration manual that you need to set up a network. This manual is available for $18.50 to APDA (Apple Programmer's and Developer's Association) members.

To measure the multitasking performance of A/UX, we ran the multitasking-shell benchmark published in the August 1984 BYTE on page 406. For comparison, we ran the same benchmark tests on a Mac II with 5 megabytes of memory and A/UX on an external 80-megabyte hard disk drive, and on a Sun 386i/250 with 8 megabytes of memory and a 327-megabyte hard disk drive running Berkeley Unix 4.3. In the benchmark results, A/UX on the Mac II ran notably slower than the Unix implementation on the Sun system (see table 1). However, performance may be acceptable when you consider that the Sun system costs about twice as much.

Close, But No Cigar

Apple's A/UX is a good first step toward transforming the Mac II into a Unix workstation. It's good because it gives you multitasking, virtual memory, and access to a network. But it is not yet well integrated with the Mac user interface. Also, the limitation of running only a single Toolbox application at a time makes it difficult to use even the Term program as a standard interface.

You might expect A/UX to make the Mac II into a true workstation, but it doesn't quite measure up. Although it does provide the ability to connect to a network, it does not provide the kind of interactive interface that is familiar to users of other workstation products. While the Mac interface is available from within A/UX, the primary interface is the Unix command-line shell.

However, A/UX is a good implementation of Unix System V and should be useful where there is a need for a system that allows Unix applications to run in a network environment and where the ability to run Mac applications is required. A/UX will be easier to use when and if Apple provides a Finder-like interface that will truly transform the Mac into a point-and-click Unix machine. ■

David Betz is a Unix consultant and a former senior editor for BIX. Eva M. White is a BYTE technical editor.

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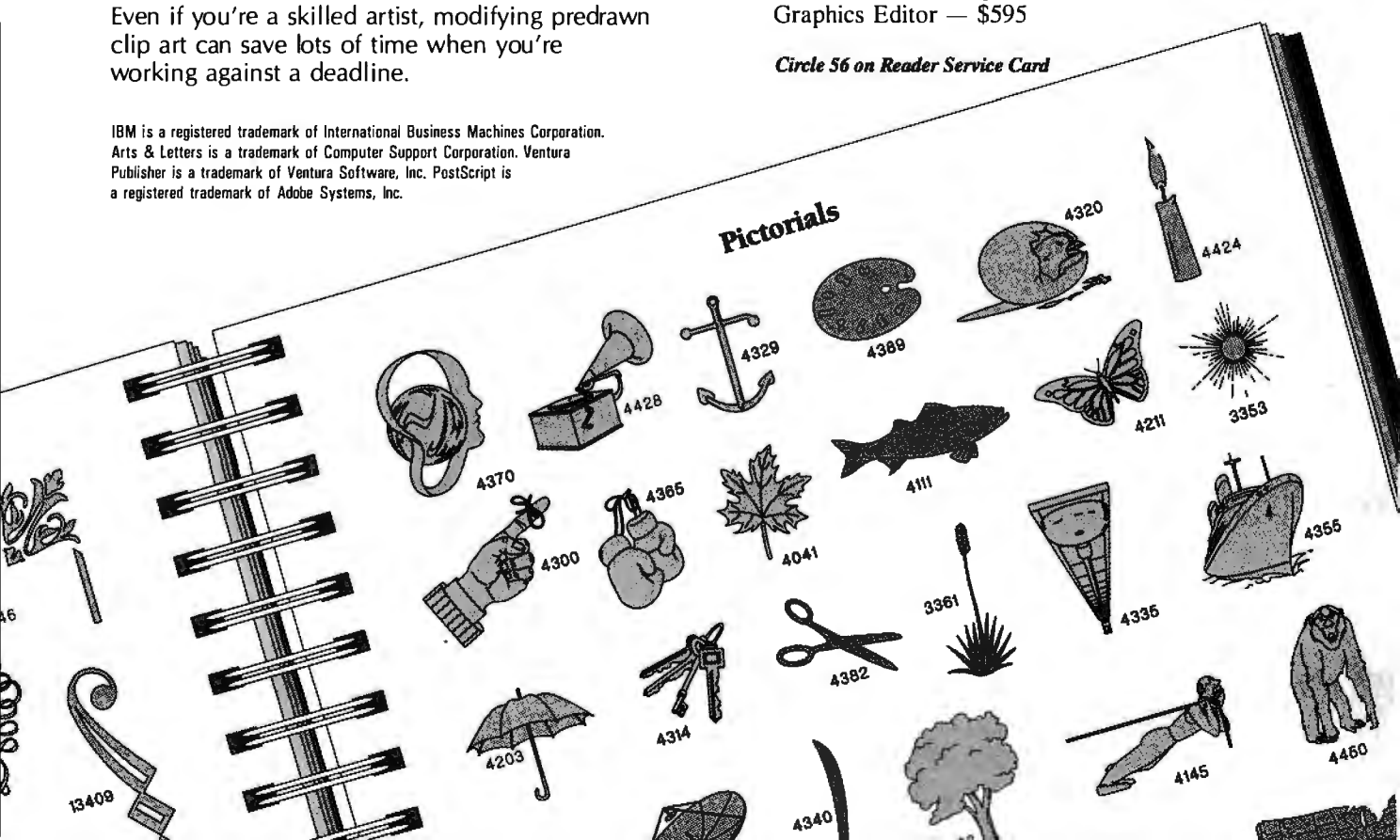

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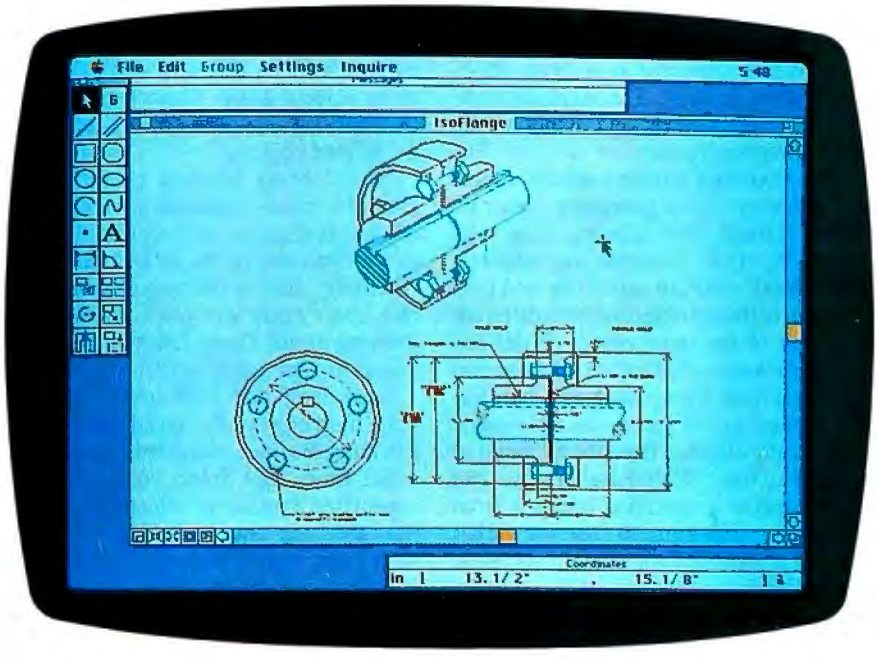
VersaCAD on a Mac



A CAD package for PCs finds its way to the Macintosh

Paul Tuten

Born with an established name in the MS-DOS world, VersaCAD Macintosh Edition is a comprehensive two-dimensional drafting and design system for creating accurate working drawings for a variety of disciplines. The VersaCAD package comes with a 247-page user's manual that includes a tutorial section, a "tour" disk that contains a demonstration program, and a disk with a HyperCard Help stack. These also serve as valuable training aids.

VersaCAD Macintosh Edition retails for $1995. It requires a Mac Plus or SE with 1 megabyte of RAM or a Mac II with a minimum of 2 megabytes of RAM, an Apple monochrome or color monitor, and Finder 5.5 or higher. You'll need extra memory to use large monitors and to make use of MultiFinder. If you have a Mac Plus or SE, you should equip it with an accelerator board with a 68881 math coprocessor to take full advantage of VersaCAD's speed. Finally, you'll need a minimum of 4 megabytes of hard disk space for programs, temporary workfiles, and drawings.

VersaCAD 1.1, the version I tested, supports a comprehensive list of output devices, including the Apple Imagewriter and LaserWriter for nonscale hard copies. For accurate drawings, it supports plotters from Bruning, Calcomp, Data Products, Enter Computer, Hewlett-Packard, Houston Instrument, United Innovations, Mutoh, Numonics, Roland, and Western Graphtec.

A VersaLINK application converts VersaCAD drawings to and from ASCII text, Initial Graphics Exchange Specification (IGES), and .DXF files. In these formats, you can exchange drawing information not only between different CAD applications but even between different computer systems.

The Working Area

The main display consists of a drawing window bordered by the familiar Macintosh title bar, close, resize, and scrolling buttons. In addition, five window-option icons are embedded along the bottom left scroll bar. Clicking on these window icons lets you magnify any area of the drawing for detail work, or back away for a bird's-eye view of the entire drawing, regardless of its size.

Beneath the menu bar is a Message window that prompts you for input during object construction and editing. At the screen's bottom is a Coordinates window that shows the location of the drawing cursor in absolute, relative, or polar coordinates. To the left is a Tools window—a palette of icons for object creation and manipulation tools. You can toggle all these windows (plus two hidden Constraints and Construct palettes) open and closed from the Settings menu bar selection.

I found that I was using the Constraints and Construct palettes more than the Message and Coordinates windows, so I closed the latter two to save room on my SE's screen. For SE users, a more productive, but also more expensive, solution would be to add an external monitor to display the drawing window. Then you could display the support functions windows on a second screen while using a multimonitor program, such as E-Machines' Double Feature.

A Pick of Tools

The two choices on the top of the Tools palette are Selection and Group. The Se-

continued

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Type
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(714) 960-7720

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Software Needed
Finder 5.5 or higher

Language
C

Documentation
247-page user's manual

Price
$1995

Inquiry 907.

lection tool lets you pick individual objects for editing and manipulation. Each object that Selection calls up displays its associated, movable, pivot-and-handle point. The Group tools let you build aggregates of objects.

The palette has 12 more tools, which you use to add objects to your drawing. The Line tool lets you create a single or continuous line, and Multiline draws two or more parallel lines simultaneously. Rectangle lets you draw squares and rectangles by designating opposite corners or three points. Polygon draws regular polygons with 3 to 180 sides.

To draw a circle, you choose a center and a radius or designate a diameter and its two endpoints. You can make an ellipse by picking the axes or a center and the axes. You create an arc from two endpoints and an arbitrary point on the arc, or from a center point and two endpoints. With Bézier, you can create three-point Bézier curves and multipoint spline curves. You handle point entry by screen position, grid snap, object snap, or coordinate entry (this is also the case with all the tools mentioned previously).

You can write on the drawing, either in individual lines or in blocks, using the Text tool. Character height and width, as well as line spacing, may be varied. You can assign font numbers to your built-in LaserWriter fonts for PostScript output. VersaCAD can automatically apply linear and angular dimensions, either singly or as baseline or chain dimensions.

The last six tools on the palette are for object manipulation. You can move and stretch objects and groups of objects. You can copy in one or two directions, or circularly, leaving one or more copies. Rotate lets you move objects about their associated pivot points. Scale shrinks or expands objects or groups of objects, either proportionally or unproportionally. Mirror flips objects or copies of objects about an axis. The Explode command breaks objects and symbols into their component parts.

The Construct palette contains important tools for precise geometric constructions. Extend/Trim lets you trim elements to other elements and objects. With Break, you can split a line and trim it to two different objects or two different portions of the same object. Fillet lets you draw a specified radius between two self-trimming lines, as does Chamfer. Perpendicular lets you create right-angle lines at any distance from the endpoint of a normal line. With Parallel, you can draw lines at a specified distance from each other. The Tangent function makes lines at a specified angle to circles, arcs, and ellipses, or tangent to arcs and perpendicular to lines. You can use Isometric to create an isometric view from three orthographic views.

The tools in the Constraints palette are used in conjunction with those in the Tools and Construct palettes. Constraints tools help you make your drawings more precise. Besides Free (or unconstrained) input, there is Rotation, X Lock, and Y Lock, which let you fix input to a specified angle, or to an x or y axis.

The Grid and Increment snap tools set up a grid with incremental points. These points then attract the cursor to the nearest specified location for geometric input. This is nice in some ways, but it often dramatically slows repainting when the grid is displayed. The No Snap function switches this option off. The Intersection, Object, and Equation tools are excellent for accurate placement of objects in relation to each other, during both construction and later manipulation.

In most cases, the tools have additional options that you can obtain by double-clicking on each tool's icon.

Picks from the Menu

The menu bar displays the Apple symbol with whatever desk accessories you have installed, along with About VersaCAD and Help. The Help item contains a drawing of the three palette windows mentioned previously, with labels that describe each tool function.

The Files menu contains New Drawing, which is for creating an empty drawing that retains the current settings of the properties, units, and window. Open Drawing retrieves drawings and also allows them to merge with the current drawing (at the same drawing units). Close stores the drawing window. Save Drawing and Save Drawing As put the current work on disk arranged by objects or by current group. Crunch compresses the workfile by permanently removing all deleted objects.

New Library lets you create special files of symbols. Symbols are collections of objects that are used repeatedly, such as windows and doors, or bolts and nuts. Obviously, having them predrawn as part of a library can save you a good deal of drawing time. Open Library gives you access to your symbols files.

Page Setup and Print give you a non-scale hard copy of displayed drawings on a printer. Besides a long list of plotters to select from, Plot Select contains an encapsulated PostScript selection; this option lets you use VersaCAD drawings with page layout programs. Plot Setup and Plot produce accurate output of the entire drawing, to any scale, on laser printers and plotters. Quit closes the VersaCAD program.

The Edit menu selection has the usual Macintosh Undo, Cut, Copy, and Paste options, plus Clear Last Entry, Restore Last Entry, Select All Objects, and Show Clipboard Contents. It also has additional items to aid you in editing objects. A Properties item lets you edit the level number, pen number, color, line density and width, line style, and top and bottom z-coordinate values of objects. A powerful Geometry item lets you look at and edit almost every geometric attribute of an object on the drawing; you can also invoke Geometry by double-clicking on the object. Handle moves the handle point of the selected object to alternate locations or back to the object's default location.

The Group menu contains options that you use in conjunction with the Group selection from the Tools palette. Clear Current Group removes all objects from the current group. Build by Inverse creates a group by replacing all objects in the current group with all other objects.

continued

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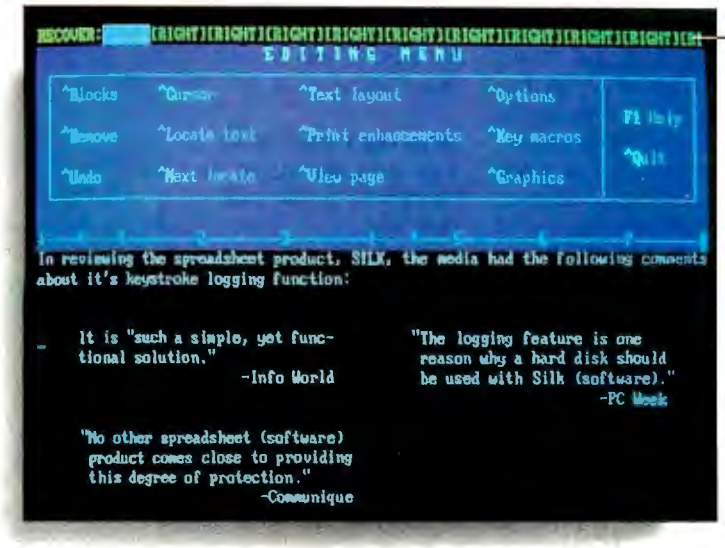

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Build by Properties lets you create or edit groups by all objects that do or do not have specified properties in common. Build by Fence creates groups by specifying objects either inside or outside a rectangular area, and Build by Objects lets you add or subtract specific object types to the current or new group.

The Settings menu contains valuable features, such as Input, which lets you directly input absolute, relative, or polar coordinates for geometric creation and manipulation. Besides the usual decimal degree and degrees-minutes-seconds options in the polar mode, bearing is also available. Properties lets you set such object attributes as level number, pen number, color, line density and width, up to eight line styles, and top and bottom *z* coordinate values. VersaCAD is sometimes referred to as a two-and-one-half-dimensional system because it can record *z*-coordinate values but not display them. This ability to record *z* coordinates can be useful if you are using drawing-coordinate data in CAM.

You can add arrows or center markers to objects, and you can set template property to objects being added. These objects could serve as construction lines for layout development, and they can be turned off for displaying or plotting.

With the Units item, you set the drawing's unit of measure when you begin. There can be only one unit of measure per drawing. VersaCAD works on the concept of real-world modeling. That is, if you are going to lay out a schematic of a new interstate highway, for example, you might make miles the unit of measure and choose polar coordinates in bearing format. On the other hand, if you were designing an assembly jig for an airplane wing, you would make inches your unit of measure and choose absolute coordinates in decimals of an inch. For an E-size plot of both drawings, you can set the plot scale so that 1 unit equals 0.125 inch.

All the necessary units are available, including decimals and fractions of inches and feet, and fractions of miles, millimeters, centimeters, meters, and kilometers. If you want, you can also define your own units of measure.

Levels lets you specify up to 250 levels to display and plot. Levels are not self-protecting; for example, you can trim lines to each other even if they are in different levels. You protect levels by turning them off, thus making them invisible.

Configuration sets the size of temporary Hatch files needed to calculate hatch boundaries. Preferences lets you set a drawing's background, grid, selected object, and cursor color (if available). Show Marker, Template, and Symbol turn the display of these items on and off. The workfile has a running clock of usage time that can be stopped with a Pause option.

Also under the Settings menu are Constraints, Coordinates, Message, Tools, and Construct items, all of which I've previously discussed. Symbols opens the symbols library from which the currently selected symbol was placed. Hatch lets you add hatching lines to any enclosed boundary; it also calculates areas and cross sections. Many of Settings' option windows can be left open for more convenient access.

The Inquire menu contains Drawing, which shows all the level numbers and pen numbers used on a drawing, along with the total number of objects, symbols, and time used. Workfile displays the storage that all the objects and symbols use, the total number of different symbols, and the corresponding storage you have left; it also indicates total drawing time and the elapsed time since your last file operation.

VersaCAD's workfile can contain 6000 objects, 2000 symbol components, and 200 unique symbols. This should be adequate storage for most drawings, but if it isn't, the workfile storage space can be expanded by an experienced programmer. Keyboard equivalents for almost all icons and menu options are present.

Stackware Utilities

Bill of Material is a HyperCard stack that counts all symbols used on a drawing. Descriptive data such as name, size, unit cost, unit weight, labor, and grade for each symbol in your library is entered in the Bill of Material stack. A Count function automatically counts the symbols, and Create Report prepares a materials-list type of report that shows the totals of each symbol and all the descriptive information.

You can edit any part of the report and save it as a text file for use in a word processor or spreadsheet, or you can convert it to VersaCAD format for use on the face of the drawing.

Bill of Material also contains a utility for calculating the total length of lines and rectangles on the drawing. For example, in a plumbing drawing, if all drain pipes are represented by lines of the same color, or on a certain level or pen number, Bill of Material can automatically add the total length of these lines.

The FileDump stack provides a convenient way to examine and edit the contents of drawing and library files. The source code for `getVcad` and `putVcad` are provided. These script functions extend HyperCard and let it read/write VersaCAD files; they also let you create customized VersaCAD HyperCard utilities. Sample drawings and libraries are included in the VersaCAD and Bill of Materials tutorials.

Drawing Conclusions

The most serious of VersaCAD's few limitations is the lack of an auxiliary view system for creating drawings with views of different scales. For example, if you want a drawing with a quarter-scale main view and a half-scale section view, you have to either draw both views at their respective scales and plot full-size, or draw the main view at half size and the section view at full size and plot at half-scale, or draw the main view full-size and the section view twice-size and plot at quarter-scale. In any case, you have a model with one or more views that are not real-world size. Perhaps a better alternative in this example would be to keep the views in two different models and overplot them on the same paper at the different scales—but VersaCAD has no built-in provisions to do this.

A vital feature of VersaCAD is its workfile. When you are working on a drawing, all work is done in a temporary workfile that VersaCAD automatically saves on disk. Thus, even if you are working on a new drawing that you have not saved, you will probably not lose all your work if a system error occurs, which I did occasionally experience.

VersaCAD seems to have all the necessary tools and options that a draftsperson needs to get the job done. However, I would not buy VersaCAD for an out-of-the-box Mac Plus or SE. Without a coprocessor accelerator board in the system, VersaCAD's slowness is a limiting factor. For example, I constructed a model with about 100 objects. On a vanilla Mac SE, a repaint of the model took well over a minute. On a Mac II, the same drawing took less than 3 seconds.

VersaCAD Macintosh Edition is a full-featured drafting tool that is well suited for a broad range of applications. But if you're going to spend almost $2000 for the program, do yourself a favor and run it on a machine that won't make you long for your drafting board. ■

Paul Tuten of Wichita, Kansas, is a tool engineering contractor for the aircraft industry and uses a CAD system daily. He can be reached on BIX as "editors."

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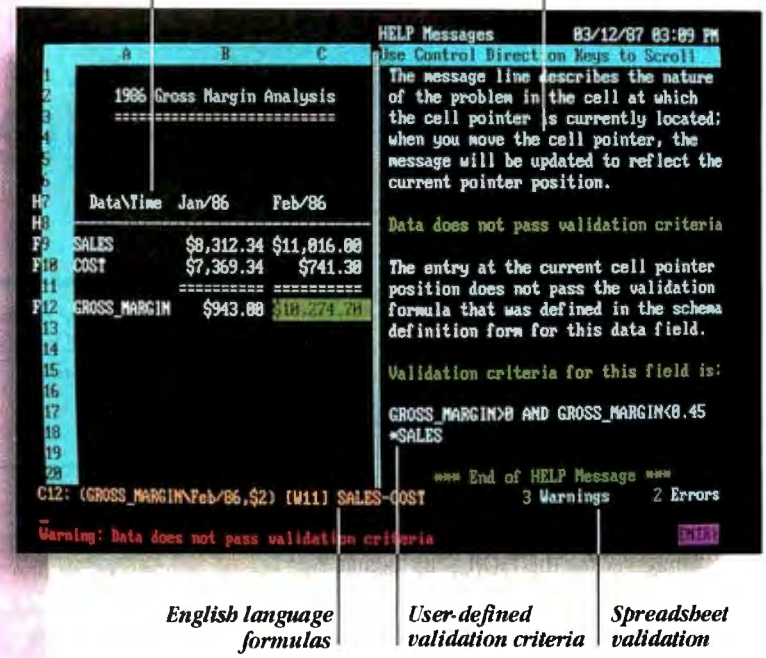

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Review Update

Fine-Tuning the Benchmarks

The results for the revised Disk I/O benchmarks still show that ALR's FlexCache 20386 comes in slightly ahead of the Compaq Deskpro 386/20 in disk performance.

	FlexCache 20386	Compaq 386/20	IBM PS/2 Model 80	IBM PC AT (8 MHz)
DOS Seek				
1-sector read	8.48	10.68	14.98	14.95
32-sector read	17.00	19.08	32.79	65.18
File I/O				
Seek	0.11	0.13	0.12	0.29
Read (sec/64K bytes)	0.42	0.45	1.11	1.33
Write (sec/64K bytes)	0.79	0.78	1.07	1.23
Disk I/O Index				
(relative to PC AT)	2.50	2.23	1.46	1.0

Note: All times are in seconds, except as noted.

The June issue saw the introduction of BYTE's new system benchmarks. The August issue marks the first, and probably not the last, revision. Version 1.1 of the low-level Small-C benchmarks incorporates several changes, all in the Disk I/O tests.

A bug fix for the DOS Seek 1- and 8-sector test came first. In the original test, checks for the end of disk failed because the test stored the sector variables in integer format. We quickly ran into sector sizes too large for Small-C to deal with as integers. We fixed the problem by changing the integer format to character pointers.

This fix uncovered an additional problem with the 8-sector part of the test. Basically, the 8-sector read was too sensitive to the effects of disk buffering. In version 1.1, we've enlarged the 8-sector read test to 32 sectors.

Finally, we changed the method of recording the results for the File I/O test. We've switched from seconds per K byte to seconds per 64K bytes for reporting the disk throughput times.

Apart from these changes, we've also made a couple of additional revisions. For the application-level benchmarks, we've dropped the Cursor Move test from the word-processing suite because of unreliable results. Second, we've switched from using an arithmetic mean to a geometric mean for calculating both the application-level and low-level indexes.

In light of these changes, we've rerun all the benchmarks for Advanced Logic Research's FlexCache 20386, which we reviewed in June, as well as for our baseline systems. The revised disk results are shown in the table above. The changes in the application benchmarks give the FlexCache a cumulative application index of 18.0. Application indexes for comparative systems are as follows: 18.0 for the Compaq Deskpro 386/20, 11 for the IBM PS/2 Model 80, and 5 for the 8-MHz IBM PC AT. The review of three 20-MHz 80386 systems on page 162 this month also reflects all these changes.

In upcoming reviews of 80386 systems, we'll be using a newly ported 32-bit version of the BYTE Small-C compiler for low-level benchmarks. For details on the 80386 version of the benchmarks, see the text box "80386 Benchmarks" by Rick Grehan on page 142 of this issue.

One last note: The graphs for the system reviews in June—ALR's FlexCache 20386, NEC's MultiSpeed HD, and Hewlett-Packard's Vectra CS Model 20—were labeled incorrectly. The application indexes, cumulative application indexes, and low-level indexes were correct, but the keys for the graphs were labeled in reverse order. We apologize for the error.

—Cathryn Baskin

Deviance with Concurrent DOS 386

Sometimes benchmark tests give you alarming results, and it's difficult to pin down the problem. That's just what happened with my review of Digital Research's Concurrent DOS 386 in the July issue.

The BYTE Lab ran the single-task benchmark for Concurrent DOS 386 on several different systems and obtained essentially the same results (which were printed with the review)—that it performed about as well as MS-DOS. But the test results obtained using my own ARC 386i were quite different, at least at first. In fact, my preliminary findings showed a single task under Concurrent DOS 386 to be about 3 times slower than the same task running under MS-DOS.

I initially ran the benchmark tests on my ARC 386i with 3 megabytes of 16-bit 120-nanosecond memory on an Everex 159 memory card installed "above" the 512K bytes of 32-bit memory on the ARC's motherboard. With the 16-bit memory installed, Concurrent DOS 386 barely puttered along, taking 40 seconds to perform one iteration of the benchmark in one window, while the same task ran in only about 13.5 seconds under MS-DOS.

Because the test program was only about 5K bytes, I decided to try the test without the 16-bit memory board installed. Admittedly, running even a 5K-byte program in only the 512K bytes of 32-bit base memory makes for a tight squeeze since Concurrent DOS 386 is so large. And certainly, most *real* applications cannot fit in so little memory. Nonetheless, without the 16-bit memory, performance improved noticeably. A single task actually ran faster than under DOS, taking 12.5 seconds to complete an iteration.

The explanation for the anomaly is painfully obvious: Running tasks in 16-bit memory on an ARC 386i slows performance down dramatically.

—Alex Lane

BYTE

Bonus All-Mac Supplement

Macintosh Special Edition

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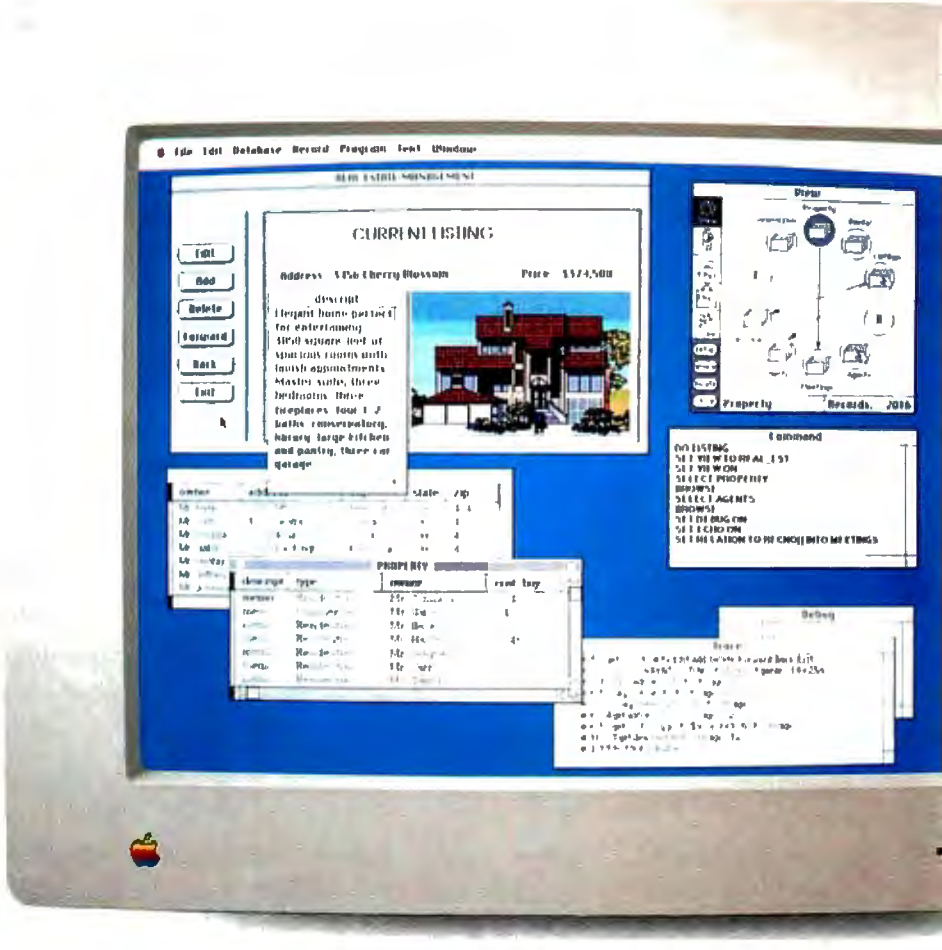

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Microcomputing's Vanguard

More and more, it's a Blue *and* Red world out there. BYTE readers have seen it coming for years.

Quick! Name the only magazine whose coverage of the Macintosh II won an award for editorial excellence in an international competition that was sponsored by the Society for Technical Communication.

Need a hint? It's a large publication, routinely reaching over 147,000 Macintosh users, far more than publications like *MacWeek*, *Macazine*, *Macintosh Today*, and the like.

Another hint: In addition to being one of the world's largest magazines for Mac users, it's one of the very few that has been there from day one back in 1984; it has covered every Mac in detail, from the first fledgling machine through the world-class power of today's Mac II.

Still stumped? Well, it's about the only magazine for Mac users that doesn't have a "Mac" in its title.

You're holding it in your hands: BYTE.

BYTE's readers were among the earliest and most enthusiastic adopters of the Macintosh. Year by year, as the Mac's power and expandability have grown—as it has finally delivered on that early bright promise—the installed base of Mac users among BYTE readers has climbed steadily. Today, over 35 percent of BYTE's 420,000 readers use Macs, and that number is still growing fast.

What amazes me is that almost all BYTE's Mac users are also IBM PC users. These readers are truly the vanguard of microcomputing—proficient on more than one type of machine and completely comfortable in the increasingly common office environment where Macs and PCs sit cheek by jowl. Like all BYTE readers, these folks are a versatile, pragmatic group, not at all locked into a single mold, or constrained by arbitrary philosophical blinders. Faced with a given task, they'll use whatever hardware and software will get the job done well, religious debates about microcomputing purity be damned. They're the corporate gurus who can assist any user on any machine anywhere in their organization.

But you already know this: It's *you* I'm talking about.

For some 4 years now, BYTE has covered the Mac as part of our "regular" coverage. No, that won't change. For example, the August issue of BYTE carries a full review of A/UX—Apple's interesting implementation of a "semigraphical" Unix for the Mac II.

But from time to time we want to do more, to concatenate our coverage and focus attention on the Mac in a major way.

The result is the Mac supplement you're now reading. If you use a Mac, you'll find plenty of useful information on Mac technology and applications in BYTE's best tradition—information that no Mac-specific magazine gives you.

If you're not currently a Mac user, you'll find a rich vein of interesting, perspective-building information that can broaden your microcomputing horizons and help prepare for the day when—count on it—you're called upon for advice in a Macintosh matter.

For example, "MultiFinder Revealed" isn't just a glossy list of features or a simplistic user's guide to MultiFinder. Instead, Apple's Phil Goldman—one of MultiFinder's creators—provides a true insider's look at how the Mac's multitasker works.

Another Apple employee, Rick Daley, explains some of the design decisions underlying A/UX, and he offers insights that can help make your use of or programming for A/UX more effective.

A very meaty piece on networking the Mac will fill you in on Mac-to-Mac, Mac-to-PC, Mac-to-VAX, and other connectivity options to allow the Mac to peacefully coexist with other hardware in almost any setting.

Two articles on HyperCard explain its strengths and weaknesses (as one author points out, there are times, after all, when a word is worth a thousand pictures). They go on to show you how to build practical, workable stacks, and point to some of the best sources for obtaining user-written stackware.

Jerry Pournelle, Ezra Shapiro, and Bruce Webster all offer their own unique perspectives on how far the Mac has come, where it's going, and what it's like to make the switch from the DOS world to that of the Mac.

A hands-on article on Color QuickDraw shows you how to make use of the Mac II's color capabilities.

And (of course) lots more.

We're pleased to bring you this high-quality bonus reading, and we welcome your feedback by mail (Write to: Editor, One Phoenix Mill Lane, Peterborough, NH 03458), by BIX, by MCI Mail, or by telephone.

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—Fred Langa
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SHORT TAKES

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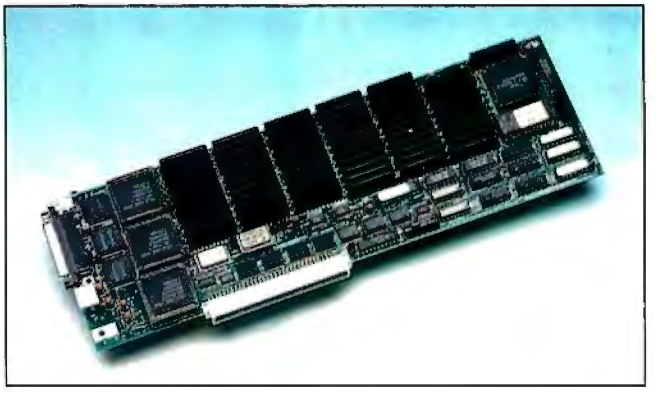

The SuperMac Spectrum/24 Video Board

If you try to use a Macintosh II with a standard video board to do image processing, you'll soon discover that having only 256 colors available for a digitized picture is pretty limiting. No longer: Not only does SuperMac Technology's **Spectrum/24** video board provide you with a 1024- by 768-pixel display on a 19-inch monitor, but each pixel can have 24 bits of color information. Put another way, while standard video boards use 1 byte per pixel for color information and give you a choice of only 256 colors out of a palette of 16,777,216 colors, the Spectrum/24 uses 3 bytes per pixel in a "chunky-planar" color format that lets you use the *entire* color palette. The Spectrum/24 also supports Apple's 13-inch AppleColor RGB monitor. Because Apple has recently announced 32-bit indexed and "chunky" direct color formats that are incompatible with the Spectrum/24's color format, it's sold only to developers. When Apple issues its system using the new color formats, SuperMac plans to release an INIT that will patch QuickDraw to properly drive the Spectrum/24.

The Spectrum/24 comes with an adapter cable and a 3½-inch floppy disk. The adapter cable matches the video board's DB-25 connector to the DB-15 connector of either a 19-inch SuperMac Color Trinitron monitor cable or an AppleColor RGB monitor cable. On the disk, a `Monitors` CDEV file lets you set the display's depth (1, 2, 4, 8, or 24 bits) and size (640 by 480 pixels, 1024 by 768 pixels, or in the 1-bit mode [4096 by 1536 pixels]) from the Control Panel. The `SMT-Images` application displays 24-bit color images. Several digitized images are on the disk for use with `SMT-Images` and show off the board's capabilities. The source code for `SMT` is included, so a developer can write applications to use the board's color capabilities.

Board installation is quick and easy: You simply turn off the Mac II, pop the hood, and plug the Spectrum/24 into a NuBus slot. Then close the hood, connect the cables, switch on the power, and drag the software files from the floppy disk to the hard disk, making sure to place SuperMac's `Monitors` CDEV into the System Folder to replace Apple's `Monitors` file.

In the 1-bit color (black-and-white) mode, you can configure the Spectrum/24 for a 4096- by 1536-pixel display, which comfortably holds a MacDraw document that's two pages tall and seven pages wide. Hardware panning, where the image automatically scrolls vertically or horizontally when the mouse pointer reaches the screen edge, is supported for this extended display. This panning feature worked smoothly.

If you find 8-bit color images breathtaking, 24-bit color images will knock you out. In this mode, digitized pictures retain their photographic quality. There is no granularity to the image: You cannot see any fringing or "boundaries" in areas of subtle color changes at all. On the down side, you'll need more memory: a minimum of 2 megabytes of RAM is required, and you'll do lots better with 5 megabytes or more. Screen updates are noticeably slower, if not downright sedate, but that's because there is 3 times as much color information to manage. However, you can set the display to the usual 8-bit color mode and work as before and use the 24-bit color mode only when your work requires it. Finally, 24-bit color image files are a lot larger than their 8-bit color counterparts: A typical 24-bit color file often fills an entire 800K-byte floppy disk. Plan to budget for a large hard disk along with the extra memory.

Although the Spectrum/24 demands more memory and limits display performance, the results are well worth it. The ability to use a virtually unlimited choice of colors with this board makes the Mac II a serious image-processing engine.

—Tom Thompson

THE FACTS

Spectrum/24 video board
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Requirements:
Macintosh II with 2 megabytes of RAM and color monitor

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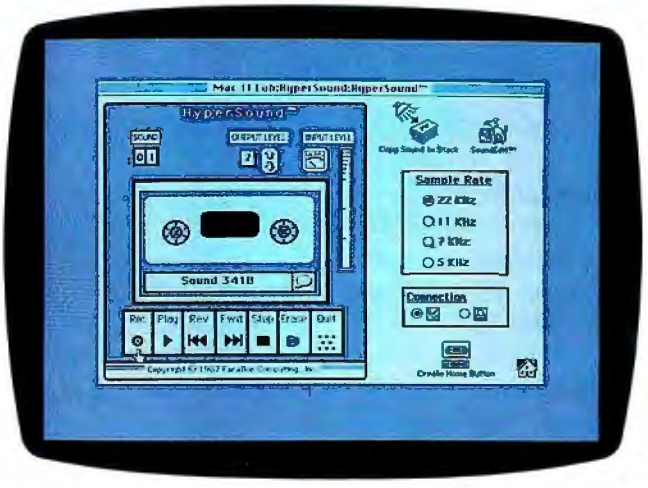

THE FACTS

MacRecorder
$199

Requirements:
Any Mac with at least 512K bytes of memory; Farallon recommmends at least 1 megabyte and two 800K-byte floppy disk drives for working with SoundEdit; HyperSound requires at least 1 megabyte of memory, at least 128K bytes of ROM, a hard disk drive, and HyperCard; users of older Macs will need a cable with male DB-9 and female DIN-8 connectors.

Farallon Computing
2150 Kittredge St.
Berkeley, CA 94704
(415) 849-2331
Inquiry M142.

tion yet—a program for putting recorded sounds into HyperCard stacks.

The MacRecorder digitizer, about the size of a big mouse, has a built-in microphone, microphone-in and line-in jacks, and a volume knob. It plugs into either the modem or the printer port. If you've got an older Mac with DB-9 ports, you'll first have to find an adapter cable; the digitizer connector has an 8-pin male plug. You can record sound live or from an audio system. With two MacRecorders, you can record two channels simultaneously. The built-in microphone isn't bad; I recorded live sounds and taped music with it, and the results were free of distortion.

The device samples sound at 22 kHz, but if you want to save space, you can set it as low as 5 kHz (where you can store as much as 3 minutes in a megabyte of RAM or disk space; at 22 kHz, the maximum is 45 seconds). When each second at 22 kHz takes up 22K bytes of memory, you have to decide between sound quality and storage. Farallon says MacRecorder will "accurately" record frequencies of up to 10 kHz.

After you've gotten the sounds into the Mac, you can work with them using SoundEdit. The program displays a window of waveforms; below it are the function icons (e.g., record, playback, and input level) and indicators (e.g., a box that shows the length of a waveform). You work with the waveform as you would a piece of text: selecting, editing, cutting and pasting, and changing characteristics. Sound strings can be stored in formats for other applications, such as Studio/Jam Session, SoundCap, and VideoWorks.

The powerful editor has a

continued

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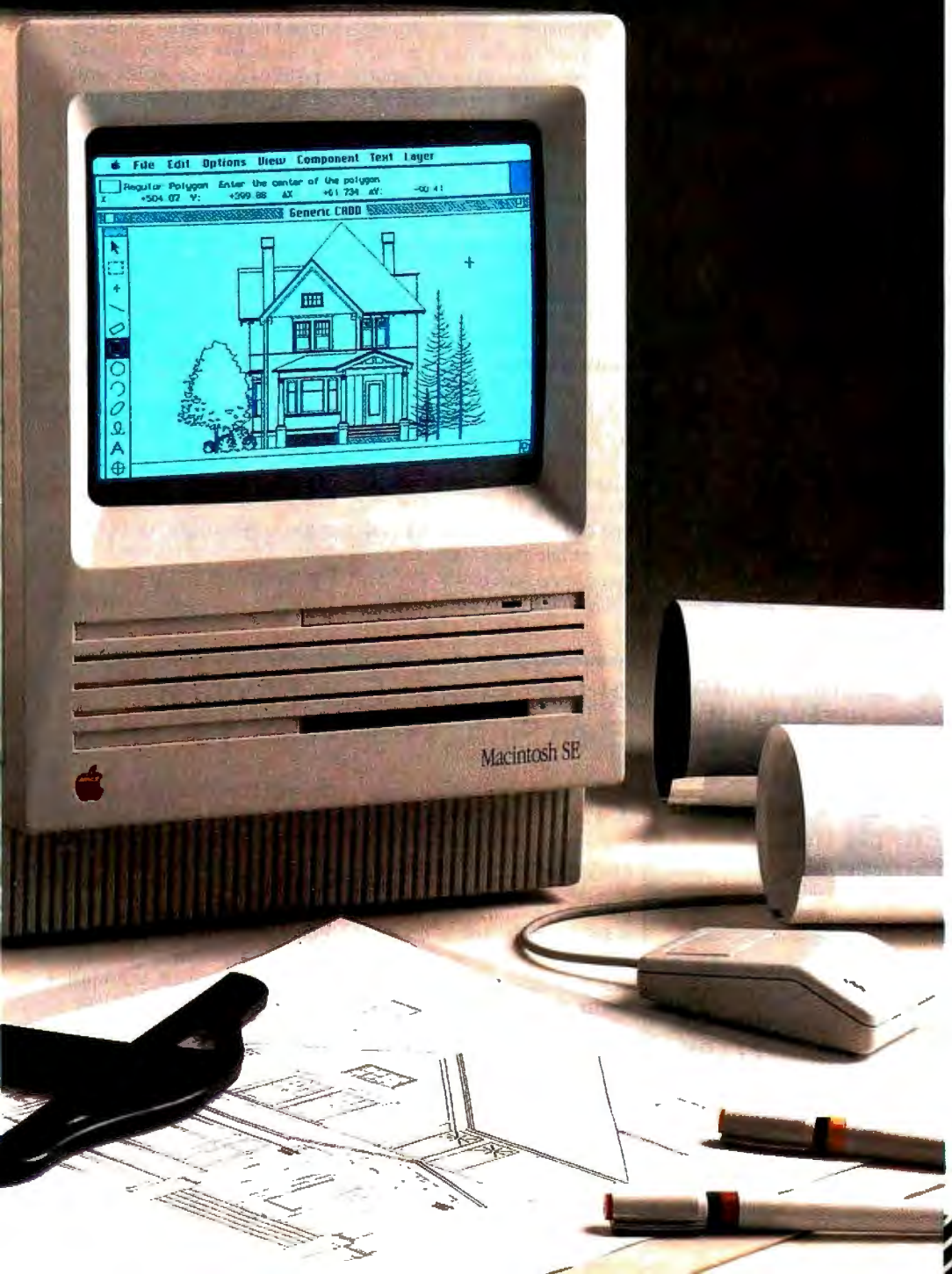

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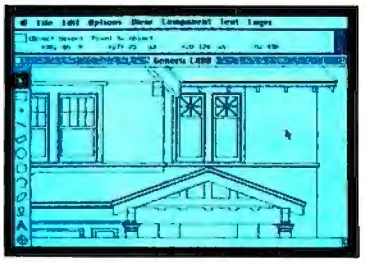

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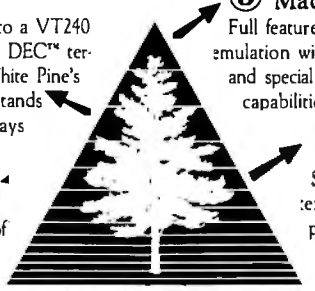

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good box of special effects that let you do all kinds of things to the sounds you've recorded, including adding reverb, changing pitch and volume, filtering, and flanging. The program can also generate frequency-modulated signals and tones.

One of my favorite effects turns recordings backward; we could have used something like this 20 years ago to run Beatles songs backward and find out if Paul was really dead, without ruining our record players.

SoundEdit also has a mixer that lets you work with input from four different channels. I don't know if professional studio engineers would use this program (and I'm sure Farallon doesn't expect them to), but you could use it at home to do some interesting things with music tracks.

HyperSound is where you can get really constructive with this package. It's an innovative program for recording mono sounds and then painlessly copying them into HyperCard stacks, from which you can play them back. The possibilities for developers working on music instruction or history stacks, for just one sample application, are intriguing. And it really works.

Getting graphics into HyperCard is simple; Farallon has made getting sound into it just as easy. You just record the sound or music or voice using MacRecorder and then copy it to the stack that you want it in; you don't have to do any HyperTalking. Due to HyperCard limitations, output has to be in mono.

HyperSound's interface looks like a cassette tape deck; you don't have to be a recording engineer to figure this thing out. The accompanying manual has a good section on sound and recording, explaining things like waveforms and frequencies, samples and cycles, and envelopes and mixers.

This is one of the best Mac packages out there because it's innovative and inexpensive; it lets you work with sound and play with sound. For people developing stackware, it's a low-cost way to add sounds to stacks, which is no little feat. My one complaint is that I wish Farallon would sell a version that comes with the adapter (male DB-9 and female DIN-8 connectors) needed to hook MacRecorder to older Macs. Finding such a cable is not easy in some parts of the world, like New Hampshire, for example.

—D. Barker

Aldus Makes a Fine Program Even Finer: PageMaker 3.0

Having done time in a newspaper production room, I'm partial to the paste-up approach to page makeup. You know: Take the typeset galley, run it through the hot wax, slap it down on the gridded layout sheet, and hack at it with an X-acto knife until it fits the design (or at least seems to fit). I took an instant liking to Aldus's PageMaker because it uses the paste-up metaphor, an intuitive approach that makes sense to me, and it means no more cranky typesetters, hot waxers, and deadly knives.

But I had enough problems with the first version of the program to make me start shopping around for another desktop publishing package. The 1985 edition of PageMaker sometimes just did weird things. Text wouldn't flow properly into the columns, chunks of type would disappear, and sometimes the program just wouldn't do what it was supposed to do. These inexplicable problems didn't occur consistently, which

continued

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THE FACTS

PageMaker 3.0
$595 ($75 upgrade for registered owners of 2.0)

Requirements:
Macintosh Plus, SE, or II with a hard disk drive; System 4.1 and Finder 5.5 or higher

Aldus Corp.
411 First Ave. S
Seattle, WA 98104
(206) 622-5500
Inquiry M143.

made them even more frustrating. But the fact that they weren't consistent makes me wonder if some Mac weirdness was to blame. (I've seen Mac users with EE degrees shrug and say, "Well, the Mac just does screwy things sometimes.") I came close to being unemployed once when a long document was delayed because of my problems with PageMaker.

Aldus fixed all that with version 2.0. I've pushed that program hard and not run into any snags. With **PageMaker 3.0** for the Mac, PageMaker got even better.

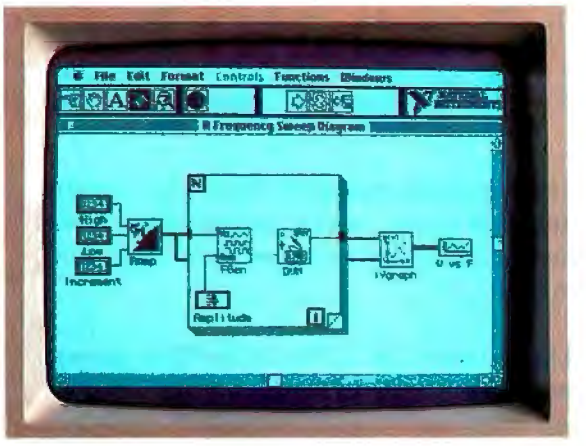
The biggest change to 3.0 is a feature Aldus calls "autoflow." In the older editions, you have to place text on the page column by column. You click the mouse, and the text pours onto the page, stopping when it gets to the bottom of the first column. You then click on a little thing that looks like a window-shade handle to get the rest of the text, move to the next column, and pour in some more text. You keep doing this clicking and loading/clicking and pouring, column after column, until the whole story is on the page.

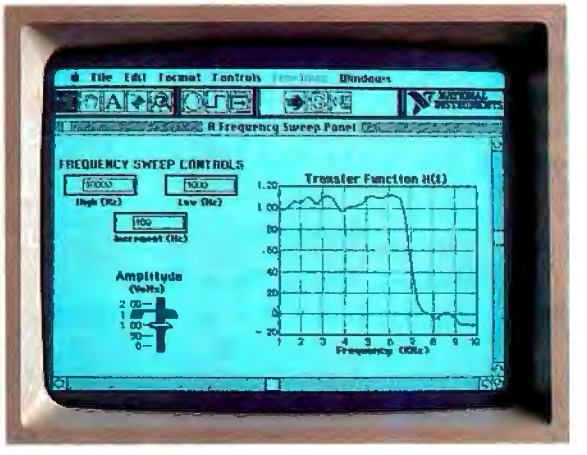
Well, with autoflow, you have to click only to get the text pouring out; the program will then snake it into subsequent columns and not stop until the whole threaded file is down on the page. This automatic flowing of text doesn't work with complicated or fancy layouts—for that, you have to use the old manual approach or the new semiautomatic approach—but it works swell with basic pages. This might not sound like a big deal, but if you're working on a long document that involves laying down lots of files on multicolumn pages, autoflow can save you hours.

If you need to wrap text around graphics, the semiautomatic text-flow mode is adequately fast and easy to use. In general, PageMaker is now considerably better at placing text in unusual ways and gives a designer more flexibility in laying out a page.

Aldus has also added publi-

continued





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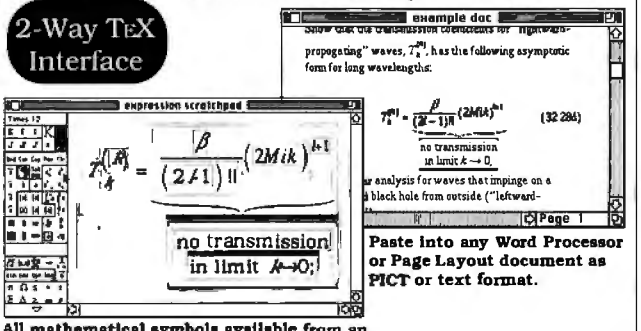

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cation templates to PageMaker. These are predefined layouts for different kinds of documents, such as a newsletter, a brochure, a business report, or a product spec sheet. Chic designers wouldn't dare use such things, but if you're in a hurry to produce a document that looks clean and readable, these templates are useful. You just delete the text that's on the prefashioned pages and dump in your own from your word-processing package. Minor adjustments depend on how fussy you are, and you can make major adjustments to these templates if you're so inclined.

I can't do justice to PageMaker's capabilities and features in this space. I've got enough room to say that 3.0 is a better package and is worth every penny of the $75 upgrade from 2.0. I've yet to find a bug. The manuals are some of the best I've read; Aldus does a fine job explaining how to use what could be a very complicated program. If you don't like reading manuals, you can work your way through this program just by jumping into it. But I wouldn't recommend that.

Although I've got a list of things I'd love to see incorporated in the next version, my only complaint with 3.0 is that it requires a hard disk drive, which means another expense for some users and (here comes the bottom line) means I can't run it on my Mac at home.

—D. Barker

Push-Button Programming for HyperCard

While you can use HyperCard without doing any programming, the HyperTalk scripting language allows you to customize HyperCard buttons, cards, and fields. Unfortunately, Apple's HyperCard user manual provides little information on how to use HyperTalk. So, to learn it, you must turn to other sources. One is **scriptExpert**, written by Dan Shafer and distributed by Hyperpress Publishing.

The scriptExpert program is a push-button code generator for HyperTalk. You can write HyperTalk scripts by simply selecting commands and messages that are displayed on the screen in the form of buttons. As you select commands, scriptExpert prompts you for appropriate messages, arguments, and loop constructs. For example, say you want to add a button to a card that beeps and displays a message. From the scriptExpert command screen, you select the Beep command and enter the number of beeps you want. Then you select the Answer command and enter the message and user responses desired. As you enter correct HyperTalk commands, the resulting script appears in a window in the right corner of the screen. An online help library is included that provides help and examples for any HyperTalk command. You can also zoom into the script window for full-screen editing of your script. After saving your script, you can return to the appropriate stack and paste the script into a button.

continued

THE FACTS

scriptExpert
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Requirements: Macintosh Plus, SE, or II with 1 megabyte of memory and HyperCard

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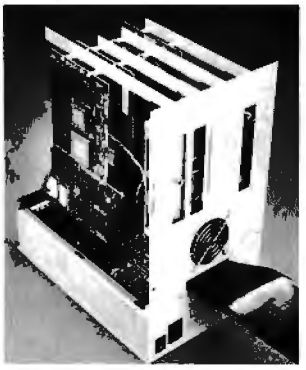

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At first glance, scriptExpert seems very inflexible. When you start a script, you have to either finish it or start over. The scriptExpert program insists on correct syntax and won't let you add invalid commands to your script. You can't save partially completed scripts and then come back later and edit them. But the purpose of scriptExpert is to help you generate working scripts, and the inflexibility actually helps novice HyperTalk programmers avoid bugs. Experienced programmers will find scriptExpert useful because it reduces the amount of typing you have to do. For example, say you want to create an IF...THEN... ELSE loop. The scriptExpert program sets up the `If` loop, and you just fill in the conditional statements and variable values. The program automatically indents the appropriate code within the loop to make your script easy to follow.

If your script does have logical bugs, you can edit the script using HyperCard's built-in editor.

My only complaint is that scriptExpert does not recover well from user errors. I lost a couple of scripts by making mistakes when editing the script window on my own.

The 50-page scriptExpert user manual is primarily a tutorial that takes you step-by-step through the process of developing a HyperCard stack application. Knowing virtually nothing about HyperTalk programming, I found the tutorial extremely helpful in understanding the basic concepts of developing a HyperCard application on my own. Although experienced programmers may find scriptExpert useful, it is really aimed at beginners learning HyperTalk. A good complement to the program is Dan Shafer's book, *HyperTalk Programming*.

—Nick Baran

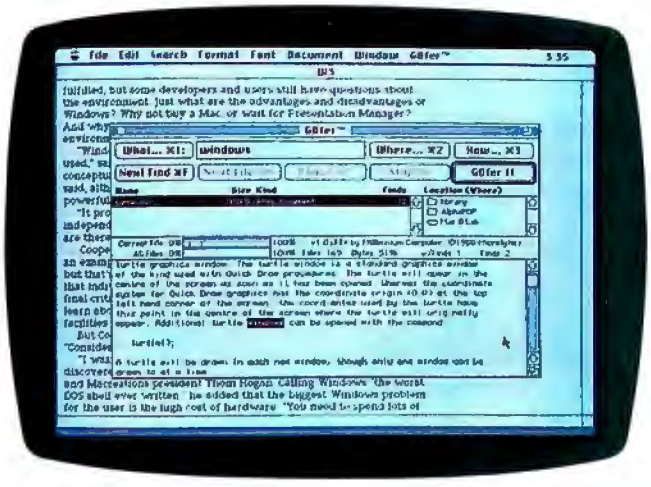
Text Retriever Pops Up on the Mac

Gofer, that handy little pop-up program for finding text buried in a file somewhere, has helped me out countless times on my MS-DOS machine. Because I also use a Macintosh, I was interested when Microlytics brought out a Mac version of the search-and-retrieve program. We've got a densely populated 80-megabyte hard disk in the BYTE Lab Mac II; there are so many files and folders on it that it's tough to quickly find whatever it is you're looking for.

The program works as a desk accessory. After you call it up, you tell Gofer what you want it (Microlytics insists on calling it "him") to find, where you want it to look, and how you want it to look. The program will search for any combination of characters or numbers, which you specify in a text-entry box. You then tell Gofer where to go, and it will look in any or every file or folder on any floppy or hard disk. The program goes on its search and keeps you posted in a window, in which you can see where Gofer is looking and how many finds it's hitting. The program will flash the finds on the screen as it flies through files or will stop at each find, depending on how you've set up the search.

You can get very specific about what you send Gofer after; you can instruct it to find exact matches or "close" matches. Asking for close matches can be risky, though. On a search of document files for anything close to *OS/2*, for example, Gofer turned up hundreds of finds, including just about every word that began with *O*. Microlytics says this approach will be fine-tuned for the next version.

If you want to be really pre-



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cise and thorough, you can set up Boolean searches using the logical operators AND, OR, NOT, or NEARBY; for example, you could tell Gofer to look for *Shapiro* NEARBY *Pournelle*, and it should find all the places where *Shapiro* and *Pournelle* are mentioned within a certain specified distance of each other.

Gofer will copy files to the Clipboard or write them to an application. If you want a hard copy of what you find, you can send the retrieved text to a printer. This capability wasn't implemented in the beta version I used, which was called 1.0a33, but Microlytics says it will be ready soon. The program can also work as a file browser, letting you scan selected files without having to set up a search.

I used Gofer to look through tons of Word and PageMaker documents, scattered across hard and floppy disks. In its simple search mode, it almost always found what I asked it to look for. When I polished up the search using the operators, it always found the text I asked it to look for. The only oddness was the scrambling of PageMaker files. In Gofer's display window, they were readable but filled with gibberish text and hieroglyphics. This should be corrected when Microlytics (or developer Millennium Computer Corp.) adds new "handlers" for different storage formats.

It's asking for trouble to compare the MS-DOS version of a program with the Mac version, but I'll do it anyway. While both programs are good, reliable, fast text retrievers, the Mac version is easier to use. The whole Mac approach—windows, menus, and dialog boxes—makes it easier to set up a search. On the other hand, it took me a while to get comfortable with the MS-DOS version.

After Microlytics implements the features mentioned in the prerelease documentation (such as letting you be more specific as to which files to look in) and makes the "close match" unit more discriminating as to what it turns up, Gofer will be a fine desk accessory for anyone who has to go through lots of crowded places to find something.

—D. Barker

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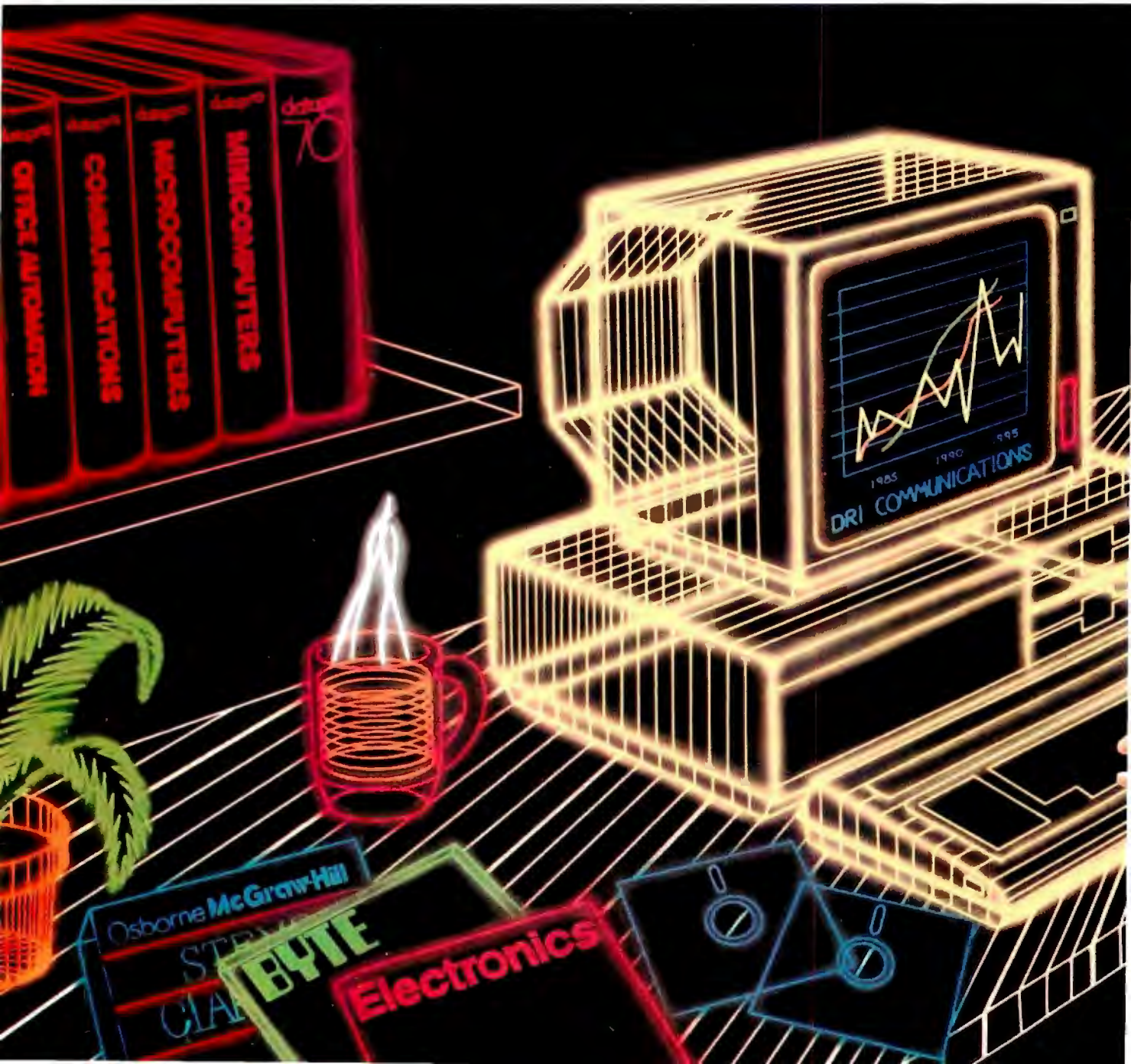

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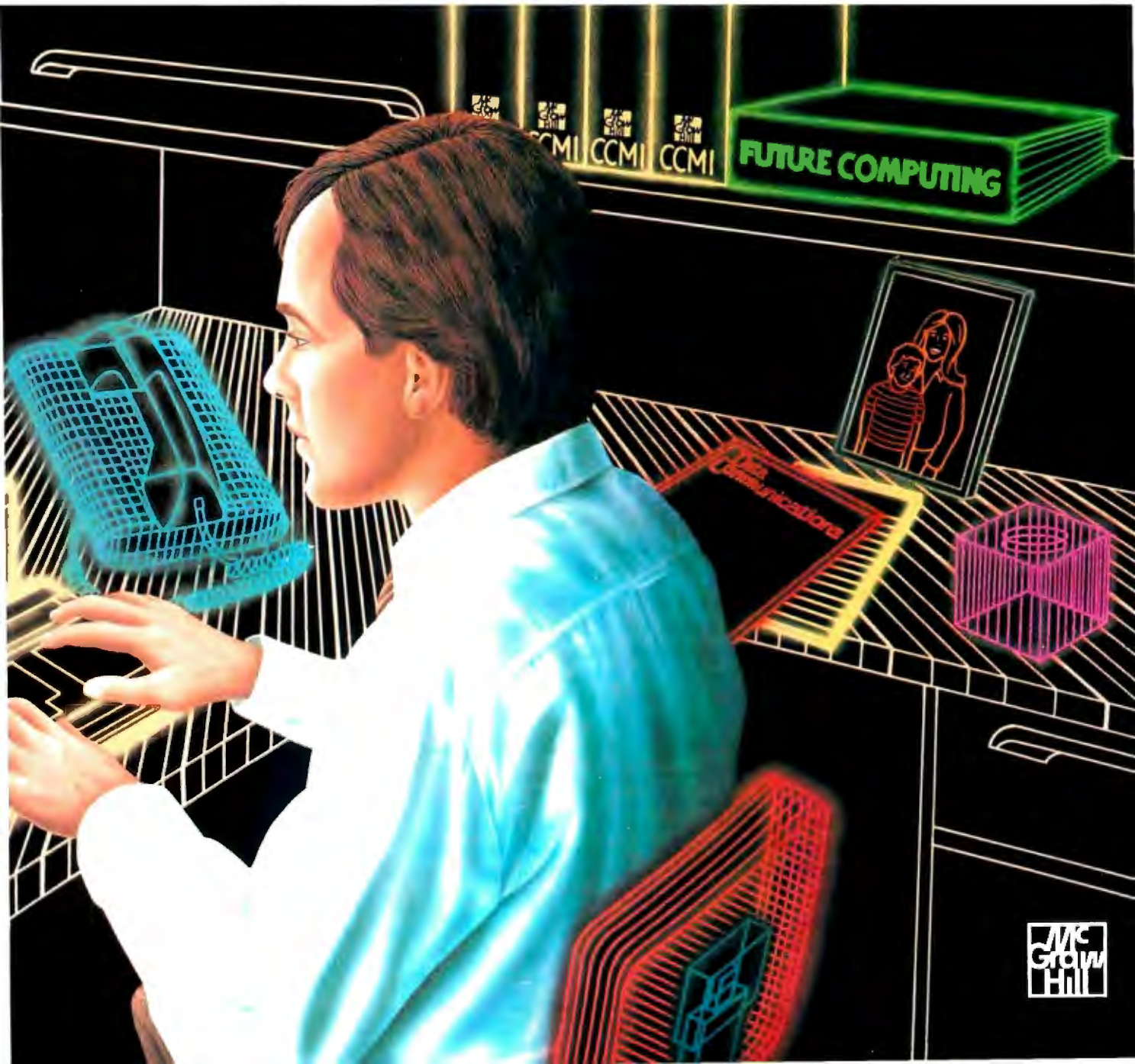

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Twelve All-Time Favorites

Ezra Shapiro

Ezra recounts the Mac's history and names his dozen top programs

Let's say you were going to be shipwrecked on a desert island for the rest of your life, and someone offered you a twist on the classic question. Instead of the traditional 10 favorite books or records, you would be allowed to bring your 10 most prized software packages for your Macintosh (yes, it's a very refined desert island, with three-pronged electrical outlets all over the place). What would you choose, and why?

The above is a therapeutic exercise that was suggested to me by Bruce Webster as a way to help me narrow my focus when I was beginning to work on this article. I dutifully sweated over my list, cheated a little ("Does it have to be 10? How about 14?"), and came up with my own personal Mac favorites. Some of the choices were predictable—and some were a little weird—but I had concocted my list.

I proceeded to put it away and ignore it for a week; when I returned to it, I noticed that it made a pretty good assessment of the state of refinement, or lack thereof, in the Macintosh universe. It also recapitulated my history with the Mac, a long story of alternately falling in and out of love with the machine.

In the Beginning

These days, it's not very fashionable to advocate a computing environment based on a closed system architecture. In many ways, however, today's open Macintosh owes its rich universe of software—if not its very existence—to the authoritarian nature of its initial design. Ask any member of the original Macintosh design team, from Jef Raskin on down, and you'll get the same answer: The Mac seduced developers into using a standardized interface.

The difficulty of writing meaningful code in the limited memory space of the first 128K-byte Mac made the interface routines provided in the machine's ROM so attractive to programmers that they adopted the standard Macintosh "look" without too much grumbling. The Toolbox ROM turned out to be far more than a collection of shortcuts for programmers; it became the guiding force in all Mac software. The combination of the Toolbox, a modular program structure, and extensive use of bit-mapped graphics proved to be a fertile ground indeed for the development of new software.

And it *was* new software, too, built around graphics rather than text. The Mac was the first successful personal computer that pumped out pixels rather than characters (though characters could be made from pixels easily enough). Looking back, it's not surprising that MacPaint was the program that propelled the Mac into consumers' hearts, while MacWrite evoked little enthusiasm, particularly from business buyers. But as the Mac slowly matured, the software base grew with it. The gaps began to be filled with spreadsheets, database managers, and other prosaic applications. It took a few years, but the Mac became a "real" computer at last.

But in the beginning, the Mac was something of a dog. Intriguing, yes. Easy to use, yes. But boy, was it frustrating to do any serious computing on the machine.

When I first joined the staff of BYTE in 1983, I found a Lisa on my desk. After playing with it for a few days, noting its slowness and inflexibility, I embarked on a serious project to unload the machine on anyone in the office who would take it off my hands. I worked out a trade and was relieved to replace the Lisa with a stock IBM PC. Nothing fancy, but software availability alone made the exchange worthwhile.

The Lisa spawned the Macintosh, and in 1984 a few Macs began filtering into the office. What caught my fancy—and indeed made everyone take notice of this new machine—was MacPaint. On a character-oriented machine like the IBM PC, I pushed words and numbers. On the Mac, I could doodle or even produce legitimate artwork. I was enchanted. So here we have the first program category for one of my Mac favorites—design.

Today, I vote for SuperPaint from Silicon Beach Software. It's a direct descendant of MacPaint, but it allows for much greater refinement. You can create with all the MacPaint tools, perform distortions, swap graphics with a wide range of other programs, edit at laser-printer resolution, magnify and shrink your work area with pinpoint control, and, in general, have a real good time. SuperPaint also lets you work on a second plane of draw-type artwork, so you also get much of the functionality of MacDraw.

I have to give a nod of appreciation to GraphicWorks, which is equal in many respects to SuperPaint, though more confusing and tougher to learn. GraphicWorks was originally named ComicWorks, and it's designed to integrate text and graphics into the sort of panels you'd have in a comic strip. The airbrush tool is more adjustable than SuperPaint's, and you can work on multiple layers. Another nod goes to Adobe Illustrator, Aldus FreeHand, and Cricket Draw, all excellent programs at the higher end of professionalism for the serious artist. But the all-around winner is SuperPaint.

One aside: I have to promote one other art program to my list, Fontographer from Altsys. With it, you can create your own laser fonts. It predates any other program that manipulates the Bézier

continued

curves that make up PostScript outlines, and it contains the germ of the technology on which they're all based. If you're patient, you can do wonderful things with this product.

Back to the Story

Even though I fell in love with MacPaint, I did not fall in love with MacWrite, Apple's companion word-processing program. The typefaces were nice, but I could run rings around it with grubby old WordStar on the IBM PC. So I held back; I was not yet ready to become a Mac convert.

The program that started to convince me that the Macintosh might be a tool for more than creative doodling was ThinkTank 128 from Living Videotext. This gem of an outliner ran perfectly well on those early memory-poor Macs. Writing an outline, then moving branches of it from place to place, made perfect sense as a mouse operation. It was exciting to realize that text manipulation could, in fact, be a very visual process.

ThinkTank 128 was rudimentary compared to the version for MS-DOS machines; many of the spiffier editing features were nixed due to memory constraints. But as soon as the Macintosh was fattened to 512K bytes, there was ThinkTank 512, which was more than enough to fulfill the promise of its predecessor. ThinkTank 512 had a host of new features, including a convenient text editor that let you create long text sections as part of an outline, and the ability to import graphics. ThinkTank 512 was suddenly far more than an outliner; it was a word processor, a database for artwork, and a spectacular tool for constructing tightly organized reports.

The reigning heir is called More (though Living Videotext has become part of Symantec), and it defines the state of the art in outline processing. More remains true to the visual outliner from which it grew, but it's almost an operating system in and of itself—an operating system within the context of indented outlines. You can use the program to sketch ideas, flesh them out with the word-processing functions in the editor, create databases with installable outline templates, dial phone numbers, convert your outlines to tree diagrams or bullet charts, and on and on and on.

More was one of the first programs to launch the discipline of desktop presentation, and it is so good a program that I almost forgot to include it in my list. It's such a natural, I assume everyone has it; I have to remind myself that it isn't sold as a part of the Mac package.

The Next Phase

Shortly after the arrival of the 512K-byte machine, dubbed the Fat Mac, my head was turned even farther by PageMaker from Aldus and Microsoft's Excel spreadsheet. PageMaker was responsible for that all-consuming concept of desktop publishing. It lets you gather text and artwork created with other programs and pull them into finished layouts. It's based on the metaphor of the paste-up artist's drawing board, and you cut and paste on the screen as you would in a graphics studio, only you can dispense with the scissors and the rubber cement.

PageMaker began as a sophisticated piece of program design, and Aldus has continued to improve it. We're now up to version 3.0, which finally lets you create humongously long publications without having to perform every little design operation one at a time. It fully supports style sheets (in fact, it can exchange named styles with Microsoft Word 3.01), and it is a pleasure to use.

I have to nod at Quark XPress and Ready-Set-Go! 4.0, PageMaker's worthy competitors, but PageMaker was my first love in this category. Also, PageMaker was the program that convinced me that the Mac was a real machine, one that I could both use *and* love.

Excel proved that the Macintosh interface was ideal for spreadsheets. Though I wouldn't have thought so before, it turned out that zooming around on a grid of numbers was made easier with a mouse. And Excel allowed linked worksheets to avoid the bloat of large worksheets fenced into smaller regions for printing. The program also has an exceptionally powerful macro language. Excel was the spreadsheet that finally began to get the Mac into business workplaces.

However, I haven't included Excel as one of my top choices, but only due to my personal habits. Though I like spreadsheets, I'm not a number cruncher by trade. I vote for Microsoft Works, a nice integrated package with spreadsheet, word processor, database, and telecommunications modules. Nothing spectacular, but solid and reliable. With the addition of two add-in programs from Tim Lundeen, WorksPlus Spell (one of the slickest spelling correctors I've ever used) and WorksPlus Command (an awe-inspiring macro package that completes the job of integration), Works handles just about everything I need to do. Needless to say, it's also my winner in the word-processing category.

If you need super power in any of Works' areas, I'd recommend going with a stand-alone program (Works is a mite slow), but for overall flexibility, Works with the Lundeen additions is my pick.

This Year's Craze

"Hypertext," the current buzzword in Macintosh application design, has come to be a term that's at least as ill-defined as desktop publishing, the former title-holder in the ambiguity department. As near as I can figure, hypertext means "interrelated text and graphics organized by the creator into a structure not necessarily bound by the limits of hard-copy output." In other words, hypertext is an attempt to exploit the abilities of the computer itself as a presentation device. Typically, hypertext programs let you link screen areas (called buttons) that can be clicked with a mouse to reveal new regions of data.

Rather than nominating HyperCard, Apple's hypertext Erector-Set-in-a-box, or Guide, a solid implementation of the concept, I find myself leaning toward TeleRobotics' Course Builder, a program that lets instructors manufacture self-contained teaching programs that implement many of the core ideas of hypertext. Written by the prolific Bill Appleton, Course Builder lets you link artwork, sound, text, and animation into the framework of a teaching system. A student can move from item to item at his or her own pace, answer multiple-choice or specific-answer quizzes, and refer to related materials in a neatly structured environment.

What's so beautiful about Course Builder is that you don't have any need to program; you define the course using a straightforward "logic editor" (that's my phrase, not Appleton's). You simply link blocks representing elements of your course in a kind of flowchart, and then Course Builder does the rest for you.

The other prong in my mild attack on HyperCard is provided by 4th Dimension, the database development system from Acius. If you're going to have to program, you might as well go for top power. This is a full-featured relational database that gives the developer absolute control of the interface. You want your own menus, click boxes, entry forms, whatever? Fine, you got 'em. You can program and debug in a programmerish way, or you can build a flowchart (much like Course Builder), and away you go. This is my choice for databases.

My third hypertext-like favorite is a game, Chris Crawford's Balance of Power. Working with maps, menus, graphs, and descriptions, Balance of Power lets you play out a global political

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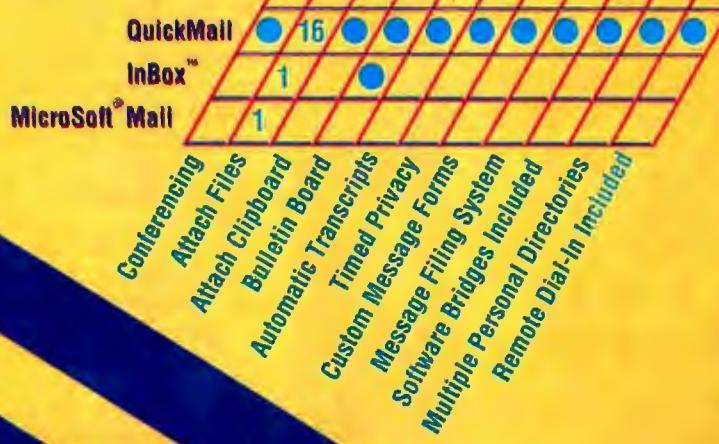

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Finally, Some Fun

VideoWorks II from MacroMind is another impressive example of pushing the Mac interface to its limits. It's an animation package that lets you mix sound and graphics into your own Macintosh movies. You have to write a script (called a "score"), which takes some time to learn, but once you get the hang of it, you're in the motion picture business. VideoWorks II even provides a nice shortcut if you're pressed: You can place an object on the screen in one position, place it again in a second spot, and VideoWorks II animates the transition.

It could very well be next year's hypertext; if not, it still represents a great area for creative exploitation. Even if you don't want to make your own cartoons, you can use it to animate your bar-graph or pie-chart presentations. Imagine an exploded diagram that actually explodes!

Not All Roses

Of course, depending on whom you talk to, the Macintosh interface is far from perfect. It lacks a number of the amenities we've come to associate with more traditional computer systems. The icon-based environment is certainly easy to learn, but some users eventually resent the way the Mac's simplicity gets in the way of real operating speed. I have rounded out my set of favorite programs with three utilities that extend the power of the Macintosh's operating system to cover some of the gaps.

One of the Mac's most lamented deficiencies is the absence of a good keyboard macro facility. Fast touch-typists find the constant interruption of mouse movements to be both distracting and time-consuming, particularly during text entry. Though most menu functions can be abbreviated to a combination of shortcut keystrokes, mouse actions (e.g., scrolling and selecting) are not usually automated from the keyboard. Enter QuicKeys from CE Software, a keyboard enhancing utility that lets you attach any single Mac operation to a one-keystroke combination command. You can still mouse along if you want to, but judicious assignment of functions to keystrokes will keep your fingers on the keyboard

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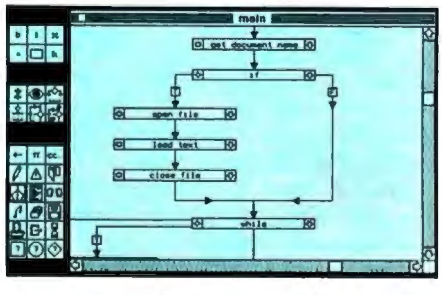

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Lundeen & Associates
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and your train of thought intact. You can even chain keyboard macros into long sequences, thus automating a whole string of commands.

My second utility, one that is fast becoming everyone's favorite, is a little program from Steve Brecher of Software Supply called Suitcase. The original Mac design allows for only 16 desk accessories and a limited number of fonts (the maximum varies from program to program). If you like to have a large collection of memory-resident desk accessories, or if you want wider access to the growing panoply of Mac typefaces, you need Suitcase. Though there are theoretical limits, installing Suitcase gives you as many accessories and typefaces as any mortal normally needs. You're more likely to run out of RAM and/or disk space before you make Suitcase choke.

The third utility, Solutions' SuperGlue, is a print-to-disk driver that lets you look at formatted output on the screen without requiring the originating program. If you send a file to disk using SuperGlue, the saved image can then be manipulated by any other program as if it were a graphic. Thus, you can capture a page of a spreadsheet, drop the image into a layout program, shrink it, and make marginal notes before printing it out. You can build a report with a word processor that uses the output of any sophisticated analytical tool you have.

In many cases, the SuperGlue image is smaller than the original file, which is handy for data transfer and true electronic publishing. The program lets you crop, resize, reposition, and extract text from images to your heart's content. Why Apple didn't see a need for such a utility built into the operating system is beyond me, but this little gem is an essential addition to the Mac arsenal.

I wish I could add one more capability to this list of remedial utilities—batch files, some sort of concise language to pipeline a series of operations that involves a number of programs and a number of files. I'd settle for the ability to add a shell to the Mac interface that could give me (dare I say it) a command line with batch handling that is not based on icons. I realize that this flies in the face of the icon-and-mouse dogma, but the more you work with computers, the more you appreciate ways to slice off a few seconds, even if it involves procedures that are not quite so easy to learn.

The Wrap-Up

There you have it, an even dozen recommendations spanning the range of Macintosh applications: SuperPaint, Fontographer, More, Works (with WorksPlus Spell and WorksPlus Command), PageMaker, Course Builder, 4th Dimension, Balance of Power, VideoWorks II, QuicKeys, Suitcase, and SuperGlue. If you ask another Mac aficionado for his or her top dozen selections, you probably won't get the same list, but I guarantee you'll get several duplicates. The Mac is getting its share of excellent software. ■

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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Macintosh Redux

Bruce F. Webster

It's mid-April as I write this, and a lot of water has gone under the bridge since last I wrote for BYTE. I've moved back to California, penned a number of articles for other publications, written some manuals for a certain unnamed software firm, and have even started work on my first honest-to-goodness book. So, why am I here? Because, in light of my extensive and consistent coverage of the Macintosh from 1984 to 1987, BYTE has graciously invited me back for the first-ever BYTE Macintosh supplement. They figured I might have a few things to say, and, true to form, I am *not* at a loss for words.

The still-warm (but cooling) news is, of course, the lawsuit by Apple against Microsoft and Hewlett-Packard for "violation of audiovisual display copyright," because Apple thought that the New Wave user interface from HP looked too much like the Mac Finder. And, of course, Microsoft has filed a countersuit. The merits and issues of this case are best discussed elsewhere (and, in fact, I think I will), but it indicates the direction Apple's attitude has taken since the Mac burst upon a skeptical world 4½ years ago.

The path from then to now was anything but easy for the Mac

Evolution in Action

I first saw the Macintosh in Guy Kawasaki's office at Apple, in December of 1983, a month or so before its announcement. Wayne Holder and I were there, representing Oasis Systems/FTL Games as president and vice president, respectively. Our ostensible purpose was to consider porting our word-processing utilities (spelling, punctuation, and style checkers) to the Mac. Our real purpose was to see the Mac ahead of time. I was initially disappointed at the lack of slots, but Guy assured me that schemes were underway to use the high-speed RS-422 ports as "virtual slots."

Three weeks after the Mac was announced (February, 1984), I bought one, off the shelf, with money out of my own pocket. It had 128K bytes of RAM, 64K bytes of ROM, a 512- by 342-pixel monochrome display, a single 400K-byte floppy disk drive, no slots (virtual or otherwise), and an 8-MHz 68000 processor. It was slow, crashed a lot, required multiple disk swaps to copy a file, and had little software available. But it was mine, and I was thrilled to have it.

The Macintosh I use today is a Mac II, with 5 megabytes of RAM, 256K bytes of ROM, two displays (AppleColor high-resolution RGB monitor with a fully expanded Mac II video card, and a Sony GDM-1952 19-inch Trinitron RGB monitor with the SuperMac Spectrum video card), a 40-megabyte hard disk drive, an 800K-byte floppy disk drive, six NuBus slots, a 16-MHz 68020 processor, and a 16-MHz 68881 math coprocessor. It's fast, seldom crashes, has thousands of software titles available, and copies files with no extra disk swapping. Unfortunately, it's not mine, and I'm not sure when I'll be able to come up with the money to buy such a system.

Apple has come a long, long way in the past 4 years, as has the Macintosh. The Mac was initially derided as a toy or dismissed as a curiosity. And through the last 4 years, it's always been a major source of controversy and contention. The Mac versus IBM debates have been hot and heavy, reaching a level of intensity reserved for such classic issues as calculators (RPN vs. algebraic notation), languages (Pascal vs. C, BASIC vs. Pascal, and assembly vs. high-level), and operating systems (Unix vs. anything else).

Now, the Macintosh is the system that everyone either wants or wants to imitate, IBM included. That's something of an amazing feat.

How Apple Got There

The path from then to now was anything but easy for the Mac. It's hard to remember now, and seems incredible in retrospect, but it was several *months* after the Mac's introduction before external disk drives (much less hard disk drives) were generally available. After an initial spurt of sales, fueled by technophiles like me, the Mac went into a slump for almost a year, a slump that many believed was not only the end of the Mac but the end of Apple as well. Some of Apple's decisions along the way (anyone remember the $1000 RAM upgrade from 128K to 512K bytes?) did little to help things. Even the emergence of the "Fat" Mac with 512K bytes didn't help that much; software and operating system alike were space hogs, and the memory and disk configurations of the Macintosh just weren't sufficient to handle their demands.

The real breakthrough, in retrospect, was the Mac Plus. With 1 megabyte of RAM and an 800K-byte floppy disk drive as standard, plus a small-computer-system-interface port for hard disk drives and significant speed improvements in the operating system and ROM, it was the first Mac system that had the resources and horsepower to do serious work. Sales took off, surprising everyone (including, I suspect, Apple); for a while there, the Mac Plus was the single best-selling model of computer in the U.S. The enlarged basic configuration and improved sales drew in a lot of software development firms that had been watching from the sidelines.

The final steps toward success were the introductions of the Mac SE and the Mac II. Like a lot of other folks, I fo-

continued

cused mostly on the Mac II (an open Macintosh, at last!) and dismissed the Mac SE as just another "toaster," in a platinum case instead of beige. However, it was the SE that shot off in sales this time, displacing the Mac Plus. The key was the capacity for an internal hard disk drive. Sales reports I've seen indicate that about 80 percent of all Mac SEs are sold with a hard disk drive.

Meanwhile, the Mac II established an open architecture for the Mac family. Hardware developers now had a standard upon which to base their efforts, and owners had a machine that could be expanded with special tools and bizarre cables. And, despite the hefty price tag, Mac II sales have been strong.

What Apple Does Right

Given its strong financial condition and growth of market share, Apple has done many things right. But what the company does best isn't something that shows up directly on the balance sheets, though ultimately it's reflected there. Its greatest strength is that *Apple operates from a place of vision*.

Before I get accused of succumbing to Apple evangelism, let me explain. I've visited a lot of computer firms, talked with their leaders and employees, read their press releases, and used their products. It's obvious that a lot of them have an attitude of "sell the iron and move on." Most of those companies just get by, despite (in some cases) having significant or innovative products. The ones that succeed the most are the ones with a vision, whatever it may be.

Apple, from what I can see, has a very well defined vision of the future and its role in that future. Its vision is reflected in its internal documents, in the talks given by its people, and by its communications with developers. The company is planning now for products that will be released in 5 years, based on how it thinks things will (and should) be then. Apple sees its products as a force for social change—hence the almost religious fervor at times. But this imbues the company with a desire for innovation not often found at firms concerned only with the bottom line.

That innovation gives Apple an important place in the market; it is the leader and everyone else is following, even IBM and Microsoft. What else can you say after an IBM spokesman, at a press conference about the forthcoming Presentation Manager, explains the product's need by pointing to the relatively brief time required for learning how to use the Macintosh? Would products like Presentation Manager, GEM Desktop, and Amiga's Workbench really exist if it weren't for the Macintosh? The fact is, Apple has some hot ideas and technology, and others want it for their systems.

In the ancient Chinese game of Go, there is a term, *sente*, which refers to one player having control of how the game is being played. I have *sente* if every move I make forces you to respond. I may have a weaker position overall, but for now, I get to control how the game goes, because you perceive each of my moves as being too threatening to ignore.

Apple has a very well defined vision of the future and its role in that future.

Apple right now has *sente* in the computer market. Apple plays the user-interface move; pretty soon, everyone is trying to come up with a Mac-like user interface (while, of course, avoiding a lawsuit). Apple plays the desktop publishing move; pretty soon, everyone says they're into desktop publishing. As other moves come into play, the rest of the players must react. That may be overstating the situation, but not by much. Just look at all the nifty "new" concepts in hardware and software on MS-DOS systems and ask yourself: How many of these showed up on the Mac first? Apple leads instead of following.

This is not to say that Apple doesn't derive ideas and concepts from elsewhere; its heritage from the Xerox PARC and other such places is well known. But the Xerox PARC stuff was around for years; why didn't anyone else use it before Apple? As it was, IBM (and Microsoft) waited until the Mac user interface was well established (and well proven) before tentatively following suit. No pun intended. It's easy to see how many concepts pioneered or developed on the Mac have migrated to other systems; there is little evidence of concepts flowing the other way.

One more thing that Apple does right, at least from the viewpoint of its employees and stockholders: It makes money. Lots of it. True, that's not always popular with consumers. I've groused for years about Apple's standard product pricing policy: Start it out high, let it drift down as needed to keep supply and demand matched, make one last official price cut to make room for its replacement product, then (at some point) halt production and let the remaining inventory sell off. And it works, especially with good products. The result is that Apple had $1 billion in sales during the last quarter of 1987, with net profits double those of a year earlier. On top of that, Apple has no real debts. Adjusting for the 2-to-1 stock split that took place last year, Apple stock currently sells for about $82 a share, whereas 3 years ago it hit bottom at around $13 a share. And that cash allows Apple to continue its innovation.

What Apple Does Wrong

I was tempted to make this section "What Apple *Did* Wrong," but it's too easy to pick over Apple's past mistakes, and, besides, it's been hashed over too many times already. What's more, Apple has fixed many of those problems. The real question is, what is Apple doing wrong now?

First, Apple is squandering its advantage. *Sente* works only as long as you are willing to avoid responding directly to your opponent's moves. Once you decide to turn and fight, there's a good chance of *sente* shifting to your opponent. And I think that's what may very well happen with the Apple lawsuit against HP and Microsoft.

Let me stop here to say that I am not as unsympathetic to Apple's suit as others are. Apple has a copyright on the Mac user interface; to fail to defend that copyright could mean losing it. And, as I've pointed out, it is Apple who spent the money and took the risk, and the company is less than thrilled about other folks jumping on the bandwagon after the fact, especially when some of those folks have the initials *IBM*. Apple has fought long and hard to get into corporate offices; its penetration is based largely on the strength of its user interface and its desktop publishing abilities. The IBM/MS-DOS domination is based on a substantially inferior user interface; how much of Apple's gains will disappear if the Other Side comes up with something even half as good as the Mac?

Having made Apple's case, I must now assert my feelings that the lawsuit will ultimately cost the company more than it saves. Reaction among industry, press, and users (including a lot of Mac users)

has been overwhelmingly negative. Some have even pointed out how good IBM looks by comparison. This, of course, ignores IBM's litigious history, as well as its subtle hints about landing with both feet on anyone cloning PS/2s without a license; I'm not sure the comparison is valid.

I don't think the lawsuit is unfounded, but I do think that it won't slow up the competition as much as Apple hopes, and it will cost the company more in goodwill than it's worth. Ultimately, the only way for Apple to continue to succeed is to continue to innovate. Rightly or wrongly, many interpret the lawsuit as a tacit admission by Apple that it doesn't have much else going for it.

The second thing that Apple is doing wrong is ignoring the home market. MS-DOS clones have gotten so inexpensive that they are making a substantial penetration into households, hurting sales of Apple IIs (especially the overpriced IIGS), Amigas, and Atari STs. Apple has taken a step in that direction by dropping the price of the Mac Plus some, but the drop isn't enough; you won't see significant home market penetration of the Mac until it hits the critical $999 price point. Given how little it costs to make a Mac Plus at this point (even with the rise in RAM prices), Apple could afford to sell the Mac Plus that cheap. True, margins on the Mac Plus itself might be a bit thin, but anyone who buys a Mac is going to buy an Imagewriter and probably an external floppy or hard disk drive.

Besides, Apple is ignoring the influence that the home market can have on business purchases. If I buy a cheap MS-DOS clone for home, I have a strong incentive to have an MS-DOS system at work as well. If I have a Macintosh at home, chances are I'm going to want one at work, too, both because I can bring work home and because it's a heck of a lot easier to use all the way around. Folks have a way of getting hooked on the Mac; having an inexpensive home system could well be another foot in the office door.

Third, Apple is getting a bit too complacent, smug, and fat. Complacent, in that it is slow to correct design flaws and bugs in its products and has sometimes been unwilling to even acknowledge their existence. Smug, in that the company goes around telling everyone its vision and seems terribly sure that no one else has an equal (much less superior) vision; that no one else might pass it up in the race for leadership. Apple might be in for a surprise. Fat, in that its current growth is explosive and appears to bog down operations somewhat. I've had friends interview at Apple recently who have commented on how nobody seems to know fully what's going on, that they aren't willing to take action or make a decision. A recent article in the *San Jose Mercury News* (Business Section, March 17, 1988, by Alex Barnum) stated that the group within Apple that is responsible just for finding and buying real estate consisted of over 100 people. The symptoms of corporate obesity are starting to appear.

Apple's Current Problems

On top of what I think are its current mistakes, Apple also has a number of problems to face. The biggest problem is the aging of its system software. John Sculley has publicly stated that Apple is doing a slow rewrite of the entire operating system. Good. MultiFinder is, from a user's viewpoint, nicer than the original Finder, but it's still not a true multitasking system. Ultimately, it's going to require a from-the-ground-up rewrite of the Mac operating system to transform it from what was developed for that original, crippled 128K Mac to something capable of truly supporting a multimegabyte, multitasking system with large mass-storage devices. The question is, can Apple do that without making all the current software obsolete? The answer is, possibly, but it ain't gonna be easy.

Another problem is the challenge of developing applications for the Macintosh. Apple has done little (if anything) to make the Macintosh easier to program. In fact, with the introduction of color, sound, and MultiFinder, programming the Mac has become even more difficult. Look at all the major companies that have had delay after delay in release dates for Macintosh software, in some cases over a year. A fair amount of criticism has been leveled at those firms (and sometimes justly so), but the trend has gotten too broad for it to be strictly a problem of the firms themselves.

A case in point: the WordPerfect Corporation. I happen to be good friends with one of the lead programmers on the team that developed the Macintosh version of WordPerfect. Back when I was living near the company in Orem, Utah, I used to ask him regularly how things were going. The response I usually got was a rueful grin, a shake of the head, and a brief discussion on the newest obstacles presented by the Mac operating system and ROMs. These were bright, talented, knowledgeable programmers; they were just frustrated by a system that was difficult to code for. The common wisdom about programming the Mac is that there is a steep learning curve at first, then it tapers off. In truth, there are two steep curves, the second showing up as you try to get an application ready for market. In other words, once you get the knack of it, it's very easy to produce Mac software that's 75 percent reliable. It's that last 25 percent (especially the last 10 percent) that's a killer.

Finally, lawsuit or no lawsuit, Apple can't keep its competitors from being innovative. Even IBM appears to have learned some things from Apple and seems to be taking steps to foster creativity in PC development and to market its products more aggressively. The problem with being the leader is that everyone has a clear shot at your back. If Apple can't respond quickly and effectively, it may find itself falling behind.

Future Directions

Ezra Shapiro made a cogent observation about predicting the Macintosh's future: Those who know what's really being developed won't talk, and those who are free to speak don't really know what's going on. I'm in that latter group, but, heck, I've never let a lack of hard information stop me before.

In the MS-DOS world, you have an almost continuous spectrum of systems from under $1000 to over $7000; in many cases, you can use the same expansion cards (and certainly the same software) on both extremes of that range. In fact, it's easy to start out with a system in the sub-$2000 range and upgrade it, piece by piece, to the over-$6000 range, with commensurate improvement in power, speed, and flexibility.

By contrast, you've got four basic Macintosh systems: Mac Plus; Mac SE with floppy disk drives; Mac SE with a hard disk drive; and Mac II with a hard disk drive. (Yeah, you could buy a Mac II with just floppies, but that's like buying a Ferrari with a two-gallon gas tank.) The Plus, SE, and II have three different standards for hardware expansion; the Plus has different ROMs than the SE and the II; and only the II supports color (officially). In other words, you basically have three subfamilies within the Macintosh line, with little ability to recycle hardware as you upgrade.

Apple needs something to bridge the gap (in money, size, compatibility, and performance) between the Mac SE and the Mac II. Two possibilities come to mind. One is an "SE-in-a-box": a system that looks somewhat like a Mac II, though possibly smaller, with just a 16-

continued

MHz 68000 on-board and a socket for a 68881. It would have room for two floppy disk drives, or a floppy and a 3½-inch hard disk drive. It would also have, say, four slots. Such a box could sell for around $2000, the current street price for an SE with two floppies. Yet it would allow users to make use of multiple video cards, color displays, and other Mac II expansion cards. And it would be a great add-in box, encouraging owners to expand in a way the Mac SE doesn't.

The second possibility is a mini-Mac II, essentially a Mac II in the box described for the Mac SE above. It would create a Mac II that didn't take up quite so much space or cost quite so much. It would have fewer slots, but the smaller box would be more popular in corporate desktop settings. A motherboard upgrade from the SE-in-a-box to the mini-Mac II would be yet another source of revenues for dealers and Apple alike. It would be priced to sell for about $1000 less than a equivalent Mac II system.

Finally, there's probably a Mac III in the future—essentially a Mac II with a 68030 processor, an 80-megabyte internal hard disk drive, and lots of memory. It might even have some direct memory access support and a graphics coprocessor, though Apple has shown a sad reluctance to unburden the CPU from doing just about everything. The Mac III will be a good $1500 to $2000 more than an equivalent Mac II system and will be aimed at the workstation market.

From Scorn to Success

Apple has done a great job of taking a system that so many scorned and making it a rousing success. However, success can lead to complacency, complacency to caution, and caution to stagnation. The Macintosh has replaced the Apple II as Apple's breadwinner. Is Apple working on the Macintosh's replacement?

As for me, the ride's been fun. The Macintosh has long been my system of choice, and the shots I've taken at Apple over the years have been out of a desire to see things improve, not out of any intent to harm or tear down. I hope that things do continue to improve at Apple; I'll be interested to see what steps the company takes over the next year or so. In the meantime, I've got work to do, so I'll get off my soapbox and get to it. ■

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

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Take a Walk on the Mac Side

Jerry Pournelle

Jerry unleashes a Macintosh II on his treasure trove of software

I'd worked until quite late and was trying to sleep in, when I was awakened by hysterical laughter. Roberta was standing at the foot of the bed whooping, "Now they've done it!"

"Uh? What?" I demanded.

"Now they've done it!"

No matter what I said, she cackled insanely and repeated her line. I got up and padded to the front door, where I found they'd indeed done it: I was greeted by a pile of boxes higher than my head. In fact, several piles of boxes, all wedged together. Enough boxes that it was impossible to get past them. We were barricaded by boxes of computers.

"Now they've done it," Roberta giggled. I had to admit things had gone a bit far. Just then the UPS truck drove up with more boxes, only there wasn't any way for him to get past the ones Federal Express had delivered—and the mailman was coming.

Eventually, we got the stuff sorted out and brought inside. It wasn't all computers. Some was stuff we had ordered from Sears. Some was software—it's amazing what all Microsoft sends in their OS/2 package.

Most, though, was from Apple: a Macintosh II, a color monitor and monitor stand, two enormous boxes of software, a LaserWriter, and another box of accessories for the LaserWriter, including cables for AppleTalk. There was also Priam's new 330-megabyte MacDisk and some other stuff I've forgotten. All told, it nearly filled the front room.

Each box from Apple was topped off with a paper threatening dire consequences if I lost anything: machine, software, boxes, packing material (including plastic worms); Apple wants *everything* back. The letter is stiff enough that I contemplated packing everything back up and getting it out of here the same day, but of course I didn't. Eventually, we had everything upstairs and unpacked, and I sent the boxes out to our public storage locker.

Setting Up

Everyone has the problem of computer furniture, but with me it's worse than most because we have so many systems here: not just computers, but also printers and monitors. Although there are always one or two main machines I'm using constantly, most systems are here just for testing. There's not enough space for everything, so some machines have to be brought out, used awhile, then put away until new software or boards arrive and they're needed again.

I looked at commercial computer enclosures, and I even bought one from Yield House, but it was too expensive and too large.

Then I bought several heavy-duty, two-shelf, lab-equipment rolling carts and fastened keyboard drawers under their top shelves. These were large enough for big machines like CompuPro S-100 "boat-anchor" systems with 8-inch disk drives. The only problem was that the carts were *too* big; it wouldn't take many to fill the storeroom.

Then the local Builder's Hardware had a sale on microwave carts. These come with casters and three shelves. There's even an enclosed bottom compartment, where I can store system documents and software. The tops of these carts were too high for comfortable typing, but I solved that by making a plywood shelf that I attached at the proper height and putting a keyboard drawer under that. These carts worked so well that Roberta is using one as the permanent place for her AT&T computer.

Those were fine at first. The carts were nearly perfect for early IBM computers. Alas, they're no good at all for Macintoshes. There's no room in those keyboard drawers for a mouse to operate. You can put the mouse on the shelf above the keyboard, but reaching across the keyboard for the mouse gets tiresome in a big hurry.

After many experiments, I set up my Mac Plus on an oversize typing table. The Plus sits on the AST-2000 hard disk drive, the DataDesk 101-key keyboard sits in front of that, and the mouse rests next to the keyboard on a genuine Apple mouse pad thoughtfully provided by Apple's Bruce Chamberlain. All in all, it works quite well.

I've also seen a computer desk called a Mac Station from Hubbard Furniture. This comes on casters and has a drop-down keyboard shelf that's wide enough for keyboard and mouse. Alas, neither the Mac Station nor a simple typing table will work with a Mac II. The machine is too large, and you don't want to sit as close to the Mac II monitor as to that of the Mac Plus.

Hubbard also has a two-shelf system on casters. This isn't bad, and it would be more than good enough for most offices; but due to severe space limits, I need the area under the table for manuals, and the Hubbard system wasn't designed for that. I could see that the Mac II was going to need a lot of space for manuals—at least at first—and I'd also need a place to put the MacDisk.

I temporarily solved the problem by putting the Mac II on one of the rolling lab carts and setting the keyboard and mouse on a typing table in front of it. This works pretty well, but it makes for an awfully big station.

The furniture problem isn't made any easier by the Mac II's basic design. The

continued

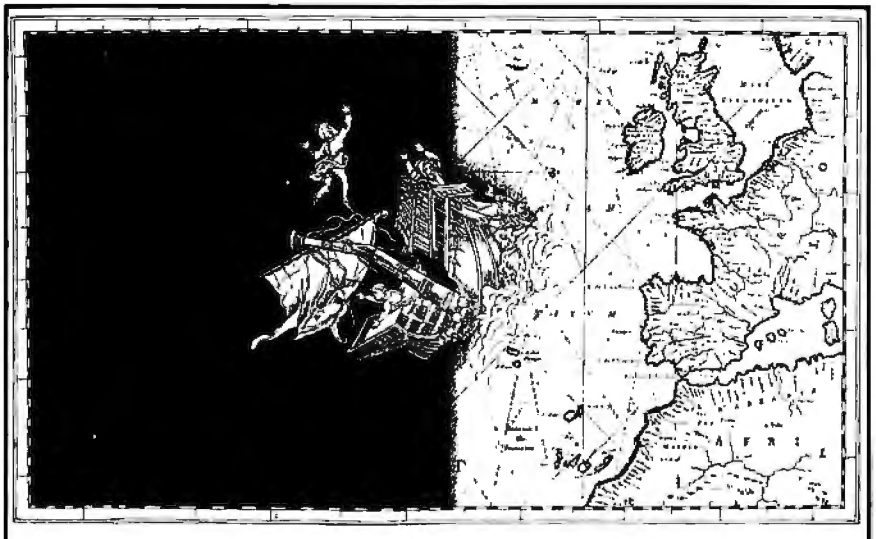
keyboard port is on the back, on the right side as you face the Mac II. The cable has to be plugged into the *left* side of the Mac II keyboard, because, although there's a cable socket on the keyboard's right side, you have to plug the mouse into that.

I suppose if you're left-handed everything would be fine. Well, maybe not. Even if you plug the mouse into the left side of the keyboard, you won't want to route the keyboard cable along the right side of the Mac II because that's where the hardware reset button is. Sometimes you just can't win.

Once you decide where to put the Mac II, setting it up is a snap. The monitor is clean and crisp. Its stand is worth commenting on, too. Most monitor stands are clearly afterthoughts, but the Mac II's tilt/swivel stand was clearly designed for the system and is about the best-working one I've ever seen.

After you get everything installed, you won't have to reach behind the machine very often, either. Although there's an on/off switch back there, the Mac II has a shutdown command in *software*. When you use it, both the Mac II and the monitor are completely powered down. There's a switch right on the keyboard that turns them back on. This is an idea whose time has come.

Incidentally, it's just as well that the shutdown procedure turns off the Mac II's monitor; it gives off more heat than my 19-inch Electrohome monitor.



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Getting Started

When the Mac II came, I was in the middle of doing my taxes. Tax time at Chaos Manor used to be pretty grim, but lately it's been much better. First, over the years I've refined my accounting program—written in compiled CBASIC for CP/M and later transferred to an IBM PC—to the point where it does most of the work.

There's still a flurry of year-end entries into the journal, but that's more tedious than difficult; and once all the entries are made, the accounting software posts them to over a hundred ledger pages, keeping track of what was family expense and what was business expense, then posts the proper percentages of family items like electricity and house insurance into the appropriate ledger pages. I did have to go in and manually correct entertainment to match the new tax law's 80 percent requirement, but that was no problem.

The second reason I don't go mad trying to do my taxes is SoftView's MacInTax. I've said before that MacInTax is worth buying a Mac for—and I haven't changed my view. Taxes are traumatic enough, though, that I didn't want to be learning to use the Mac II while I was doing them, so I set MacInTax up on the Mac Plus.

Everything worked fine until I wanted to print my tax forms. Then I discovered that the Mac Plus had forgotten how to use the Imagewriter.

I don't normally have a printer attached to the Mac Plus. The Imagewriter, a very early one bought (along with the 128K-byte Mac that eventually was upgraded into a Mac Plus) about a month after Apple brought out the Macintosh, normally resides in my youngest son's room. Richard Stefan is on the Notre Dame debate team—they're going to both the state and national competitions this year—and has his own Mac that he uses to support the debate team activities. Every year, though, I borrow the Imagewriter to print my taxes, and it has always worked until now; thus, it was

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quite a shock when it wouldn't print.

Since it was after 6 p.m. on April 15th, I was more than a bit concerned. Then I remembered the Mac II. Surely it would know how to print. In something of a panic, I unpacked the Mac II and set it on one of my test stands. I didn't read any papers. I just plugged the cables into the obvious places and turned it on.

It came up just fine. I used the Mac Plus to download MacInTax and all my tax forms onto a 3½-inch floppy disk and brought that over to the Mac II; made a new folder on the Mac II's hard disk drive and labeled it "Taxes 1987"; and copied everything into it. MacInTax came up fine when I double-clicked it. For about a minute I contemplated setting up the LaserWriter, but I thought that might be pushing my luck. I connected up the Imagewriter and tried to print.

I forget the error message, but it was considerably more informative than the one I got with the Mac Plus; it said something about driver not installed, I think. Whatever it said drove me to open the Mac II manual for the first time. That told me that on disk II of the System Tools I would find the Imagewriter driver, and I should copy that into the System Folder on the Mac II's start-up disk. Then I should use the Chooser, which I'd find by pulling down the Apple Logo, to install the Imagewriter, after which everything ought to work fine.

It did. In a couple of minutes I had the satisfactory sound of the printer going wheep! wheep!, and I could go to dinner. It took about an hour to print out the forms, but so what?

I figured out the next day that if I'd followed the same procedure—copying the driver into the System Folder and using the Chooser to select it—on the Mac Plus, that would have worked, too. I think what happened is that sometime in the past year, one of the boys updated the system software on the Plus and didn't bring over the printer driver.

Anyway, once the taxes were done, it was time to set up the Mac II properly. As I said earlier, the modified microwave carts were totally inadequate, so I found a new and better workstation; the Mac II is now right next to my desk.

The Mac II is shipped with a booklet that says "DON'T DO ANYTHING UNTIL YOU'VE READ THIS." Naturally, I didn't see it until long after I had the Mac II up and running; if I had, I wouldn't have had to go to the thick Mac II manual to get my taxes printed. The booklet is pretty complete on how to set it up and get going. A pity I didn't see it earlier, but there was no harm done.

On the other hand, I did learn that you really can get these things going with a minimum of fuss and bother. Most of the setup is intuitive, and where it's not, the manuals are very clear and well indexed. Usually. There are exceptions, as we'll see; but my pleasant introduction to the Mac II certainly prejudiced me in its favor.

Priam MacDisk

I have a Priam 330-megabyte hard disk drive on my big Cheetah 386, and I love it. While I was on the phone to Priam's Pat Kline, I mentioned that I was getting a Mac II.

"We make the same disk for the Mac that you have on your PC." She laughed. "Want to try one?"

That decision didn't take long. As it happens, the MacDisk came in the same

continued

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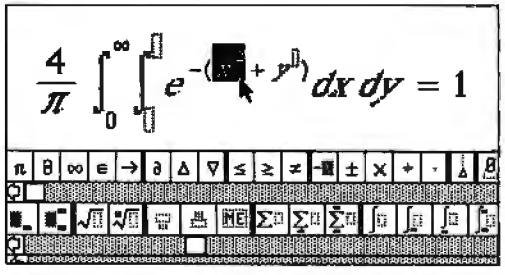

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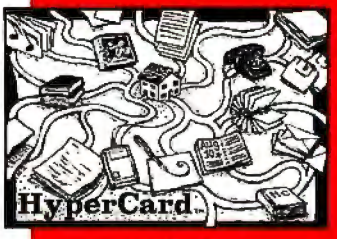
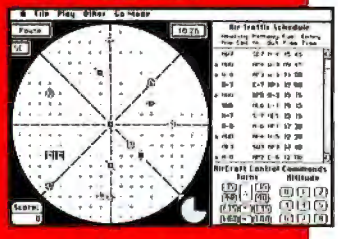


150 Games



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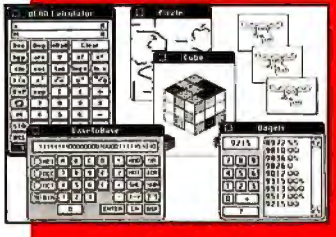

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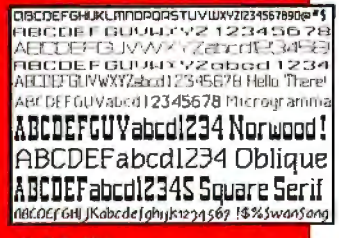

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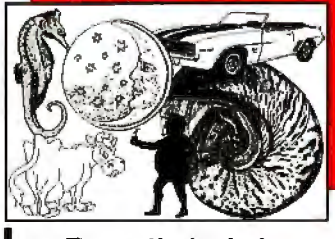

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shipment as the Mac II. I didn't install it on Panic Night—at the time I wasn't interested in anything but getting my taxes out the door—but when it came time to set up the Mac II, I had the MacDisk ready.

The first problem was that the documentation, while quite complete, never mentioned the Mac II at all. It told how it could be connected to a Mac Plus or an SE, but that's all. But it was clearly a small-computer-system-interface (SCSI) device. I called Priam just to be sure; but if I hadn't managed to get anyone, I was prepared to go ahead and connect it to the Mac II anyway. As it happens, I got a technician who told me I'd guessed right—installation is the same for the Plus, SE, and II.

The MacDisk is a self-contained box about the size of a ladies' shoe box. It has two lights on the front and a little window on the back. The lights are the usual power-on and disk being accessed. There are buttons above and below the little window. By pushing these buttons, you can make any number between 0 and 7 appear. If you intend to boot your machine from the MacDisk (as you might if you have a Plus or an SE with no other hard disk drive), the number must be set to 1; otherwise, it can be anything but 1 or 7 (7 is reserved by Apple for internal use).

The little buttons are close to the power switch on the back, so it's easy to hit one by accident. If you do, there's no permanent harm done, but your Mac may not be able to find the MacDisk until you put the setting back the way it was.

Installing the MacDisk is the simplest thing in the world. Set the priority number in the little window; connect the SCSI cable to the Mac II and the MacDisk; plug the SCSI terminator (supplied in the box with the MacDisk) into the other slot on the back of the MacDisk; and turn on the power switch. Now turn on the Mac, insert the disk that comes with the MacDisk, and transfer the Priam file into your start-up System Folder. Reset the Mac.

Once that's done, you're in business. The MacDisk is already formatted, and it has 330 megabytes available. It's blazingly fast: an 11-millisecond average seek time, meaning it's about as fast as RAM disks were in the old CP/M days. Like all Priam disk drives, it's rugged. I've had one in my old CompuPro 8/16 Dual Processor since 1982. It's in use just about every day, and while I always tell people to back up their data, the fact is that I have never lost a byte from any Priam disk drive.

When you turn off the power to the MacDisk, it automatically parks the heads in a safe landing zone. You can then carry it to another machine, like a Mac Plus or an SE, plug it in, and—provided that you've installed the disk-access driver—the new machine will be able to get at all the files on the MacDisk. I've been using the MacDisk for painless data transfer from the Plus to the Mac II.

Also, since the MacDisk has two SCSI ports on the back, you can daisy chain it with any other SCSI device, including another MacDisk. In my case, I chained it with the AST-2000 that resides under my Mac Plus. The AST-2000 does *not* have two SCSI ports, but it doesn't mind being downstream of the MacDisk.

I have two minor complaints about the MacDisk. First, it has a more high-pitched noise than I prefer. It happens that though I am nearly deaf in the lower frequencies, I hear high frequencies better than most people, so I may be ultrasensitive; no one else seems even to have noticed the sound. Also, I don't want to make too much of this. The MacDisk is certainly no noisier than the fan in the Mac II, and after a few minutes, I don't notice either one of them.

The second complaint is the cable's length. The cable Priam supplies is just long enough to let you put the MacDisk next to your Mac II. If you put it on the right-hand side, it will block access to the hardware reset switch. It would go nicely on the left side, but as it happens, I have the Mac II all the way over to the left side of its lab cart.

A better place for the MacDisk is on a shelf underneath the Mac II, and that's where mine is, but it has to sit on a box because the blooming cable isn't long enough to let it rest on the lab cart's lower shelf.

The odd part, incidentally, is that the AST-2000, which sits underneath the Mac Plus a mere 3 inches away from the Plus's SCSI port, comes with a cable about 3 feet long. One day I'll swap those cables.

Anyway, those are minor irritations, easily worth putting up with for what I get: blinding speed, utter reliability, and enough disk space that even I won't fill it up soon. Highly recommended.

Keyboards

I've been using DataDesk 101-key keyboards on all my PCompatible computers for some time. I was never much impressed with the original Macintosh keyboard, and the one they installed when they upgraded the machine to a Plus wasn't a lot better; so when DataDesk of-

fered me a Mac Plus keyboard, I jumped at it.

I've been using it for months now, and I'm very fond of it. True, after I spilled Grand Marnier in it the keys began to stick, but I cured that by washing it in the kitchen sink; about 100 dead ants floated out. I dried it with a hair dryer, and it has worked fine ever since. DataDesk keyboards are rugged, and I like their feel.

Naturally, I supposed that the Mac II keyboard would be the usual Apple clunker, so even before I got the Mac II, I got DataDesk to send me their Mac II keyboard.

I was wrong.

You can save money by buying a DataDesk keyboard and getting your Mac II with no keyboard at all, and that may well be worth doing. There's nothing wrong with the DataDesk keyboard. Indeed, it's pretty good. It even has the sockets for the keyboard cable and mouse in the center of the board, which is a much better place for them than where Apple has them. DataDesk also gives you free software to configure your function keys; Apple makes you pay extra.

The feel of the DataDesk keyboard for the Mac II is *not* the same as those for the Mac Plus and PCompatibles; it's more like the original IBM PC keyboard's feel. It's also about that noisy. If you loved the old IBM keyboard, you'll love this.

The thing is, though, the Apple Mac II keyboard is more than pretty good. It's very good indeed. It's sculpted. The keys have a good feel—for my money, better than the DataDesk Mac II's (but not as good as the DataDesk for the Mac Plus or PCompatibles). The only odd thing about Apple's Mac II keyboard is that the little bumps to indicate home keys to a touch-typist aren't on the *f* and *j* keys where you'd expect them, but on the *d* and *k* keys. This can take getting used to.

Apple's Mac II keyboard does cost more, and you'll also have to buy configuration software; whether it's worth the difference in cost is something for you to decide. For me, the bottom line is that I've installed the Apple keyboard on the Mac II and put the DataDesk keyboard in the closet; but then, I'm not paying for it. (I still use the DataDesk keyboard on the Mac Plus.)

Software

After I got the Mac II set up with the 330-megabyte MacDisk, I went poking about in nooks and crannies turning up Mac software. There was a lot. After a while, I happily sat down to a perfect orgy of software installation.

Alas, a lot of stuff won't work with the Mac II.

It's particularly sad that I can't run Strategic Conquest Plus on the Mac II. This was my runner-up Game of the Year for 1987, and it's in contention for 1988 as well; it's one of those games that's fun to play many more times than once. You can save games in progress on the AST-2000 hard disk drive on the Mac Plus; to actually run the game, you need the copy-protected hard disks. (You can run the game from copied disks, but if the game detects that, it sets the difficulty level impossibly high and proceeds to blow you away.)

You can start the game from the hard disk drive, but it looks to the floppy disk drive; if the game's disk 1 is in the internal drive, the floppy disk drive trundles for a moment, then ejects disk 1 with a message asking for disk 2. Disk 2 contains all (and only) the files concerned with sound effects. After they're loaded into memory, the disk is ejected and the machine asks for disk 1 again.

If you try running the game on the Mac II, though, it loads and appears to be running; but disk 1 never pops out, and you are never asked for the sound-effects disk. The game plays, but there are no sound effects. I then tried transferring both game disks to the hard disk drive and starting up from here (with the original disk 1 in the Mac II's floppy disk drive), but I got the same result. It never sees the sound effects.

On the other hand, the Mac II's screen is bigger than the Plus's—and the game shows more of the game map on the Mac II's screen than it did on the Plus. Also, when it generated a map, it made the *strangest* one I've ever played on (and I've played a lot of Strategic Conquest Plus, I'm ashamed to say). I played it for a while; the game seems to play fine, except for the lack of sound effects. Eventually, I saved the game onto a floppy disk and transferred it to the Mac Plus. It runs fine there. I'm even winning; I wasn't winning on the Mac II, which I suspect thought I was playing with a pirated copy.

On the other hand, Reach for the Stars, another game much played here, not only runs fine on the Mac II but comes up automatically in color. You see more of the star map, and it's certainly faster. Of course, it's not copy-protected, either.

Compatibilities

There's no predicting what will run on the Mac II and what won't. Dark Castle—one of the most visually impressive

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games ever done—won't run; whether it's started from the hard disk drive or the floppy disk drive, it gives the following message:

"Sorry, Dark Castle cannot run because there is a problem with the way memory is allocated (77588878 high bytes).

"This could be due to other software that is already installed in memory (for example, Switcher, Tempo, RAM disks, print spoolers, network software, etc.).

"The simplest way to avoid this type of problem is to turn off the Macintosh and start up using Dark Castle disk number one."

Needless to say, following that advice only produces that same message.

MindWrite is a rather good word processor and outline program that I have grown rather fond of on the Mac Plus. It isn't copy-protected, either: it runs fine off the Plus's hard disk drive. However, not only wouldn't it work on the Mac II, it failed disastrously: when I tried to run it, the machine hung so thoroughly that I had to use the hardware reset to recover.

Apparently the MindWrite folks had the same problem I did when I tried to run MindWrite 1.1 on the Mac II. They wrote MindWrite 1.1 to Apple's specs and released it shortly before Apple released MultiFinder. They tell me that Apple changed the MultiFinder just before they released it, in a way that causes MindWrite 1.1 to crash. They're providing a free update that corrects the problem.

On the other hand, WriteNow, an easily learned and very "Mac-like" word processor/text editor that was written before the Mac II ever came out, works fine on every Mac I have, from the old 512K-byte Mac through the Plus to the II (and is perfectly adequate for most of my word-processing jobs).

Epyx's Sub Battle, which is also not copy-protected, almost works, but some of the visuals are distorted, there's no sound, and eventually the machine hangs and has to be reset. Mac Attack, a tank battle game, has to be started from the floppy disk drive; when you do, it first displays a logo, then a message that the sound effects won't work on a Lisa (!), then finally gives you bombs and a system error message, after which the machine goes so dead you have to use the power switch to restart it.

I could go on listing things that do and don't work, but surely the point is made: you simply can't know what Mac Plus software will run on the Mac II. In general, it's less likely to work if it's copy-protected, but that's no infallible guide, as witness MindWrite. All I can really tell you is to experiment.

LaserWriter and AppleTalk

The Apple philosophy is to make things simple. That's fine as long as everything works. But as soon as something goes wrong, it's a different story.

Setting up the Mac II was simple enough that I didn't think there'd be any problem installing the LaserWriter. After all, the directions were clear. I went through them step by step, installing first the hardware, then the software. In 5 minutes both were done, and it was time to test the printer.

It wouldn't work. The Mac II couldn't find the printer. Unfortunately, the error message wasn't any more helpful than that, either.

I went back through the printer documents and carefully followed the installation procedure again. When that didn't work, I read everything I had about

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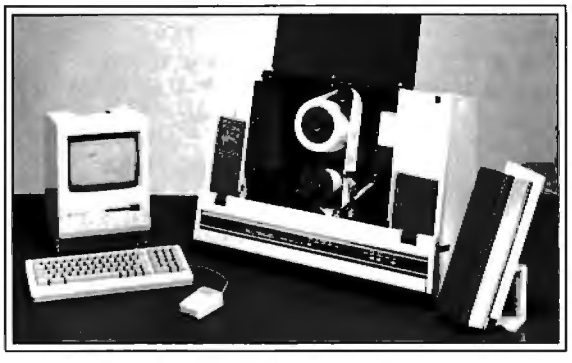

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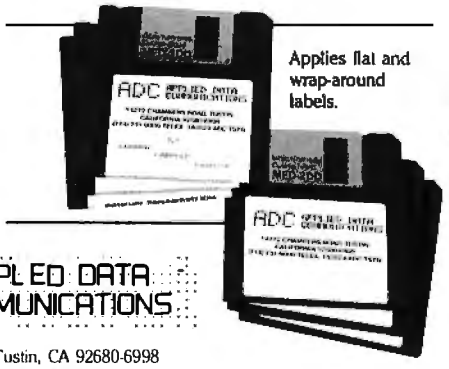

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AppleTalk. Alas, that wasn't much, but it was enough to show I'd connected all the cables properly.

Finally, I tried setting up the Mac Plus to run the LaserWriter. I got the same results as with the Mac II. That printer just wasn't talking to computers. It was time to call Apple. I suppose I could have used this as an opportunity to test Apple's technical-support system, but BYTE was in a tearing hurry for this column, so I called the office that sent me the Mac II in the first place.

The people there know their stuff. I described what I'd done. I was conducted through a few tests. I'd guessed them from the documents, but I was glad to have my guesses confirmed. The diagnosis was positive: either a cable was bad, or the electronics board in the LaserWriter had gone south in shipment. I was offered a choice: they'd send new cables and a new electronics board by Federal Express, or I could take the printer to a local Apple dealer. I opted to have the parts sent to me.

By this time, I was really desperate. This was a Wednesday afternoon. Thursday at noon I was due to catch an airplane to Colorado Springs to take part in some activities at the Air Force Academy. On Saturday morning, I was due to catch an airplane that would get me back here just in time to attend Larry Niven's 50th birthday party—and this column had to be in New Hampshire by the following Monday morning.

Apple was true to their word: on Thursday morning, the new cables and board arrived. It took me precisely 1 minute to replace the LaserWriter's electronics board. (I'll admit that I rehearsed by removing and reinstalling the original the night before.) Then I plugged in the new AppleTalk cables and turned on the system. It still didn't print, but that was because I'd skipped a step in the reinstallation; when I called in the Chooser and set things up properly, everything was fine.

Cables

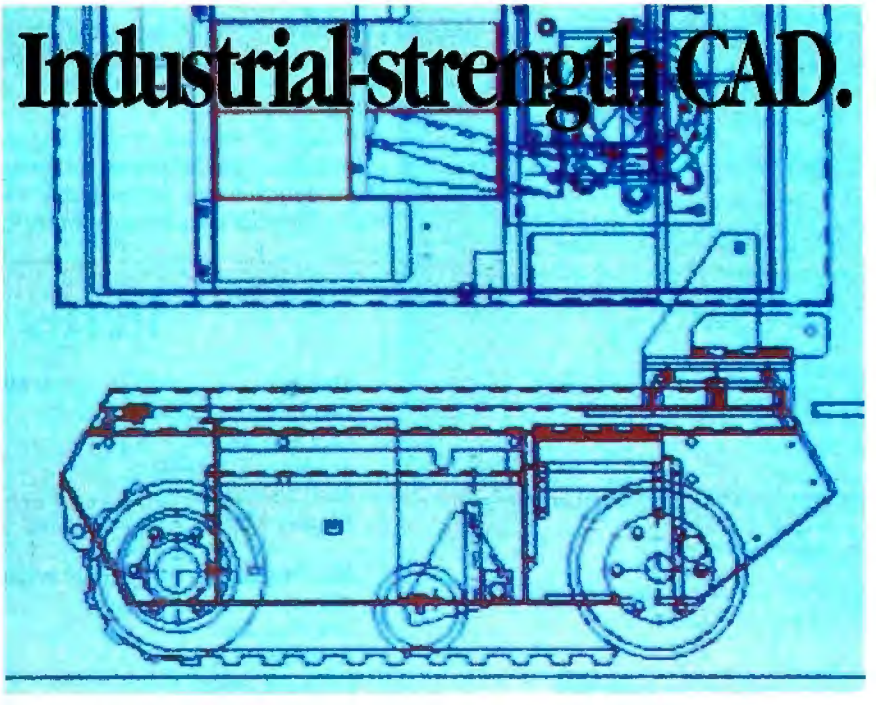
After I got back from Colorado Springs, I left the new cables in place and reinstalled the old board in the LaserWriter; not only wouldn't it print, but I got the same symptoms as before. So that board definitely was defective; it wasn't the cables at all.

On the other hand, it might have been. I've had some experience in cable design: I was once in charge of human factors for a good part of Boeing, and designing cable ends so that they can't be plugged in backward or to the wrong place is one task of the human factors group. Thus, I can say with some authority that the Apple cabling system is a miserably poor design.

The original Macintosh—all the way up to the Mac Plus—used standard DB-9 plugs for the printer and a different plug system entirely for the keyboard. Under the new system (Mac Plus, SE, and II), *all* Apple cables terminate in tiny round cable ends about ⅜ inch in diameter. Some of these cables have 8 or 9 active pins in them. Others have only 3 or 4.

They're supposed to have small plastic keys that make it impossible to plug the wrong cable into the wrong socket, but in fact that doesn't work. It's not only physically possible, it's also fairly easy to jam an AppleTalk (9-pin) cable into a socket intended as the auxiliary keyboard socket. Worse, since these are on the back of the machine and are labeled only with ambiguous (and tiny) icons,

continued



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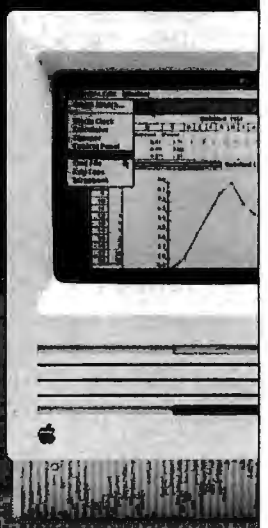

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that's easy to do even if you're trying to be careful. I managed to do it, with the result that the machine did some very *odd* things until I set it right.

Worse, though, if you do jam the cable into the wrong socket, you may well damage the cable. The pins in a male Apple cable are tiny and are easily pushed deep into the cable end. I ruined two AppleTalk cables. One was repairable with needle-nose pliers and a lot of patience. The other had the wires pushed so far back into the cable that nothing would get them out again. Since it's also impossible to take the cable housing apart, once that plug is damaged, you're probably going to have to buy a new cable.

Except for potential profits to Apple in cable sales, I see no reason for going to these delicate and unrepairable cable ends. I predict considerable profit for a third-party outfit ready to supply better cables for Apple computers.

WriteNow Nonsense

WriteNow is not a bad editor, but its publisher, T/Maker, has done something that could drive you crazy if you're not careful.

T/Maker provides you with two disks, one containing the WriteNow program, and another with a demo version called Sample WriteNow, which you're free to copy and pass on to friends who want to try it out. Sample WriteNow works just like the regular version, with one exception: it prints "CREATED WITH SAMPLE WRITENOW" across the top and bottom of every page of every document you create.

Here's the problem: if you have Sample WriteNow anywhere on your hard

continued

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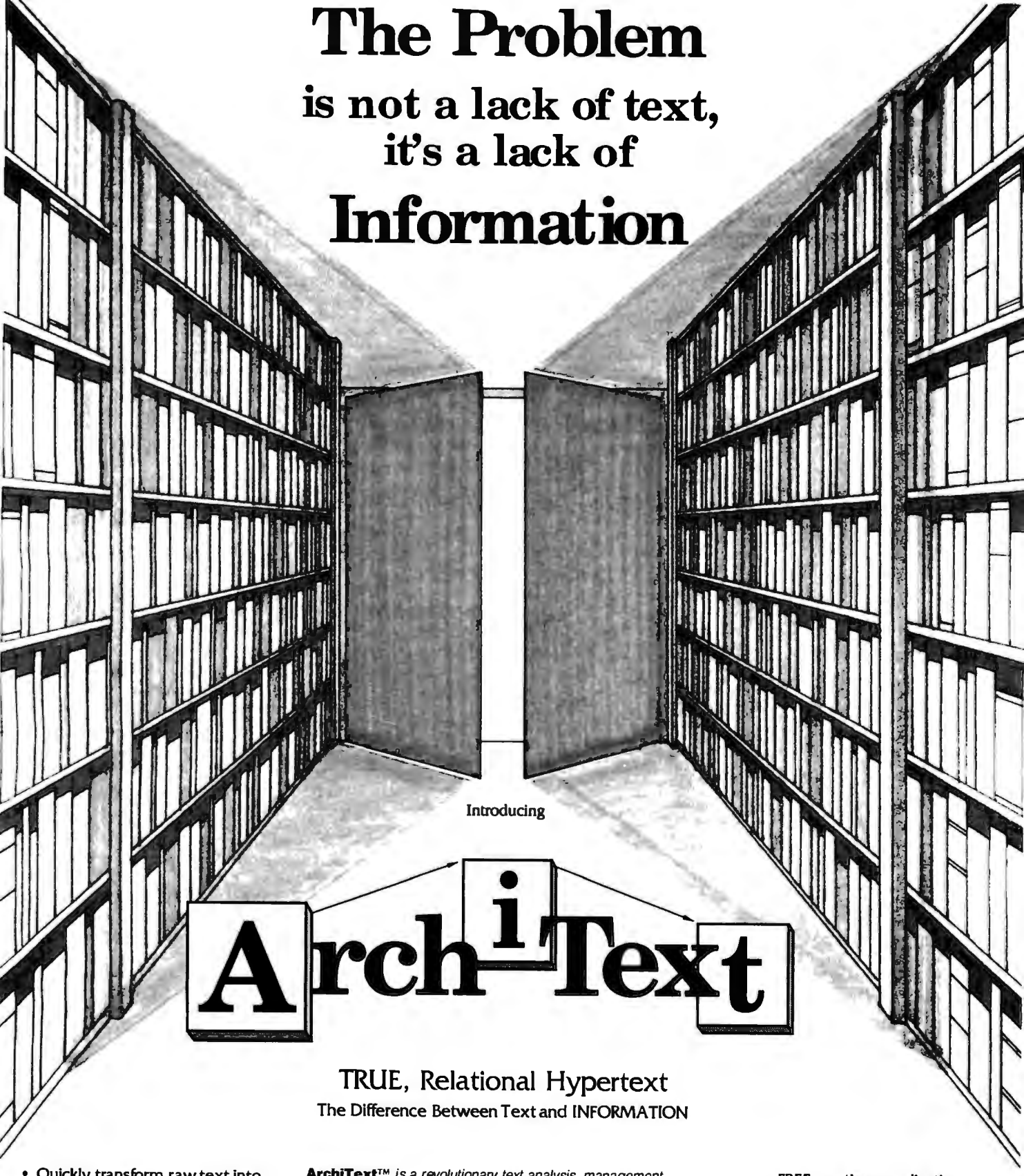

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disk when you click on a WriteNow document, it could come up in the Sample version.

That is and isn't T/Maker's fault. When you click on a Macintosh document of any kind, the Finder will locate the appropriate application no matter where you've got it ferreted away (unlike DOS machines, which won't look outside of the current directory unless you explicitly tell them to). In the case of WriteNow, the version you get depends on which one you most recently fiddled with—even moving a version to another folder seems to be enough to reset the default to that version.

It happened that Larry Niven's birthday came just after I got the Mac II. Now that I had a LaserWriter, I thought I'd make a really fancy card to go with the present. I'd used WriteNow on the Plus, and since I was more or less familiar with it, I tried it first. Alas, I hadn't eliminated Sample WriteNow before I did that, and my 3 hours of composition were completely wasted, since I couldn't print the card without the "CREATED WITH SAMPLE WRITENOW" idiocy.

Surprise: so diligently does the Finder search for that idiotic Sample version that even with the Sample version on *another hard disk*, the Finder will go find it and bring it in when you invoke WriteNow by clicking on a document.

After eliminating all traces of Sample WriteNow from the MacDisk, I wrote a new birthday card by invoking WriteNow. It printed fine; but the next time I called it in, that damnable message printed across top and bottom.

I was about to erase all copies of WriteNow and go to MacWrite or Ready-Set-Go!, when I got suspicious and used the Mac II's Find File desk accessory to search for the word *Sample* in a filename. Sure enough, it told me there was a copy of Sample WriteNow on the internal hard disk drive. When I erased that and tried to bring in my birthday card, the system told me I should get the application file out of the Trash.

In rage, I turned off the machine. When I turned it back on, I was finally rid of the Sample Curse: now I can bring in documents and print them without the horrible "CREATED WITH SAMPLE WRITENOW" printed top and bottom.

For all that, WriteNow is a good editor that is easy to use—once you've *permanently* eliminated all traces of the Sample program.

Locked!

The real reason for getting a Macintosh isn't languages (although if you're an APL addict, you'll find that works better on a Mac than it's likely to on a PCompatible). When Excel was available only on a Mac, you might have been seriously tempted to get one just for that; but now they've got Excel available running under Windows, and it's at least as good on PCs with EGA as it is on the Macintosh. MacInTax also runs about as well on PCompatibles with EGA as it does on the Macintosh.

The real reason to get a Mac is that it can run programs and do things few other machines can do. VideoWorks II is a spectacular program for the Mac.

You might get a Mac because of its ease of operation. Unfortunately, there are problems. I personally find it as easy to get around in PC-DOS as to manipulate icons, and indeed, I can get awfully sick of dragging little pictures to the Trash. Worse, though, the Mac can do strange things to you.

Example: in trying to test the MacDisk, I created an enormous file by copying into one folder named Foo everything else on both the MacDisk and the Mac's internal hard disk drive. Then I moved the files back and forth. Eventually, I was through playing and needed to eliminate the Foo folder.

I dragged it to the Trash, but it wouldn't erase. The Mac kept telling me the folder contained locked files. To make it worse, after the machine told me it wouldn't do what I wanted, it made me click on "OK," even though it wasn't OK at all.

Study of the Mac II manual eventually showed me how to determine whether a file is locked or not: you have to find the file, select it, then go up to the menu bar and "Get INFO" on it. After that, you can unlock it.

Unfortunately, the Mac operating system has no other way to tell you which files are locked, so you have to go through them one at a time. I had over 70 different files in Foo, and I had to look at each one before I could erase the thing. I can't say I appreciated that.

VideoWorks II

The real reason to get a Mac is that it can run programs and do things few other machines can do. VideoWorks II is one of the most spectacular programs for the Mac. This is a program for creating and displaying animated graphics. It will also do sound effects.

I've only started playing with VideoWorks II, and I already love it. The tutorial programs are good enough that I haven't much needed the manual. The manual is good enough to remind you of what you learned in the tutorials. VideoWorks II can take advantage of color monitors and other features of the Mac II; indeed, it's one of the best demonstrations of the Mac II's capabilities. Recommended.

Winding Down

I'm out of space, and there's still scads of Mac II stuff lying on my desk. I haven't discussed HyperCard, which is another program you might consider getting a Mac for.

There's no room for Owl International's Guide, a program that's a serious match for HyperCard. What with the Apple/Microsoft lawsuit, one wonders how hard Microsoft will work on Mac software in the future, but even so there's a pile of it now.

The Mac game of the month is PBI Software's Strategic Conquest Plus. I hope they come up with a version that works on the Mac II.

I expect it's obvious that although I started off with serious reservations, I like the Mac II quite a lot. The bottom line is that I've moved Old Zeke, my original CompuPro Z80, off to the storeroom, and I'm using a CAD program to help me design furniture to put the Mac II in his place. ■

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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MultiFinder Revealed

Phil Goldman

One of MultiFinder's coauthors provides clues to the mysteries of MultiFinder

MultiFinder is a first-generation multitasking operating system for the Macintosh. It runs on all machines from the Macintosh 512Ke up to the Mac II.

The phrase "first generation" has two important meanings. First, it highlights the fact that MultiFinder has been added to the system software at a time when the Mac environment is relatively stable and well defined. Therefore, it was necessary to support all the features of the systems, some very subtle, that applications have come to depend on.

"First generation" also implies that there will be successive generations. MultiFinder is released every six months as a part of the Apple system-software update. As a result, MultiFinder is an evolving product; yet, at the same time, it must guarantee that applications continue to work across releases.

The Look of MultiFinder

MultiFinder doesn't markedly change the look and feel of the Macintosh. When a Mac boots up, the only indication that MultiFinder is running is the small icon located on the far right-hand side of the menu bar. The look does change, however, in one small but important way: When you open an application from the Finder (the application you see when you start up the Mac), the Finder itself doesn't disappear. Before MultiFinder, you could execute only one application at a time, and only one application could be visible at a time.

With MultiFinder, multiple applications can be visible at once. Each application is represented by its set of windows, known as its *layer*. As a user, you interact with only the frontmost layer (i.e., the application in the top layer receives all the user events, such as mouse and keyboard clicks), the same way you typically interact with only the frontmost window of a given layer. Other layers can be visually active, but the actions of the corresponding applications don't occur in direct response to your actions. The application in the frontmost layer also owns the menu bar.

You can switch between applications in three ways. First, clicking the mouse in any window of a layer brings the application in that layer to the front. Second, the apple menu includes a list of the currently running applications; choosing a particular item with an application's name brings that application's layer to the front. And third, clicking on the icon in the menu bar cycles through the applications in each layer.

Cooperation, Not Competition

At the very heart of MultiFinder lies its task-switching mechanism. This mechanism implements an operating-system technique known as *cooperative multitasking*, which allows the tasks themselves to completely control the mechanism. In MultiFinder, a task is simply one instance of an application program. There is no policy to which applications must adhere; each task determines exactly when it wishes to yield control of the CPU—it will never return control until it explicitly decides to do so.

Cooperative multitasking has its advantages and its disadvantages. As an applications developer, you can assume your application has complete control over the machine while it runs. Thus, you can make many simplifying assumptions, especially when you want real-time control. If the operating system itself decides when to switch between tasks, as in preemptive multitasking, it can't always know exactly when is the best time to switch; it simply doesn't know as much about a task as the task itself does.

On the other hand, cooperative multitasking requires correct responses from every task. If a single task decides that it won't yield the CPU, then the entire system will appear to hang. Even if a task just holds the CPU for too long a period, the response time of the system can suffer dramatically.

The entire structure of the Macintosh application model revolves around the assumption that an application will constantly call the Toolbox traps, `_GetNextEvent`, `_WaitNextEvent`, and `_EventAvail`, to retrieve an event and respond to it. It's relatively painless to switch between applications when those calls are made.

For these same reasons, cooperative multitasking would be a disaster in a generic Unix environment. In this case, there is a real loss of transparency as Unix tools are command-line-driven rather than event-driven, and thus don't necessarily make certain calls with any known frequency. Also, when you use such an environment, you're more likely to create your own quick-and-dirty applications, which might crash but shouldn't hang the entire system if they do. Of course, if you use only shell scripts as tools, then it would be simple to build the necessary cooperation into the shell interpreter.

The moral of this is that cooperative multitasking is very useful, but only when you can make certain assumptions about the run-time environment. However, there wasn't much of a choice for the Macintosh. Although the existing application model could theoretically support preemptive multitasking, it would involve a great deal of rewriting of Tool-

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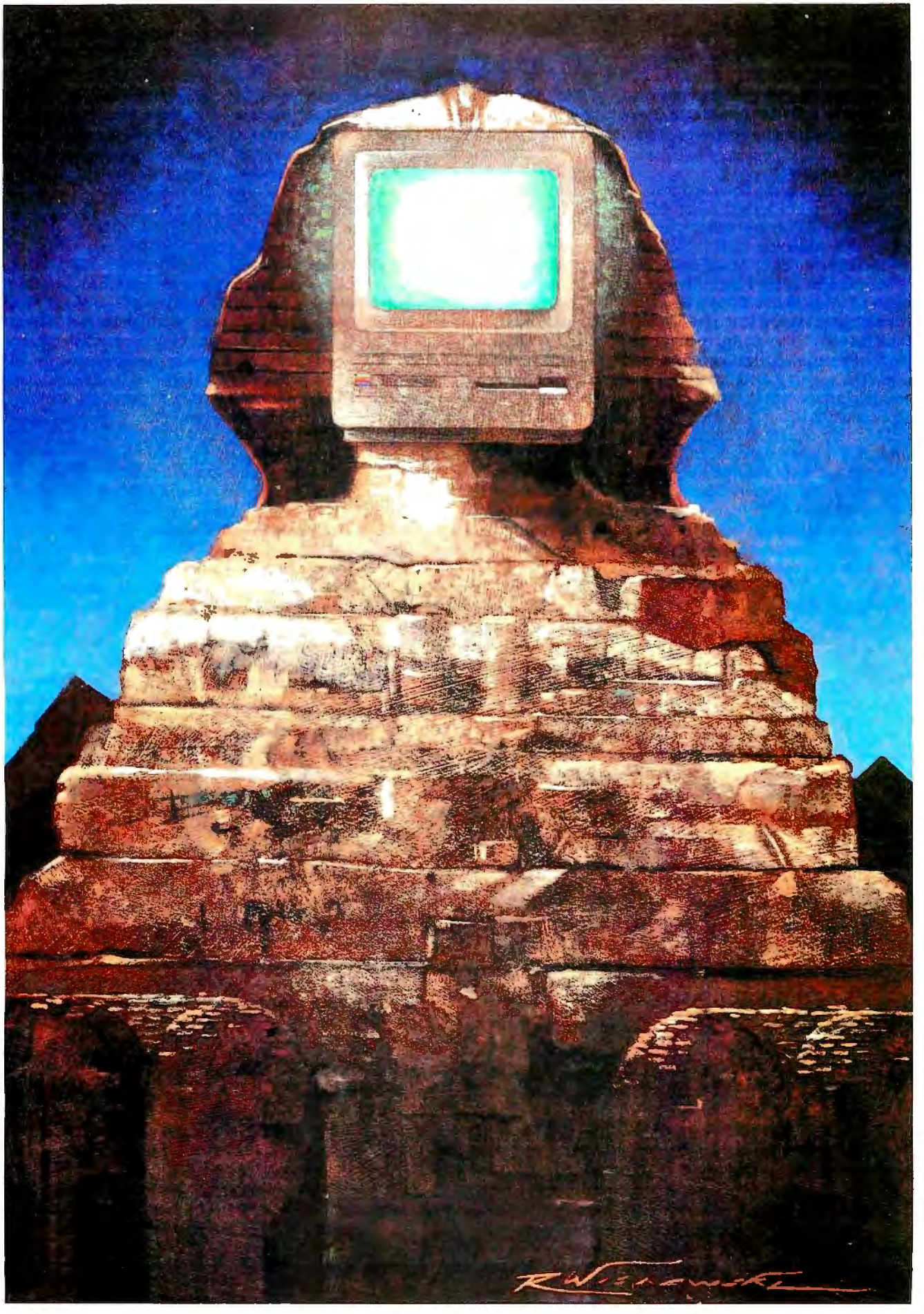

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box and operating-system code, code that is currently in ROM. In addition, there would be greater compatibility problems.

Heaps of Memory

Before explaining the hows and whys of cooperative multitasking under MultiFinder, let's discuss the backdrop against which task switching occurs: the memory model provided by MultiFinder.

MultiFinder doesn't radically change the Macintosh interface that a user sees, but instead extends that model in a logical manner. This is also true of the model that the applications developer uses. The memory model, for example, changes little except to support multiple applications in memory at one time.

The basic Macintosh memory model consists of one application heap (a heap is a large chunk of memory partitioned and managed by the Memory Manager) and one system heap. MultiFinder has multiple application heaps (see figure 1). These heaps are created as nonrelocatable blocks in the MultiFinder heap, which is located in the same place as the single application heap is in the basic model—directly above the system heap.

MultiFinder still uses a single system heap. The basic Macintosh model has a somewhat arbitrary partitioning of memory and resources between the system and application heaps. With the new model, one of the primary purposes of the system heap is to share resource blocks among the applications (resources are blocks of data that are read from resource files and tracked in memory using resource maps).

This design works out nicely for three reasons. First, sharing naturally saves space, which is critical on a system with 1 megabyte or less of RAM. The space needed by a single application can be a very large percentage—sometimes 100 percent—of the machine's total memory.

Second, moving system resources out of the application heap implies that significantly fewer system-memory requirements will be made of the heap. An application that attempts to do a complete accounting of memory usage in its heap has problems when the system allocates blocks behind its back. The new scheme alleviates this problem to a great extent.

Finally, since all the shared resources are located in the system heap, they don't need to be reinitialized each time an application launches. Much of the time spent in the original system's launch code, and in the initialization code of the application itself, was spent reloading the resources from disk. Some of these resources, such as fonts, can be very large.

However, MultiFinder's sharing creates a much greater, and much more dynamic, need for space in the system heap. Early in the development effort, the system heap was significantly enlarged when MultiFinder itself started up. However, it became obvious that this was too great a space penalty to pay. The Memory Manager was modified to allow the system heap to grow and shrink (at the expense and gain of the MultiFinder heap) as memory needs dictated, thus allowing extra space for both system-memory requests and new application heaps.

Although the changes to the memory model are fairly subtle, some applications make assumptions that are no longer valid. Some applications assume that the system and application heaps are contiguous. Others assume that certain resources will be put in the application heap rather than the system heap. The latter assumption is particularly dangerous because of the actions that an application might take based upon it. For example, one application has a procedure that continually purges such resources when there is no free space in the application heap. Under MultiFinder, the application is actually freeing space in the system heap, and not alleviating the problem at all. Worse, the application actually ends up deadlocked in a loop, continually purging these resources but never freeing up enough memory.

This entire situation is a result of certain strong implicit assumptions about the "classic" Mac's memory model. Fortunately, very few applications make such assumptions.

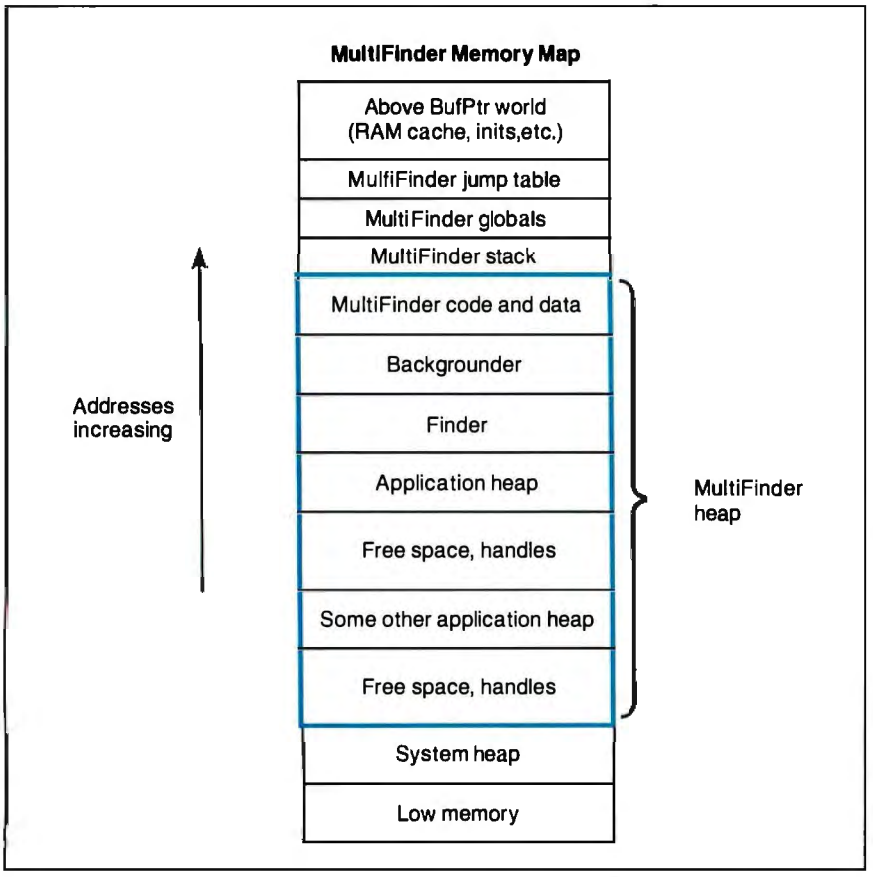

Figure 1: *The MultiFinder memory map. Notice that MultiFinder has more than one application heap.*

Context Switching

MultiFinder employs cooperative multitasking, switching contexts only when the application calls the trap `_WaitNextEvent`, `_GetNextEvent`, or `_EventAvail`. The scheduler does a context switch in three cases: as part of a layer switch, as a switch into a background application, or to let an application update its windows.

A context switch is a fairly large operation on a Macintosh. The environment is so rich that the context belonging to a task is potentially very large. Fortunately, on average, most applications avoid creating huge contexts for themselves (except for the many low-memory locations that are

accessed on their behalf) by making use of the memory-saving features below.

In general, a context switch consists of saving the context of the task being switched in (known as the source task) and then restoring the context of the task being switched out (the destination task). In the Mac, the switch also requires removing (and saving) application-specific entities from system data structures from the source task, and restoring those entities from the destination task. These entities include:

• *Device-control entries (DCEs):* The Unit Table is an array of handles to device-control entries, located in low memory. Each DCE corresponds to a local driver, one that belongs to the application. The driver's resources come from the application's resource file. (Although it might come from a different file, it can never be the system file.) The memory for the driver is located in the application's heap.

When a task is switched out, the system must remove all the DCE handles for its local drivers from the Unit Table and save them in a structure local to the task. When the task is switched back in, the system restores its drivers from its local structure. When an application quits, either with dignity or because of a crash, the system again removes its DCE handles from the table.

Most applications don't employ local drivers. An application's own desk accessory (such as a word processor with a spelling checker) is simply a special type of driver on the Mac.

However, most of the drivers come from the system file, including the system desk accessories, AppleTalk drivers, and default print drivers. These drivers are never switched; therefore, it's very important that the unit number (i.e., the index into the Unit Table) of a particular local driver not match that of any system driver. If it does, then when the local driver is switched in, its local DCE handle will clobber that of the system driver in the Unit Table. Worse, when the task is switched out, there will be an empty hole in the Unit Table, and you won't know which system driver should be restored.

• *Trap patches:* Trap patching is the method by which the routine associated with a given A-line trap is replaced by a new routine. (An A-line trap captures those instructions whose first byte is A.) Pointers to these routines are kept in two tables in low memory known as the operating-system and Toolbox trap tables. The A-line dispatcher indexes into the appropriate table based on the number of the trap executed.

While most applications never need to patch traps, there are some that do. For example, an application might patch out all the Memory Manager traps that allocate master pointers (MPs). When the Memory Manager runs out of MPs in a heap, it allocates a new block of them. This new block is nonrelocatable, so it could easily cause fragmentation. Therefore, the trap patches would just make sure to compact the heap if there are no MPs left when the trap call is made.

MultiFinder tracks the traps that each application patches. When the application is switched out, its patch-routine pointers are removed from the trap table and replaced by the pointers to the previous routines. When the application is switched back in, its routines are restored. Patches are also permanently removed when the application quits.

In order to track patches by the applications, MultiFinder itself must patch the trap `_SetTrapAddress`, which is the mechanism by which other traps are patched. At the time the trap is called, a record is saved denoting the new trap routine, the old routine (i.e., the one that is currently being used), and the trap number.

One of the problems with patching is that the application's patch must jump to the old routine; it can't call the old routine as a procedure. This is necessary because system patches often look back up the stack to see who called them. They will activate only if they see a particular return address on the stack. Therefore, you have to call these routines without changing the stack. The only way to do this is to jump to them.

This has two major implications. First, it's not possible to do patch code entirely from a high-level language. At the very least, you'll need assembly language *glue* (a glue routine is one that converts between the different calling conventions of other languages and the Pascal that the Macintosh ROM expects). Second, it's illegal for an application to have a patch that does post-processing—that is, that has code after the call to the old routine.

• *Vertical-blank tasks (VBLs):* VBLs are small routines that run during the vertical-retrace interrupt on the Macintosh. This is the interrupt that signifies that the Mac screen has just been completely redrawn from the screen memory. It is used for creating flicker-free animation and also for any type of quick, repetitious tasks.

Under MultiFinder, VBLs are treated much like DCEs; that is, they are switched in and out of the VBL queue as their corresponding application is switched in and out. MultiFinder doesn't track these VBLs in the same way it does trap patches. Instead, during the context switch, it walks down the VBL queue, looking for tasks that fall within the application's heap; the VBLs are saved and removed like the DCE handles. They are restored in the same manner. The VBLs belonging to an application are also removed when it quits.

This method provides a way for applications to have persistent VBLs. That is, if an application installs its VBL in the system heap rather than its application heap, the VBL is never removed, not even if the application itself quits.

• *Resources:* The Resource Manager has been changed under MultiFinder so that all resources from the system file are placed in the system heap. This is necessary in order to share these resources among the applications. It's impossible to share a resource in another application's heap; the data for the resource will be destroyed if that other application quits.

Originally, MultiFinder used an algorithm for resources similar to those for VBLs, patches, and DCEs. That is, it would walk through the system map, saving and restoring resource entries belonging to each application. Besides the wasteful redundancy of data involved, using this method greatly damaged the application-initialization and context-switching times. The latter time was so poor that background tasking seemed too inefficient to implement if a context was to be provided to the background application.

The sharing itself is easily implemented by allowing all the applications to share the system resource map in their resource chains. A resource chain is a linked list of resource maps used as a search path for resources (see figure 2a). Therefore, the old picture of a resource chain has been transformed into a resource wheel (see figure 2b), with the system heap as its hub and each chain as a spoke. The arrows illustrate the search order for resources. They also represent the only order in which the list comprising each spoke is linked. It's impossible for any application to traverse from its spoke to another, so each application still sees only its resource chain.

• *Low memory:* Toolbox and operating-

continued

system low-memory locations are conceptually divided into those locations that are application-specific and those that are system-wide. For the most part, these correspond to the Toolbox and operating-system locations, respectively, but there are many exceptions. Under MultiFinder, the application-specific locations are saved and restored between low memory and a copy of those locations (one per application) when the task is switched out and then back in.

You must take special care when switching certain memory locations. Some must be switched in a prescribed order relative to others. For example, there is a system VBL, called the "stack sniffer," that constantly checks to make sure the bottom of the application's stack is above the top of the application's heap. Its purpose is to detect collisions between the two—if detected, a system error is generated, and the application quits. Therefore, it's necessary to actually set the variable named `StkLowPt` to 0 (disabling the stack sniffer), and then switch out the variable that points to the application heap. You must restore this variable, called `ApplZone`, from the new application *before* you restore `StkLowPt`, because as soon as the latter becomes nonzero, the stack sniffer is reenabled. When this occurs, the system had better be in a consistent state.

• *Registers:* Each application must have its own set of registers, so the context switch remains transparent in this regard as well. However, since MultiFinder knows that context switches occur only inside calls to particular traps, it needs to save only those registers that, by convention, a trap routine won't destroy: data registers D3 through D7 and address registers A2 through A7.

Some of these registers indirectly contain more context information that is switched when the register itself is. For example, register A7 points to the application's stack. Therefore, when A7 is switched, so is the run-time stack being used, even when processing is still in the heart of the MultiFinder switching code. Likewise, register A5 typically points at an application's global variables, which are referenced as negative offsets from this pointer; for this reason, they are known as A5 globals. When register A5 is switched, references to globals are switched as well.

If the machine has a floating-point unit (FPU), as the Mac II does, then the floating-point registers and context are also saved and restored. Here, the term "context" refers to the internal state of the FPU itself.

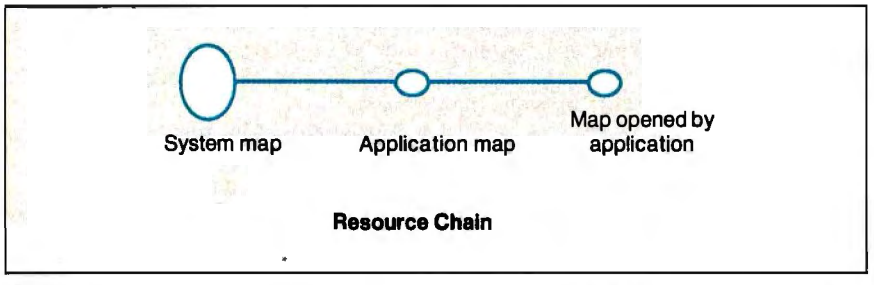

Figure 2a: *The original MultiFinder plan for sharing resources involves searching a resource chain like this one.*

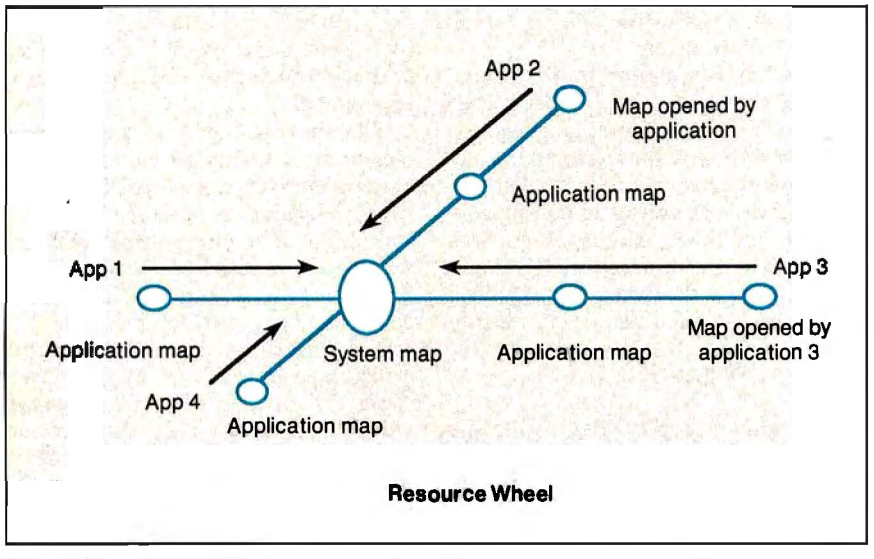

Figure 2b: *A more efficient plan has been implemented using a resource wheel. The resource chain still exists for each application, but the plan adds the system heap as the hub of the wheel.*

Moving Between Layers

A layer switch is the process by which another layer of windows comes to the front, ahead of the current top layer. The process is rather lengthy compared to a context switch (it occurs across several calls to `_WaitNextEvent` or `_GetNextEvent`), and actually includes it as part of the layer-switch process.

Layer switching is not transparent to the application. In fact, the switch requires the explicit cooperation of the applications being switched, whether they know it or not. They must accomplish such activities as changing the active state of their topmost window, converting their local Clipboard format to and from the global one if necessary, and desisting from attempting to control the cursor or the menu bar.

It's difficult to persuade older applications (written before MultiFinder) to do all these things, so a little subterfuge is in order. MultiFinder uses a technique known as *scrap coercion* to fool an application into believing that you have chosen a desk accessory (with a window that's very far off-screen) and the copy item (from the edit menu) from the source task; it convinces the destination task that you have chosen the paste item and then closed the desk accessory. (*Scrap* is data that you want to transfer between applications.)

The motivation for employing this process is twofold. First of all, it forces the source application to deactivate its frontmost window (usually deactivating its scroll bars) in its layer when moving *from* the front, and vice versa for the destination task, which is coming *to* the front. Without this, the visual effect of multiple layers would be confusing—the frontmost window of every layer would appear to be active. Worse, some applications take advantage of the fact that no other window lies on top of the frontmost window, and do semilegal drawing that wouldn't work if the application weren't

continued

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in the frontmost layer. An application can't see the window list of other applications, so the scrap-coercion desk-accessory window can be viewed as a reminder to the application that there are other windows above it, even if it can't quite see them.

In another way, the desk accessory acts as a marker for the rest of the world, and this is its primary role in the scrap-coercion process—to "coerce the scrap." That is, it must persuade an application to convert its private scrap to the global scrap (the data for the Clipboard). This is important because the application's private scrap could be located anywhere, in any form, in memory or on disk. When the application converts to the global scrap, it puts the data in a well-defined location (in a file named `clipboard` or in memory referenced from low-memory global `ScrapHandle`) in a well-defined format. Thus, MultiFinder can copy the data to the global scrap of the destination application.

The premise behind scrap coercion is that once you have cut or copied work with desk accessories, it's necessary for an application to convert to the global scrap when you wish to paste the Clipboard into a desk accessory. Likewise, the application must convert the global scrap to its private one when it thinks you have chosen paste with the frontmost desk-accessory window. The application thinks that the desk accessory has altered the contents of the global scrap; thus, the private one must be refreshed.

If applications are somewhat more MultiFinder-friendly, you don't need to go through the entire charade. If an application can handle Suspend and Resume events, then it knows when it's being layer-switched to and from (for which it receives Resume and Suspend events, respectively, as notification). However, in this case, it's still necessary to convince the application of the desk-accessory activity, so it will deactivate its top window. Therefore, an application can actually set a flag that officially deems it MultiFinder-friendly, meaning that it will deactivate its front window when it receives a Suspend event and activate it again when it receives a Resume. In this way, you don't need any of

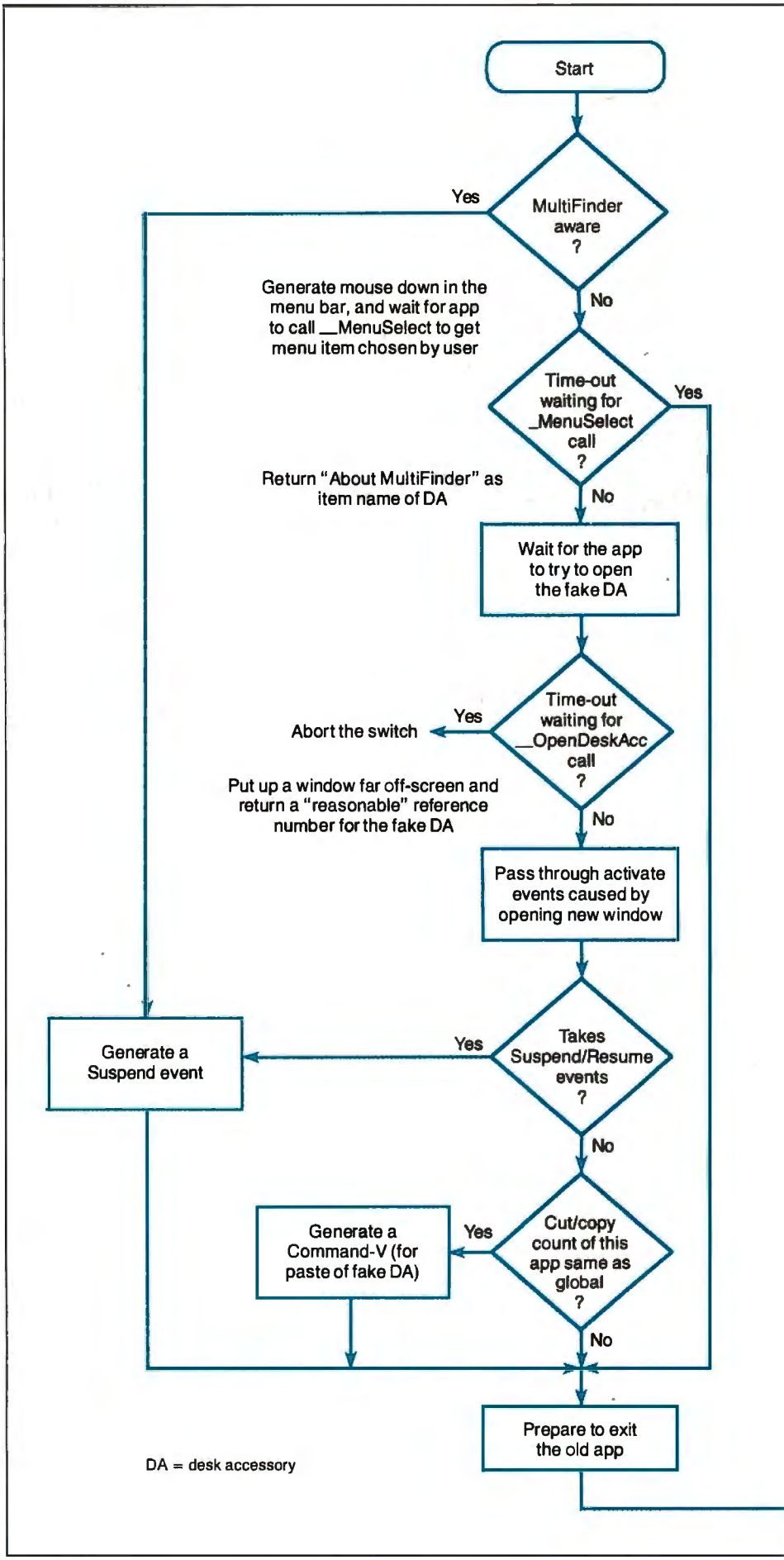
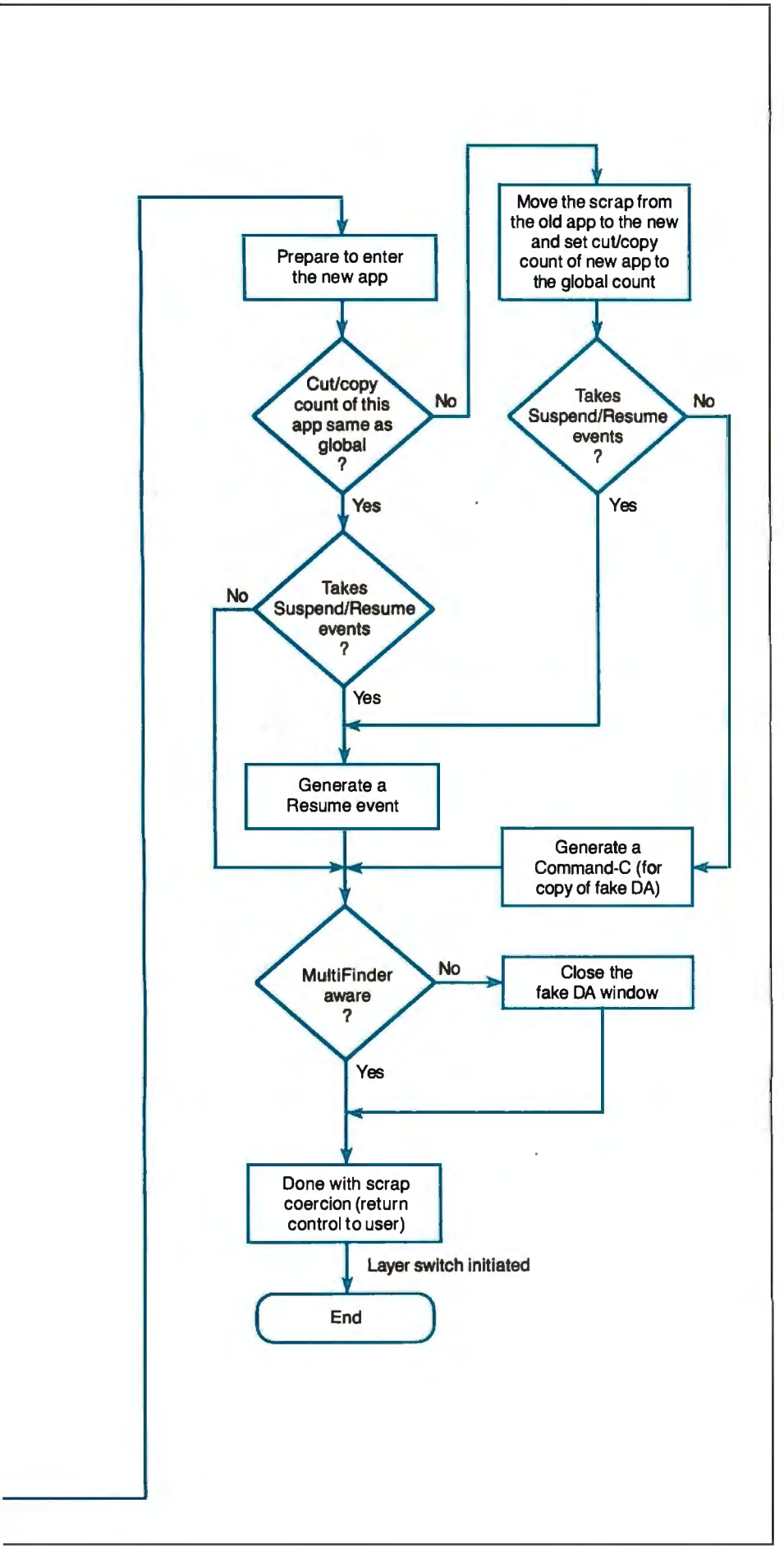


Figure 3: *MultiFinder's method of optimized scrap coercion. Note that you can keep the number of states down by using Suspend and Resume events and if your application has the most recent data in its scrap. This method eliminates the process of copying between global scraps.*



the machinery for the desk-accessory charade, thus speeding up the layer switch.

MultiFinder uses a state machine in order to implement scrap coercion. Each state represents the accumulation of all the expected actions the application has accomplished during the process, and the arcs between states represent the correct or expected action to get closer to getting the desk accessory opened and eventually closed again. An action basically consists of a call to some Toolbox trap, most likely `_GetNextEvent` or `_WaitNextEvent`, or a time-out caused by not calling the expected trap soon enough.

The state machine is really known as optimized scrap coercion (see figure 3). The original notion of scrap coercion came from Switcher, an application from Apple to switch applications, allowing one application at a time on the screen. Much of the time in Switcher's scrap coercion was spent copying the scrap between applications. Therefore, MultiFinder keeps track of whether you have done a cut or copy, and thus changed the Clipboard, and it copies handles only when the application being switched to has stale data. This is reflected in the flowchart. Notice that the number of states entered is much smaller if the application receives Suspend and Resume events and is MultiFinder-friendly. The number of states is also smaller if the application already has the most recent data in its scrap, and the potentially time-consuming process of copying between global scraps is completely eliminated.

What's New

One of MultiFinder's goals was application-level transparency, as evidenced by the machinery described for context and layer switching. However, in certain areas, providing new services creates major optimizations in time and space. Thus, only those applications that use the new services break the transparency; for them, it's obviously beneficial.

WaitNextEvent: One example of the new services is the new Toolbox trap `_WaitNextEvent`. This trap is similar to `_GetNextEvent`, in that it can be used as the event dispatcher at the heart of any event loop. In addition, it provides a way for an application to sleep for a specified time if no events are pending. This allows the trap to move away from the polling behavior implicit in the use of `_GetNextEvent`, which is called as often as possible.

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Another service provided by _WaitNextEvent is to return a new event, *mouse-moved*, when the cursor has moved outside a bounding region provided by the application. This again makes polling unnecessary, as in the case where an application needs to change the cursor as it passes over different areas on the screen. This need might occur, for example, when an application wants to change the cursor from the arrow to the I-beam cursor shape while the cursor moves into a region that contains editable text.

A final need for polling in the classic Mac model was to give drivers time to run. This was accomplished by requiring the application to call the trap _SystemTask as often as possible, which, in turn, would dispatch time to the drivers as appropriate. This requirement is eliminated by using _WaitNextEvent. The trap routine is responsible for scheduling the drivers.

The Pascal calling convention for the trap is as follows:

```
FUNCTION WaitNextEvent(mask: INTEGER; VAR event: EventRecord; sleep:
LONGINT; mouseRgn: RgnHandle):
BOOLEAN;
```

The mask and event parameters are the complete set of arguments for _GetNextEvent. The sleep parameter is the number of clock ticks until the system should awaken the application (and return a null event to it) if no events have been returned beforehand. MouseRgn is a handle to a region that should bound the cursor.

Temporary memory calls: MultiFinder provides a service by which it can, for example, allocate or deallocate blocks in its heap just as it would handles in other heaps. This is useful when an application has a short but memory-intensive need. There is a new set of traps for accessing these services—different from the direct Memory Manager traps available. These traps allow for a level of indirection that will prove useful for MultiFinder. For example, they would allow memory to be found in places where it wasn't originally located (perhaps not even in a heap). This might be useful, for instance, if a Mac II NuBus card provides extra RAM, but the RAM isn't contiguous with main memory; with these new traps, it would be possible to build another heap from which to allocate temporary memory.

More importantly, the explicit calls for the temporary memory allow MultiFinder to track memory use by all applications. Therefore, if an application quits without deallocating its memory, or if it crashes, then MultiFinder can clean up after it and not orphan the temporary memory blocks that the application didn't release. Also, it would be desirable to do more stringent error checking on the blocks, as an inconsistent MultiFinder heap could easily cause the entire system to crash.

Launch: The original operating-system trap _launch terminates the current application and then executes the new application. Recent systems have provided an additional feature to _launch known as sublaunch. Basically, in sublaunch, an application sets a certain launch flag that tells the operating system that it expects to be relaunched after the new application terminates. This provides a degree of automation when the launchee is to be used for a brief, specific purpose. However, it suffers from all the obvious problems inherent in a unitasking model. Also, the launcher's context (e.g., the documents that are open, the window sizes, and the positions) is lost when the application is relaunched, unless it explicitly saves and restores it itself. Even then, this is a fairly time-consuming process to sit through.

With MultiFinder, the application can set yet another launch flag that tells the operating system that the application expects to return from the launch trap itself; it doesn't automatically wish to be terminated. In this way, the application avoids the loss of context caused by the sublaunch, as it just sticks around.

In its development stages, MultiFinder always allowed _launch to return to the launching application, rather than terminating it. This offered a great deal of leverage to many applications in that they automatically could take advantage of the new launch capabilities without having to be programmed for them explicitly. Unfortunately, some applications implicitly assume that the _launch trap will never return. Usually, the problem is that there is simply no more code in the program after the call to _launch; after the return, the application runs wild. Thus, it was necessary to force applications to prove that they were ready to continue running. They prove it by setting the TwitchLaunch flag in the extended _launch parameter block.

Under MultiFinder, the call to _launch is simply a request to launch and execute an application. In the trap itself, memory is allocated for the application from the MultiFinder heap, and the system data structures necessary to sup-

port the application are initialized. However, the first instruction of the application code isn't actually executed until the layer switch, which was also initiated in _Launch, is completed. In newer versions, MultiFinder determines if the launchee already exists. If it does, MultiFinder merely initiates a layer switch to the application; it doesn't create a new copy.

Open document and quit events: When the user chooses Shutdown from the Finder's Special menu, the Finder will try to quit all the other running applications first. It does this by passing a special event to MultiFinder, one per application, which MultiFinder converts into the actions necessary to persuade the application to quit gracefully.

Basically, these actions are used to inform the application that the user has decided to quit. More specifically, they convince the application that the Quit item has been selected from its File menu. Then control returns to the user for responses to any ensuing dialogues, such as requests to save changed documents before quitting.

A problem arises if the application has no File menu or Quit item, or if they are spelled slightly differently. Therefore, the Finder doesn't actually pass these strings explicitly in the Quit event that it sends to MultiFinder. Instead, the Finder specifies two resource IDs, numbers 100 and 101. These are used to find string resources of type 'mstr' where the two IDs refer to the File-menu name string and the Quit-item name string, respectively.

MultiFinder first looks in the application for these resources. If it doesn't find them, then it will use the default ones located within its own resource map. This allows applications with nonstandard versions of these strings to still be quittable before shutdown. For example, HyperCard has its own resource ('mstr', 101) set equal to the string "Quit HyperCard." Using the resources also solves the one problem posed by using applications in other languages. You can customize older applications with different menu strings by using ResEdit or some other tool to put the 'mstr' resources in the application's resource file. MultiFinder itself can be modified so that its default 'mstr' resource is in the language most commonly used by the applications it runs.

In much the same way as with the Quit event, the Finder also sends an Open event through newer MultiFinders when you open the document of an already existing application (usually by double-clicking on its icon). The Open event is converted to the actions necessary to convince the application that you have chosen the Open item from the File menu, but it really looks for the resources ('mstr',102) and ('mstr', 103), respectively, for the title and item strings. Unlike the situation with the quit actions, in this case MultiFinder doesn't return control to the user quite yet.

Most applications at this point bring up the Standard-File dialog box to allow you to choose which document to open. MultiFinder already knows which document it wishes to open (the Finder has told it), and, therefore, it convinces the application that it has indeed put up the dialog box (by patching out _SFGetFile and _SFPGetFile), and that the user has chosen the particular document. Since the dialog box is never made visible, what you see after the double-click in the Finder is a layer switch to the document's creator application, followed by the application magically opening a window for the document.

Explicit calls for temporary memory will allow MultiFinder to track memory use by all applications.

Building and Burning Bridges

During the development of MultiFinder, we were amazed at how many applications worked with it, no matter what twist or turn we were experimenting with at the time. These applications were so resilient that they seemed to be impossible to break, even while MultiFinder itself was unstable.

Unfortunately, certain other applications were much more fragile. While the number of incompatible applications eventually became very small, this was due largely to explicit fixes within MultiFinder to fix problems within the applications themselves, bugs that the MultiFinder environment revealed.

For example, a couple of applications would crash unless they were loaded into the first megabyte of the MultiFinder heap. Therefore, we had to "special-case" these applications and make sure that the launch-time memory allocation kept the blocks for these applications within the first megabyte. This was difficult because the Mac's Memory Manager has no concept of absolute addresses; the memory-allocation traps grab memory from wherever they can find it. You have to play some ugly tricks on the Memory Manager to get the bounded block.

Another problem with the allocation is that because the application's heap block must lie so low in the MultiFinder heap, it might have to be launched into a block lower than the system heap can shrink, and thus these applications might be unlaunchable even when there's plenty of memory above 1 megabyte. In any case, they definitely stunt the system heap's growth.

Another application assumes that the value of low-memory global CurrentA5 never changes during asynchronous file reads and writes. This variable is so named because it serves as a static pointer to an application's globals; you could reload register A5 from this global if for some reason the register's contents had changed. Unfortunately, the asynchronous file-completion routine supplied by the application runs at interrupt time, so it might execute after another application that has a different value for CurrentA5 is already running. Therefore, MultiFinder waits for a pending asynchronous file operation to complete before context switching.

There are many more examples of such hacks in MultiFinder. From one point of view, they are ugly, application-specific pieces of code that shouldn't be part of an operating system. But, from another point of view, they can be seen as bridges between the liberties permitted applications in the original Macintosh operating system and the more restrictive rules necessary in the MultiFinder environment. Newer applications must obey these rules, so no new hacks will be added. In addition, as applications are revised and fall into disuse, it will be possible to remove the hacks for them. Thus, these bridges will eventually be burned—but not until the entire application base has crossed them. ■

Phil Goldman is coauthor of MultiFinder and a member of the Macintosh OS Group with Apple Computer in Cupertino, California. You can reach him on BIX as "editors."

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Circle M36 on Reader Service Card (DEALERS: M37)

The Well-Connected Mac

Janet J. Barron and Robert L. Mitchell

A guide to networking on the Macintosh

What constitutes a network? Everyone has a different opinion. Essentially, a network is any hardware or software configuration that interconnects computers and other intelligent devices to allow a meaningful exchange of data.

A network can comprise a simple set of connections that allow two Macintoshes to share a laser printer. It may be a more sophisticated local-area network (LAN) that supports application, file, and peripheral sharing, or it may include microcomputer-to-host links that let the Mac access mainframe resources, such as the corporate database.

The success of the Mac has helped Apple get its foot in the corporate door. Now, with an increasing number of Macs in the office, the next step is to integrate them with other computing resources. Macs, IBM PCs, minicomputers, and mainframes can share the same building, but they can't always share the same applications or data. Fortunately, much of the technology necessary to network these disparate environments is already in place.

The foundation of Mac networking is the LAN: the physical and logical connections that assemble data into packets and route it through a cabling system to its proper destination. Upon this platform, higher-level functions such as file sharing, electronic mail (E-mail), and internetwork communications occur.

Applecentric Networking

Because networks have never been easy to implement, most people probably think of LANs as being quite complicated, consisting of a bunch of jerry-rigged wires connecting groups of similar, local machines. The ease with which you can construct an AppleTalk network may go far to change that image.

Anthony Cagle, Apple's manager of Communications Product Development, breaks networking into two basic models: a simple AppleTalk Personal Network configuration in which you can share peripherals among multiple workstations, and a more sophisticated, more recent model that, via Appleshare file-server software, centralizes file storage to let networked Macs share resources and control file access.

At the heart of the company's communications strategy is AppleTalk, a proprietary seven-layer communications architecture that's similar to the International Organization for Standardization's Open Systems Interconnection (OSI) reference model. AppleTalk comprises a suite of networking protocols built into the Mac that serve as the foundation of the AppleTalk Personal Network and that determine every aspect of Macintosh communications, from the type of LAN interconnections that is used to how applications communicate between workstations (see figure 1).

What sets an AppleTalk LAN apart from its PC LAN counterparts is that it supports peer-to-peer communications between devices. Unlike a 3Com or Novell PC LAN, there is no controlling node in an AppleTalk network; all communications are of equal importance and all commands are processed sequentially.

An AppleTalk network is also relatively easy to set up because the network is self-configuring. This is made possible by the AppleTalk Name Binding Protocol (NBP), which dynamically assigns a name and address to each node as it's connected to the network. By contrast, adding a new node to a typical PC LAN requires the system administrator to bring the network down and then make the necessary hardware and software changes to reconfigure it.

AppleTalk's Printer Access Protocol (PAP) provides the connections necessary to allow shared access to a laser printer, and AppleTalk Filing Protocol (AFP) determines how file sharing takes place over the network. AppleTalk runs over a proprietary shielded twisted-pair cabling scheme called LocalTalk at 230.4 kilobits per second (kbps). Since AppleTalk is part of the Mac operating system, network operating-system software is not required. The AppleTalk design also includes a LocalTalk interface that's built into the Mac serial port, eliminating the need for a LAN interface card.

LocalTalk supports up to 32 users over distances of up to 1000 feet between nodes. However, bridge devices, such as Hayes's NetBridge, let you interconnect distinct AppleTalk LANs to expand the total number of users. Repeaters amplify the AppleTalk signal to extend maximum cabling distances; the TOPS repeater, for example, increases the maximum cabling distance to 2000 feet.

Alternatives to LocalTalk

AppleTalk is not limited to LocalTalk connections: You can configure it to operate over a variety of other media. One alternative is to use less expensive unshielded twisted-pair wire. Farallon Computing's PhoneNet, for example, replaces LocalTalk with telephone wire and RJ-11 telephone jacks. You can daisy chain the devices together or use existing telephone wire in a star configuration. In the latter, a hub controller routes data between devices. Another, more expensive implementation is Northern Telecom's LANStar AppleTalk, which supports up to 1344 Mac IIs, IBM PCs, and other devices at 2.56 megabits per second (mbps) over existing telephone wiring. A central controller can directly connect all devices, or it can

continued

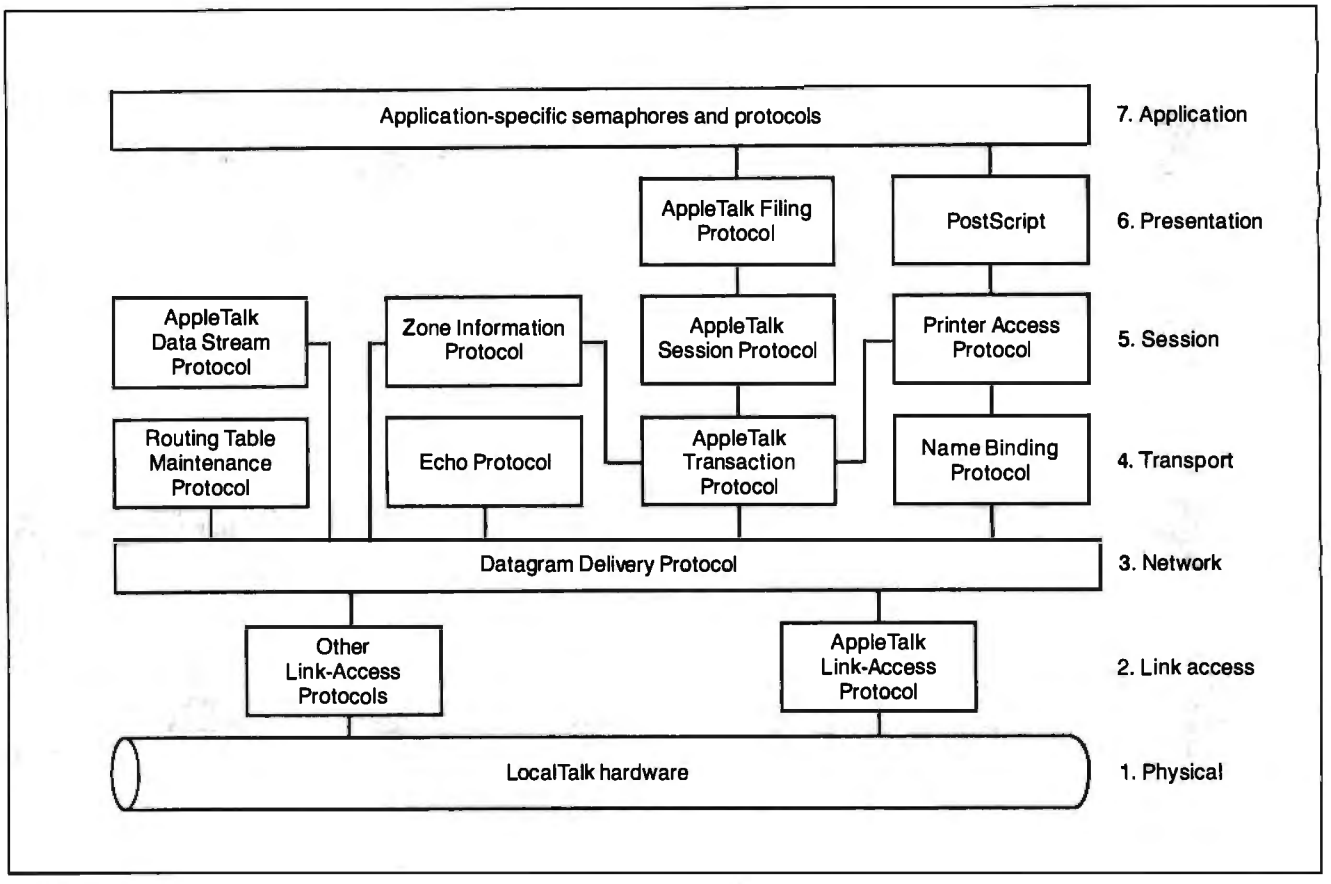

Figure 1: *AppleTalk's seven-layer architecture is similar to that of the OSI reference model. The protocols, however, are proprietary.*

act as a bridge between AppleTalk LANs throughout a building.

If electrical interference or network security is a problem, another alternative is to run AppleTalk over a fiber-optic cabling system, such as that supplied by DuPont Electronics of New Cumberland, Pennsylvania. Fiber isn't easily tapped, it's impervious to electromagnetic interference, and you can run it up to 4900 feet between devices. On the other hand, fiber cabling systems are expensive, and the medium's high bandwidth (in the hundreds of megabits) usually makes it more cost-effective as a backbone for interconnecting multiple AppleTalk LANs. Dupont's scheme currently supports transmissions at LocalTalk speeds (230.4 kbps), far short of fiber's potential. Dupont is working on a system that will support AppleTalk at higher speeds.

If LocalTalk speeds are too slow, you can run AppleTalk over a 10-mbps coaxial-cable Ethernet network. Ethernet is key to connecting the Mac to many other computing environments. Apple's implementation, EtherTalk, is a NuBus Ethernet interface card for the Mac II that replaces AppleTalk's physical and link-access protocols with the IEEE 802.3 coaxial-cable Ethernet specifications. Other vendors, like Kinetics, offer an Ethernet interface card for the Mac SE or an external box that works with the Mac's small computer system interface (SCSI) port.

An alternative to connecting Macs directly to Ethernet is to provide an AppleTalk-to-Ethernet gateway, such as Kinetics' FastPath. Macs on LocalTalk access Ethernet through a device that converts between LocalTalk and Ethernet protocols.

A recently approved standard for running Ethernet over unshielded twisted-pair wire offers the advantages of Ethernet speeds without the expense of installing coaxial cable. A Mac interface card that supports Ethernet over standard telephone wire should be available from Kinetics by the time you read this.

LocalTalk simply provides basic connectivity between Macs. You'll need additional software to support services such as file sharing. Apple's Appleshare file-server software lets you share files stored in a central location. Designed around AFP, Appleshare runs on a dedicated Mac Plus with a hard disk drive and lets you restrict access to files you create. You must first log on to Appleshare before you can access the server. You own each file that you create, and you determine who has access to each file and at what level. Each person on the network can have no access, read-only access, or read-and-write access. Another security feature is Appleshare's drop folder; anyone on the network can deposit documents into it, but files in the drop folder are invisible to everyone except the folder's owner.

In addition to file-sharing capability, file- and record-locking capabilities are necessary to ensure that two users don't attempt to write to the same file at the same time. Each application must handle this function for its own files; most conform to the AFP specifications.

The main drawback of Appleshare is that you have to dedicate a Mac Plus as a file server. One alternative, TOPS, takes advantage of AppleTalk's peer-to-peer communications capability to provide distributed file service; all nodes act as both file servers and requesters (see the

continued

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Circle M42 on Reader Service Card

It's TOPS

Nicholas M. Baran

TOPS is an AppleTalk-compatible distributed network operating system that lets Macintoshes and IBM PCs share files, hard disks, and laser printers. Unlike Appleshare, however, TOPS does not require a dedicated central file server, but distributes this function between all workstations. TOPS consists of software for each Mac and IBM PC, and it runs over LocalTalk or telephone-wire cabling, such as Farallon Computing's PhoneNet. It's compatible with applications that support the AppleTalk Filing Protocol (AFP), and it can also support Sun workstations.

If you're using TOPS/DOS on the PC, you'll also need the TOPS FlashCard or another AppleTalk PC interface card. FlashCard supports standard 230.4-kilobit-per-second (kbps) LocalTalk speeds for laser printer and PC-to-Mac communications, but it can also transmit PC-to-PC at 770 kbps. By the time you read this, a similar product may be available for the Mac, according to TOPS. FlashCard includes a standard plug-in card with software drivers and an installation guide.

Distributing File Service

TOPS is a distributed network operating system. When you use TOPS, you don't need to dedicate a Mac as a file server, as you do with Appleshare, Apple's centralized file-server software. Each machine in the network acts as both a "client," using the resources of other machines, and as a "server," providing its resources to other computers on the network.

For example, if your workstation is an IBM PC XT, once you run TOPS/DOS and log on to the network, you can "publish" local file folders, volumes, or an entire hard disk, so any networked Mac or PC can access it. Only those files that you publish are available to other network clients. On the Mac desktop, the XT's hard disk appears as an icon representing another Mac hard disk. The Mac can also transfer files from the XT for local storage.

A key issue with every network is security. TOPS uses a password scheme that you can apply to any published folder, volume, or disk on the network. You can also specify that the files be read-and-write or read-only access, and that only one user access the volume at a time. It's not possible, however, to let some users have limited access and some have no access to a file, as you can with Appleshare.

By contrast, Appleshare lets you set access privileges with a desk accessory, and security is more stringent. You must log on to the network to access the file server. You own the folders (or subdirectories) that you create, and you determine which users have access to those folders and what level of access each user has.

Setting Up

I set up a TOPS network that consisted of a Mac SE, an IBM PC XT, and an Apple LaserWriter IINTX, arranged in a typical daisy-chain configuration. I connected the devices to each other via Farrallon's PhoneNet connectors, which consist of two RJ-11 plugs: one input jack, and one output jack. The daisy-chain end connectors have only one RJ-11 connection; a special resistor provided with the connector kit terminates the other plug.

Getting TOPS up and running is simple. You connect each Mac by plugging a LocalTalk connector into the Mac's printer port. If you're connecting PCs to the network, you install FlashCards, connect the RJ-11 cables supplied with the PhoneNet RJ-11 connectors, and install the software on each system, and you're ready to go. TOPS on the PC is a RAM-resident program that you load from the DOS prompt or via an `AUTOEXEC.BAT` file. The program requires 170K bytes to 230K bytes of RAM, and it is copy-protected, so you must buy a copy of TOPS for each workstation.

text box "It's TOPS" by Nicholas M. Baran). Another way to avoid buying a dedicated server is to allow a Mac to act as both a central file server and a workstation. Tangent Technologies' MacServe, for example, offers the benefits of centralized file storage for up to 16 users on a Mac hard disk. You can designate the hard disk of any Mac as a shared disk and divide it into private or shared volumes. This arrangement works best with a few nodes; as network activity increases, the server workstation's performance rapidly decreases.

Mac to PC

Unlike the Mac, there is no de facto communications architecture built into the IBM PC. Rather, each LAN vendor has developed its own proprietary set of networking protocols. While these companies use industry-standard LAN topologies, such as Ethernet and Token Ring at their lowest levels, each one has its own method of providing higher-level functions. The result is a fragmented approach to interconnecting Macs and PC LANs.

There are two ways to integrate Mac and PC LAN environments: You can integrate PCs into an AppleTalk network, or you can extend the PC LAN environment to support the Mac. The latter may not be an option if your PC LAN doesn't support the Mac, however. On the other hand, if all you need to do is perform simple file exchanges between Macs and PCs or occasionally access a PC application, you may want to look into several LAN alternatives (see the text box "Exchanging Data" by Cynthia W. Harriman on page 62).

PCs can participate on an AppleTalk network via an AppleTalk PC interface card, which fits into a standard expansion slot on the IBM PC. However, this still limits PCs to printing documents on a networked laser printer. Appleshare PC, an extension of Appleshare, lets PC users access an Appleshare file server. Other software packages, such as TangentShare from Tangent Technologies, let you configure an IBM PC or PS/2 to participate on an AppleTalk network as an AFP-compatible file server.

Another way to network Macs and PCs is by linking the Mac to a PC LAN. However, PC LANs are generally more complicated and more expensive than AppleTalk LANs, and they may be less cost-effective for small work groups. The dominant vendors are 3Com, Novell, and Banyan. As a participant on the LAN, a Mac may have access to a range of services, including E-mail, file sharing, gateways to hosts, and other LANs.

3Com offers an extension to its 3+Share network operating system that allows the Mac SE or II to participate as a

On the Mac, the TOPS system resides as a desk accessory that automatically loads when you start the Mac. (You can bypass TOPS installation by holding down the Command and Option keys when you start up.)

Making an Impression

Aside from file sharing, perhaps the greatest incentive for using TOPS is being able to share a laser printer. But using a laser printer on the network has some limitations. PCs can't print directly to the laser printer unless you buy a copy of NetPrint software for each PC. If you don't have NetPrint, you can send a file to the laser printer from the DOS prompt using the TPRINT command, which is similar to the DOS PRINT command. With TPRINT, you have to first print the file to disk using your word processor or some other application and then send it to the laser printer via TPRINT. This two-step printing process can prove to be a bit cumbersome.

NetPrint intercepts output that has been directed to the PC's printer port and sends it instead to the laser printer on the network. It supports PostScript files and includes a translator for printing IBM ProPrinter or Epson-compatible files. NetPrint operates in the background so that you can continue with other work after you've sent the file to the print queue.

Another feature allows Mac or PC users without hard disks to share hard disks in other workstations. I created a separate directory on my PC's hard disk for Mac files, installed several Mac programs on the PC, and ran them from the Mac without a hitch.

The major consideration when sharing a hard disk is data compatibility. Obviously, you can't use a Mac file in a PC application unless it has a compatible data format. TOPS provides a set of translator programs on the Mac that converts between many popular Mac and MS-DOS application files. For example, you can translate a WordStar file to MacWrite or a Lotus 1-2-3 file to Jazz. Many other applications use common data formats on the PC and the Mac or include conversion utilities.

My only complaint with the TOPS system is the documentation, which could explain some details more clearly. I had to make several calls to TOPS's technical-support line before I had things running smoothly. However, TOPS's technical support was excellent. TOPS also provides on-line technical support on BIX.

The cost for TOPS is about $250 for each Mac, $59 per laser printer, and $430 for each PC without NetPrint. Including NetPrint, which I highly recommend, the cost per PC rises to almost $620. Although the price per PC is a bit steep, TOPS is an elegant and simple solution for small networks of PCs and Macs.

Nicholas M. Baran is a BYTE technical editor. He can be reached on BIX as "nickbaran."

TOPS 2.0

Type
AppleTalk networking software for Macintosh and IBM PC

TOPS/Macintosh
Price: $249
Requirements: Mac 512K, Plus, SE, or II

TOPS/DOS
Price: $189
Requirements: IBM PC or compatible with DOS 3.1 or higher; 512K bytes of RAM recommended; one expansion slot for FlashCard

TOPS FlashCard
Price: $239
Requirements: IBM PC and one available expansion slot

TOPS NetPrint
Price: $189
Requirements: Same as TOPS/DOS

TOPS Teleconnector
Price: $59

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3Com network node. As such, it can share peripherals and access PC or Mac files stored on a central file server. An Appleshare file server can also support Mac workstations over a 3Com network; however, 3Com's file server does not support AFP. Appleshare file servers on LocalTalk can be linked directly to a 3+Server, which acts as a gateway to 3Com's Ethernet network. Macs with an Ethernet interface card can also operate on a 3Com network directly. A product is also in the works that will allow the Mac to communicate with the 3+Open file server, which runs OS/2 Extended Edition.

Once linked to a 3Com network, Mac participants can access gateways to other LAN environments, such as a token-ring network. Many large corporations also use 3Com's internetwork bridges and gateways to construct wide-area networks (WANs) that connect geographically dispersed LANs via Tymnet or other packet-switched networks.

Novell recently introduced NetWare Macintosh, an AppleTalk-compatible version of its NetWare LAN operating system. In contrast to 3Com's approach, Novell does not require that an extension of its network operating system reside on each Mac. Instead, Novell has mapped the AppleTalk protocols to NetWare. All protocol translation occurs on the Novell file server, which provides the Mac with transparent access to Novell LAN resources. To Macs attached to a NetWare LAN, the NetWare server appears to function as an Appleshare device. You can connect the Mac to a NetWare server via Ethernet or LocalTalk connections. Once linked to the Novell LAN, you can access resources on DEC and IBM hosts and can take advantage of X.25 interfaces to packet-switched services and WAN bridges.

At the time of this writing, Banyan had not introduced its much rumored software that would extend its VINES network operating system to the Mac. However, Macs can indirectly access files on a Banyan server via a TOPS network. A PC attached to both a TOPS and a VINES network acts as a gateway between the two environments.

Mac to DEC

Early last spring, Apple and DEC announced a joint development effort to integrate AppleTalk and DECnet networks. While products have yet to emerge, areas for potential product development include terminal emulation, file sharing and network management, and services such as E-mail. The Apple/DEC alliance strengthens AppleTalk's credibility in the corporate world and may provide users with network-man-

continued

Exchanging Data

Cynthia W. Harriman

If a simple exchange of data between Macs and IBM PCs and compatibles is what you're looking for, several inexpensive alternatives to constructing a LAN are available: establishing a direct connection, performing disk-format conversion, and adding PC coprocessing to your Mac.

Direct-connection schemes use file transfer software to send data between the Mac and PC over dial-up lines or through an RS-232C or small computer system interface (SCSI) link. Disk-format conversion requires adding a third disk drive to your Mac that can read and write PC disk formats. PC coprocessing boards and software let you run PC applications on the Mac. Depending on your needs, a combination of these options may be appropriate. You may also need file-translation software to allow Mac applications to read PC files.

Direct Connection

The easiest approach to exchanging data is to cable the Mac and PC machines together for quick file transfers. If you choose this approach, you can connect the serial ports on the two machines with an appropriate cable (if you already own one, Apple's Imagewriter I printer cable has the right pin-outs), and you can use standard communications software to send files back and forth.

A more basic approach is to buy a turnkey package like MacLink Plus. This product comes with a serial cable and easy-to-use custom file-transfer software for both the Mac and the PC. The drawback of serial connection, however, is that you'll have to transmit at a relatively slow speed: 57.6 kbps is the current limit.

You can overcome this constraint by using the Mac Plus, SE, or II's SCSI. This requires a SCSI PC board and a connecting cable to the Mac's SCSI port. Transmission speed ranges from 1.4 mbps (Mac SE to PC) to 4.2 mbps (Mac II to AT)—substantially faster than serial connections. QuickShare is one product that supports SCSI Mac-to-PC file transfer.

If your machines aren't close enough to allow direct connection, you can use a modem to establish a dial-up connection. For example, MacLink Plus offers a modem option that includes password protection. You can boot MacLink Plus on your office PC, then dial in from a Mac at home, enter the password, and download a Lotus 1-2-3 worksheet. You can then work on it using Excel (which accepts 1-2-3 files) and send it back to the office PC when you're finished. The remote Mac controls the session; you don't need someone at both ends. In addition, MacLink Plus translates many PC application files to Mac application formats.

Adding a Drive

Another popular file-transfer solution is to add a special disk drive that lets the Mac read and write DOS-formatted disks. Several options currently exist that let you add an MS-DOS drive to the Mac, and at least one product, MatchMaker, provides a Mac drive on the PC. While all three MS-DOS drives let the Mac read PC disks, each differs in its hardware requirements, its user interface, its file-translation capability, and the PC media it supports.

Dayna Communications' DaynaFile connects to the SCSI port on any Mac Plus, SE, or II and handles both PC-to-Mac and Mac-to-PC conversions. It's available in configurations that support either 360K-byte and 1.2-megabyte 5¼-inch floppy disks, or 720K-byte and 1.44-megabyte 3½-inch floppy disks. DaynaFile interacts with the Mac's operating system and other software to appear as another Mac drive. In Finder, you can transfer files to and from your PC disk just as you would between Mac floppy disks. Within applications, you can access PC files transparently with the usual Open and Save commands. DaynaFile also includes translation software that converts between PC and Mac application files.

Apple's PC 5.25 Drive is similar to DaynaFile, but it requires a special interface board that makes it usable on only the Mac SE and II. You can transfer files in both directions, but the floppy disk drive reads only 360K-byte PC disks and requires a special transfer program (included with the Mac) to move files; Mac Finder and Mac applications can't access the PC disk directly.

A third alternative is Peripheral Land's Infinity I, a high-capacity 5¼-inch floppy SCSI drive intended as a mass-storage device for Mac files. It reads 360K-byte and 1.2-megabyte PC disks, but you can't write Mac files to it.

If you primarily use a PC, you can install MatchMaker, a half-size drive controller board and software that lets you connect a single- or double-sided Mac external floppy disk drive to your PC. The software supports five commands: COPY, DIR, DELETE, TYPE, and

agement capabilities under Ethernet that AppleTalk currently lacks.

The venture also benefits DEC, which has had limited success with its personal computer offerings. Integrating the Mac into DECnet will be good news for the many firms that use both Macs and VAXes. DEC's research has shown that 36 percent of its VAX users also have Macs and need ways to integrate and enhance these systems.

In the meantime, there are several ways to connect Macs and VAXes. These include VT-100 and VT-200 terminal emulation, DECnet software for the Mac, and AppleTalk file-server software for the VAX (see figure 2). The latter two alternatives require a Mac connection to DECnet's Ethernet backbone via an Ethernet interface card or an AppleTalk/Ethernet gateway.

Terminal-emulation packages, available for the Mac Plus, SE, and II, perform the necessary protocol translation to allow the Mac to act as a DEC terminal. Terminal emulation requires software for the Mac and the host, and an RS-232C cable to link the two machines. In addition to remote-terminal capabilities, many terminal-emulation packages also provide file transfers and other functions. Pacer Software's PacerLink, for example, supports file transfer, virtual disk, and print spooling.

Unfortunately, terminal emulation does not take advantage of the Mac's intelligence; all processing takes place on the host. One solution is to install DECnet software, such as Technology Concepts' CommUnity-Mac, which lets a Mac function as a DECnet end node. Such packages support the Mac interface so that attached Macs can share host resources and access files transparently. Unlike terminal emulation, however,

INIT (format). [Editor's note: *For more information on QuickShare, DaynaFile, and MatchMaker, see "PCs and Macs Working Together" by Emil Flock in the May BYTE.*]

Coprocessing

If you need to run PC programs as well as access PC data on your Mac, consider adding PC coprocessing. You can choose either of two coprocessor boards from PerfecTek and AST Research, or you can select software from Insignia, which emulates MS-DOS on the Mac. Mac coprocessing is currently unavailable for the PC.

When comparing coprocessing options, look into the way each product emulates various PC video options (CGA, Hercules, and monochrome are available); how it allows for keyboard differences between the two machines; whether it can access DOS data files and programs from a PC floppy disk drive attached to the Mac; and whether MS-DOS files can share a Mac's hard disk drive. Further, check out how much memory this two-for-one approach eats up, and how performance compares to that of a stand-alone PC or AT.

Whatever system you use to exchange data between Macs and PCs, keep in mind that transferring data between the two machines may be only half the battle; files often need to be translated between Mac and PC application formats before they're usable. Luckily, the current trend is toward greater file compatibility between Mac and PC programs. For example, Microsoft's Excel can accommodate Lotus 1-2-3 spreadsheets, and Mac and PC versions of Excel, Microsoft Word, and other applications are available. But many other programs still require file-translation software that may or may not be included with the data exchange option you choose.

Products Mentioned

DaynaFile
single-drive unit ..... $650–$850
two-drive unit ..... $810–$1205
Dayna Communications, Inc.
50 South Main St., Suite 530
Salt Lake City, UT 84144
(801) 531-0600
Inquiry M182.

Infinity I $1095
Peripheral Land
47800 Westinghouse Dr.
Fremont, CA 94538
(415) 657-2211
Inquiry M184.

Mac + PC
for MacPlus $995
for Mac SE $1095
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AST Research, Inc.
2121 Alton Ave.
Irvine, CA 92714
(714) 863-1333
Inquiry M186.

MacLink Plus $195
DataViz, Inc.
16 Winfield St.
Norwalk, CT 06855
(203) 866-4944
Inquiry M180.

MatchMaker $149
Micro Solutions
132 West Lincoln Hwy.
DeKalb, IL 60115
(815) 756-3411
Inquiry M185.

PC 5.25 Drive $528
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry M183.

QuickShare $465
Compatible Systems Corp.
P.O. Drawer 17220
Boulder, CO 80308
(303) 444-9532
Inquiry M181.

SoftPC $595
Insignia Solutions, Inc.
1255 Post St., Suite 625
San Francisco, CA 94109
(415) 885-4455
Inquiry M187.

Cynthia W. Harriman of Portsmouth, New Hampshire, is the author of The MS-DOS—Mac Connection *(Brady/Simon & Schuster, 1988). She can be reached on BIX as "editors."*

DECnet node emulation allows the Mac to function as an intelligent peer device and requires no special host software. Connection to the DECnet backbone requires an Ethernet interface card or Ethernet gateway. CommUnity software for MS-DOS computers and Sun workstations also provides connectivity with the Mac via DECnet.

A third option is to buy software, such as Alisa Systems' AlisaTalk, that lets a VAX operate as an AFP-compatible file server. A similar alternative is Pacer Software's PacerShare, which is an implementation of Appleshare for the VAX. These packages let the Mac access VAX files and laser printers, and they are based on AppleTalk for VMS, a developer's tool that implements the AppleTalk protocol suite on the VAX.

Once Mac-to-VAX network links are set up, application-level communications can occur. One promising development in Mac-to-VAX communications is Network Innovations' CL/1, an SQL-based connectivity language that programmers can use to transparently link Mac and VAX databases. Mac databases that support CL/1 can automatically retrieve data from a VAX database. Access of remote data is transparent to the user, to whom all transactions appear to be happening locally. An Apple subsidiary, Network Innovations plans to extend CL/1 to support other host computers in the future. A few Mac database programs, such as HyperCard, are already providing VAX links through CL/1.

Mac to IBM Host

The primary method of connecting the Mac to an IBM mainframe is through terminal emulation. Several configurations are possible (see figure 3). A co-

continued

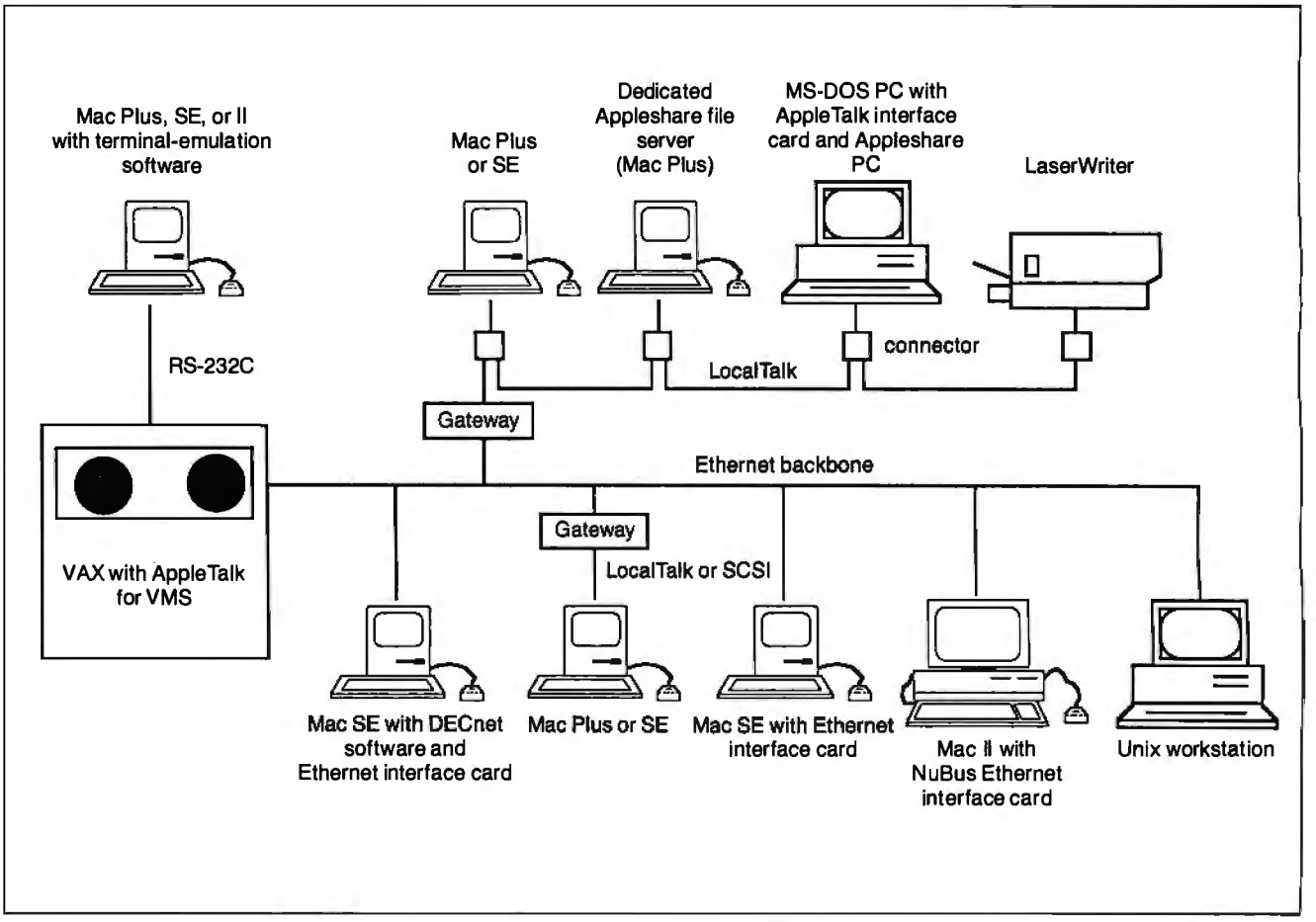

Figure 2: *Macs connected to DECnet's Ethernet backbone can function as DECnet nodes, or the VAX can act as an AppleTalk file server.*

axial cable can connect the Mac to an IBM 3174 cluster controller, which assembles terminal input into packets and forwards them to the mainframe.

A similar approach is to install an AppleTalk–to–IBM 3270 gateway such as Tri Data Systems' Netway 1000. The Netway acts like an IBM 3274 cluster controller to let multiple workstations on AppleTalk establish concurrent 3270 terminal-emulation sessions (Netway supports up to 16 simultaneous sessions). Most 3270 terminal-emulation packages also support file transfer, but the Mac is still a dumb terminal: It simply acts as a window to processes occurring on the host.

The third option is far more powerful. It's a peer-to-peer approach in which Mac applications support MacAPPC, a developer's tool that implements IBM's Advanced Peer-to-Peer Communications or Logical Unit (LU) 6.2 architecture on the Mac. Unlike terminal emulation, MacAPPC lets the Mac interact transparently as an intelligent node with any computer supporting LU 6.2.

In an APPC environment, the user may know nothing about the network and need not be aware of when a connection to the network or to another computer occurs. The application running on the Mac handles this automatically. Applications supporting MacAPPC operate on behalf of the user to transparently provide connection to the network.

MacAPPC comprises a set of APPC functions that reside on a Mac II acting as a nondedicated LU 6.2 gateway on AppleTalk. MacAPPC includes a 68000-based intelligent communications card installed in the Mac II, and an LU 6.2 server utility that supports LU 6.2/Node Type 2.1 functions and acts as the LU 6.2 gateway.

The system administrator controls the APPC gateway. Once activated, the gateway downloads all the LU 6.2 and Node Type 2.1 protocols onto the 68000 card, which distributes sessions over AppleTalk to Macs running special driver software. The Mac's Chooser lets you select from one or more LU 6.2 gateways on the network.

With the advent of MacAPPC, the stage is set for distributed processing between Macs and IBM mainframes. You'll have to wait for the development of applications that take advantage of this new platform, however.

Mac to Others

Apple's push is in the areas of DEC and IBM connectivity; however, the Mac can link to many other systems, as well. For example, several methods are available for connecting Macs with Unix workstations and hosts. Here, the standard Macintosh operating system, which supports AppleTalk, requires a different approach than the A/UX Mac, Apple's Unix workstation. A/UX supports the Transmission Control Protocol/Internet Protocol (TCP/IP) and Sun Microsystems' Network Filing System (NFS)—the de facto network transport and file-sharing standards in the Unix environment (see "Unix and the Mac Interface" by Rick Daley on page 89).

Since the A/UX Mac supports NFS and TCP/IP, connecting to a Sun or other

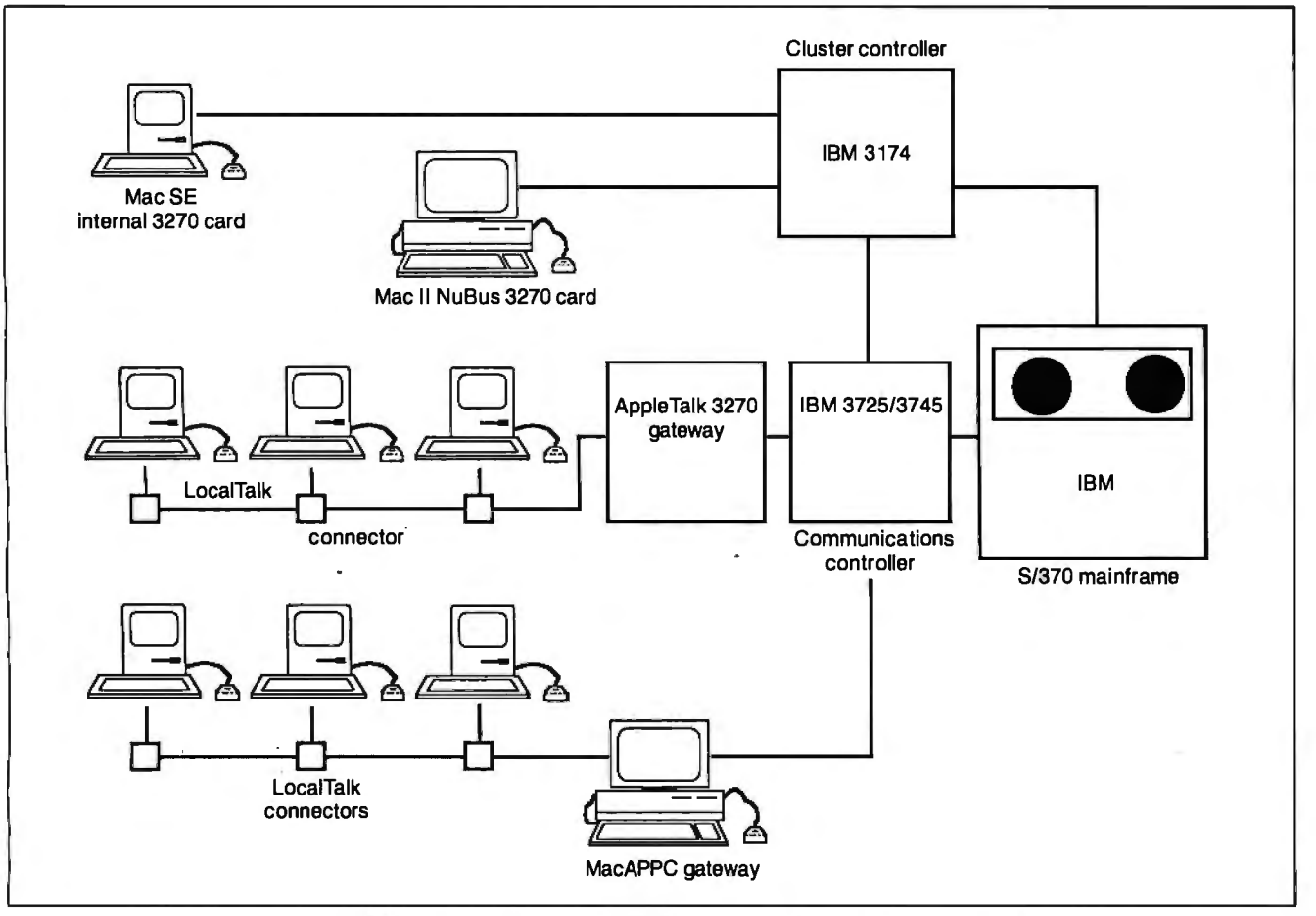

Figure 3: *MacAPPC goes beyond 3270 terminal emulation and 3270 gateways to let the Mac act as an intelligent peer node on an IBM SNA network.*

Unix workstation is simply a matter of buying an Ethernet interface card to establish the LAN connection. For the standard Mac operating system, TOPS/Sun workstation software lets a Sun workstation act as a TOPS network file server. Macs can access both PC and Sun files on the file server, and can indirectly access host files through an NFS network. The Sun workstation connection to the TOPS network requires an AppleTalk-to-Ethernet gateway.

Information Presentation Technologies offers even broader connectivity with Unix-based systems. Its product, uShare, connects Macs, A/UX Macs, PCs, and Apollo workstations, and it provides gateways between AppleTalk, Ethernet, and Apollo Domain token-ring networks. Macs can also take advantage of gateways between Apollo, DEC, and IBM environments.

The uShare software lets the A/UX Mac or an Apollo Unix-based workstation function as a nondedicated Appleshare-compatible file server on an AppleTalk LAN, or the Mac can emulate a Unix workstation to access and run Unix applications. To the Mac, the Unix workstation appears as an ordinary Appleshare server. Connection is via an AppleTalk interface card in the Unix host or an Ethernet interface card in the Mac. Other services supported include E-mail, virtual disk, and print-spooling capabilities.

Beyond the Unix environment, links to other hosts are limited to terminal emulation. Packages are available to connect the Mac to Prime, Pyramid, Data General, Stratus, Tandem, Wang, Hewlett-Packard, and Cray hosts.

Coming Attractions

In addition to supporting AppleTalk, Apple has stated its commitment to develop links to IBM's Systems Network Architecture (SNA), the OSI protocols, and the TCP/IP internetworking protocol suite. Apple has also committed itself to supporting the OS/2 environment, and the company is developing a Micro Channel–compatible AppleTalk interface card for PS/2s.

When it comes to support for internetworking, Apple is being pragmatic; it plans to support both OSI and TCP/IP. Apple already supports TCP/IP on the A/UX Mac and plans to support it under the Mac operating system. Regarding OSI protocols, Apple is also working on X.400 and X.25 gateways. An X.400 gateway would provide LocalTalk connectivity to other networks supporting the X.400 E-mail interchange standard. An X.25 gateway would provide a direct interface between AppleTalk and public packet-switched networks such as Tymnet. Support for token-ring LANs is also in the works. However, Apple has not announced when these products will be available.

Apple owns a minority stake in Touch Communications, an OSI software vendor that implements the full suite of OSI protocols in a variety of computing environments. Touch's OSI Mac Developer's Kit ports the OSI protocol stack to the Mac. Developers who write applications for Touch's OSI Mac can link them to

continued

A Sampling of Mac Connectivity Products

3+ for the Mac
3+ for the Mac.....$495
3+Share and 3+Server..... $7995
Extension of 3+Share network operating system that connects the Mac to 3Com's 3+Network
Requirements: 3+Share, Ethernet interface card or LocalTalk, 3+Server
3Com Corp.
3165 Kifer Rd.
Santa Clara, CA 95052
(408) 562-6400
Inquiry M152.

3+Mail for the Mac $595
Lets Mac send E-mail to other Macs or PCs over 3+Network
Requirements: 3+Share, 3+ for the Mac
3Com Corp.
Inquiry M153.

EtherLink/NB.....$595
Ethernet interface card
Requirements: Mac II
3Com Corp.
Inquiry M154.

AlisaTalk..... $4700 to $14,400, depending on VAX CPU
Software lets DEC VAX function as AFP file server
Requirements: AppleTalk/Ethernet gateway or Ethernet interface card
Alisa Systems, Inc.
221 East Walnut St., Suite 175
Pasadena, CA 91101
(818) 792-9474
Inquiry M155.

TSSNet $495
DECnet terminal-emulation and file-transfer software for the Mac
Requirements: AppleTalk/Ethernet gateway or Ethernet interface card
Alisa Systems, Inc.
Inquiry M156.

MacMainframe
Mac II card.....$995
Mac SE card $795
External unit..... $1195
3270 terminal-emulation card
Requirements: Mac 512Ke or higher (external unit)
Avatar Technologies, Inc.
99 South St.
Hopkinton, MA 01748
(617) 435-6872
Inquiry M157.

Constellation III for the Mac
Constellation III.....$495
Mac network interface card.....$249
20-megabyte Omnidrive $2795
Mac network operating system that runs on Omninet twisted-pair LAN
Requirements: Omninet, Mac interface card, Omnidrive disk server
Corvus Systems, Inc.
160 Great Oaks Blvd.
San Jose, CA 95119
(800) 426-7887
Inquiry M158.

MacIRMA $1195
IRMA card for Mac 3278, 3279
Requirements: Mac II or SE
Digital Communications Associates
1000 Alderman Dr.
Alpharetta, GA 30201
(404) 442-4000
Inquiry M159.

FastNet.....$899 and up
Ethernet controller products for the Mac SE, Plus, and II (SCSI version also available); includes Technology Concepts, Inc.'s CommUnity-Mac software
Requirements: Mac SE, Plus, or II
Dove Computer Corp.
1200 North 23rd St.
Wilmington, NC 28405
(919) 763-7918
Inquiry M160.

InterBridge $799
Bridge device interconnects AppleTalk networks via remote or direct connection
Requirements: Mac 512Ke or higher
Hayes Microcomputer Products, Inc.
P.O. Box 105203
Atlanta, GA 30348
(404) 449-8791
Inquiry M161.

PhoneNet
Per Mac..... $59.95
StarController $1695
Cabling system supports up to six AppleTalk nodes over twisted-pair. Optional StarController links up to 12 PhoneNets
Requirements: None
Farallon Computing, Inc.
2150 Kittredge St.
Berkeley, CA 94704
(415) 849-2331
Inquiry M162.

uShare
Mac.....$149
Host ..... $395 to $2995
AppleTalk interface card $395
AFP-compatible file-server software for A/UX Mac II, Apollo, and other Unix machines. Supports AppleTalk, Ethernet, and Apollo Domain token-ring environments
Requirements: Mac Plus, SE, or II; Unix to Appleshare connection requires AppleTalk/Ethernet gateway, Ethernet interface card, or AppleTalk Interface Card (for Unix hosts).
Information Presentation Technologies, Inc.
23801 Calabasas Rd., Suite 2011
Calabasas, CA 91302
(818) 347-7791
Inquiry M163.

Liaison $295
Software bridge that interconnects LocalTalk networks via RS-232C or dial-up links. Liaison also connects LocalTalk and EtherTalk networks and lets remote Macs access AppleTalk or EtherTalk networks
Requirements: Mac 512Ke or higher, RS-232C cable, or Hayes-compatible 1200-bps modem on each network
Infosphere, Inc.
4730 Southwest Macadam Ave.
Portland, OR 97201
(503) 226-3515
Inquiry M164.

MacServe.....$250
Software converts Mac on AppleTalk to disk and print server; read-access file sharing only; runs in background mode
Requirements: AppleTalk
Infosphere, Inc.
Inquiry M165.

FastPath.....$2495
AppleTalk to Ethernet gateway
Requirements: Mac 512Ke
Kinetics, Inc.
A Division of Excelan
2540 Camino Diablo
Walnut Creek, CA 94596
(415) 947-0998
Requirements: Mac Plus or higher.
Inquiry M166.

EtherPort
EtherPort II.....$695
EtherPort SE.....$695
SCSI connection.....$1150 to $1250
EtherPort SEL.....$695
Network interface controllers for direct Mac-to-Ethernet connections. EtherPort II and SE are internal cards for the Mac SE and II. EtherSC is a stand-alone device that uses any Mac SCSI port. The SEL is an interface to Synoptics' Lattisnet
Requirements: Mac SE, Plus, or II
Kinetics, Inc.
Inquiry M167.

Series II, Series III Twinax
Series II (multiport).....$1495 to $3495
Series III (single port).....$1195
Mac to IBM System 34, 36, and 38 protocol-conversion and file-transfer software
Requirements: Any Mac
KMW Systems Corp.
6034 West Courtyard Dr.
Austin, TX 78730
(512) 338-3000
Inquiry M168.

MacMenlo.....$395
Tandem 6520 and 653X terminal-emulation and file-transfer software
Requirements: Any Mac
Menlo Business Systems, Inc.
201 Main St.
Los Altos, CA 94022
(415) 948-7920
Inquiry M169.

PacerLink..... $2000 and up
Software performs terminal emulation, file transfer, and resource sharing between Mac and DEC VAX (VMS and Ultrix), Prime, Pyramid, Cray, and Stratus hosts. Connection is via Ethernet (AppleTalk/ Ethernet gateway or Ethernet interface card), RS-232C, or modem
Requirements: Mac 512Ke or higher
Pacer Software, Inc.
7911 Herschel Ave., Suite 402
La Jolla, CA 92037
(619) 454-0565
Inquiry M170.

PacerShare.....$400 and up
Turns VAX/VMS into an Appleshare file server and lets the Mac access VAX files
Requirements: PacerLink, Ethernet
Pacer Software, Inc.
Inquiry M171.

NetBridge.....$399
AppleTalk network device bridge
Requirements: Mac 512Ke or higher
Shiva Corp.
222 Third St., Suite 100
Cambridge, MA 02142
(617) 864-8500
Inquiry M172.

InBox
Software for three Macs.....$350
Each additional Mac.....$125
Per PC.....$195
E-mail software for AppleTalk networks
Requirements: AppleTalk
Symantec Corp.
Think Technologies Division
135 South Rd.
Bedford, MA 01730
(800) 648-4465
Inquiry M173.

TangentShare Server.....$700
AFP file-server software for IBM PCs or PS/2s
Requirements: IBM PC or PS/2 with 512K bytes and a hard disk drive
Tangent Technologies, Ltd.
5990 K-Unity Dr.
Norcross, GA 30071
(404) 662-0366
Inquiry M174.

CommUnity-Mac
Per license.....$495 to $350
Media/documentation fee.....$200
DECnet-compatible software; includes VT-100 and VT-220 emulation
Requirements: Mac Plus, SE, or II
Technology Concepts, Inc.
A Bell Atlantic Co.
40 Tall Pine Dr.
Sudbury, MA 01776
(800) 777-2323
(617) 443-7311
Inquiry M175.

TOPS Terminal.....$189
Terminal-emulation software that links to any host supporting TCP/IP
Requirements: Mac 512K or higher, AppleTalk/Ethernet gateway or Ethernet interface card
TOPS, a Sun Microsystems Co.
950 Marina Village Pkwy.
Alameda, CA 94501
(415) 769-9669
Inquiry M176.

Netway 1000.....$3995
AppleTalk-to-3270 gateway device provides IBM 3270 terminal emulation and file transfer for up to 16 Macs
Requirements: Mac 512Ke or higher, AppleTalk
Tri Data Systems, Inc.
1450 Kifer Rd.
Sunnyvale, CA 94086
(408) 746-2900
Inquiry M177.

Reflection 1 for the Mac.....$249
Hewlett-Packard 2392A terminal-emulation and file-transfer software
Requirements: Mac 512K or higher
Walker Richer & Quinn
2825 EastLake Ave. E
Seattle, WA 98102
(206) 324-0350
Inquiry M178.

Mac 240.....$199
DEC VT-100, VT-200, VT-220, VT-240 terminal-emulation software
Requirements: Mac 512Ke
White Pine Software, Inc.
94 Route 101A
Amherst, NH 03031
(603) 886-9050
Inquiry M179.

Apple's Macintosh Connectivity Products

Network Interface Cards

LocalTalk PC Card
AppleTalk interface card for the IBM PC that provides basic connectivity to a LocalTalk network; it lets the PC access a networked laser printer.
Price: $249

EtherTalk Interface Card
An Ethernet interface card for the Mac II.
Price: $699

Terminal Emulation

AppleLine
A protocol converter that translates between AppleTalk and IBM 3270 protocols to establish Mac-to-IBM mainframe communications.
Price: $1295

MacTerminal
Multifunction terminal-emulation software that lets a Mac emulate a DEC VT-52 or VT-100 terminal or an IBM 3278 Model 2 terminal when used with an AppleLine protocol converter.
Price: $125

AppleLine 3270 File Transfer
Software that works with the AppleLine protocol converter to transfer files between the Mac and an IBM 3270 mainframe.
Price: $99

Software Development

AppleTalk for VMS
An implementation of AppleTalk that runs on a VAX.
Price: $5000 per site license

CL/1
Database connectivity language from Apple subsidiary Network Innovations Corp. Mac database applications supporting CL/1 can transparently access data in VAX databases.
Price: $3000 to $23,750 per host

MacAPPC
Hardware and software that lets Mac applications support IBM's Advanced Program-to-Program Communications architecture. APPC allows for distributed transaction processing between Macs and other computers supporting APPC. Available late 1988.
Price: $2500 per site license

MacWorkstation
Software that lets minicomputer and mainframe host software developers create applications that support the Mac user interface.
Price: $2500 per site license, $5000 per developer's license

LAN Software

Appleshare
Apple's file-server software that runs on a Mac Plus. The Mac Plus becomes a dedicated file server.
Price: $799

Appleshare PrintSpooler
Print-spooler software that runs on Appleshare.
Price: $299

Appleshare PC
Software that lets PCs participate on an Appleshare file server. It requires an AppleTalk interface card.
Price: $149

Interpol
Network-management utility; troubleshooting and fault isolation.
Price: $99

DEC VAX and IBM PC environments through Touch's OSI implementations for those systems.

Another promising development is Apple's MacWorkstation, which lets host software developers and programmers build a Mac user interface into host-based applications. MacWorkstation goes a step beyond terminal emulation in that it gives host applications access to the Mac interface without requiring host processing time. In addition, MacWorkstation "Exec" software modules let programmers migrate some host-processing tasks to the Mac.

One benefit of MacWorkstation is that it makes network use more efficient. By allowing MacWorkstation to handle the user interface, Apple claims that some beta users have reduced network traffic by 75 percent. MacWorkstation will run over a variety of connections, including AppleTalk, Ethernet, serial, and IBM SNA networks.

What's Missing

Ultimately, to have a complete range of networking capabilities for the Mac, companies such as Apple, DEC, IBM, and others must agree on ways to make their systems work together. Progress toward this goal is being made through Apple's joint development project with DEC and through commitments to OSI and to providing links to IBM's SNA. However, to a large extent, Apple depends on other companies to provide connectivity products for the Mac.

Apple plans to meet with many of these companies to present a complete set of specifications and interfaces for which developers will be invited to build products. The point, as Apple's Cagle puts it, is to develop products that go beyond simply allowing the Mac to emulate dumb terminals. "Are we doing anything more useful than would be done by putting a dumb terminal on a desk?" Cagle asks. "If not, for the same amount of money [that you'd spend on a Mac], you can get several dumb terminals."

Developers need to do more than just provide a window to the mainframe, Cagle says. "Electronic mail is a beginning, but there are a lot of vertical applications that are very important. We intend to be more focused from the perspective of the user's needs." ■

Janet J. Barron is a technical editor and Robert L. Mitchell is an associate technical editor for BYTE. They can be reached on BIX as "neural" and "r.mitchell."

Glossary

AFP
AppleTalk Filing Protocol allows file sharing to take place by controlling file access on an AppleTalk network.

APPC
Advanced Program-to-Program Communications, also known as Logical Unit (LU) 6.2, is IBM's SNA session protocol. In an SNA network, APPC allows direct, peer-to-peer communications between applications, eliminating the need for a host to act as an intermediary.

AppleTalk
Apple's proprietary communications architecture for the Mac. AppleTalk's seven-layer structure is similar to that of the OSI Reference Model (see the text box "Overview of AppleTalk," on page 164 of the July 1987 BYTE).

Bridge
A device that interconnects similar local-area networks, such as two AppleTalk LANs. Both LANs must share a common addressing scheme. No protocol conversion is necessary.

CSMA/CD
Collision Sense Multiple Access with Collision Detection. LAN access protocol used in Ethernet and the IBM PC Network. Nodes listen to the bus and wait until the network is quiet before transmitting. When two nodes attempt to transmit simultaneously, each detects the resulting collision and waits a random time interval before attempting to retransmit (see the text box "IEEE 802 LAN Standards," on page 150 in the July 1987 BYTE).

CSMA/CA
Collision Sense Multiple Access with Collision Avoidance. Network access scheme used in AppleTalk's link access protocol. As with CSMA/CD, the node waits until the bus is quiet before attempting to transmit, but rather than detecting collisions, CSMA/CA attempts to minimize their occurrence by using request-to-send and clear-to-send packets before sending data (see the text box "Overview of AppleTalk," on page 164 in the July 1987 BYTE).

Gateway
An intelligent device that interconnects dissimilar networks; it performs necessary protocol conversion to allow communication between both environments.

LocalTalk
The physical network components and link-level protocols for sending data across an AppleTalk network. These protocols are built into the Mac and can run over shielded twisted-pair or telephone wire at 230.4 kbps.

LU 6.2
See APPC.

Node Type 2.1
Also called Physical Unit 2.1. IBM SNA network-node specification that allows direct physical links between peer nodes. Previously, SNA specified a master/slave relationship in which two nodes couldn't establish a session without going through a mainframe.

SDLC
Synchronous Data Link Control. Link-level protocol that forms the foundation of IBM's SNA.

SNA
Systems Network Architecture. IBM's communications architecture that defines physical connections, protocols, and procedures for all IBM computers and devices.

TCP/IP
Transmission Control Protocol/ Internet Protocol. A set of internetworking protocols originally developed by the Department of Defense for ARPANET; now an industry standard.

X.400
International standard for E-mail exchange specified by the CCITT.

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HyperCard What Is It?

Brian L. Dear

Finally, the Macintosh has a friendly environment for programmers. HyperCard has been called a hypertext system, a relational database manager, a game, and an "information handler." Despite all proclamations, however, it's none of these; rather, it's a tool for developing any and all of them. Undeniably, it's a fun way to work, but what exactly is it, and why the fuss? HyperCard is an *authoring system*, and it is significant because it is the first authoring system to reach the general public.

Classifying HyperCard as an authoring system opens the door to all the issues, implications, and problems that have come to be associated with such systems. For example, one of the strongest temptations for an author is to overuse available special effects: too many colors or fonts, too much text, too many graphics, too much audio. Much of the stackware currently available for HyperCard suffers from these kinds of problems. Perhaps, if we understand what is already known about authoring, we can lessen the likelihood of repeating history.

Sometimes a word is worth a thousand pictures

Authoring Systems

An authoring system is an integrated software toolkit used to create interactive applications that communicate knowledge. Typically, the goal of these applications is to impart knowledge, and the purpose behind using them is to *learn*. In computer-based learning applications, for example, this knowledge falls into a particular academic or training domain: The application takes the role of tutor; the user takes the role of student. Increasingly, authoring systems have been used to develop other kinds of applications as well. With an authoring system like HyperCard, the knowledge is likely to be of a more practical nature, such as name and address lists, appointment calendars, and travel and business information.

Authoring systems are not new. There is an old and well-established authoring community, whose scope, historically, hasn't spread much beyond the bounds of educational institutions. Authoring systems originated out of a need to generate large amounts of computer-based learning materials, or courseware, in a shorter period of time than it would take with a traditional programming language.

Educators have many long-standing reasons for favoring authoring systems over more traditional programming languages. Key among them is the emphasis on interactivity, or give and take, with the machine. In computer-based learning situations, it's crucial that the computer actively stimulate and involve the student. Stimulation requires a wisely chosen blend of outputs—graphics, text, and, when appropriate, color, audio, and video. Involvement requires the same wise selection of available inputs—keyboard, mouse, touch-sensitive screen, digitizing pad, speech, and so on.

Good courseware is, by definition, highly interactive. A good authoring system typically features a variety of tools, providing a rich assortment of possibilities for stimulating and involving the student. While the number and sophistication of these tools varies greatly from system to system, experienced authors agree on the "essential" ingredients.

- *Branching.* An authoring system must support direct, conditional, and user-controlled movement through the application.
- *Creating, storing, and displaying bit-mapped graphics.* For most applications, you need a resolution of at least 512 by 350 pixels; the system should support such resolutions.
- *Response analysis.* Since interactivity is the key to success in an authoring system, it should support a powerful set of string functions to examine a user's input and match it against a list of correct alternatives. The system should also check for correct spellings and let you set a *threshold* level for misspellings; that is, it should accept minor misspellings if you wish.
- *Audio and video support.* The system should support the software routines required to control random-access audio and videodisk devices.
- *Multiple levels of authoring.* Because expertise varies greatly from author to author, the system must be able to support a range of authoring skills. The lowest level is typically menu-driven and the easiest to use. A more experienced author would probably access a higher level, which should include an editor for writing source code in an authoring language.
- *Standard programming features.* The authoring language should support the constructs found in a standard programming language, such as `IF...THEN... ELSE`, `REPEAT...UNTIL`, `FOR...NEXT`, and so on.
- *File manipulation.* The authoring system should support the necessary tools to manipulate (e.g., create, read, write, and destroy) files; in other words, it should support database management.
- *Other language support.* You should be able to write your own routines in a general-purpose language, like Pascal, C, or assembly language, and include them in the authoring language.

Strengths and Weaknesses

When you need to develop a highly interactive application, an authoring system is probably your best bet. A good authoring system often turns out to be especially

continued

amenable to developing materials that have nothing to do with education. Over the years, many people have discovered that such a system proved to be just the right tool for creating presentation programs or developing games (except for those that require assembly language, such as arcade games). Authoring systems save time because you don't need to program a specific set of response-analysis, display, and branching routines for each application. These functions are built in and usually much more flexible than those available in a traditional language library.

On the other hand, applications developed with an authoring system almost always run more slowly than their traditional counterparts. Sometimes the increased flexibility is worth the cost in speed and efficiency, but it's a choice you have to make. Applications developed with an authoring system are also likely to consume more disk space and memory, due to the larger overhead required. HyperCard, for instance, requires a great deal of overhead to keep track of cards, buttons, and scripts.

Three Ways of Seeing

The Macintosh interface is based on solid psychological theory that can be traced to the work of psychologist Jerome Bruner and his colleagues. In Bruner's book *Toward a Theory of Instruction* (Cambridge: Harvard University Press, 1966), he identified three types of mental representation: enactive, iconic, and symbolic.

The first, *enactive* representation, involves how we remember action, movement, and coordination—the "psychomotor" skills. Learning the latest dance, how to swing a baseball bat, or how to operate a stick shift, we represent these skills enactively. When we want to "tear off" HyperCard's Tools menu, we call upon enactive representations of various actions with the mouse: clicking, dragging, and releasing.

The second type of mental representation is *iconic*; it refers to the mental summarization of visual and other sensory stimuli. We call on iconic representations to fill in, complete, or extrapolate. Icons and bit-mapped graphics are two examples of the Macintosh's heavy use of iconic representation.

The highest levels of abstraction involve the third type, *symbolic* representation: This refers to words and language. When we name a card in a HyperCard stack, write a HyperTalk script, or say the word HyperCard itself, we are using symbolic representations.

Many nonprogrammers are quickly becoming HyperTalk experts.

The Macintosh is considered a user-friendly machine because it appeals to all three forms of mental representation. It's easy to learn, and its software is easy to use because of the heavy dose of enactive and iconic representation, forms we are most likely to resort to when learning something new. The success of the Macintosh user interface is largely due to its rich mix and constant cycling of the enactive, iconic, and symbolic.

In contrast, we could classify IBM PC software—dBASE III, WordStar, and the command-line style of MS-DOS itself, for example—as more symbolic than Mac software. One theory might be that preference for a Mac over an IBM PC or vice versa is due at least in part to how comfortable you are with heavily symbolic representation.

Recent software developments reveal some intriguing trends. The IBM PC world is paying more and more attention to enactive and iconic representations: Witness Microsoft Windows, Excel, and OS/2. The Macintosh world, on the other hand, is now adding more symbolic kinds of representation to its repertoire: Consider A/UX, Apple's implementation of Unix.

HyperCard takes advantage of the various capabilities of the Macintosh interface. It resides in the Mac's very flexible operating environment, whose design is sensitive to all three modes of mental representation. HyperCard incorporates highly advanced concepts in computer science, many of which originated in the research on object-oriented programming environments such as SmallTalk. Many people who have never programmed before are quickly becoming experts in HyperTalk and stack development because of its ingenious *context*. Everyone knows what a button is.

Older authoring systems, especially those on time-shared minicomputers or mainframes, were limited in their ability to meet an author's demands. The speeds at which you could display text, graphics, and animated sequences on older hardware had a great impact on the possibilities available. In a way, this was a blessing, because the limitations forced you to consider your options more carefully.

As these hardware and software limitations disappear, the range of options widens tremendously. HyperCard is merely a hint of the future for authoring systems. But as the range of options expands, we will have to be increasingly careful with our designs.

Creating Stacks

Stack developers need to be especially careful in designing stacks. There is a strong temptation to overdo it and get carried away with all the options available. Designing and developing interactive computer applications is an exciting and engrossing task, but it requires restraint, temperance, and constant consideration of the user for whom the stack is intended. Here are some points for you to consider, based on lessons learned by authors of computer-based learning materials.

- *The right tool.* Is HyperCard the right tool for the job? Or would a conventional Macintosh programming language be more appropriate for this application? HyperCard isn't the solution to every problem.
- *Time.* How much time do you have to develop the stack? Applications take time, and you're just as likely to find bugs in your HyperTalk scripts as you are in a C or Pascal program. The authoring process is very similar to the life cycle of creating any programming product; good programs require constant testing and refinement.
- *Goals.* Why are you using HyperCard? What do you hope to achieve? Does your goal meet the user's needs; for example, will it increase the user's productivity?
- *Usefulness.* Will the stack serve some genuinely useful purpose? Or are you writing it simply as an exercise, as programming practice? Experienced authors always ask, "Why does this application need to be on-line?" You should make a list of all the reasons why it should be on-line and compare it to one showing all the reasons it would work fine off-line—in print, for instance.
- *Audience.* Who will be using the stack? Is it for personal use, or do you plan to sell it commercially or offer it as shareware? Even if it's just for your own use, you should be sensitive to how its design appeals to the three levels of mental representation. Pictures get old fast. Sometimes, as Bruner said, a word is

continued

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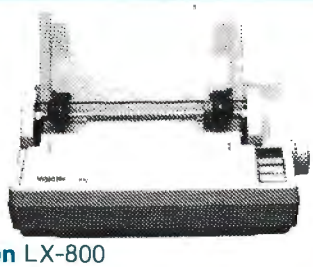

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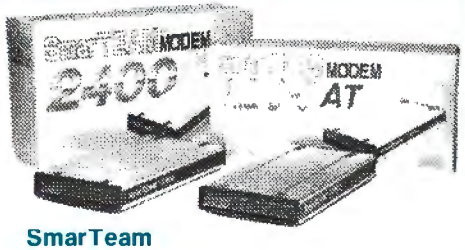

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worth a thousand pictures. If you're designing the stack for many users, then you need to be extra sensitive to the broad range of user preferences.

For example, suppose you're designing a personal financial-planner stack that ends with a simple electronic checkbook. Which would be better for its users: making them use the mouse to click on a bunch of buttons in a fancy graphic representation of a calculator (emphasis on the enactive and iconic), making them type their arithmetic expression into the HyperCard message box (emphasis on the symbolic), or giving them the option to do either?

• *Sound.* The Macintosh can generate fairly decent digitized and synthesized sound. You should use sound resources with restraint. Ask yourself whether the stack's users will really benefit from those digitized audio clips of Captain Kirk's voice.

• *Title pages.* Do you really need one? How often do you expect users to access the stack? Will they use it all the time, or only once in a great while? Most software packages deliberately lack a title page. Consider what the users really get out of looking at your title page every time they enter the stack.

• *Shadowing.* Shadowing two adjacent sides of a box may indeed enhance the three-dimensional illusion. But are you trying to highlight the box, or the information in the box? If you're only shadowing for aesthetics, you may be better off without it.

• *Fonts.* Using too many different fonts is almost always worse than using just a few. If the design calls for using unusual fonts in a stack intended for other users, remember that many users may not have your font files on their systems; if you use them, you may have to include them as resource files in your stack.

• *Foreground vs. background.* A relatively recent feature of authoring systems is the ability to designate some portions of the screen as foreground and others as background. Sharing the same background among a sequence of cards reduces both the amount of new information on the screen and the amount of storage required for the stack.

• *Visual effects.* One of HyperCard's more interesting—and fun—features is its collection of visual effects. When designing your application, however, be careful about using them. Effects like barn door, iris, dissolve, and venetian blind may be stimulating and attention-getting, but they may also be distracting. An application that uses a lot of visual effects tends to call attention to itself; in other words, too many or too complex visual effects can make what should usually be a transparent interface all too apparent.

• *Degree of realism.* If there's one thing authors of computer-based learning materials face every day, it's the balance between realism and practicality. How realistic do graphics have to be to get the point across? Unfortunately, many Mac-

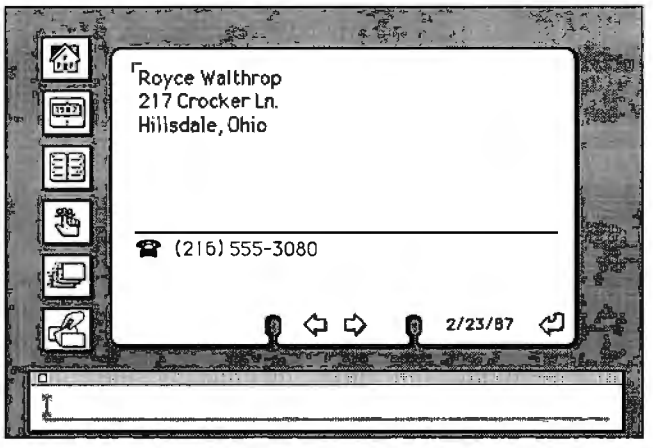

Figure 1: *Do the Rolodex card-file notches really add to the understanding of the information in this stack?*

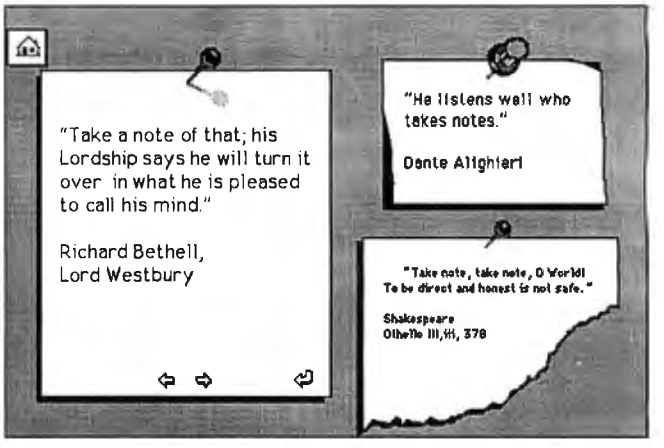

Figure 2: *Torn scraps of paper and memo pins look realistic, but what purpose do they serve on a computer screen?*

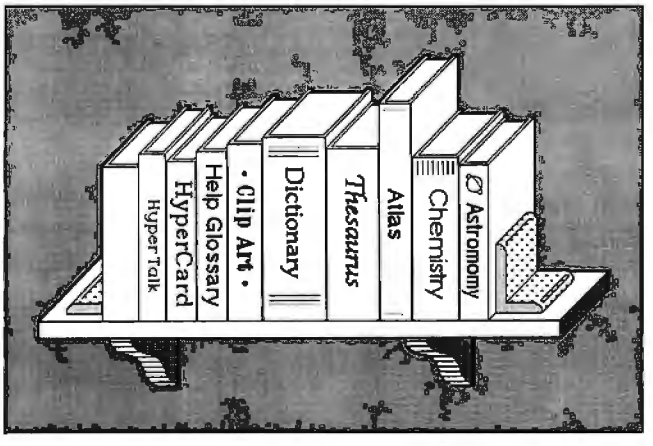

Figure 3: *The books make a pretty menu, but is it an appropriate user interface?*

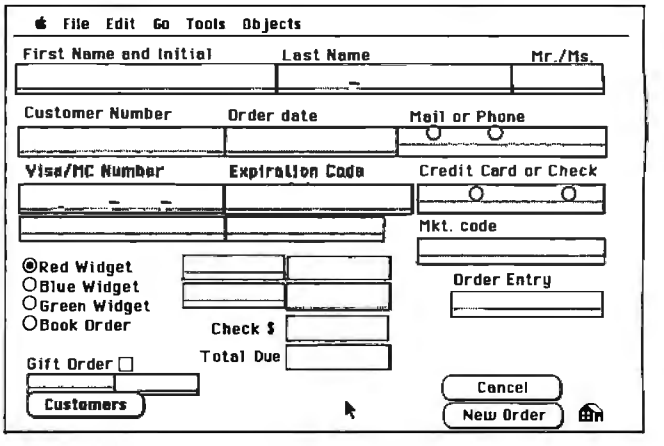

Figure 4: *Forms like these may work fine on paper, but online they impede the user's productivity.*

intosh developers can't resist the temptation to over-simulate physical reality: In effect, they try to make hardware out of software.

Stackware developers need to ask themselves these kinds of questions over and over again: Do I really need that pretty, digitized image of a telephone? Will the users really benefit from pictures of Rolodex cards so faithful to the real thing that even the card's notches are present? Real Rolodex cards have those two notches for a reason. Think long and hard before putting them on-line. Remember, in stackware (as in courseware), graphics gobble up disk space fast. Consider the degree to which your HyperCard displays facilitate or impede the user's abilities to mentally process what you have presented (see figures 1, 2, and 3).

• *Forms.* When designing fill-in-the-blank forms on a computer display, first consider how faithful the form must be to its paper equivalent. Some forms, like the 1040 tax form, work well when faithfully transferred on-line. Users are quite familiar with the paper versions of the 1040 forms; thus, a faithful computer rendition is important. But most paper forms demand a better design when put on-line. Remember that paper forms are designed primarily for the benefit of the clerk who must read them. Since on-line forms eliminate that drudgery, the design of such forms should consider its users (see figure 4).

A New Standard

In its short lifetime, HyperCard has become the standard against which all others must now compete. Its ease of use and intuitive interface have captured the imagination and boosted the confidence of many novice programmers.

But we must remember that HyperCard is the latest in a long line of authoring systems. Many lessons have been learned over the years, and stackware developers should strive to consider the issues, both good and bad, that authoring systems raise. With an understanding of the design principles of authoring systems, we are less likely to make the same mistakes again. ■

ACKNOWLEDGMENT

I am grateful to Apple Fellow Alan C. Kay for a discussion of Bruner's theory and the Macintosh.

Brian L. Dear is director of product development at Coconut Computing, Inc., in San Diego, California. He can be reached on BIX as "whofan."

HyperCard How Does It Work?

Laurence H. Loeb

Make it work the way you want it to

What I remember most from the Boston MacExpo in August 1987 is Bill Atkinson's smile as he showed off HyperCard's tear-off menus for the first time. He waited as the implications of using tear-offs started to percolate through the room. As more and more people started to comprehend what their eyes were telling them, Bill broke out into this great, loopy grin that said, "Isn't it nice to have something work the way you want it to?"

This new tool forced me to do some serious questioning about how I'd been using the Macintosh in my dental business. I had been using several discrete programs to do the business functions, in a manner that had remained basically the same since 1984. I generated information for each patient with a database and a word processor, and I used the Finder to sort by date for accounts receivable. A simple system, true, but it worked.

I had tried to make an electronic patient chart with MacPaint. While I could save the graphical information I needed, I hadn't used it very much. I needed different kinds of information while I was working, not just graphics; I needed the text as well. Moreover, I didn't want to have to reenter data I already had in electronic form. I needed the maximum return for each input.

HyperCard lets me combine graphics with text—it's MacPaint with buttons that do things. (I use a mouse better than a keyboard when I have gloves on, anyway.) A HyperChart can bring up detailed areas of interest without a fixed sequence. That's the point of the navigation features: to let HyperCard keep track of where you've been. It does housekeeping—and windows, to boot. They're called cards, but you can do things with them that are "windowlike."

The patient chart is a common denominator in dental treatment: It's a graphical record that's pretty standard in content. Specific implementations of it may vary, but the information tends to be similar. If I could devise a way to present this record on a Mac's screen, I could refer to it, as I do to paper records, during treatment. And while I was at it, I thought I'd make it user-extensible; that is, if I wanted to change the symbols I used to mean various kinds of treatments, or add new ones, I could—without a major effort.

Customizing with HyperCard

HyperCard gives me the paint tools that let me customize an application any way I see fit—and they're built in. I don't need any complicated calling sequences. Eventually, I used the background of a card the same way I had used the MacPaint document earlier; that is, the background contains the basic graphical information I need on all charts (see figure 1). I can then overlay whatever symbols I want on top of this, ending up with a graphical record that is the equivalent of a drawing on a preprinted form (see figure 2). If I need a reminder about something specific, I can attach a Post-it note at the touch of a button (see figure 3). More "paper simulation," sure, but that's what I'm comfortable with.

After deciding on the basic paradigm, I had to decide how the stack should "flow." In this application, I need to move from the general to the specific—from the basic chart to a specific tooth. And what simpler way to get there than to click over its position on the chart? HyperCard lets me do this with a "transparent" background button—one that a patient-information card can inherit. If I click on the button, it tries to do what its

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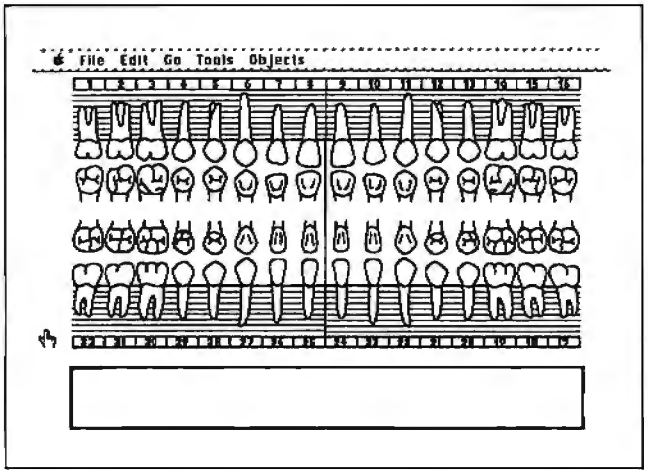

Figure 1: *The basic graphical information needed for a dental chart.*

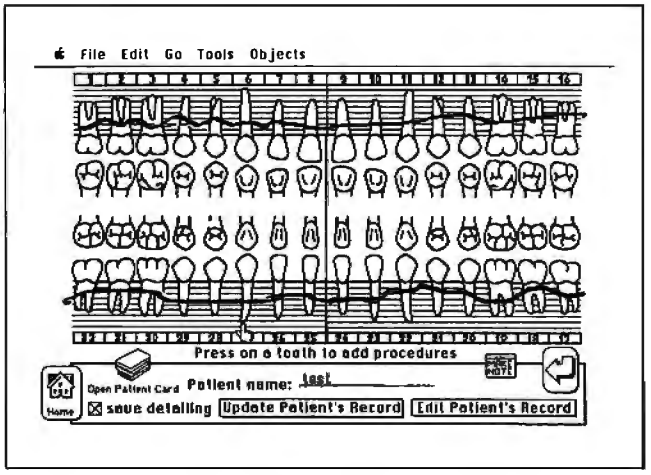

Figure 2: *This chart contains bone-level information drawn with a brush tool.*

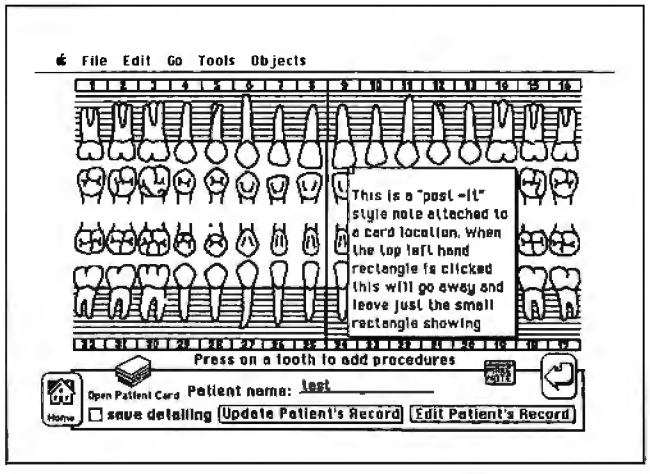

Figure 3: *A Post-it note serves to remind me of anything unusual.*

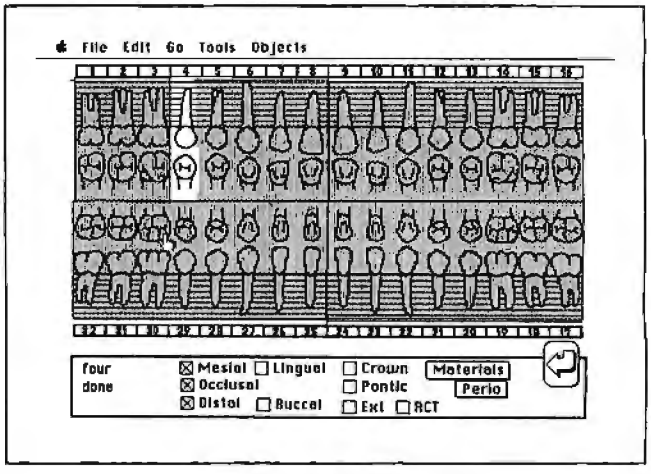

Figure 4: *I can put in the treatment for a specific tooth by pushing the applicable buttons.*

script tells it. Since it's "transparent," all I see is that I'm pointing at and clicking on a specific tooth. In the background button's script, I set up the card I want to go to next. Once I select a specific tooth—and, by implication, the card as well—I can either record current information or call up a history of what has occurred in the past.

I find that the simplest way of showing history is to have a procedure record in English that I can display as I need it. To make the integration work well, the stack has to create this record as each treatment is recorded. To input the information, I simply click on the applicable buttons (see figure 4), and the stack creates a text container with this information in it. To do this, the stack checks the highlight property of each of the buttons when the card is closed by the action of the return button. (A fragment of the `closeCard` routine I used is shown in listing 1.) If the highlight of a detail button is true, that button has been clicked. The stack then builds a text container that has the name of the clicked button in it.

When I have recorded all the treatment information, a button click updates the appropriate text file with all the text containers for a particular date. (It would be easy, for example, to use tabs in building the text file if I later wanted to use this file in Excel or another database that recognizes tabs.)

Adding the Extras

One protection I wanted to build into the stack was to have it remind me if I forgot to save my changes. Almost all Macintosh programs do this, so why not a stack? The script to do this is deceptively simple (see listing 2) and is performed when control leaves the patient's card. (The variable `changedRec` is set to true when one of the hold variables has something other than `empty` in it. The name of the current patient, `currentpt`, is also the name of the patient's card.)

This script shows HyperTalk's ability to send messages that HyperCard can actually *perform*. Instead of having to `goto` a line of a script, you can pass an activating message to a particular object, and it will perform its own script. For instance, in this script, sending the `mouseUp` message to the button has the same effect as clicking on the button with the mouse. This kind of system message is an elegant way to program "top down." Each object can potentially be accessed as a executable module. (Yes, this *is* object-oriented programming.)

But HyperTalk can't deal with everything: It can't put up a standard Mac file-select dialog box, for example. For this, HyperCard's designers left a "backdoor" entry, called XFCNs, which provide a way to link code generated by an-

Listing 1: *This routine checks the highlight property of the buttons when the card is closed.*

```
on closeCard

    [omitting global setups and the like]

    put empty into buildline
      --you can't use a container without letting
      --HyperCard know about it first
    put empty into flagger

      --check each button
    get the hilite of background button id 4
    if it is true then
      put "L" before buildline
      put true into flagger
      --let our end know we have
      --something in the buildline
    end if

    get the hilite of background button id 5
    if it is true then
      put "B" before buildline
      put true into flagger
    end if

    [more similar code omitted]

    if flagger is true then
      put "--5--" & return & buildline &&
     restmat & return into hold5
      --holding area for tooth 5
    end if
end closeCard
```

Listing 2: *This script puts up a typical Macintosh reminder so I don't forget to save my changes.*

```
on closeCard
 global changedRec
 get the hilite of button 3
 if it is true then
      --indicates the save check box is clicked
  if changedRec is true then  --put up dialog box
   answer "Save changes to patient record?"
   with "OK" or "Cancel"
      --exit now if they don't want to save changes
   if it is "Cancel" then exit closeStack
   send mouseUp to card button id 45 of this card
      --press the "update patient record" button
      --just as if the mouse had clicked it
   put false into changedRec
      --since we wrote the patient's record,
      --reset the flag
  end if  --end the first if construct
 end if   --end the check box construct
end closeCard
```

other programming language (like C or Pascal) into HyperTalk-accessible verbs. Steve Maller of Apple wrote a nice XFCN to put up the file-select dialog box. In my text-editor card, I use this widely available XFCN, along with Dewi Williams's HyperTalk function for getting only the last part (the true filename) out of a full path name; that's what the `FileName` XFCN puts into a container (see listing 3).

continued

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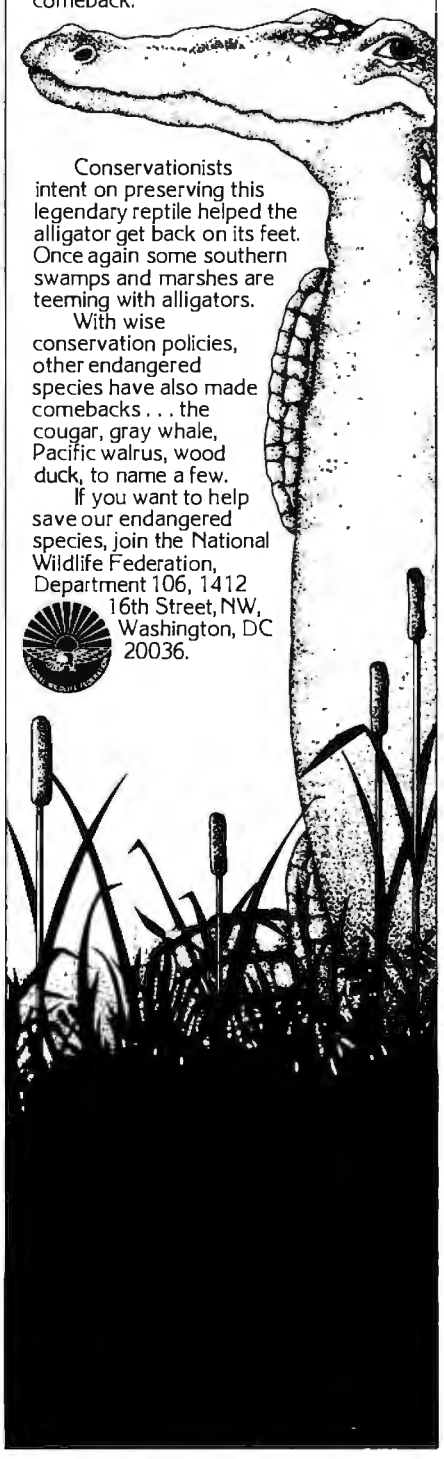

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If you want to help save our endangered species, join the National Wildlife Federation, Department 106, 1412 16th Street, NW, Washington, DC 20036.

Listing 3: *This routine gets the real filename out of a full path name.*

```
on mouseUp
  put FileName("TEXT") into theFile
     --invoke the FileName XFCN only showing TEXT files
  set lockscreen to true
  if theFile is not empty then    -- cancel hasn't been pressed
    open file theFile
    read from file theFile for 16384
     --take the entire file in at once; up to the EOF
    put it into card field "Text Box"
     --display file in text box on card
    set the scroll of card field "Text Box" to 0
     --set to the top of the field
    close file theFile
    put LastPathComponent(theFile) into card field "File Name"
     --file name from full path
    put "Patient Record" into card field "whatKind"
     --force feed this, so the edit card can be reused
  end if
  set lockscreen to false
end mouseUp

-- LastPathComponent: given a file pathname, returns the last
-- component (i.e., whatever comes after last colon, if anything).
-- From Dewi Williams

function LastPathComponent name
     --scan backwards for the last colon.
  repeat with i = the length of name down to 1
    if character i of name is ":" then exit repeat
  end repeat

  if i is 1 then
    -- Name was of the form ":thing" or "thing". Check for leading
    -- colon, and adjust if necessary. Done for generality.
    if first character of name is ":" then
      put 2 into i
    end if
  else
    add 1 to i -- skip the colon
  end if

  -- Name was of the form "Thing:otherthing". Return "otherThing".
  put empty into lastpath
  repeat with j = i to the length of name
    put character j of name after lastpath
  end repeat
  return lastpath
end LastPathComponent
```

One of the tools I used during development was a stack that had most of the available public domain HyperCard tools available on it. You don't need to reinvent the wheel. The creator of the Developer Stack is Steve Drazga, who organized the information in a HyperCard-like manner. This is an extremely well done stack. He even put HyperTalk syntax in it for a quick on-line reference, similar to Steve Capps's *Programmer's On-Line Companion*. I found it easier to have the syntax available within HyperCard for the odd quick reference than to have to search through a book. (I probably could have used the Help stack that is included with HyperCard, but the arrangement in the Developer Stack was much more compact.) Updating the stack is also done in an ingenious manner that doesn't require downloading the entire stack again and again. You can transmit just the changes, and the stack updates itself.

System Details

I finally came up with a "master record" card that I could clone into specific patient records. This is the first card you encounter upon opening the stack. I wanted to allow only three actions at this

Listing 4: *This script creates an employee card by hiding and showing a card field.*

```
--"edit the employee data" button
on mouseUp
  set lockscreen to true
  set the scroll of card field 4 to 0
  show card field 4
  show card button id 9
  set lockscreen to false
end mouseUp

--when done editing click this button
on mouseUp
global nopush
  put true into nopush
  send opencard to this card  --surprise! send an openCard message
end mouseUp

--what happens when you open an employee card?
on openCard
  global nopush
  if nopush is true then
     --otherwise the openCard message
     --would scramble the popping order
      put false into nopush
    else
      push recent card
  end if
  set lockscreen to true
  hide card field 4  --hide the history field
  put card field 4 into record    --put the text into a variable
  if offset("**",record) > 0 then
     --"**" is a marker for end of
     --employee's address information
    put char 1 to (offset("**",record) -2)
      of record into card field 3
     --put up to the "**" into a visible LOCKED field,
     --so user can't mess with the data
  else
    put "Error encountered in opening card" into msg
    play boing
    show msg
    wait for 3 seconds
    hide message
    pop card
    exit openCard
  end if
  set lockscreen to false
end openCard
```

point—go back home, make a new card, and open an existing one. So I wouldn't alter the master card, I covered it with buttons in the forefront that will do these tasks when clicked. Most HyperCard novices overlook the manner of arranging buttons (or other objects) so that an intended overlap occurs. The Home Card button overlaps all the other buttons on my stack, for instance. If two HyperCard objects occupy the same space, one will overlap the other. To get the desired overlap, you select the button and invoke the bring closer/send back HyperCard commands. This is similar to what you might do in MacDraw with objects, except that in HyperCard each type of object has its own layer.

If I select the open button, a dialog box appears asking for a name. At this point, an implicit shift in the card handling may occur. You can define a special name to mean that a different kind of record—for instance, an employee record—should be retrieved rather than a patient record. That employee card may include employee data, such as address and phone number, or you could use it as a payroll system if appropriate HyperCard func-

continued

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tions are embedded in it.

I made a HyperText employee card simply by hiding and showing a card field. (A card field works for this rather than a background field, because it can store individual information as well as display it. If you used a background field common to all employee cards, there would be more overhead to make sure the correct information was being shown.) Listing 4 contains the script for the buttons that do all the work for this field.

Create Your Own

What possible use would you have for a dental stack? Perhaps a lot, if you're a dentist; probably none if you're not. But HyperCard as a tool can, with a dose of ingenuity and creativity, help you make something that you need. I certainly couldn't have created this application as simply without it, and `DentalStack` has helped me a great deal. ■

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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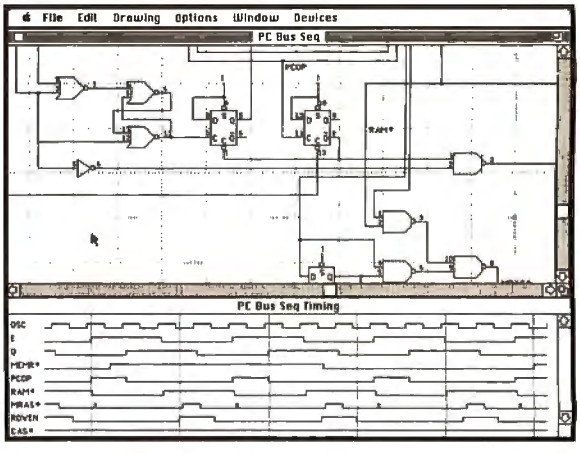

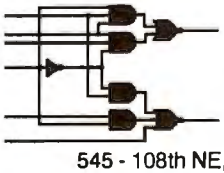

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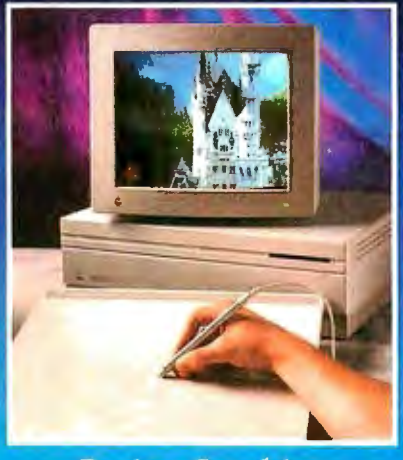

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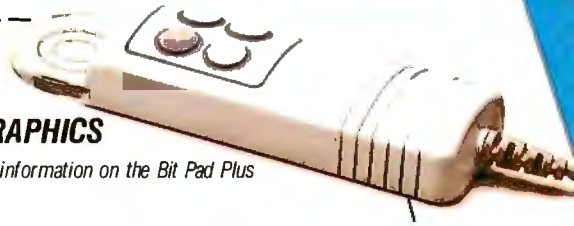

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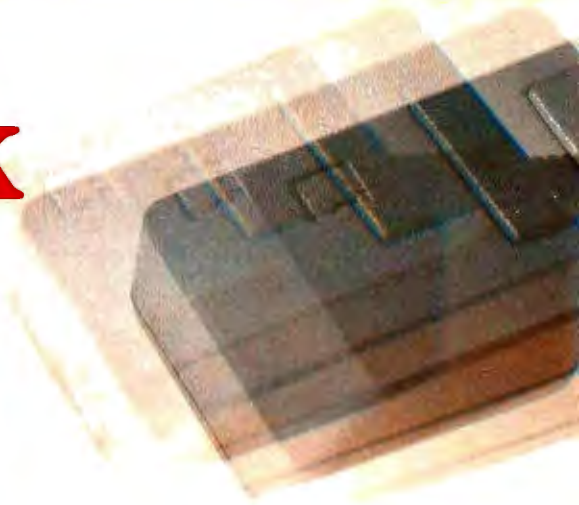

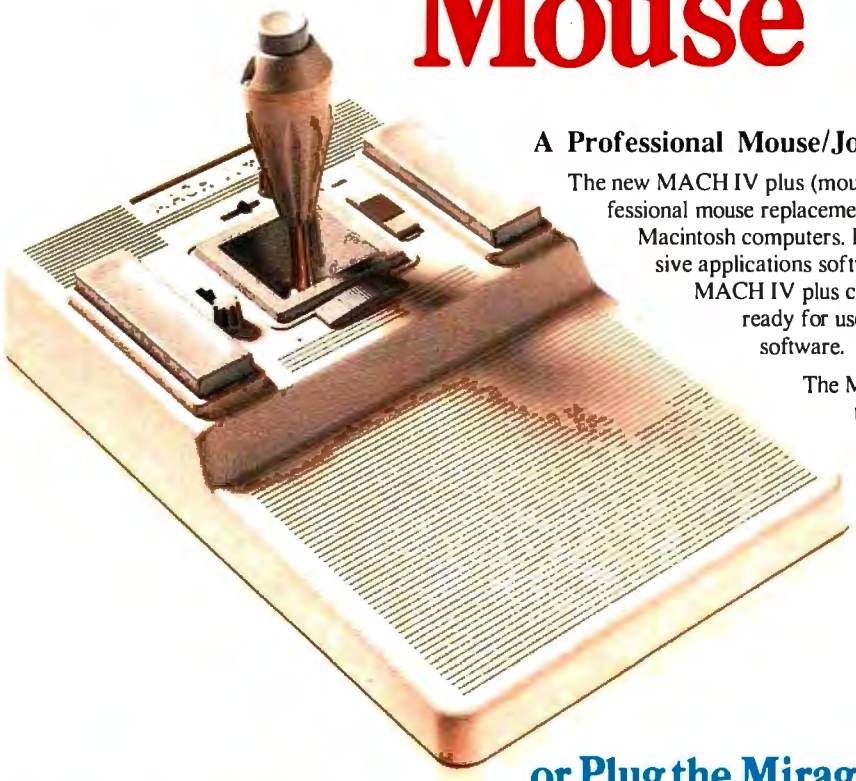

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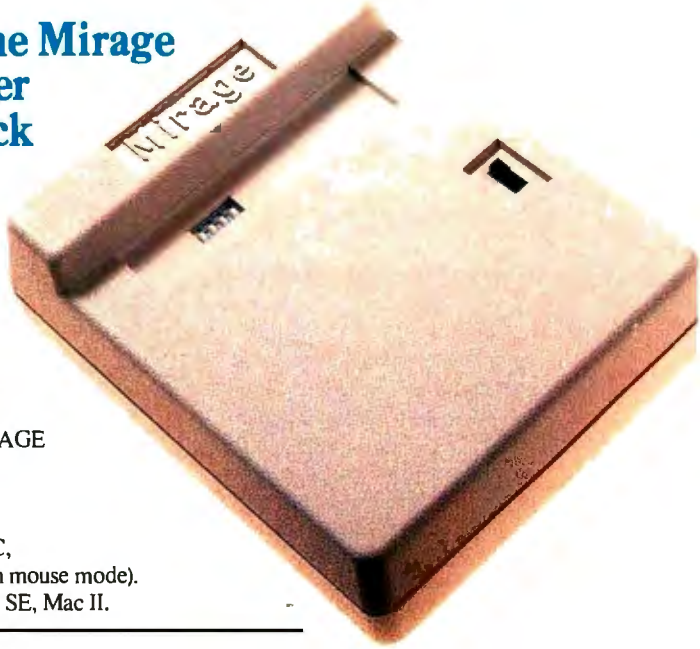

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Using Color QuickDraw on the Mac II

Jan Eugenides

I have to admit it: I didn't think color on the Macintosh was important. But when I began to explore my new Mac II, I saw I was wrong. Color adds vitality and clarity; it's no mere frill. Best of all, it's not that difficult to add color to your own programs, using Color QuickDraw.

I obtained an early beta draft of *Inside Macintosh Volume V* (1987, Apple Programmer's and Developer's Assoc.), which contains information on the various color routines. After much experimentation, I worked out an interesting method of color animation. The technique involves constantly modifying the color lookup table contained in the video RAM. It works with any AppleColor monitor and video card, and should work with any third-party video board as long as it supports a 256-color mode. This application produces absolutely stunning, almost mesmerizing, effects, so I've named it Mesmer (see photo 1). The C listing is fairly long, so only fragments of it appear here. [Editor's note: *The complete listings for this article are available in a variety of formats.* *See page 3.*]

I'll briefly explain some of the features of Color QuickDraw and how these are used to produce Mesmer's effects. A detailed description of Color QuickDraw is beyond the scope of this article, but it is available in *Inside Macintosh Volume V* or you can check out Scott Knaster's *Macintosh Programming Secrets* from Addison-Wesley. We're only going to cover the groundwork we need to understand what Mesmer does, and dive right in for a close look at the code. At the end of this article I'll explain some caveats to using this technique, but Mesmer provides several working examples of how to access and use Color QuickDraw for your own needs.

Here's a working example of a Mac II color animation

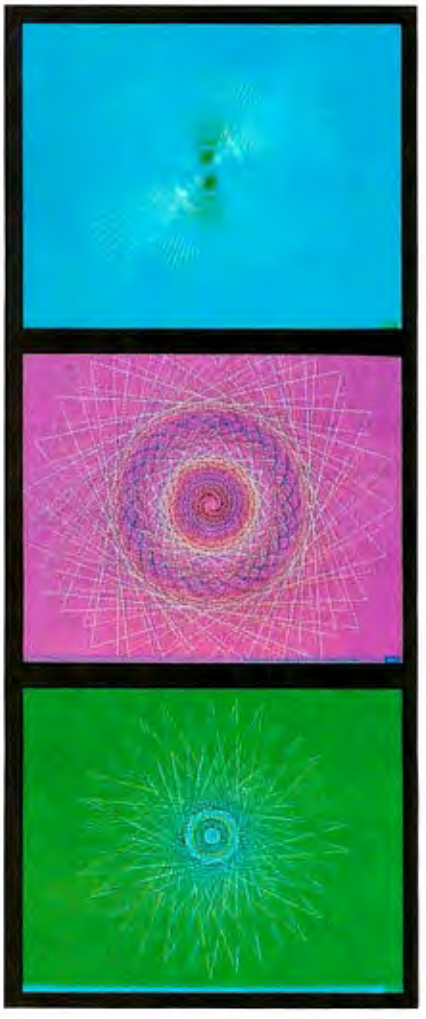

Photo 1: *Mesmer in operation.*

Color QuickDraw

If you are familiar with QuickDraw, Color QuickDraw holds few surprises. Most of the same drawing commands are available, except that you can now specify the color to be used for the operation. The standard Macintosh drawing interface, the `grafPort`, supports the eight original QuickDraw colors: black, yellow, magenta, red, cyan, green, blue, and white. Since Mesmer uses 256 colors to produce its effects, this requires you to draw in a color `grafPort` (`cGrafPort`) instead. The structure of a `cGrafPort` is practically identical to a `grafPort`, and both structures are the same size. Apple was able to pack more information into a `cGrafPort` by changing several fields (`bkPat`, `pnPat`, and `fillPat`) from bit-pattern data to handles pointing to color information. Also, the `portBits` field no longer points to a `BitMap` structure that itself points to the `grafPort`'s bitmapped data, but has a handle to a color pixel map that contains information on the color image. The easiest way to allocate a `cGrafPort` is to simply call `NewCWindow()` in your application. This ROM call is similar to the old `NewWindow()` call, but instead creates a color window using a `cGrafPort`.

All colors in Color QuickDraw are manipulated in an *RGB space*. The RGB space serves as a common ground where applications can use color in a consistent, hardware-independent manner. Color values are represented by an `RGBColor` data structure that specifies the red, green, and blue components of a color. (See code fragment 1.) Each of the three components are short integers (16 bits) that can have values from 0000 hexadecimal for the lowest intensity to FFFF hexadecimal representing the highest intensity. If all three components are zero, the color is black. If all three are FFFF hexadecimal, the color is white. Whenever all three components are equal to one another, the result is a shade of gray. All other combinations result in colors. You should note that although `RGBColors` store each component as a short integer, Color QuickDraw currently uses only one byte of information per color compo-

continued

Code fragment 1: RGBColor *data structure.*

```
typedef struct RGBColor{
  unsigned short  red;      /* magnitude of red component */
  unsigned short  green;    /* magnitude of green component */
  unsigned short  blue;     /* magnitude of blue component */
} RGBColor;
```

Code fragment 2: ColorTable *data structure.*

```
typedef struct ColorTable{
  long          ctSeed;   /* unique identifier for table */
  short         ctFlags;  /* flags describing the spec array */
  short         ctSize;   /* number of entries - 1 */
  CSpecArray    ctTable;  /* array [0..0] of ColorSpec */
} ColorTable, *CTabPtr, **CTabHandle;
```

Code fragment 3: *The* Environs *structure.*

```
short machine, rom;

Environs(&rom, &machine);
```

Code fragment 4: *Using* GetGDevice *to extract the pixel depth*

```
GDHandle            gH;
PixMapHandle        pH;

gH = GetGDevice();    /*get a handle to main graphics device*/
pH = (**gH).gdPMap;              /*get a handle to its PixMap*/
if((**pH).pixelSize == 8)      /*examine the pixelSize field*/
  /*a pixel size of 8 indicates 256 colors are available*/
```

Code Fragment 5: *Inner drawing loop for Mesmer.*

```
for(theta = 0.0; theta < 480.0*v; theta += v)
  {
  RGBForeColor(&color);  /* set the drawing color */
  r = theta/v;
  x = midx+r*cos(theta); /* make some patterns */
  y = midy+r*sin(theta);
  LineTo(x,y);           /* draw a line from the last point to
                            this one */
  index++;          /* cycle thru all 256 colors in the clut */
  if(index>=255)index = 0;
  Index2Color(index,&color);
  }
```

Code fragment 6: *Using* SetEntries( ).

```
for(n = 0; n < 512; n++)
  {
  tempval = temptable[255];     /* shift all entries down one */
  for(j=254; j>=0; j--)
     temptable[j+1] = temptable[j];
  temptable[0] = tempval;
  SetEntries(0,255,temptable); /* install the new clut */
  Delay(1L,&ticks);            /* slow rotation slightly */
  }
```

nent, which gives you a palette of 2^{24} or 16,777,216 colors.

How is an RGBColor presented on, say, a monitor? Color QuickDraw uses a lookup table mechanism that translates RGBColors into values that a video board then uses to index into its own map of color information. The information in this map, or color lookup table (CLUT), is used by the hardware to drive the monitor. This arrangement effectively hides the messy hardware details from programmers and allows them to focus on developing products rather than worry about compatibility problems.

Color QuickDraw groups a cGrafPort's colors into a data structure called a ColorTable. Its structure is shown in code fragment 2. As you can see, each entry in the color table is not simply an RGBColor but a ColorSpec. A ColorSpec data structure consists of a value field (short integer) followed by an RGBColor. This value field is nothing more than 3 to 5 of the most significant bits of each component of the RGBColor record. These values are used to index into the video board's color map to determine what colors you see. My output device was a color monitor, but these values could index into a color map whose values describe the "best-fit" colors for a color printer. These values are used internally by Color QuickDraw (actually the Color Manager) and shouldn't be modified by your application. I'll show how this mechanism works in the "Using the Color Manager" section.

In place of the old familiar BitMap used by a grafPort is the PixMap, a structure that defines the cGrafPort's pixels. The first three fields of a PixMap are the same as those of a BitMap: a pointer to the pixel image (baseAddr), an offset that determines the number of bytes from one row of pixels to the next (rowBytes), and the boundaries of the image (bounds). A PixMap contains additional fields that define the horizontal and vertical resolution of the image (hRes and vRes); the image's depth, or physical bits per pixel (pixelSize); and other information. In its current incarnation, Color QuickDraw uses a "chunky" pixel image format that has all of a pixel's bits stored consecutively in memory, and all of a row's pixels stored consecutively as well.

Although QuickDraw works with RGB colors, it also provides other ways to define a color. Color QuickDraw has conversion routines for HSV (hue, saturation, and value), HLS (hue, lightness, and saturation) and CMY (cyan, magenta, and yellow) color models. The

Color Picker package contains routines to display a color wheel that lets you select a particular color from it (see photo 2), and routines to convert between the various color definitions.

There's more to Color QuickDraw, of course: color cursors, color patterns, new drawing modes, a new picture format, and new text-handling routines. But, in general, Color QuickDraw can be regarded as an enhancement to the old QuickDraw, not a departure from it. Programs written with the original QuickDraw still run under Color QuickDraw, as long as they don't make any assumptions about an image's pixel depth or memory requirements.

Checking Your Machine Environment

When writing a color application, it's a good idea to add code that checks whether Color QuickDraw is available on the Macintosh executing your program. Since these routines are written in 68020 code, attempting to run them on a Mac Plus or Mac SE will produce a system bomb—a clearly undesirable result. Fortunately, it's easy to have your application check what type of machine is running it. The `Environs()` function returns information about the machine and the ROM; it is shown in code fragment 3. If a Mac II is running your application, `machine` will be equal to 2.

Currently, only the Mac II has color capabilities, so this is a sufficient check. However, for future compatibility, it's better to check directly for the availability of Color QuickDraw itself, using the `SysEnvirons()` call. Apple's Technical Note #129 explains how to do this.

Once you have determined that the color calls are available, you should determine the current pixel depth; put another way, how many colors are currently available? This question arises from the fact that the number of colors displayed can be set by the user via the Control Panel.

For simplicity, I designed Mesmer to require 256 colors. This is not a great idea for a commercial application, which should be capable of running with any number of colors, but it's fine for a short demonstration application. To ensure that the display is using 256 colors, Mesmer examines the pixel depth of the main graphics device, which is the display that encompasses that part of the Desktop with the menu bar.

continued

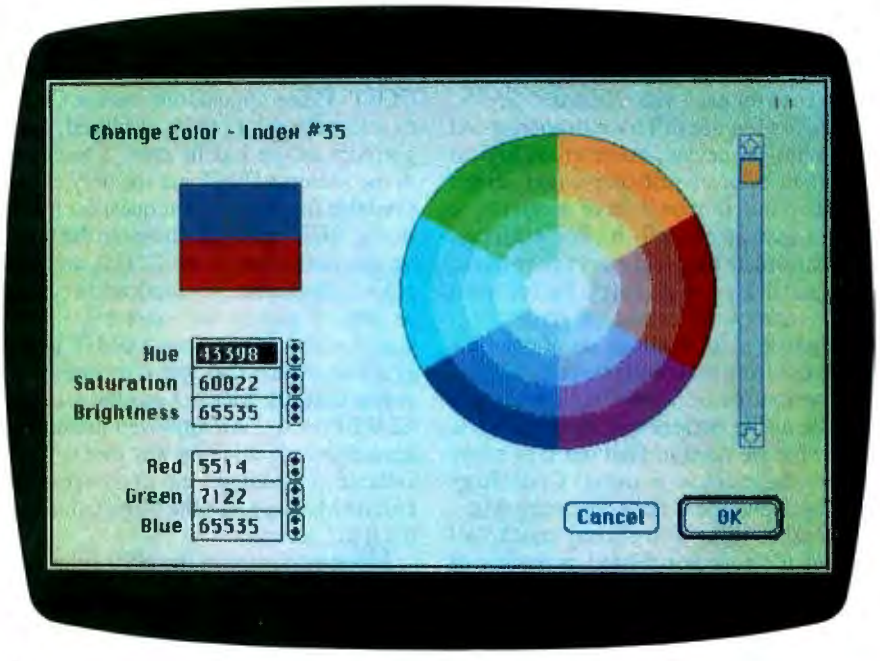

Photo 2: *The Color Picker Dialog box. You can select a color by pointing and clicking on the color wheel or by typing values into the text field boxes. Values for a color can be entered as an RGB color model or an HSV color model.*

Listing 1: *The* `gDevice` *data structure. Mesmer extracts information about the depth of the screen from* `gdPMap`*, which is a handle to the* `PixMap` *associated with this* `gDevice`.

```
typedef struct GDevice
{
  short         gdRefNum;     /* reference number of driver */
  short         gdID;         /* client ID for search procedures */
  short         gdType;       /* device type */
  ITabHandle    gdITable;     /* handle to inverse lookup table */
  short         gdResPref;    /* preferred resolution of GDITable */
  SProcHndl     gdSearchProc; /* list of search procedures */
  CProcHndl     gdCompProc;   /* list of complement procedures */
  short         gdFlags;      /* grafDevice flags word */
  PixMapHandle  gdPMap;       /* PixMap for displayed image*/
  long          gdRefCon;     /* reference value */
  GDHandle      gdNextGD;     /* handle of next gDevice */
  Rect          gdRect;       /* device's bounds in global coordinates */
  long          gdMode;       /* device's current mode */
  short         gdCCBytes;    /* rowBytes of expanded cursor data */
  short         gdCCDepth;    /* depth of expanded cursor data */
  Handle        gdCCXData;    /* handle to cursor's expanded data */
  Handle        gdCCXMask;    /* handle to cursor's expanded mask */
  long          gdReserved;   /* future use. MUST BE 0 */
} GDevice, *GDPtr, **GDHandle;
```

Graphics Devices

Because the Mac II supports a variable-size screen, different pixel depths, and even multiple screens, we need a way to keep track of and manipulate whatever video devices are attached. Color QuickDraw uses a structure called a gDevice, or graphics device, that describes each device's characteristics. The structure of a gDevice is shown in listing 1.

When you start up the Mac II, it determines the number of installed video boards, reads the device-specific information on each (such as screen size and pixel depth), and creates a linked list of gDevices for each video board.

A gDevice doesn't have to correspond to a physical device, however. A logical gDevice behaves just like a real screen device, but it won't have a software driver associated with it. For example, you can create a logical gDevice in memory, and draw into it. This is useful when you want to write into an off-screen PixMap whose pixel depth or set of colors is different from that of the screen.

The routine GetGDevice( ) returns a handle to the current gDevice, which is just what we need to find out how many colors the monitor is using. Code fragment 4 shows the C code for doing this.

Another thing you should check, although it's not color-related, is the size of the screen. The QuickDraw global screenBits.bounds contains the rectangle of the main screen. Mesmer uses this information to open a full-screen-size window. If your application needs to figure out the shape and size of a Desktop that spans several screens, the low-memory global GrayRgn (at address 9EEh) contains the RgnHandle (region handle) to a standard QuickDraw region that describes the Desktop.

Creating a Color Look-Up Table

To achieve its swirling animation effects, Mesmer requires a customized CLUT. Color QuickDraw uses a CLUT to select the colors to be displayed; each graphics device has its own. The colors in the screen's CLUT are the only colors available for display. A request for a particular RGB value is matched to the nearest available color in the CLUT, and that color is displayed. An application cannot be sure of getting the exact color it requests unless it provides a CLUT to the graphics device that specifies the exact values it needs. Mesmer sets the screen's CLUT directly. An approved method of accomplishing this in a way that is more suitable in a complex environment is the Palette Manager (see the "The Good and the Bad" section).

I took advantage of the HSV color definition to calculate a "rainbow" of colors (that is, colors that blend smoothly from one hue to another). By leaving the saturation and value parameters at their highest values and varying only the hue, it's easy get colors that are evenly spaced all around the rim of the color wheel. These are the most brilliant colors available, which is just what I wanted for Mesmer. The Color Picker's HSV2RGB( ) routine converts each HSV color to its RGB equivalent, and these values are then stored in an array. Listing 2 shows a part of the code I used to create Mesmer's CLUT. It generates an array of 256 evenly spaced colors that are then written into a clut resource of an arbitrarily named resource file. After creating the file, I used ResEdit to copy and paste the clut resource into Mesmer's resource file.

Using the Color Manager

The Color Manager is a set of routines designed to work directly with graphics hardware, providing RGB color space information to Color QuickDraw or instructing the hardware to modify its color map as required to display a new set of colors. Macintosh graphics devices convert arbitrary pixel values in their frame (display) buffer into actual RGB values, as determined by the CLUT for the device. Changing the CLUT changes

Listing 2: *LightspeedC code to generate the color look-up table (CLUT) resource for the Mesmer application. A CLUT that contains a "rainbow" of smoothly blended colors is generated and written into a resource file called Fred.*

```
/*color table generator*/
  MakeCLUT()
{
  CTabHandle    ctabH;
  HSVColor      hColor;
  short         refNum;

  ctabH = (CTabHandle)NewHandle((long)sizeof(ColorTable)); /*allocate  space
                                                            for color table*/
  hColor.saturation = 65535;     /*set saturation to max*/
  hColor.value = 65535;          /*set value to max*/
  for(n = 0; n < 256; n++)       /*for 256 colors*/
      {
      hColor.hue = n*256;        /*create 256 evenly spaced hues*/
      HSV2RGB(&hColor,&(**ctabH).ctTable[n].rgb);
      /*the value field is just the most significant bits of the RGBColor*/
      (**ctabH).ctTable[n].value = 0; /*just set it to zero, color manager does
                                        the rest*/
      }
   (**ctabH).ctSeed = GetCTSeed();    /*use the current version identifier*/
   (**ctabH).ctSize = 255;
/*size of color table minus one*/
   CreateResFile("\pFred");           /*create a resource file*/
   refNum = OpenResFile("\pFred");
   AddResource(ctabH, 'clut', 200, "\pFred");
/*add our new clut to it*/
   CloseResFile(refNum);
}
```

the colors displayed without changing the pixel values stored in the frame buffer. This is the secret of Mesmer's animation effects: Once an image is created, the colors can be changed by modifying the device's CLUT without redrawing the image. By carefully selecting the sequence of colors in the CLUT and shifting the index to them around, you can generate a wide variety of special effects. Mesmer's graphics, as nice as they are, really just scratch the surface.

There are three sets of Color Manager routines that Mesmer uses to produce the animation effect: `Color2Index()`, `Index2Color()`, and `SetEntries()`. `Color2Index()` finds the best match to a random starting `RGBColor` for each drawing sequence. It returns the index value into the CLUT for that color, which becomes the starting color. For each iteration of the inner drawing loop, this index is incremented. It wraps around at 255 so that all 256 colors of the CLUT are used in sequence, starting with the random color. This produces a rainbow-colored drawing. The pattern itself is randomized as well, so it produces many combinations of colors and patterns.

As the index is incremented, the `Index2Color()` routine is used to retrieve the `RGBColor` corresponding to that index from the CLUT. The Color QuickDraw call `RGBForeColor()` sets the drawing color, and `LineTo()` does the actual drawing. This inner drawing loop is shown in code fragment 5. The variable v is set randomly before the loop begins, as is the starting index value, `index`. The variables v, `theta`, and `r` are all `float`-type variables, while `index`, `x`, and `y` are short integers.

Once the rainbow-colored pattern has been drawn, the real fun begins. `SetEntries()` changes the current `gDevice`'s CLUT (in this case, it's the screen). You can change the entire table, or just specified entries. Mesmer uses `SetEntries()` to swap the whole CLUT. First, a copy of the CLUT is made. Next, each table entry is rotated up one position, with the contents to the top entry moved to the bottom. Then the screen is set to the new CLUT using `SetEntries()`. The result is that each color on the screen changes to the color that was adjacent to it in the CLUT. Because the colors are selected sequentially around the color wheel, it appears as though the colors themselves move to the next line in the pattern. Since the patterns move in a circular way outward from the center of the screen, the colors appear to swirl outward as well, blending and changing as they go (see photo 1). The C code fragment 6 shows how this is done. After the CLUT rotates a couple of times in one direction, it reverses direction for another two full rotations.

There is one caveat to using the `SetEntries()` routine. You must be careful to set the CLUT back to its original state before leaving your application. Otherwise, you can wind up with some very strange and even illegible displays produced by subsequent applications that rely on the screen CLUT having the standard set of colors. Mesmer does this by using its own copy of the standard CLUT, saved as a resource. A better way would be to save and restore the current CLUT each time the application runs.

The Good and the Bad

The main disadvantage to Mesmer's approach is that it uses the Color Manager directly, instead of the Palette Manager, to animate colors. The Palette Manager routines operate more or less transparently across multiple screens, while the Color Manager routines do not. Thus, Mesmer is limited to operating on the main screen only. Apple strongly recommends that color animation be accomplished through the Palette Manager to avoid potential problems that result from manipulating colors at the Color Manager level. In a multitasking environment, changing the screen CLUT directly can confuse other applications that are running concurrently with your own, since there is no way for them to sense that the colors have changed. Nothing will crash, of course, but the displays may be less than optimal.

The advantage to Mesmer's animation scheme is that it's relatively easy to implement, while the Palette Manager routines are more complex. Since most of us have only one screen, Mesmer still serves as a good example of how to use Color QuickDraw, and it shows the interaction between Color QuickDraw, the Color Manager, and the video hardware. ■

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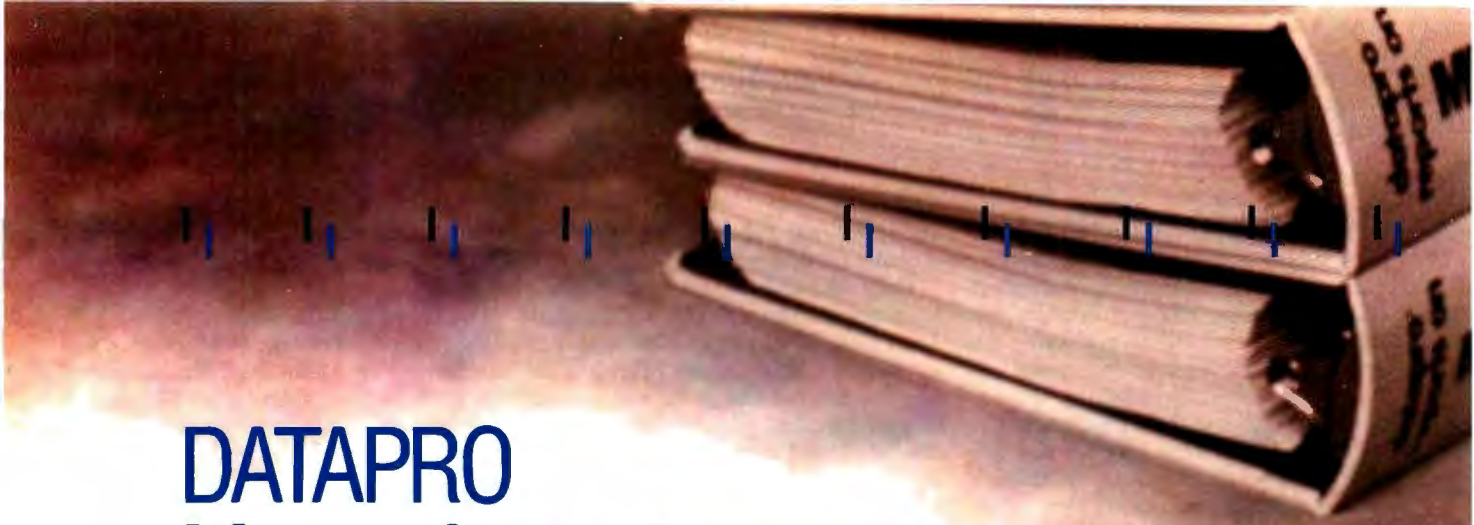

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Unix and the Mac Interface

Rick Daley

The A/UX Toolbox for the Mac II gives you the potential for a point-and-click Unix

A/UX 1.0 is Apple's version of AT&T Bell Laboratory's Unix System V version 2 for the Macintosh II. What makes A/UX stand out from other Unix systems is the A/UX Toolbox (software that gives A/UX programs access to the Mac user interface ROM routines). With the Toolbox, applications developers can give their programs the familiar look and feel of the Mac user interface. (For further details on A/UX 1.0, see "Unix for the Mac II" by David Betz and Eva M. White on page 185 of this issue.)

The Toolbox is a set of tools and libraries that let you run existing "well-behaved" Mac applications under A/UX, or write new A/UX applications that can use the Mac user interface.

There are two main components in the Toolbox: It has a program named `launch` for executing existing Mac binaries, and a C library named `LIBMAC.A` for creating new A/UX programs that can access the user interface toolbox as well as standard Unix libraries.

Table 1 shows which Mac operating system routines the Toolbox 1.0 supports. In this first release, you can run only one A/UX Toolbox application at a time, and the finder, desk accessories, and printing manager are not supported. Nor does the Toolbox support custom device drivers. The A/UX Toolbox in A/UX 1.1 (which should be in beta version by the time you read this) will support the desk manager, the printing manager, the color manager, and the palette manager.

Compatibility Issues

The main compatibility issues are in the areas of memory management, process scheduling, and file management. To understand what is involved in integrating these environments, you must first understand the differences between A/UX and the Mac operating system. A/UX is a multitasking, 32-bit virtual memory operating system; the Mac is a single-tasking operating system that uses a handle-based memory manager. A/UX requires a 68851 paged-memory-management unit (PMMU) for multitasking and virtual memory support as well as protection of one task from another. Virtual memory lets a process access more memory than the machine physically has. Unfortunately, these features isolate you from the hardware, and you are expected to make requests to the operating system kernel to manipulate the hardware. This is important, because it means that a bug in one program won't inadvertently crash the entire system.

While the Mac operating system provides an interface to the hardware, it cannot prevent you from accessing hardware and memory directly. Other conflicts between the Mac operating system and A/UX are caused by the fact that the Mac's handle-based memory manager assumes only 24 bits of significance. The A/UX library takes care of the 24- to 32-bit problem for programs that used the prescribed interface, but some programs go around the Mac operating system's interface to gain speed. You must modify these so-called "ill-behaved" applications for them to run under A/UX.

A/UX and the Mac ROM

The Mac ROM contains a large library of routines that an application can call. These routines are broken into two sections. The first section is the user interface toolbox, which contains code to present the standard Mac user interface. These include routines to draw text and graphics, to create and manipulate windows and menus, and to get input from the user through the mouse and keyboard. The second section of the Mac ROM contains the operating system calls. These are routines to read and write files, to allocate memory, and to manipulate various devices, such as the serial ports.

Figure 1 shows the strategy that A/UX uses to communicate between an A/UX C program and the Mac ROM: When you make a call to the Mac operating system, the Toolbox routes the call to one of A/UX's operating system calls; when you make a call to a Mac user interface routine, the Toolbox translates it to a call in the Mac user interface ROM code.

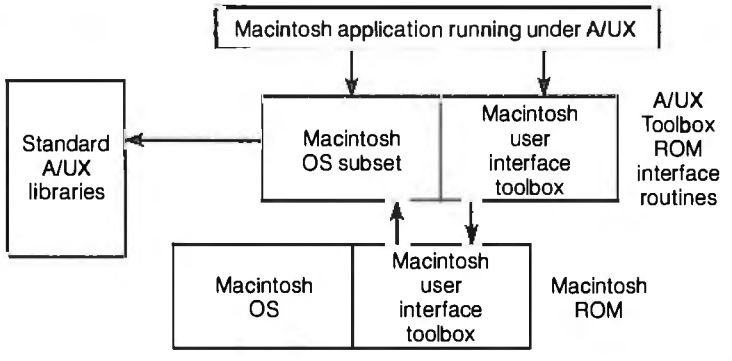
The A/UX Toolbox sets up a memory map that is close enough to the one used by the native Mac operating system that it fools the code in ROM and in applications. Because the PMMU's job is to keep programs from accessing anything but their own code and data, Apple had to provide a means to get around some of the protection facilities of A/UX so that programs can get to the screen's frame buffer and the Mac ROM. Before transferring control to a program, the Toolbox library makes several calls to the A/UX kernel to change the memory map making the ROM and the screen's frame buffer accessible. Also, it creates a small memory segment at virtual address 0 to contain Mac low-memory globals. The ROM code maintains these globals, and some applications can even access them directly. The resulting memory map is shown in figure 2.

The recommended way for an application to access the Mac ROM routines is through the 68000 CPU family's 1010 emulator trap mechanism, often called an A-line trap. A 1010-emulator trap oc-

continued

Table 1: *A list of the Macintosh operating system calls that the Toolkit 1.0 supports.*

ROM library	Implemented?
Apple desktop bus	No
AppleTalk manager	No
Binary-decimal conversion package	Yes
Color manager	Dummy routines only
Color picker package	Dummy routines only
Control manager	Yes
Deferred task manager	No
Desk manager	Dummy routines only
Device manager	Some dummy routines
Dialog manager	Yes
Disk driver	Some dummy routines
Disk initialization package	Dummy routines only
Event manager, OS	Partially
Event manager, toolbox	Yes
File manager	Partially
Font manager	Yes
International utilities package	Yes
List manager	Yes
Memory manager	Partially
Menu manager	Yes
Package manager	Yes
Palette manager	Dummy routines only
Printing manager	No
QuickDraw	Yes
Resource manager	Yes
SANE package	Yes
Scrap manager	Yes
Script manager	No
SCSI driver	No
Segment loader	Partially
Serial driver	No
Shutdown manager	Yes
Slot manager	No
Sound manager	Some dummy routines
Start-up manager	Not needed
Standard file package	Yes
System error handler	Partially
TextEdit	Yes
Time manager	Partially
Utilities, operating system	Partially
Utilities, toolbox	Yes
Vertical retrace manager	Partially
Video drivers	No
Window manager	Yes



curs when the CPU executes an instruction that begins with the hexadecimal digit A. The CPU then transfers through an exception vector to a routine that handles the A-line trap. A/UX also uses the A-line trap mechanism to access the Mac ROM.

Under the Mac operating system and the A/UX Toolbox, the A-line trap routine uses the low 12 bits of the A-line trap word and a dispatch table, found in the low-memory globals, to locate the address of the routine that actually performs the requested function. Initially, the entire dispatch table is loaded with pointers to functions in ROM. However, under the Mac operating system, many entries in the dispatch table are replaced with pointers to functions in RAM. These patches are installed to fix bugs and to add new features. Consequently, Apple had to install these same patches under the A/UX Toolbox. And, of course, calls made to the Mac operating system are replaced with equivalent Unix system calls.

For example, A-line traps that call the file manager are replaced with code that uses A/UX system calls, such as open, close, read, and write. A-line traps that call the vertical retrace manager are replaced with code that uses the A/UX system calls `setitimer` and `signal`.

Memory Manager

The differences between the two memory managers require the most adjustment. These differences mainly stem from the fact that A/UX is a 32-bit virtual memory system while the Mac is a 24-bit handle-based system.

Apple implemented A/UX's virtual memory by making calls to the C library's `malloc`, `free`, and `realloc` routines. These routines simply maintain a circular list of memory blocks. When an application makes an allocation request, the system searches the list to find the first free block that is large enough. If there is no free block large enough, the `sbrk` system call asks the kernel to extend the heap, thus creating more virtual memory. If this fails, which only happens if the area of the disk reserved for paged-out memory is full, then so does

Figure 1: *The strategy A/UX uses to communicate between an A/UX C program and the Mac ROM. If the C program makes a call to the Mac operating system, the Toolbox routes the call to an equivalent A/UX kernel function; if the program calls a Mac user interface routine, the Toolkit does an A-line trap to the Mac ROM.*

the request. These routines don't perform memory compaction, so they are much simpler than the algorithms that the memory manager uses in the Mac operating system.

Without compaction, memory fragmentation can cause paging even though there is actually enough physical memory. Applications can start paging and run more slowly even if they allocate less memory than the system has.

However, there are also some advantages to A/UX's memory-allocation scheme. It does not spend time moving blocks around in an effort to compact the heap. A common bug in a Mac application is to dereference a handle, then call a memory manager routine using the dereferenced handle. Since the block can move due to heap compaction, the dereferenced handle is no longer valid. These bugs will not occur under the A/UX Toolbox because memory blocks are moved only when their size increases. Applications also have trouble recovering from out-of-memory conditions; many don't even try to recover, but some try and fail. Even if the application recovers, it's still likely that it won't be able to do what you request. With virtual memory, running out of memory is very rare.

Some of the Mac memory manager functions don't make sense under virtual memory. In a virtual memory environment, it's not clear what value the call to determine the amount of free memory available should return. The current implementation returns 1 megabyte minus the amount of memory already allocated. However, the amount of memory an application can allocate is typically much more than this. This seems to keep existing applications running well. Still, developers of future applications should really try not to use these calls; it's better to allocate the amount needed and check to see if the request succeeds.

Significant Bits

The most common reason a Mac application fails to run under the A/UX Toolbox is if it stores extra data in the high bits of pointers. Having only 24 bits of the 32-bit handles be significant was a limitation designed into the 68000 CPU. However, the 68020 CPU used in the Mac II can use all 32 bits of addresses. The current version of the Mac operating system, to maintain backward compatibility, uses the PMMU to ignore the high 8 bits of addresses. Under A/UX, all 32 bits of addresses are significant.

Some current Mac applications go around the memory manager routines to gain speed. The memory manager routine `NewHandle` allocates a relocatable storage block. Instead of returning a pointer to a memory block, like the C routine `malloc`, `NewHandle` returns a pointer to a master pointer, which points to the memory block (see figure 3a).

This extra level of indirection lets the memory manager compact memory by moving these relocatable memory blocks. The application can still find the data because the memory manager will update the master pointer when it moves the block. The memory manager stores some flag bits in the high-order bit of the handle, telling the memory manager whether the corresponding block is relocatable or temporarily locked (and therefore can't be moved).

Storing these flag bits in the high-order bits of the master pointer works in the Mac operating system, but not in A/UX where all 32 bits of the address are significant. So the memory manager version that runs under the A/UX Toolbox stores the flag bits in a second longword of memory, just after the master pointer (see figure 3b). This works fine as long as the application uses the access routines to manipulate these flag bits. Unfortunately, many applications currently bypass the access routines. For example, rather than calling the `HLock` routine, some applications just set the appropriate bit in the master pointer. These applications will not run under A/UX without modification.

Another example of access routines that applications often bypass is access routines to low-memory global variables. These variables are automatically updated via hardware interrupts in the Mac operating system, but not under A/UX. For example, under the Mac operating system, some applications directly ac-

continued

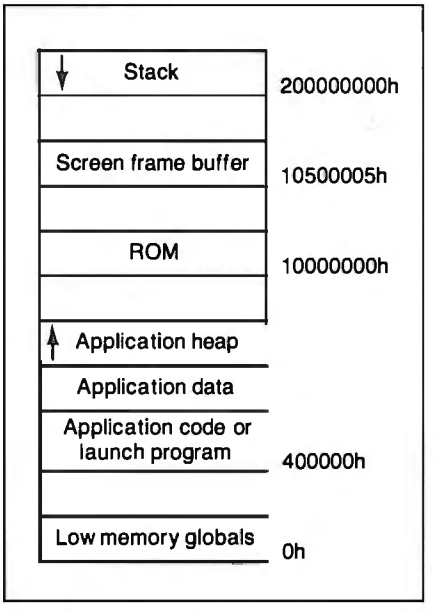


Figure 2: *Except for the low-memory globals, none of the addresses that A/UX uses are the same as the ones used by the native Mac operating system. This doesn't matter, since everything is referenced through pointers in memory.*

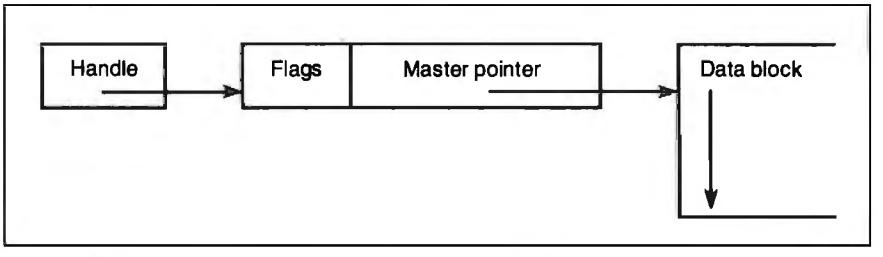


Figure 3a: *A relocatable memory block under the Macintosh operating system. Flag bits are stored in the high bits of the master pointer. This saves space, but it doesn't work in a 32-bit environment.*

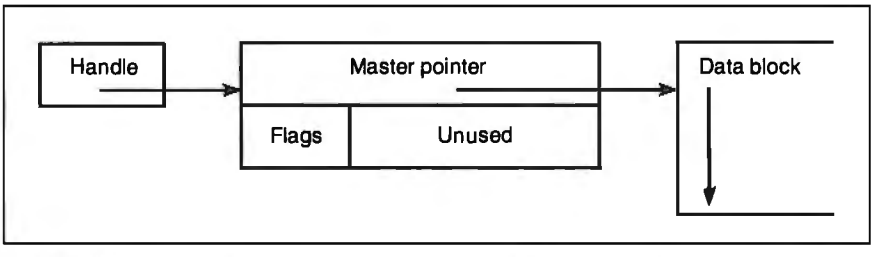


Figure 3b: *Under the A/UX Toolbox, the flag bits are stored in a separate longword. Some space is unused, but this is 32-bit clean.*

cessed the Ticks variable, which contains the number of clock ticks since the last reboot. This variable never gets changed under the A/UX Toolbox; you should use the TickCount access routine, instead. Other such variables include Time and EventQueue.

Application developers are sometimes concerned about the extra CPU time the A-line trap mechanism uses. The overhead is not very large, but it can make a difference in some tight loops. In those cases where the A-line trap overhead is significant, you should consider using the GetTrapAddress trap to get a pointer to the access routine. Then you can call the routine directly, without the overhead of the A-line trap. In the case of a trap like HLock, it is not quite as fast as setting the bit directly, but it will work on all future systems.

Process Scheduling

Mac applications are event-driven. Typically, the main body of an application is a loop that uses the GetNextEvent trap to look for events, such as keystrokes or mouse clicks. If there are no events pending, GetNextEvent returns null.

The busy-looping model worked fine in the original Mac system. However, it is a waste under a multitasking operating system such as A/UX. Busy looping takes time away from any other processes that are currently running. Also, the process scheduler makes scheduling decisions based on how much CPU time a process has recently used.

To solve this problem, a new trap, named WaitNextEvent, will be added in A/UX 1.1. WaitNextEvent is similar to GetNextEvent, but you use it to yield the CPU until an event is available. This trap is available under the A/UX Toolbox, MultiFinder, and even under the Mac operating system, if you use a recent system file. All future applications should use WaitNextEvent when possible. WaitNextEvent is defined in C like this:

```
short WaitNextEvent(eventMask,
      theEvent,timeOut, mouseRgn)
short          eventMask;
EventRecord    *theEvent;
long           timeOut;
RgnHandle      mouseRgn;
```

The eventMask and theEvent parameters are just like the parameters to GetNextEvent. The eventMask specifies a set of events the application is interested in, and theEvent is a pointer to a record that will get filled in with information about the event. The timeOut parameter defines how long (in sixtieths of a second) WaitNextEvent should wait before returning a null event. The mouseRgn specifies a QuickDraw region that contains the mouse. If the mouse moves out of this region while WaitNextEvent is waiting, an event of type app4Event is returned with a value of FA000000h in the message field. This allows an application to use WaitNextEvent even if it is tracking the mouse position.

Storing Macintosh Files

Another area where A/UX differs greatly from the Mac operating system is in file structure. An A/UX file is just a sequence of bytes. Some information about the file is also stored apart from the data. This information includes the file's name, length, owner, permissions, and creation date. A Mac file has two sequences of bytes: a data and a resource fork. Typically, the data fork contains the same sort of data you would find in an A/UX file. The resource fork contains a list of resources. Resources can store a wide range of things. For example, they often contain templates that describe windows or menus. Often, resources contain code fragments. The segments that make up a Mac application are stored as code resources. You refer to a resource by a resource specification, which is a four-character type, and either an ID number or a name. Resources are manipulated by the Mac resource manager. In addition to the two forks, a Mac file contains information that the Mac Finder uses. This information includes the file's type, creator, and icon location.

Apple has defined two closely related formats for storing Mac files on non-Mac file systems. The formats are called AppleSingle and AppleDouble. The A/UX Toolbox supports both these formats.

In the AppleSingle format, both of the forks and the finder information are all stored in a single Unix file. In the AppleDouble format, the data fork is stored in a separate file. The file containing the resource fork and the finder information has the same name as the file containing the data fork, but it is prepended with a % character. The AppleSingle format is generally more convenient; it is easier to rename, move, and manipulate files in this format. However, the AppleDouble format also has several advantages. First, this is the only way to store resources in an application built under A/UX. The executable code must be stored in a separate file. Second, it is often desirable to access a file's data fork using Unix utilities. This is simple with the AppleDouble format, since the data fork is in a separate file. Finally, the AppleDouble format files can be more efficient to manipulate than AppleSingle format files. Since both forks are stored in one file with the AppleSingle format, the second fork gets moved whenever the first one increases in size.

A/UX's filenames are 14 characters long. You can use a backslash instead of a colon to separate directories, and the filenames are case sensitive, whereas the Mac does not differentiate between uppercase and lowercase. Also, in ASCII files in the Mac environment, lines are terminated with a carriage return (0Dh); under A/UX lines are terminated with a line feed (0Ah). This difference is usually masked by the C language's newline character.

Another issue unrelated to the file system is that the Toolbox is run as a process in user mode, so privileged instructions are not available. This means you must use move ccr <ea> to access the condition code bits. The instruction ccr is available on the 68020 but not on the 68000, so you will have to check which CPU your code is running on. Because the finder is not available under the Toolbox routines, you must call the InitDialogs and TEInit routines yourself, or use the -i option with the launch command.

Not Here Yet

Unfortunately, A/UX 1.0 is really only the foundation for a point-and-click Unix. It makes it possible for you to write applications using windows and menus, but you still have to use the same command-line interface and telegraphic commands to use A/UX. A novice can't sit down and execute A/UX commands from windows and menus.

The version of the A/UX Toolbox that shipped with A/UX 1.0 was really only useful for developers. Applications could use the user interface toolbox, but several key features were missing. The most notable omission was access to the printing manager. However, version 1.1, when it becomes available, will fill in these holes by adding support for printing, desk accessories, and color devices.

Ultimately, A/UX will be a Unix that a naive user can use without ever seeing anything but the mouse and window-based user interface that has made the Mac so successful. At the same time, a programmer will still be able to use all the tools that make Unix so powerful. ■

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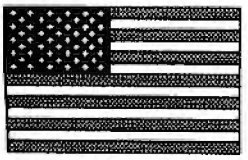
☐ **Famous Women #1 & #2 (M116 & M117)** - (2 disk set) Contains miscellaneous famous women graphics. Includes Madonna, Brooke, Marilyn, Tina, Natalie & more.
☐ **Car Graphics (M118)** - Contains Porsche, BMW, car logos, Mercedes and other car graphics.
☐ **Holidays Graphics (M119)** - Contains Christmas, 4th of July, Thanksgiving & more holiday graphics.



☐ **Miscellaneous Objects (M121)** - Contains miscellaneous objects graphics like arrows, aspirin, bandaids, cameras, cards, dollar bills, eyeglasses & many more.
☐ **Disney Characters (M126)** - Contains Minnie, Mickey, Scrooge, & other Disney characters.
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☐ **Famous Men #1 (M138)** - Contains miscellaneous graphics of famous men. Includes Beatles, Bogart, Rambo, R2D2, the Coz & more.
☐ **Comic Book Characters (M140)** - Contains Garfield, Bill the Cat, Opus & others.
☐ **Miscellaneous Graphics #1(M141)** - Contains miscellaneous graphics that could not be categorized. Features Batman, billboard, ghostbusters, robots, jack in the box & others.

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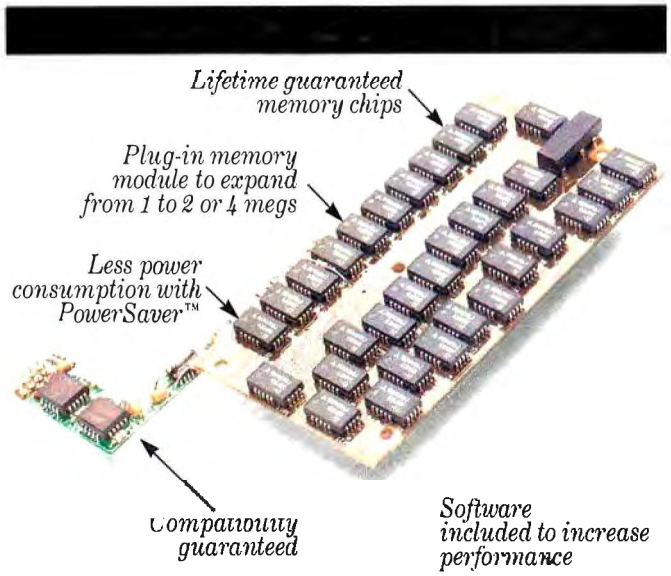

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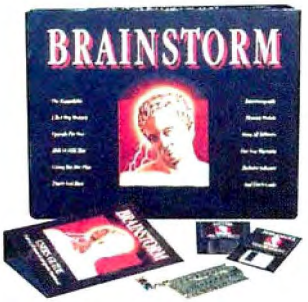

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continued from page 34

or bottom of screen; top or bottom of document.

• Screen: one screen forward or back; scroll 12 lines up or down.

• Delete: character; next or previous word; to end or beginning of line; sentence (cursor anywhere in the sentence); paragraph (cursor anywhere in the paragraph).

• Other: underscore from cursor to end of line; change case (uppercase to lowercase or lowercase to uppercase); directory; certain other DOS functions; automatic paragraph numbering.

And that's only a partial list.

If you want these things laid out as in WordStar, you can come close. In fact, with that in mind, someone has written a keyboard file for XyWrite called XyStar. Many other functions are available, and all are called by two-letter codes that can be installed or rearranged within the keyboard file at any time you wish. You can have more than one keyboard file and load the alternates for use at any point in a document.

You can create style sheets, or their equivalent, save them as save/gets, and load them at boot-up or any other time, including in the middle of a document.

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Be assured that I have no connection with XyQuest other than my faith in its product.

Peter H. Weil
Larchmont, NY

My original introduction to XyWrite was from my friend and publisher Jim Baen, who told me I'd love it. Alas, by then I was addicted to SideKick, and in those days XyWrite wouldn't run with SideKick or, indeed, with any other memory-resident program.

The latest XyWrite does work nicely with memory-resident programs, and it even runs under DESQview, so there aren't any real barriers to my using it; but by the time they got it to do that, I was in the middle of a book with something else.

I'll get at XyWrite Real Soon Now, I promise. I know that a lot of my colleagues use it, and it does a neat job of interfacing with Atex, which most publishers like.—Jerry

OS/2 Makes It Easier

Dear Jerry,

You've missed some of the major points concerning OS/2. These include the following:

• *Hardware independence.* OS/2 has the potential of blowing the roof off the software industry. Instead of having to write device drivers for video, printers, and input devices, programmers can concentrate on improving algorithms, adding features, and better debugging. Developing new products and upgrades to old ones can thus be speeded. By the way, there is absolutely no reason OS/2 won't support EGA. All someone has to do is write a display driver for it. Once. The issue of device independence also applies to Microsoft Windows, which is part of the proving ground for these ideas.

• *OS/2 does not replace MS-DOS.* OS/2 will not be available to end users until sometime this year. Applications will start to trickle out about that time. It won't be until 1989 that OS/2 applications will start putting pressure on the MS-DOS market. Millions of 8088/86 machines will be able to run only MS-DOS. Many of these machines will never need OS/2. Microsoft has announced its continuing support of MS-DOS.

• *You don't have to buy a PS/2.* IBM would like you to believe that the PS/2 is the wave of the future. Fortunately, because OS/2 frees applications from being hardware-dependent, we will be saved from enslavement to Big Blue. All you will need to run OS/2 with Presentation Manager is an 80286 or higher processor, 2 or more megabytes of memory, a hard disk drive, and a graphics adapter. These are my recommendations, not necessarily the listed requirements. These features are increasingly common these days. It's not as if you are required to buy the most expensive configuration available. Many 8088 machines will be upgradable to OS/2 compatibility.

If you can run CP/M until your Z80s grow moldy, then I'm sure there will be those who are still running MS-DOS when I crumble to dust. Operating systems are tools for applications; applications are tools for users. In the "old days," users shopped for software and then bought the computer that ran it. Now that computers have become somewhat commodity items, users will shop for software and buy the operating system that runs it. If you don't need OS/2, then don't buy it.

Dennis Williamson
Memphis, TN

We'll just have to see what happens; the key to OS/2 will be how many software developers write programs making use of it. I do hope you're right about the operating system making things easier; I also hope that someone gets a good Modula-2, or even Ada, for OS/2, since I am not about to try programming in C, particularly the C that comes with the OS/2 Developer's Kit.—Jerry ■

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IN DEPTH

The C Language

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by Brian W. Kernighan and Dennis M. Ritchie

215 **A Better C?**
by Bjarne Stroustrup

219 **It's an Attitude**
by Jonathan S. Linowes

226 **Resource Guide**

Programming languages—what can you say about them? They're supposed to let you write software that can be understood more easily than machine language, and in fairness they do. But many are so terse and cryptic that you wonder how machine language could be any more difficult to read.

And choosing the right language for a particular task is becoming as complex as knowing which dialect of which tongue the people speak in a remote area of Botswana. If you're writing artificial-intelligence applications, you want one language; for scientific formulas, you want another; and the choices multiply almost by the number of variables in your system. On-line business applications might require one language, while the off-line ones should be written in yet another.

One constant that arises out of this apparent chaos is the choice of the C language for system programming. From its inception, C has lifted the system programmer out of the constant bit-twiddling of assembly language—a welcome relief. And now C is expanding its influence to applications programming as well. But C has its limitations. While you can program around most of them, you have to do just that.

C++ was designed to be C's successor. It overcomes many of the limitations of the C language, it offers object-oriented programming, and it presents a more comprehensive applications-programming language.

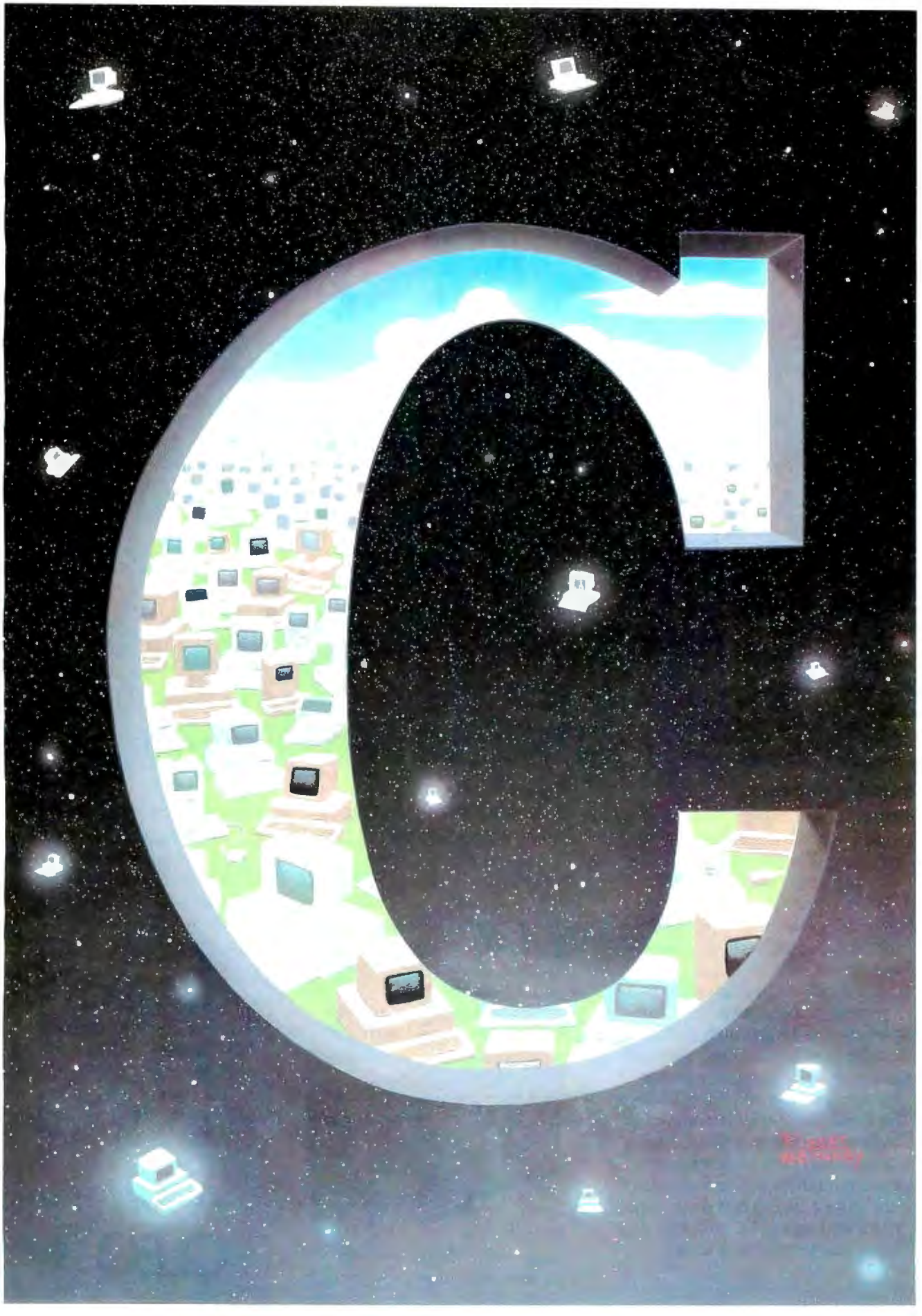
This month, we are proud to offer two articles by noted experts in the C language. First, the famed team of Brian W. Kernighan and Dennis M. Ritchie explains how C is evolving in "The State of C." They delve into what C can do—and what it can't—and provide a look at the elements involved.

Then, the guru of C++, Bjarne Stroustrup, explains how C++ differs from C and describes the object-oriented approach to applications programming in "A Better C?"

But C devotees are not to be outdone. In "It's an Attitude," Jonathan S. Linowes shows how object-oriented programming can indeed be accomplished in C, although that's not its natural habitat. This article discusses the OOPC conventions.

The battle between C and C++ is just heating up. There are quantities of C compilers and interpreters available for both the Macintosh and the IBM PC worlds. More and more companies are announcing C++ compilers and translators. C has seized control of the system-programming field, but only time will tell whether C or C++ will win the fight for the applications arena.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth



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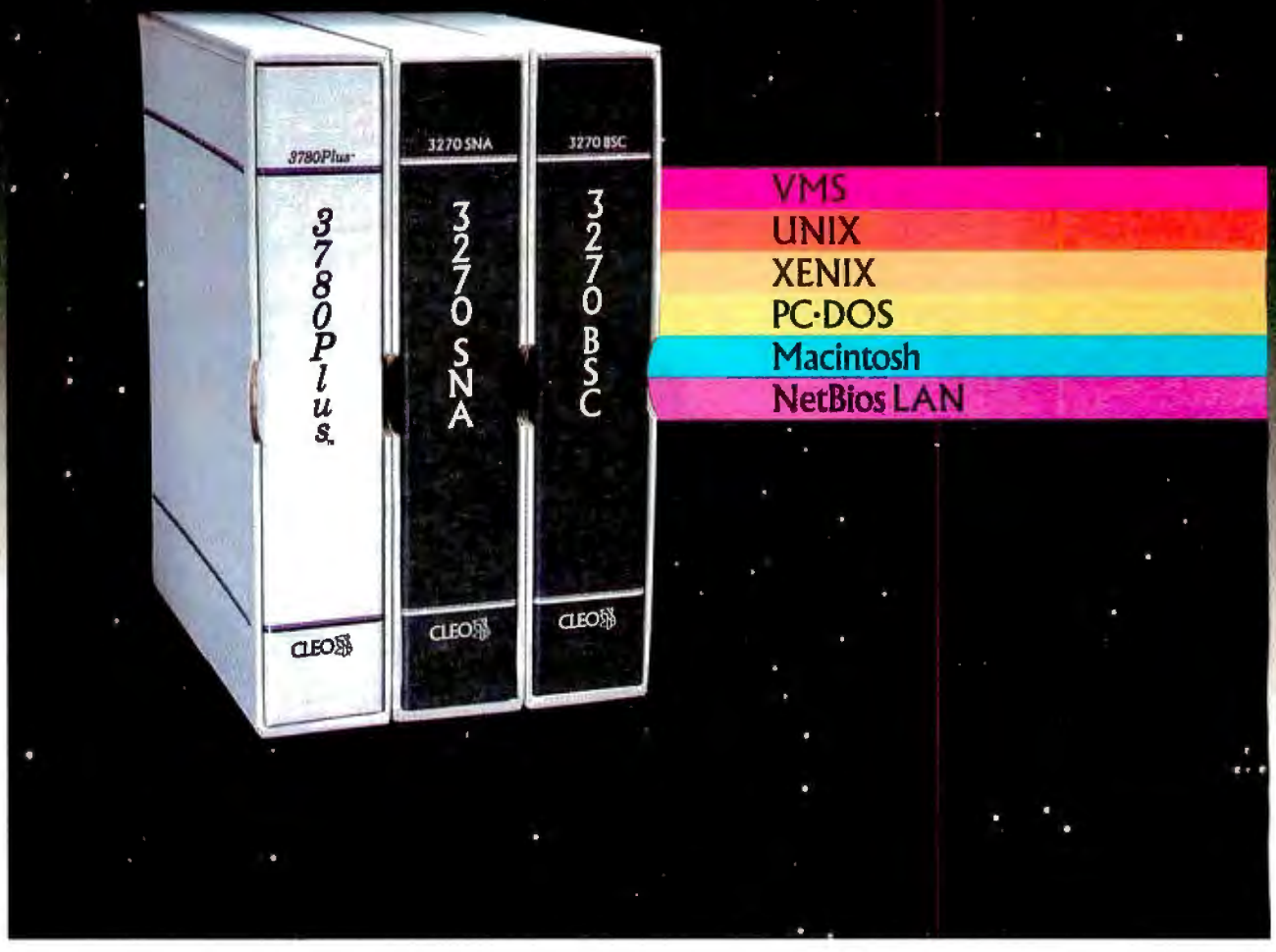

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The State of C

It's not just for system programming anymore

Brian W. Kernighan and Dennis M. Ritchie

C is a general-purpose programming language that was originally designed and implemented around 1972 by Dennis Ritchie at Bell Labs. Its early growth was closely associated with the Unix system where it was developed, since both the system and most of the programs that run on it are written in C. In recent years, C has become popular in a much wider variety of environments, and it is no longer tied to any one operating system or machine.

The C language was originally designed for "systems programming"—that is, for writing programs like compilers, operating systems, and text editors. But it has proven quite satisfactory for other applications as well, including database systems, telephone-switching systems, numerical analysis, engineering programs, and a great deal of text-processing software. Today, C is one of the most widely used languages in the world, and C compilers exist for almost every computer.

Where Did It Come From?

C has its roots in the language BCPL, designed by Martin Richards around 1967. BCPL is a "typeless" language: It operates only on a single data type, the machine word. As such, BCPL was an excellent match to the hardware of word-oriented machines. In 1970, Ken Thompson designed a stripped-down version of BCPL for use with the first Unix system on the PDP-7; this language was called B. It too is typeless.

With the advent of the PDP-11, on which the next version of Unix was written, it became clear that a typeless language did not match this hardware nearly as well. The PDP-11 provided several different sizes of fundamental objects—1-byte characters, 2-byte integers, and 4-byte floating-point numbers—and B provided no way to even talk about these different-size objects, let alone operators to manipulate them.

The C language was originally an attempt to deal with a variety of types of data by adding the notion of data type to the B language. In C, as in most languages, each object has a type as well as a value; the type determines the meaning of the operations that can be applied to the value, and how much storage is occupied. For example, declarations like `int i, j;`, `double d;`, and `float x;` determine the operations and space requirements of the variables. In the statement `d = x + i * j;`, the compiler uses the type information to determine that integer multiplication is adequate for `i * j`, but the result must be converted to floating point before it is added to `x` and then converted to double precision for assignment to `d`.

continued

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Although C was originally implemented for a PDP-11, it was used on other machines as early as 1975. Steve Johnson implemented a "portable compiler," designed to be relatively easy to modify, to generate code for different machines. Since then, C has been implemented on most computers, from the smallest microcomputers to machines as large as the CRAY-2. The C language is sufficiently well standardized, even without a formal standard, that with some care you can write C programs that will run without change on any machine supporting the language and a minimal run-time environment.

C began on a small machine and was derived from a sequence of small languages; its designer preferred simplicity and elegance to features. Furthermore, C has, from the beginning, been meant for system-programming applications, where efficiency matters. Accordingly, it's not surprising that C is a good match for the capabilities of real machines. For example, it provides as its basic data types only those objects that are directly supported by typical hardware: characters, integers (perhaps of several sizes), and floating-point numbers (again in several sizes).

You can create more complicated objects like arrays, structures, and so forth, but C provides few operators for manipulating them as a unit; you must write the functions that compare strings, assign one array to another, and so on.

Somewhat more unusual, C doesn't provide input and output operations as part of the language. This is not to say that C programs can't do I/O, of course, but simply that I/O is done by functions defined by the user or in a library, and not by built-in statements of the language. This is in contrast to, for example, FORTRAN's READ and WRITE, and the INPUT and PRINT of BASIC, which are parts of those languages.

To complete the list of things that C might provide but doesn't: It has no storage management, like Pascal's new function, and no facilities for concurrent processing, such as Ada's rendezvous mechanism. You can easily write these capabilities in C, but they are provided by function libraries, not as part of the language. Function calls are notationally clumsier than direct operators; for example, compare BASIC's string comparison

```
IF A$ = B$ THEN ...
```

to the way you might write it in C:

```
if (equal(a, b)) ...
```

Function calls also involve more overhead than in-line code.

In any case, the degree to which features are omitted from C is one of its distinguishing characteristics.

Linguistic Elements

Control flow: Control flow in C is quite conventional, although richer than in FORTRAN or BASIC. C contains two decision-making statements: `if...else` and `switch`. In the statement

```
if (expr) stat1 else stat2
```

expr is evaluated; if it's true (nonzero), *stat1* is executed; otherwise, *stat2* is executed. The entire `else` part of the statement is optional. In

```
switch (expr) {
 case const1: stat1
 case const2: stat2
 ...
 default: stat
}
```

expr is evaluated and its value compared against the various *const*s. If it finds a match, the corresponding *stat* is executed. If it doesn't, the *stat* for the `default` part is executed. The `default` is optional. The `switch` statement is like Pascal's `case` statement, except that Pascal has no `default`.

C also contains three loops: `while`, `for`, and `do`. In the statement

```
while (expr) stat
```

expr is evaluated; if it's true, *stat* is executed, and *expr* is evaluated again. When *expr* becomes false, the loop terminates. The statement

```
for (stat1; expr; stat3) stat2
```

is equivalent to the `while` loop:

```
stat1
while (expr) {
 stat2
 stat3
}
```

The `do` statement is like Pascal's `repeat...until` except for the sense of the termination test. In the statement

```
do stat while (expr)
```

stat is executed, and *expr* is tested. If it's true, the loop repeats.

The statement `break` causes an immediate exit from an enclosing loop or `switch`; the statement `continue` causes the next iteration of a loop to begin. C also provides a `goto` statement, but it's infrequently used.

In all these examples, a *stat* can be a single statement like `x = 3` or a group of statements enclosed in braces, which are like `begin...end` in other languages. Statements end in semicolons.

Data types: The basic data types in C are `char` (a single byte); `int`, `short`, and `long` (integers of various lengths); and `float` and `double` (floating-point numbers of two different lengths). The `char` data and the various integers can be signed or unsigned.

You can combine these objects into an infinite (in principle) set of "derived" data types using arrays, structures, unions, and pointers. Arrays are familiar:

```
char mesg[100];
```

defines an array `mesg` of 100 bytes, accessed as `mesg[0]` through `mesg[99]`. C doesn't provide a string data type; it uses arrays of `char` instead, with the end of the data marked by a 0 byte. This is what the compiler generates for a string constant like `"hello world\n"`. Within a string, certain "escape sequences" like `\n` are used to represent special characters like `newline`. This string contains 12 characters and a terminating 0 byte.

A structure is a collection of related variables that need not have the same type (like a record in Pascal). For example,

```
struct object {
 int x, y; /* position */
 float v; /* velocity */
 char id[10]; /* identification */
};
struct object obj;
```

declares a structure called `object` and defines a variable `obj` of type `struct object`. Individual members of the structure are referred to as `obj.v`, and so on. Notice that the `object` structure includes an array `id`, whose components are `obj.id[0]` through `obj.id[9]`. You can have arrays of structures, as well.

C provides pointers, or machine addresses, as an integral part of the language, in a much less restricted form than in Pascal and Ada. The declarations

```
char *pc;
struct object *pobj;
```

declare `pc` to be a pointer to `char`, and `pobj` to be a pointer to an `object` struc-

ture. The value that a structure points to is accessed by *pc or *pobj, as suggested by the form of the declaration; the "dereferencing" operation * is equivalent to the caret (^) in Pascal. Individual members of the structure are accessed by, for example, pobj->v.

If p is a pointer to an object of type T and currently points to an element of an array of Ts, then p+1 is a pointer to the next element in that array. Similarly, if p and q point to elements of the same array, and p is less than q, then q - p is the number of elements from p to q. In short, arithmetic operations on pointers are scaled by the size of the object to which they point; the actual size is usually irrelevant as you program. When it is relevant, a sizeof operator exists to compute it, so the program doesn't specify the explicit size for any particular machine. C's complete integration of pointers and address arithmetic is one of the strengths of the language.

Operators and expressions: C has a rich set of operators compared to most conventional languages. Besides the usual arithmetic operators +, −, *, /, and % (remainder), several other groups deserve special mention.

First, C provides operators for manipulating bits within a word (see table 1). For example, the function in listing 1 counts the 1-bits in its argument by repeatedly testing the rightmost bit, then shifting the argument one position to the right until it becomes 0. The declaration unsigned means that n will be treated as a logical quantity, not an arithmetic one.

The function bitcount illustrates a second group of operators. Any operator such as >> that takes two operands has a corresponding "assignment operator," such as >>=, so that the statement

```
v = v >> expr
```

can be written more concisely as

```
v >>= expr
```

This notation is easier to read, particularly when v is a complicated expression instead of a single-letter variable.

A third group of operators deals with logical conditions. The operators && and || are evaluated left-to-right, and evaluation stops as soon as the value of the expression is known. In a construction like

```
if (i < N && x[i] > 0) ...
```

if i is greater than or equal to N (which is presumably the size of the array x), then the test involving x[i] will not be made. This behavior of logical operators is called "short-circuit evaluation."

Functions: The overall structure of a C program is a set of declarations of variables and functions. These definitions are often kept in separate files if the program is large; you can compile them separately and link them together with a linking loader.

Within a function, variables are normally "automatic"—that is, they appear when the function is entered and may disappear when it is left, as in the bitcount. However, if you declare a variable as static, it retains its value from one call to the next. Variables declared outside of any function are global; they can be referred to anywhere in the program.

Functions are recursive; the standard (and hackneyed) example is the factorial function (see listing 2). The arguments to a function are passed by value, which means that the function receives a copy of the argument, not the original object. (Notice that the function bitcount modified its argument; this is safe because it's actually a copy.) You can always obtain the effect of call by reference when necessary by passing a pointer to the object. Function arguments and return values can be any of the basic types—pointers, structures, or unions. To pass an array, you pass a pointer to its first element.

The ANSI Standard

For many years, the definition of C was the reference manual in the first edition of *The C Programming Language*. In 1983, ANSI established a committee to provide a modern, comprehensive definition of C. The result, the ANSI standard, or ANSI C, is expected to be approved late in 1988. Modern compilers already support most of the features of the standard.

The language has changed relatively little since 1978; one of the goals of the standard was to make sure that most existing programs would remain valid, or, failing that, that compilers could produce warnings of new behavior.

Basically, the most important change is a new syntax for declaring and defining functions. A function declaration can now include a description of the function's arguments; the definition syntax changes to match. This extra information makes it much easier for compilers to detect errors that are caused by mismatched arguments; in our experience, it's a very useful addition.

continued

Table 1: *The C operators for manipulating bits within a word; these are necessary for many system-programming applications.*

&	bitwise AND
|	bitwise OR
^	bitwise exclusive-OR
~	one's complement
<<	left shift
>>	right shift

Listing 1: *The* bitcount *function counts the 1-bits in its argument by repeatedly testing the rightmost bit, then shifting the argument one position to the right until it becomes 0.*

```
bitcount(n)     /* count 1 bits in n */
  unsigned int n;
{
  int b;
  for (b = 0; n != 0; n >>= 1)
    if (n & 1)
      ++b;
  return b;
}
```

Listing 2: *The classic example of a recursive function—the factorial function—written in C.*

```
fact(n)         /* returns n! (n >= 0) */
  int n;
{
  if (n <= 0)
    return 1;
  else
    return n * fact(n-1);
}
```

To illustrate, consider this typical fragment of C as it would once have been written:

```
int n;
double x, sqrt();
x = sqrt(n);
```

The sqrt function expects an argument of type double, but n is an int. This error is not detected, and the results are guaranteed to be nonsense. With the new *function prototype* syntax from ANSI C, you would write the fragment this way:

```
int n;
double x, sqrt(double);
x = sqrt(n);
```

Here the compiler has been informed about the type that sqrt expects, so it generates code to convert the integer n to floating point. If you inadvertently wrote an expression that couldn't be converted to double, such as x = sqrt(&n);, the compiler would catch the error.

The syntax of function definitions changes to match; formal parameters are listed between parentheses after the function name. Thus, the function bitcount would become:

```
bitcount(unsigned int n)
{
  ...
}
```

There are also other small-scale language changes. Structure assignment, enumerations, and the void data type, all of which had been widely available, are now officially part of the language. You can initialize automatic structures and arrays, and you can do floating-point computations in single-precision; this may lead to more efficient computation on smaller machines.

The properties of arithmetic conversions are spelled out more carefully. There are now hexadecimal constants and escape sequences as well as the octal ones. The C preprocessor, which does textual macro substitution, is much more elaborate; it gives substantially more control over the macrogeneration process. Most of these changes will have only minor effects on your programming.

A second significant contribution of the standard is the definition of a library to accompany C. It specifies functions for accessing the operating system (e.g., to read and write files), formatted input and output (scanf and printf), memory allocation (malloc), string manipulation (e.g., strcmp), mathematical computations (e.g., sin and log), and the like.

A collection of standard header files to be included with user-written programs provides uniform access to declarations of functions and data types. Programs that use this library to interact with a host system are assured of compatible behavior. Most of the library is closely modeled on the Unix system's "standard I/O library," and similar routines are widely available on other systems as well. Again, you won't see much change.

Because most computers directly support the data types and control structures that C provides, the run-time library required to implement self-contained programs is tiny. The standard library functions are only called explicitly, so you can avoid them if you don't need them. Most of them can be written in C and, except for the operating-system details they conceal, are themselves portable.

An Assessment of C

C is a compact, efficient, and expressive language. Indeed, C is good enough that it has almost completely supplanted the use of assembly language programming on many systems. The use of a clean, readable high-level language has overwhelming advantages; one is simply that it becomes possible to *read* programs, which is excruciatingly difficult in some languages.

C is a relatively "low level" language. This characterization is not pejorative; it simply means that C deals with the same sorts of objects that most computers do—namely, characters, numbers, and addresses. These can be combined and moved about with the arithmetic and logical operators implemented by real machines.

Since C is relatively small, it can be described in a small space and learned quickly. You can reasonably expect to know and understand and, indeed, regularly use the entire language.

Another advantage is its portability. Although C matches the capabilities of many computers, it is independent of any particular machine architecture. With a little care, it's easy to write portable programs that can be run without change on a variety of machines. The standard makes portability issues explicit and prescribes a set of constants that characterize the machine on which the program is run.

Another of C's strengths is its absence of restrictions. A popular trend in programming languages is "strong typing," which (roughly speaking) implies that the language undertakes to check carefully that the program contains only valid combinations of data types. Strong typing sometimes catches bugs early, but it also means that some programs just can't be written, because they inherently require violations of the type-combination rules.

A storage allocator is a good example: You can't write Pascal's new function—which returns a pointer to a block of storage—in Pascal, because there's no way to define a function that can return an arbitrary type. But it's easy and safe to write it in C because the language lets you state that a specific violation of the type rules is intentional.

C is not a strongly typed language, but as it has evolved, its type checking has been strengthened. The original definition of C frowned on, but permitted, the interchange of pointers and integers; this has long since been eliminated, and the standard now requires the proper declarations and explicit conversions that good compilers had already enforced. The new function declarations are another step in this direction. Compilers will warn of most type errors, and there is no automatic conversion of incompatible data types. Nevertheless, C retains the basic philosophy that programmers know what they are doing; it only requires that you state your intentions explicitly.

C has even proven to be a good language for other languages to compile into. One of the best examples is the Yacc-compiler compiler, which converts the grammar specification for a language into a C program that is used to parse statements in that language. Naturally, one language specified this way is C itself.

What's wrong with C? At the lowest level, there are some poor choices of operator precedences. Some users feel that the switch statement should be changed so that control doesn't flow through from one case to the next, as it does now. The concise syntax is sometimes daunting to newcomers; complicated declarations are often hard to read. One of the new examples in the second edition of *The C Programming Language* is a pair of programs to convert C declarations into words and back again.

Portability problems sometimes arise if you rely on undefined or implementation-defined properties. For example, the order in which function arguments are evaluated is not specified, so it's possible to write code that depends on that order and will thus execute differently on

continued

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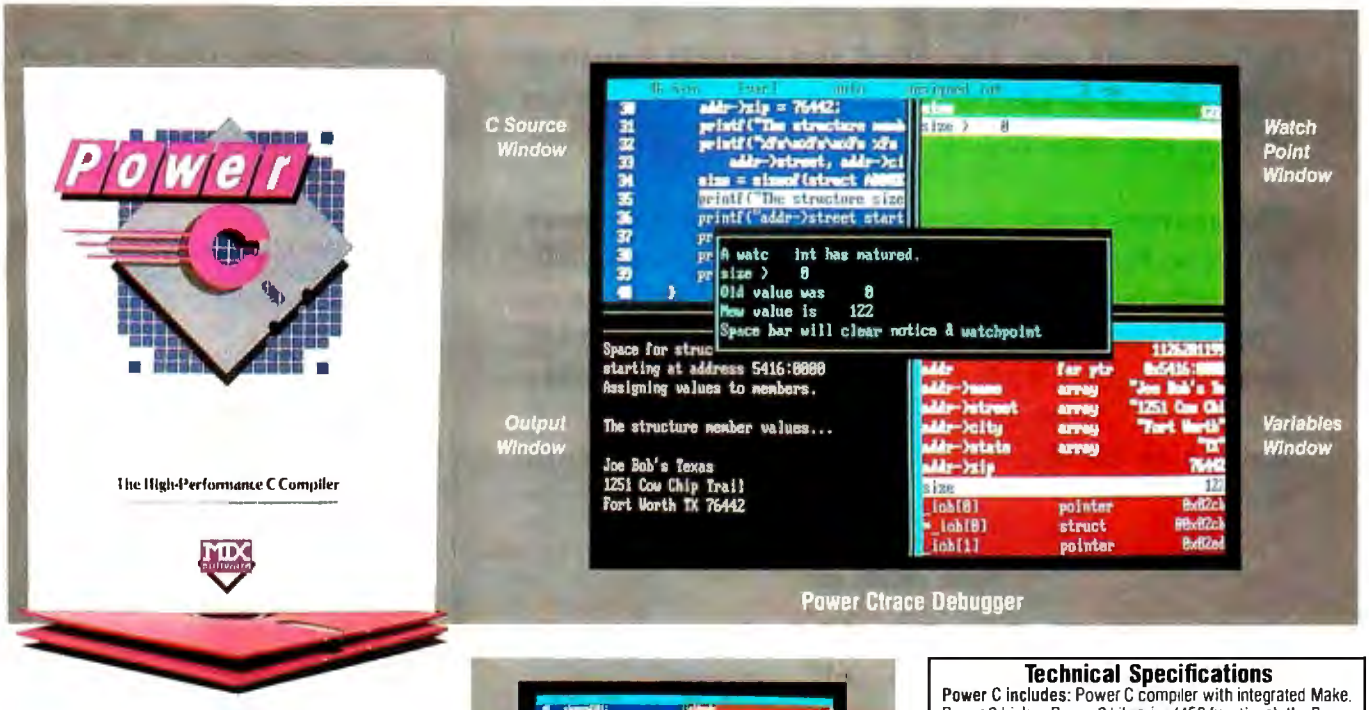

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different machines. This is not a grave problem, since it's easy to detect the dependency, but people still overlook it from time to time, with unfortunate effects.

What's Next?

Over the past decade, C has evolved, although the rate of change has been slow. The ANSI standard formalizes these changes and adds a few of its own. There has been a steady increase in the amount of error-checking by the compilers: Although there are still few restrictions on what you can say, you now need to be more explicit when you're doing something strange.

Where is C likely to go in the next few years? The most likely evolution is to continue this slow but steady improvement, with new features added cautiously. Caution is necessary simply because of the importance of maintaining compatibility with the huge body of C code already in use. Changes cannot be made gratuitously.

Realistically, C itself isn't likely to change to a major degree; rather, new languages will come from it. One example is C++, which provides facilities for data abstraction and object-oriented programming while remaining almost completely compatible with C (see "A Better C?" on page 211). In the meantime, C wears well as your experience with it grows. With 15 years of C experience, we still feel that way. ■

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Brian W. Kernighan and Dennis M. Ritchie are members of the Computing Science Research Center at AT&T Bell Laboratories in Murray Hill, New Jersey. Dennis is the designer of the C language. Together they wrote the standard reference on C. They can be reached on BIX as "editors."

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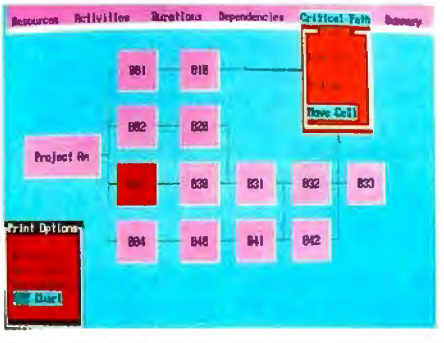

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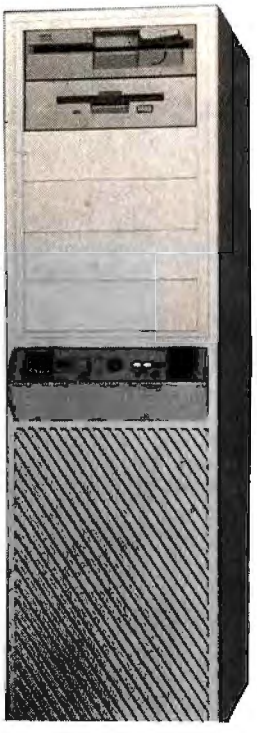

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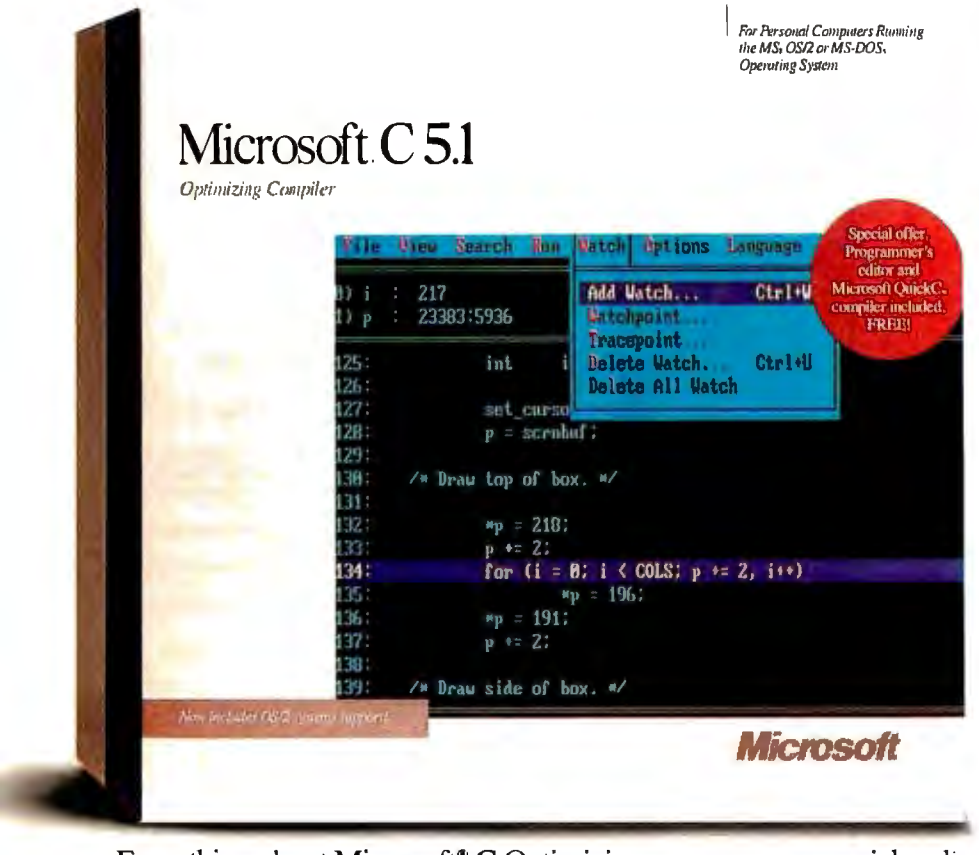

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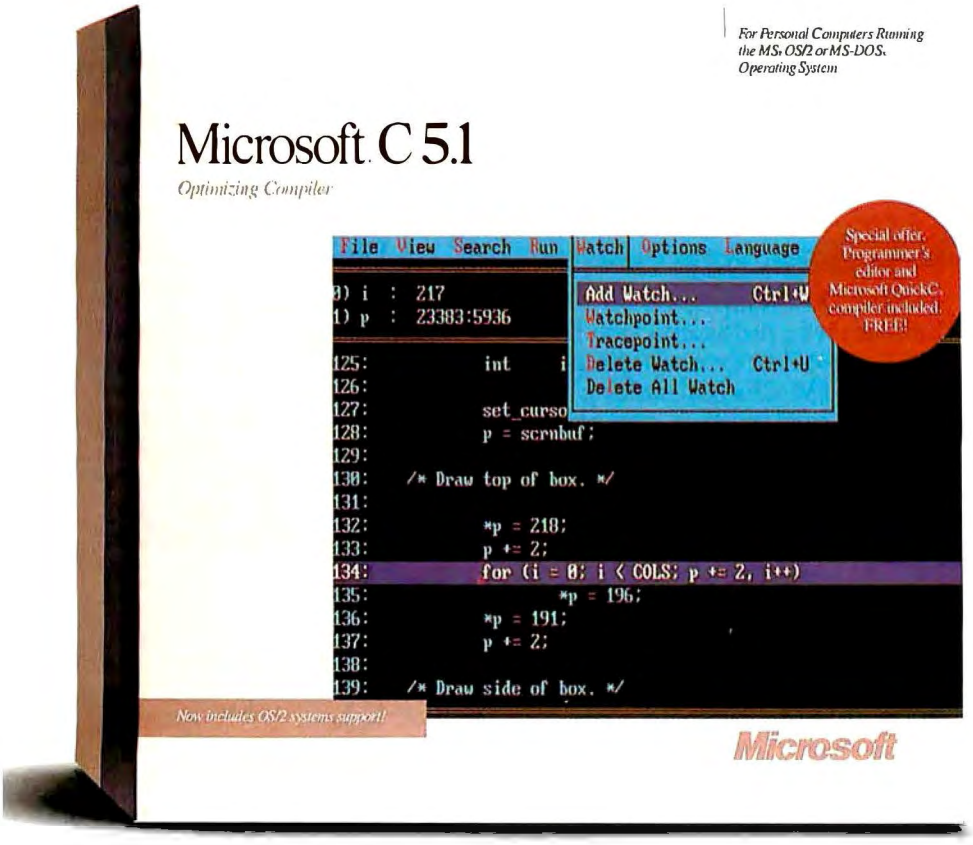

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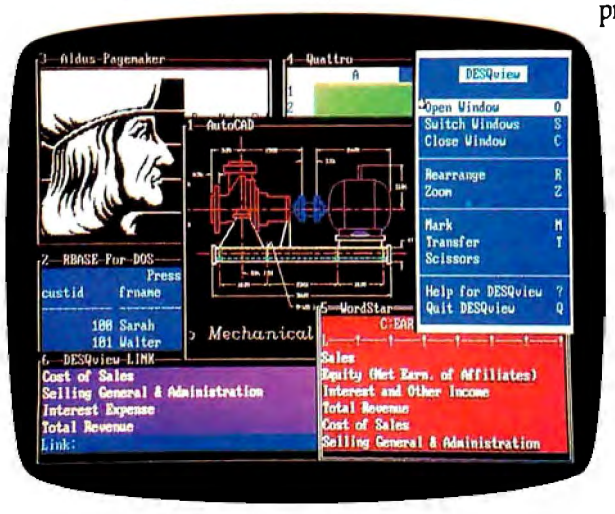

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A Better C?

This child of C goes its parent one better in compatibility and portability

Bjarne Stroustrup

The C++ language is a general-purpose programming language that is, except for minor details, a superset of C. It improves on C through its support of data abstraction and object-oriented programming. The main influences on its design, in addition to C, were Simula-67 and Algol68 (see references 1 and 2).

C++ was first installed 5 years ago. Today, it has several independent implementations and many thousands of installations. It is being used for major university research projects and for large-scale software development in companies such as Apple, Apollo, AT&T, and Sun.

It has been applied to most branches of programming, including banking, CAD, compiler construction, database management, image processing, graphics, music synthesis, networking, programming environments, robotics, simulation, scientific computation, switching, and very-large-scale-integration design.

A Better C

C++ improves the notational convenience of C and provides greater type safety. It compensates for C's weaknesses without compromising C's strengths. In particular, there is no program that can be written in C but not in C++, nor is there a program that can be written in C so that it achieves greater run-time efficiency than it does in C++ (see reference 3).

C is clearly not the cleanest language ever designed nor the easiest to use, but it owes its current pervasiveness to several key strengths:

- *Flexibility*: You can apply C to almost every application area and use almost every programming technique with it. The language has no inherent limitations that preclude writing particular kinds of programs.
- *Efficiency*: C's semantics are "low-level." That is, its fundamental concepts mirror those of a traditional computer. Consequently, it's relatively easy, both for you and for a compiler, to efficiently use hardware resources for a C program.
- *Availability*: Given any computer, from the tiniest microcomputer to the largest supercomputer, chances are that there's an acceptable-quality C compiler available for it, and that such a compiler supports an acceptably complete and standard C language and library. There are also libraries and support tools available, so you rarely need to design a new system from scratch.
- *Portability*: While a C program may not be easily or automatically portable from one machine (or operating system) to another, such a port is usually possi-

continued

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The Origin of C++

Rich Malloy

C++ (pronounced "C plus plus"), like many other languages, began life as a tool to solve a specific problem. Bjarne Stroustrup, a Bell Labs researcher, needed to write some simulation programs. Simula67, the first real object-oriented language, would have been ideal for these programs except for its comparatively slow execution speed. Dr. Stroustrup chose instead to write a new version of C, which he called "C with Classes." By 1983, the language had evolved considerably and the name was changed to C++.

After further evolution, Bell Labs' parent company, AT&T, began offering the language as a product in 1985.

The name C++, like the language itself, is terse but meaningful. The name, coined by an associate of Stroustrup's named Rick Mascitti, concisely describes the evolutionary nature of the language. The term "++" is, of course, the increment operator in C, suggesting that the language C++ is "a bit more than C." A possible alternative name, C+, is not only less inspired but also liable to generate a syntax error.

Rich Malloy is an associate managing editor at BYTE. You can reach him on BIX as "rmalloy."

ble. The level of difficulty is also usually low enough that even porting software that contains inherent machine dependencies is both technically and economically feasible.

C++ preserves these strengths and remedies some of C's most obvious problems. For example, function arguments are type-checked in C++, and coercions are applied where they are found to be appropriate:

```
extern double sqrt(doublt);
// declare square-root function
...
double d1 = sqrt(2);
// fine: 2 is converted to
// a double
...
double d2 = sqrt("two");
// error: sqrt() does not
// accept a string
```

The // notation was introduced into C++ from BCPL (see reference 4) for comments starting at the // and ending at the end of the line.

As shown, C++ makes you specify a function's argument types in a function declaration so that the standard type conversions (such as `int` to `double`) can be implicitly applied, and type errors (such as calling a function requiring a `double` with a `char*` argument) can be caught at compile time. With minor restrictions, the draft ANSI C standard accepts the C++ function-calling rules and the syntax for function declarations and function definitions (see reference 5).

C++ provides in-line substitution of functions:

```
inline int max(int a, int b)
  { return a>b?a:b; }
...
int x = 7;
int y = 9;
...
max(x,y);
// generates: x>y?x:y
max(f(x),x); // generates:
// temp=f(x); temp>x?temp:x
```

Unlike the macros commonly used in C, in-line functions obey the usual type and scope rules. Using in-line functions can lead to apparent run-time improvements over C. In-line substitution of functions is especially important in the context of data abstraction and object-oriented programming. With these styles of programming, very small functions are so common that function-call overhead can become a performance bottleneck.

In addition, C++ provides typed and scoped constants, operators for free store (dynamic store) manipulation, and many other features.

When the ANSI C committee finishes its work, the definition of C++ will be reviewed to remove gratuitous incompatibilities. This will not be a major task, though, because C++ and ANSI C have already absorbed most of the "new ANSI C" features from each other.

For example, the notion of a pointer to "raw storage," `void*`, was incorporated into C++ from ANSI C, as were notational conveniences such as the suffix `u` indicating an unsigned literal (e.g., `12u`) and hexadecimal character constants (e.g., `'\xfa'`). However, the most important features of C++ relate to the support of data abstraction and object-oriented programming and are thus outside the scope of ANSI C and unaffected by changes in the draft ANSI C standard.

Data Abstraction

Data abstraction is a programming technique in which you define general-purpose and special-purpose types as the basis for applications (see reference 6). These user-defined types are convenient for application programmers since they provide local referencing and data hiding. The result is easier debugging and maintenance and improved program organization.

In C++, you can define types that you then can use as conveniently as, and in a manner similar to, built-in types. Common examples are arithmetic types such as rational and complex numbers.

```
class complex {
  double re, im;
public:
  complex(double r, double i)
    { re=r; im=i; }
  complex(double r)
    { re=r; im=0 }
  // float->complex conversion
  friend complex
    operator+(complex, complex);
  friend complex
    operator-(complex, complex);
  // binary minus
  friend complex
    operator-(complex);
  // unary minus
  friend complex
    operator*(complex, complex);
  friend complex
    operator/(complex, complex);
};
```

The declaration of class `complex` specifies the representation of a complex number and the set of operations on it. The keyword `class` is C++'s term for *user-defined type*. The declaration of class `complex` has two parts.

The initial part specifies the representation of a `complex` number and is by default `private`. This representation (consisting of the two double-precision floating-point numbers `re` and `im`) is accessible only to the functions defined in the declaration of class `complex`.

The second part of the declaration specifies how a user can create and manipulate complex numbers. It is called the `public` part of the declaration because it provides an interface to the general public. It consists of two constructors and the usual arithmetic operations. A constructor is a function that constructs a value of a given type. The first constructor for `complex` creates a com-

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plex number given a coordinate pair; the second creates a complex number given a single floating-point number (using the obvious mapping of the real line into the complex plane). Together they provide the two obvious ways of initializing a complex variable. For example:

```
complex a = complex(1.2);
// a becomes (1.2,0)
complex b = complex(3.4,5.6);
```

The arithmetic operations are defined by `friend` functions: Specifically, these functions are completely ordinary except that they are granted access to the otherwise inaccessible representation of complex numbers by the `friend` declarations. The notation `operator+` is used to name a function defining the addition operator, +. The number of arguments determines whether an operator function implements a binary or a unary operator. For example, `operator-(complex,complex)` defines subtraction of complex numbers, whereas `operator-(complex)` defines unary minus.

Such functions can be defined as

```
complex operator+(complex a1,
  complex a2)
{
  return complex(a1.re+a2.re,
    a1.im+a2.im);
}
```

and used like this:

```
main()
{
  complex a = 2.3;
  complex b = complex(1/a,7);
  complex c = a+b+complex(1,4.5);
}
```

Here, `a` receives the value `(2.3,0)` by implicit application of the constructor `complex(double)`; `b` receives the value `(1/2.3,7)`; and `c` becomes the value `(2.3+1/2.3+1,7+4.5)`—that is, about `(3.7,11.5)`.

The constructors and the operator functions let you use complex numbers just as if they were built into the language. In-line functions let the run-time efficiency of a user-defined type come close to an equivalent built-in type.

Hiding the representation is the key to modularity. It allows the representation of a class to be changed without affecting users. For example, you might decide to change the Cartesian representation of `complex` used above to a polar one. Such a change would affect *only* the functions listed in the class definition. User code, such as `main()`, is unaffected. Debugging can also be greatly simplified by proper use of such data hiding.

Programming with classes shifts the emphasis from the design of algorithms to the design of classes (user-defined types). Each class is a direct representation of a concept in the program; each object the program manipulates is of some specific class that defines its behavior. In other words, every object in a program is of some class that defines the set of legal operations on that object. This lets you program in a language with a set of types, or concepts, appropriate to the application. An engineer might use complex numbers, matrices, and fast Fourier transforms, while the telephony-software designer might prefer types such as switch, line, trunk, handset, and digit buffer.

In C++, this style of programming is supported by a general and flexible set of mechanisms for data hiding, by constructors providing optional guaranteed initialization, by destructors providing optional guaranteed cleanup (termination), and by operator overloading and user-defined coercions providing a convenient and conventional notation for many kinds of applications. All these features are cleanly integrated into the language, and all uses are checked for type violations and ambiguities at compile time to catch errors as early as possible and to avoid unnecessary run-time overheads.

Object-Oriented Programming

Concepts do not usually come as self-contained entities. On the contrary, most concepts relate to other concepts in a variety of ways. For example, the concepts of airplane and car relate to those of vehicle and transport; the concepts of mammal and bird relate to each other through the more general concept of vertebrate animal, through the concept of food, and so forth; and the concepts of a circle, rectangle, and polygon involve the general concept of a shape.

Therefore, representing concepts directly as types in a program also requires ways of expressing the relations between types. C++ lets you specify hierarchically organized classes. This is the key feature supporting object-oriented programming. Hierarchical organization is an extremely important way of coping with complex issues in many fields and has, not surprisingly, also proven to be a good way of organizing programs in a wide variety of application areas.

Consider defining a type `shape` for use in a graphics system. The system has to support circles, triangles, squares, and many other shapes. First, you specify a class that defines the general properties of all shapes:

```
class shape {
  point center;
  color col;
  // ...
public:
  point where() { return center; }
  void move(point to)
        { center = to; draw(); }
  virtual void draw();
  virtual void rotate(int);
  // ...
};
```

You can define the calling interfaces for `draw()` and `rotate()`, but you cannot yet define their implementation. They are, therefore, declared `virtual` (the Simula67 and C++ term for "to be defined later in a class derived from this one"). They will be defined for each specific shape. Given this definition of class `shape`, you can write general functions manipulating shapes:

```
void rotate_all(shape* v[],
  int size, int angle)
// rotate all members of
// vector "v" of size "size"
// "angle" degrees
{
  for (int i = 0; i < size; i++)
    v[i]->rotate(angle);
}
```

For each shape `v[i]`, the proper `rotate()` function for the actual type of the object will be called. That "actual type" is not known at compile time.

To define a particular shape, you must say that it is a shape and specify its particular properties:

```
class circle : public shape {
// a circle is a shape
  int radius;
public:
  void draw() { /* ... */ };
  void rotate(int) {}
  // yes, the null function
};
```

A class is said to be *derived* from another class, which is then called its *base* class. Here, `circle` is derived from `shape`, and `shape` has a base class of `circle`. A derived class is said to inherit the properties of its base. In addition to such inherited properties, a derived class has its own specific properties. For example, class `circle` has the member `radius` in addition to the members `col` and `center` that it inherited from class `shape`.

Note that the new shape `center` was

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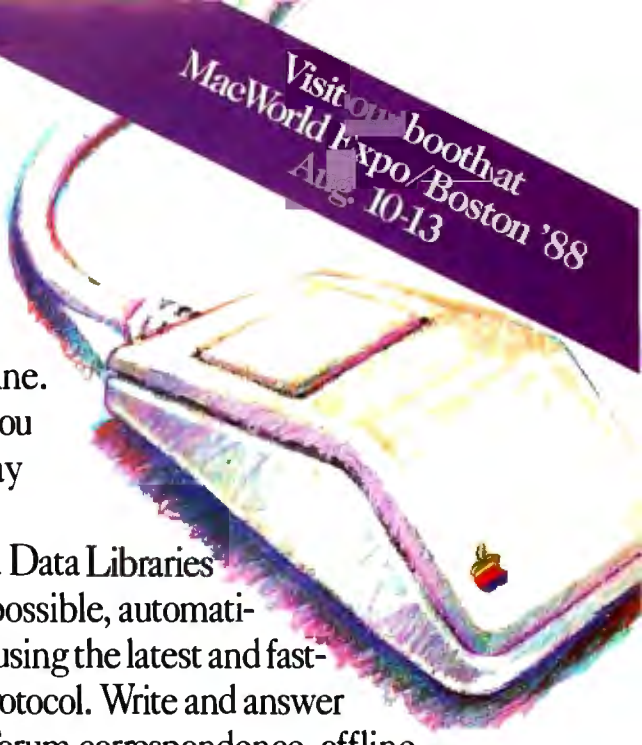

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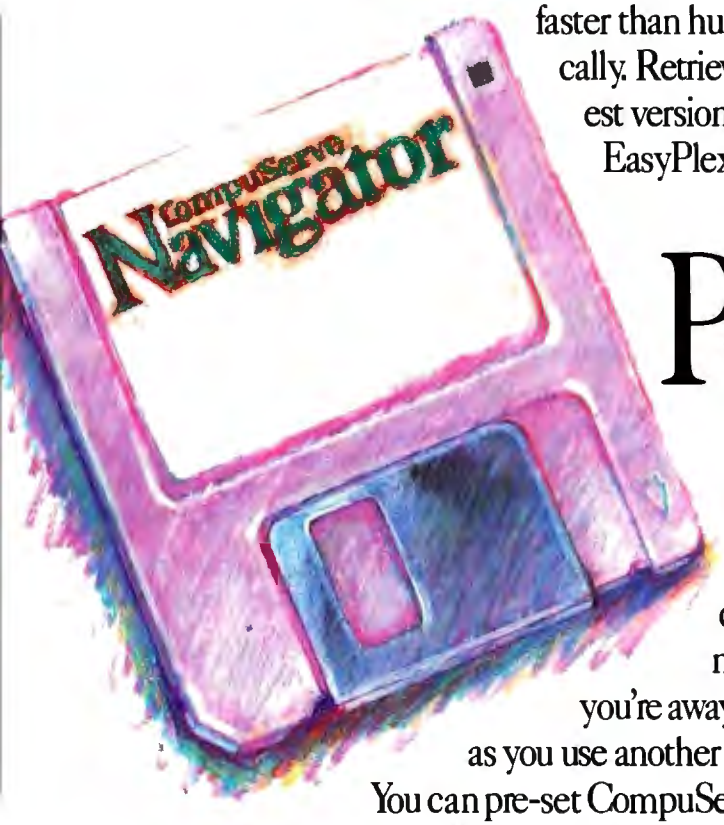

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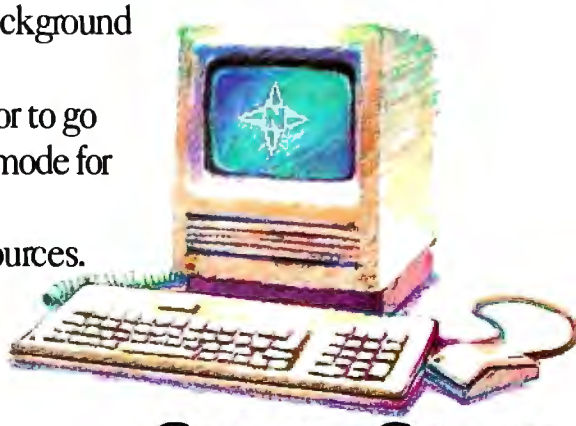

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added without modifying "old code," such as the `rotate_all()` function and other shapes. The ability to extend a program by adding new variations of a basic concept (i.e., adding new derived classes given a base class) without touching old code is a major boon. Using traditional techniques, such additions require access to the source code of the system you want to extend, require understanding of the key implementation details of the old code, and carry the risk of introducing errors in the already-tested old code. Furthermore, using derived classes, improvements and bug fixes done to a base class are automatically "inherited" by every class derived from it.

I chose the "shape" example because everyone understands about shapes, not because object-oriented programming has anything particular to do with graphics. Graphics is a good area for object-oriented techniques, but most uses of such techniques in C++ have nothing to do with graphics. Other examples are compilers, operating-system kernels and device drivers, switching software, and network simulations.

In many contexts, it is important that the C++ virtual-function mechanism be nearly as efficient as a "normal" function call. The additional run-time overhead is about five memory references (depending on the machine architecture and the compiler), and the memory overhead is one word per object plus one word per virtual function per class.

C++ provides multiple inheritance (see reference 7), or the ability to derive a class from more than one direct base class. For example, if you have a class `task` representing the concept of a concurrent activity, and a class `displayed` representing the concept of something displayed on the screen, you might write:

```
class displayed_task
  : public displayed, public task
  { ... }
```

Now a `displayed_task` is really both a `displayed` and a `task`, so a `displayed_task` can be used wherever a `displayed` or a `task` is required:

```
void wait(task*,int);
// do something to a task
void update(displayed*);
// do something to a displayed

f()
{
  // make a displayed_task:
  displayed_task* dtp =
    new displayed_task(
    /* appropriate arguments */ );
  wait(ctp,10);
  // use displayed_task as a task
  update(ctp);
  // displayed_task as displayed
}
```

Naturally, the usual type-checking rules, ambiguity rules, and encapsulation mechanisms are applied to multiple inheritance to ensure the usual degree of safety and efficiency.

Why C++?

What distinguishes C++ from other programming languages? C++ was designed under severe constraints of compatibility, internal consistency, and efficiency. No feature was included that would cause a serious incompatibility with C at the source or linker levels; would cause run-time or space overheads for a program that did not use it; would increase run time or requirements for a C program; would significantly increase the compile time compared with C; or could only be implemented by making more demands than in a traditional programming environment.

Traditional languages such as C, FORTRAN, Pascal, and Modula-2 don't provide anything comparable to C++'s features for data abstraction and object-oriented programming. This gives the C++ programmer a strong advantage when it comes to understanding, writing, and maintaining programs. It's often important that the improved structure of C++ programs be achieved without sacrificing efficiency or restricting the range of areas for which the language is suitable.

Ada provides facilities for data abstraction that may not be as elegant as C++'s but should be about as effective in actual use. But Ada doesn't provide an inheritance mechanism to support object-oriented programming, so C++ has greater expressive power in this area.

C++ is distinguished among languages that support object-oriented programming, such as Smalltalk, by a variety of factors: its emphasis on program structure; the flexibility of encapsulation mechanisms; its smooth support of a range of programming paradigms; the portability of C++ implementations; the run-time efficiency (in both time and space) of C++ code; and its ability to run without a large run-time system.

C++ is a programming language in the traditional sense and is not a complete program development system or a complete execution environment. It can be installed easily into an existing C program development or execution environment, and C++-specific tools can then be added as needed. In addition, several C++-specific environments are being built to suit specific needs (see references 8 and 9).

The emphasis on explicit static structure (as opposed to a weak type-checking, as in C, or purely dynamic type-checking, as in Smalltalk) is particularly important for projects involving many programmers and for individual programmers using large libraries written by others. C++'s strong type-checking and encapsulation mechanisms have repeatedly proven themselves by dramatically reducing integration time for larger projects. Similarly, C++ provides a good base for designing libraries with precisely defined, elegant, and statically checked interfaces.

C++ has a single, very flexible, type system. This makes it possible to use hybrid programming styles without violating the C++ type system. It also lets you choose a style of programming closely matching individual application areas. ■

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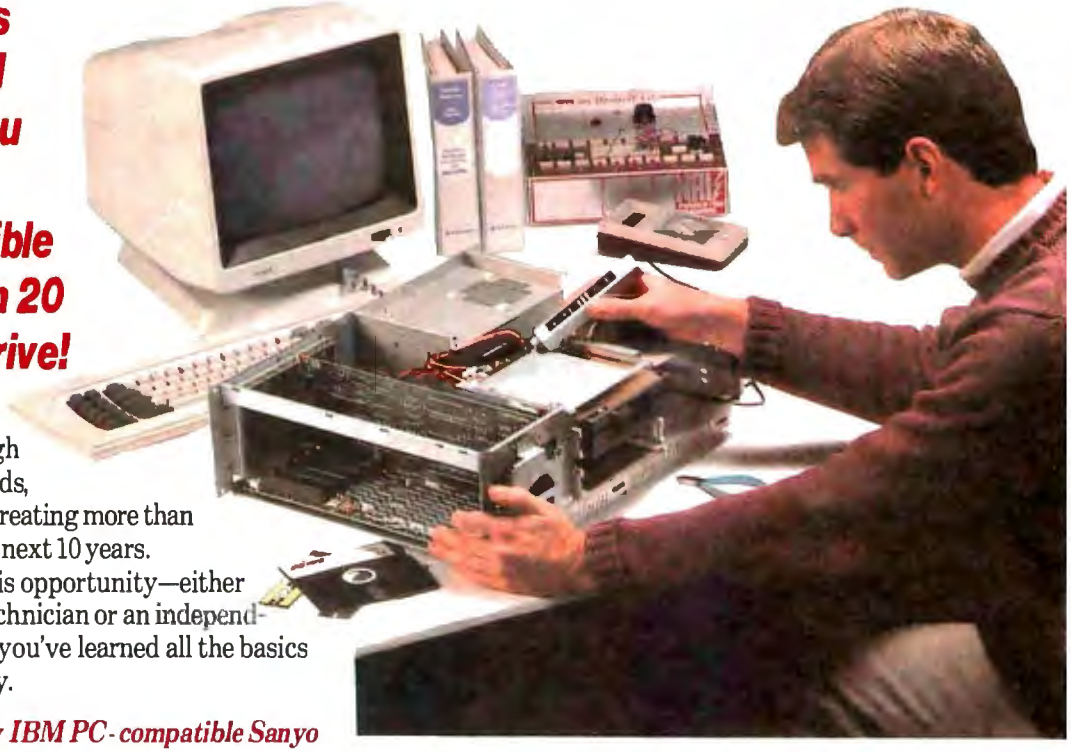

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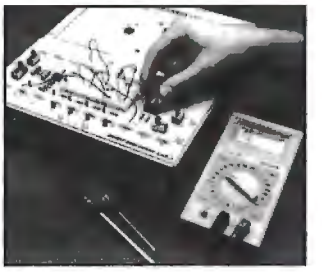

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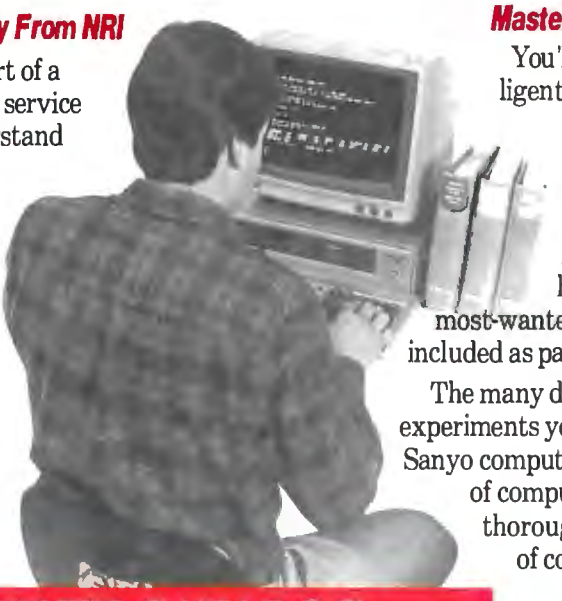

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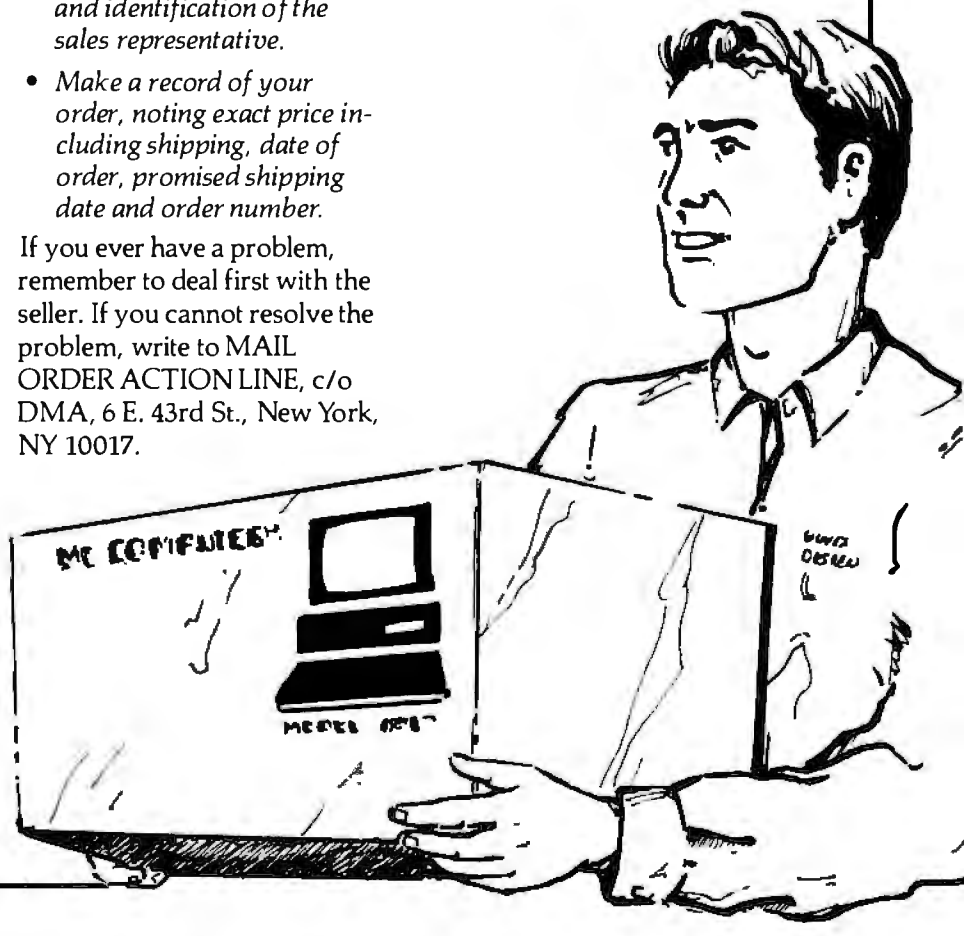

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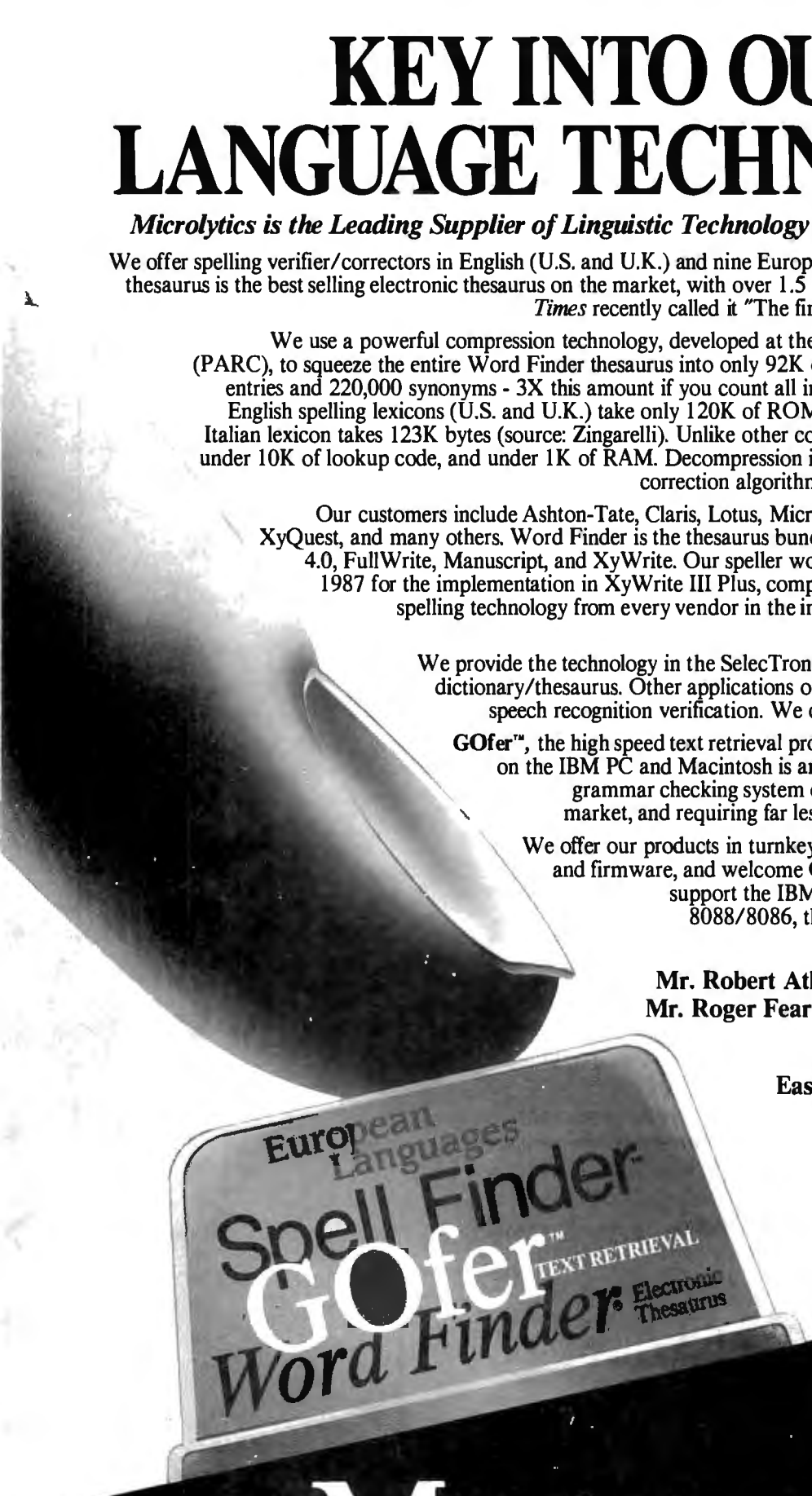

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It's an Attitude

There's a lot of extra coding, but you can do object-oriented programming in conventional C

Jonathan S. Linowes

Object-oriented programming is not dependent on any given programming language; it's an attitude. Structured programming asks you to answer the questions, "How is my data transformed?" and "What are my inputs and outputs?" Object-oriented programming asks, "What are the things I will be working with?" and "What do I expect these things to do?" It is becoming a popular alternative to conventional structured techniques for organizing and thinking about programs.

OOPC is a mechanism for object-oriented programming using standard C. It's not a programming language in itself, nor is it a preprocessor. Rather, it's a collection of conventions and programming techniques that, if followed, give you many of the benefits of today's object-oriented programming languages—benefits such as data encapsulation, modularity, and inheritance.

Through OOPC, I introduce the concepts of object-oriented programming in a practical and familiar context, rather than complicating the issue with a new language and a new syntax. To demonstrate OOPC techniques in action, I have implemented the MyShape example adapted from *The C++ Programming Language* by Bjarne Stroustrup (Addison-Wesley, 1986), pages 213 to 221.

Object-oriented programming techniques are very good for prototyping applications. In fact, OOPC was developed for the MIT Media Laboratory UseIT project, a user-interface test-bed system. The UseIT system lets you easily build components of a user interface, modify an interaction technique (such as changing a pop-up menu into a pull-down), and quickly program entirely new objects. This was a fairly complex project with multiple programmers and required the ability to make quick code modifications. Using object-oriented programming techniques made the UseIT system easy to understand and modify.

Objects as Virtual Devices

You can think of object-oriented systems as a collection of independent virtual devices communicating with each other, each with its own internal structure. These virtual devices, called *objects*, consist of *properties* (private data) and *methods* (the operations applied to that data). The internal structure of an object is not accessible to any other object or program. This concept of data encapsulation is key to object-oriented programming, as it separates the object's implementation from its use.

Objects communicate with other objects through *messages*. You send messages to create new objects, to modify and inquire about an object's property

continued

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values, and to request the object to perform specific actions. In a sense, messages are like op codes to the object. An object can send messages to any other object, including itself.

You create objects by instantiating classes. Classes act as templates for objects, which have a particular set of properties and methods. All instances of a given class have the same properties and methods, although the values of each property will vary.

The distinction between object classes and instances is analogous to the relationship between structure definitions and structure variables. For example, in C, `struct sname { ... };` declares a template for structure sname, and `struct sname varname;` declares varname as an instance of sname.

Object classes are organized into a hierarchical taxonomy of subclasses and superclasses. With subclasses you can define increasingly specialized object types. Superclasses let you share generalizations among separate classes.

An object inherits all the properties and methods of its superclass. A class can distinguish itself from its superclass by assigning different default property values, substituting methods for specific messages, and adding new properties, methods, and messages.

When you send a message to an object, the object's message handler receives the message and checks for a local method for that message. If it has none, the message is forwarded to the object's superclass message handler, and the method there is used. If the superclass doesn't recognize the message, it sends the message along to *its* superclass, and so forth, until a method is found. The message is declared invalid if no method is found.

Listing 1: *OOPC code for the MyShape example program. This code creates several shapes—a rectangle, a line, and a face (MyShape)—and then stacks them on top of each other.*

```
    stack_on_top( p2, p3 );
    stack_on_top( p1, p2 );

    /* re-draw */
    refresh_shapes( screen );
}

stack_on_top( q, p )
    Object q, p;
{
    Msg_North_Result north;
    Msg_South_Result south;
    Msg_Move_Param move;

    Send( p, MSG_NORTH_r, NULL, &north );
    Send( q, MSG_SOUTH_r, NULL, &south );

    move.dx = north.x - south.x;
    move.dy = north.y - south.y + 1;
    Send( q, MSG_MOVE_p, &move, NULL );
}

refresh_shapes( screen )
    Object screen;
{
    extern Object shape_list[];
    extern int shape_count;
    Msg_Draw_Param draw;
    int i;

    Send( screen, MSG_CLEAR, NULL, NULL );
    draw.screen = screen;
    for (i=0; i<shape_count; i++)
        Send( shape_list[i], MSG_DRAW_p, &draw, NULL );
    Send( screen, MSG_REFRESH, NULL, NULL );
}
```

Using OOPC Objects

The OOPC programmer interface consists of a header file, the functions New and Send, and a library of message-handler functions. Message handlers receive messages and invoke the corresponding methods. Every object class in the object library has a message handler.

The header file, OOPC.H, contains common definitions for standard data types in OOPC, such as class message-handler function declarations and message definitions.

Instance objects are identified with a reference, or handle, of type Object, defined in OOPC.H, returned when a new instance is created. You must use this identifier whenever you reference the object—for example, when sending it messages. When you use the Object handle, applications need never know the internal structure of the object.

You create a new instance with the function New:

```
object = New( handler );
```

where handler is the message-handler function for the class of the object you

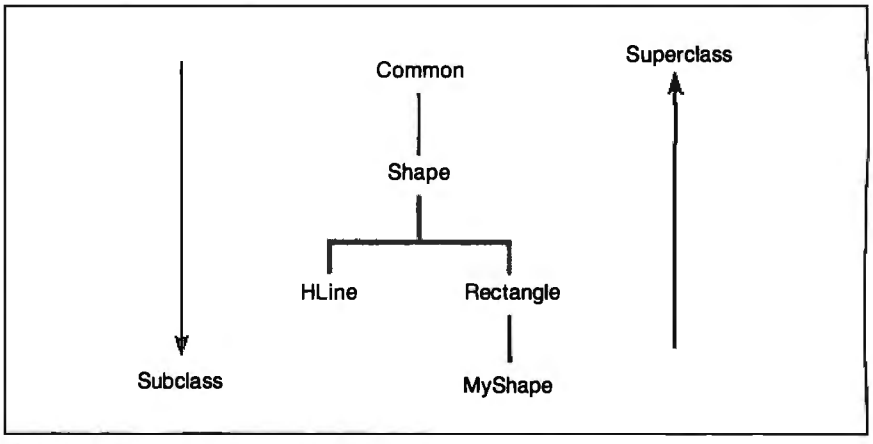

Figure 1: *Class hierarchy in the MyShape example.*

```
#include <stdio.h>
#include "oopc.h"

main()
{
    Object                      screen;
    Object                      p1, p2, p3;
    Msg_Set_Rectangle_Param     set_rect_p;
    Msg_Set_Hline_Param         set_hline_p;
    Msg_Set_Myshape_Param       set_myshape_p;
    Msg_Draw_Param              draw_p;
    Msg_Move_Param              move_p;
    int                         i;

    /* create screen buffer */
    screen = New( Screen );

    /* create shapes */
    p1 = New( Rectangle );
    set_rect_p.xmin = 0;  set_rect_p.ymin = 0;
    set_rect_p.xmax = 10; set_rect_p.ymax = 10;
    Send( p1, MSG_SET_RECTANGLE_p, &set_rect_p, NULL );

    p2 = New( Hline );
    set_hline_p.x = 0; set_hline_p.y = 15; set_hline_p.length = 17;
    Send( p2, MSG_SET_HLINE_p, &set_hline_p, NULL );

    p3 = New( Myshape );
    set_myshape_p.xmin = 15; set_myshape_p.ymin = 10;
    set_myshape_p.xmax = 27; set_myshape_p.ymax = 18;
    Send( p3, MSG_SET_MYSHAPE_p, &set_myshape_p, NULL );

    /* draw them */
    refresh_shapes( screen );

    /* re-arrange the shapes */
    move_p.dx = -10; move_p.dy = -10;
    Send( p3, MSG_MOVE_p, &move_p, NULL );
```

are creating. The function New returns the handle of the instance into whatever variable name you've specified for the object. When you create an object, New allocates memory for the object's properties and initializes this memory to default values. It returns a null object if it can't create the instance.

Objects are sent messages with the Send macro function:

```
error = Send( object, message,
&parameters, &result );
```

where object receives the message, message enumerates it, and the last two arguments are pointers to the parameter and result blocks whose contents depend on the particular message specified (they could be null). The function Send returns an error code (0=ok).

A message is actually just an enumerated integer type, such that each message has a unique value. Some examples include MSG_SET_RECTANGLE_p, which sets a rectangle's corner coordinates; MSG_ASK_NORTH_r, which requests the top-center point of a rectangle; and MSG_DRAW_p, which tells the object to draw itself. The name extensions _p, _r, and _pr remind you that the object requires a parameter block, result block, or both, along with the message.

When a message requires parameters, it has an associated data structure for stuffing the parameter values, named, by convention, *message*_Param. For example, Msg_Draw_Param is the parameter block for the MSG_DRAW_p message (Msg_Draw_Param specifies the screen on which to draw the object). Similarly, results are returned in the structure *message*_Result. For example, structure Msg_North_Result contains the point returned by MSG_NORTH_r. These parameter and result blocks are the same regardless of which object receives the message.

Unfortunately, because OOPC requires that you be able to send different data structures to the same function, you can't perform type checking to verify that the correct blocks are specified for a given message. However, the message-naming convention, combined with the parameter- and result-block structures, form a satisfactory interim solution without a preprocessor. The naming conventions make it easier to visually verify the code, and the C compiler will verify the types of each specific parameter/result field within the blocks.

An Example

The class hierarchy in figure 1 shows the superclasses and subclass used for the MyShape example. The class Rectangle includes coordinates defining its two corners. MyShape is a subclass of Rectangle that implements a picture of a face. It uses the Rectangle properties to define its border and adds properties for the eyes and mouth (defined as horizontal lines). Messages and methods regarding the border of a MyShape object are inherited from its superclass, Rectangle; other messages are handled by the local method, MyShape. In OOPC, all objects are subclasses of class Common.

The main program, shown in listing 1, creates three shapes—a rectangle, a horizontal line, and an instance of MyShape (a face)—and draws them on the screen. Then, the line is stacked on top of the face, the rectangle is stacked on top of the line, and the drawing is refreshed.

When an instance of a class is created, its properties are set to default values, leaving it to the application to set them to desired values. For example, new rectangles are created at (0,0)-(0,0), which is not very useful. The new object must then be set, such as at (0,0)-(10,10), as in the example.

The MyShape example shows how you can write procedures that manipulate objects without knowledge of the objects they will be manipulating. For example, the stack_on_top function rearranges arbitrary objects, as long as they understand the messages MSG_NORTH, MSG_SOUTH, and MSG_MOVE, to get their top-center and bottom-center points and to change their positions. Similarly, the function refresh_shapes sends MSG_DRAW to the objects in the display list, without knowing anything about the objects there. In fact, you can code and compile these functions before writing the object classes they are manipulating.

continued

Listing 2: *The chain of inheritance for the* rectangle *class. If a* rectangle *object is not able to recognize a message, the* Base *macro will pass it up to a superclass,* Shape, *to see if the message is defined there. If* Shape *can't decode the message, it will pass it up to* Common. *If* Common *can't understand the message, an error is returned.*

```
/*-------------------------------------------------------------------
* excerpt from file: rectangle.c
* definition of rectangle object structure
-------------------------------------------------------------------*/

typedef struct {
#   include "rectangle.p"
} Rectangle_Object;


/*-----------------------------------------------
* file: rectangle.p
* properties for Rectangle class (subclass of Shape)
-----------------------------------------------*/

#include "shape.p"      /* inherited properties */

/* local properties */
int xmin, ymin;         /* northeast corner */
int xmax, ymax;         /* southwest corner */


/*-----------------------------------------------
* file: shape.p
* properties for Shape class (subclass of Common)
-----------------------------------------------*/

#include "common.p"       /* inherited properties */

/* no local properties */


/*-----------------------------------------------
* file: common.p
* properties for Common class
-----------------------------------------------*/

/* Common is top level, has no parent */

/* properties common to all objects */
Functionp   dispatch; /* message handler function */

/* other properties may include a class
              identifier, archive file name, etc.*/

/*-----------------------------------------------
* excerpt from file: rectangle.c
* methods for Rectangle class (subclass of Shape)
-----------------------------------------------*/

#include <stdio.h>
#include <malloc.h>
#include "oopc.h"

/* base class dispatcher */
#define Base(this,msg,par,res)
                        Shape(this,msg,par,res)

/*-----------------------------------------*/
/* message dispatcher */
/*-----------------------------------------*/
```

continued

Implementing OOPC Objects

OOPC uses an `#include` chaining technique that requires that each object be compiled separately. Each class is made of at least two source files: *class*.C and *class*.P. The .C file contains the message handler and individual methods. The .P file contains the class properties. You must include the header file OOPC.H at the top of every source (.C) file in addition to the object's class property file.

Using nested file inclusion, the .P files provide the mechanism for property inheritance. For example, listing 2 shows the Rectangle_Object data structure. The fields of this structure are included from the RECTANGLE.P file. The first statement of the file is another include file, SHAPE.H, containing the properties from Rectangle's superclass.

Superclass properties appear in memory before subclass properties, as shown in figure 2, which facilitates method inheritance. When a message is deferred by a class to its superclass, the object's handle is passed. Since this handle is actually a pointer to the object's property data, the superclass can access the properties it knows of, yet need not (and should not) access the subclass properties.

Each object class has a single message-handler function having the same name as the object itself. Thus, rectangles have a message handler called Rectangle.

The handler is a "switch" statement with cases for each message recognized locally by the class, calling the corresponding method—a static local function. If the message handler does not recognize the message, the message is forwarded up to the superclass message handler. Listing 2 is an excerpt of the file RECTANGLE.C, showing the chain of inheritance an unrecognized message will follow.

Even if an object has a method for a message, it can still inherit the superclass method and then augment the result. In the initialization method, for example, the object first inherits its superclass method to initialize the superclass properties and then initializes its own properties.

Because the topmost class is Common, the first property of every object is a pointer to the object's message-function handler. The Send macro function takes advantage of this fact by simply accessing the first field of the object. The following is an excerpt from OOPC.H showing how Send is implemented:

```
typedef int (*Functionp)();
```

continued

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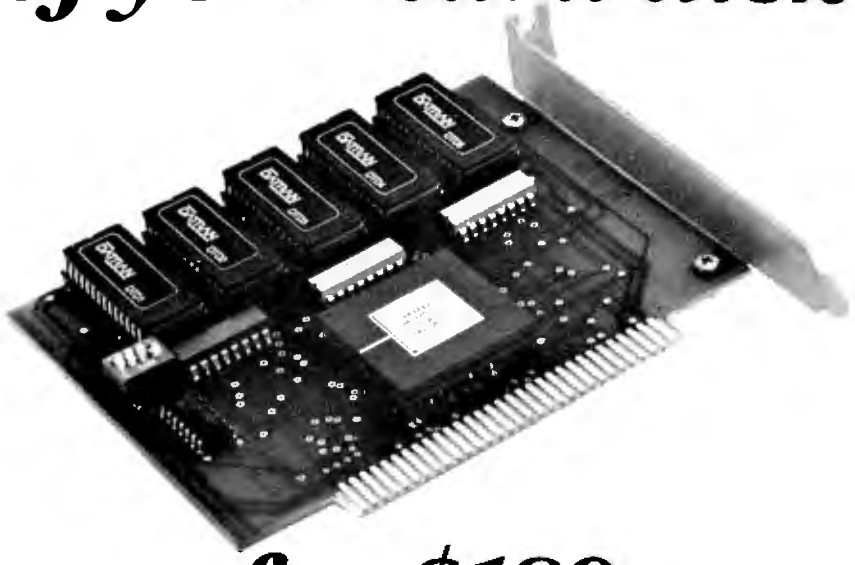

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```
int Rectangle( this, msg, param, result )
    Rectangle_Object*   this;
    Message             msg;
    Caddr               param;
    Caddr               result;
{
    int error = 0;

    switch (msg) {
    case MSG_NEW_r:
        error = Rectangle_new( result );
        break;
    case MSG_INITIALIZE:
        error = Rectangle_init( this );
        break;
    case MSG_SET_RECTANGLE_p:
        error = Rectangle_setrect( this, param );
        break;
    case MSG_MOVE_p:
        error = Rectangle_move( this, param );
        break;
    case MSG_DRAW_p:
        error = Rectangle_draw( this, param );
        break;
    case MSG_NORTH_r:
        error = Rectangle_north( this, result );
        break;
    case MSG_SOUTH_r:
        error = Rectangle_south( this, result );
        break;
    default:
        error = Base( this, msg, param, result );
        break;
    }

    return error;
}

/*-----------------------------------------------*/
/* rectangle class methods */
/*-----------------------------------------------*/

static int Rectangle_move (this, param)
    Rectangle_Object *this;
    Msg_Move_Param *param;
{
    this->xmin += param->dx;
    this->ymin += param->dy;
    this->xmax += param->dx;
    this->ymax += param->dy;
    return 0;
}
```

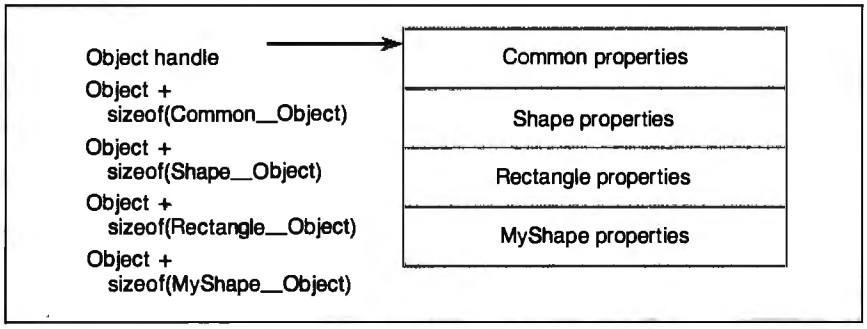

Figure 2: *Memory organization of MyShape class properties.*

```
typedef struct { Functionp
  dispatch; } *Object;

#define Send(obj,msg,param,
  result)\
((*(obj->dispatch))(obj,msg,
  param,result))
```

To implement Send, I first define the data type Functionp, which is a pointer to a function. Then I define a data structure that declares as its member an item called dispatch, which is of type Functionp. Finally, I give this structure the tag *Object, so that Object is a data type that is a pointer to a structure whose first member is a pointer to a function. In the Send macro, obj is of type Object, so obj->dispatch will fish out the pointer to the desired function. The rest of this line executes the function.

Finally, the function New is an interface for sending a MSG_NEW message to a dispatch function. New creates an instance for an object class that you can then use with the function Send.

```
typedef struct { Object object; }
  Msg_New_Result;

Object New( dispatch )
      Functionp dispatch;
{
      Msg_New_Result new;
      (*dispatch)( NULL,
        MSG_NEW_r, NULL, &new );
      return new.object;
}
```

Limitations of OOPC

As you can see, there is a lot of extra coding you must tend to yourself, such as setting up the include chain and making sure that you pass the correct parameters to an object. These are details that an object-oriented language can manage for you. Object-oriented languages differ in their support for memory management.

The advantage of using a conventional language is that it doesn't require the additional investment of buying and learning a new language. Plus, it's code-compatible with any existing libraries and tools you currently use. ■

Editor's note: *The source code for the OOPC object classes and the MyShape example are available in a variety of formats.* *See page 3 for further details.*

Jonathan S. Linowes is a founding partner of Sirlin Computer Corp. in Hudson, New Hampshire, specializing in database and computer graphics systems. He can be contacted on BIX as "editors."

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MAKING THE MOVE TO OS/2

Top programmers from Borland, Norton, and Lotus talk about converting a database, TSR, and spreadsheet from MS-DOS to OS/2

With all the talk about OS/2—its multitasking features, the heritage it brings from MS-DOS, the problems it leaves behind, complaints that it costs too much or takes up too much memory—the question foremost in the minds of most personal computer users is: Should I bother? Granted, OS/2 has some powerful features, but how many programs will actually run under it, and how many of those will take full advantage of its capabilities? If only a few programs run under OS/2, or if they run only in the DOS-compatibility box, why not just stick with MS-DOS?

Whether or not a critical mass of OS/2 programs becomes available depends on two things: how hard it is to write new OS/2 programs, and how hard it is to port established MS-DOS programs to OS/2. Given the time it takes to develop an application program, we can expect that the first OS/2 programs will be updates of MS-DOS programs.

So, how hard *is* it to port a program from MS-DOS to OS/2? To find out, we asked top programmers from Borland, Norton Computing, and Lotus Development to tell us about their experiences in converting a popular program to run under OS/2. Their thoughts should be valuable if you're considering upgrading to OS/2—and wondering whether the number of available programs will justify the cost and effort—or if you're thinking about porting your own programs to OS/2.

AN OS/2 PARADOX

Robert E. Shostak

You might expect that with its gaggle of new features, including multitasking and interprocess communication, porting a DOS program to OS/2 might be a big job. Indeed, if you plan to take advantage of these new features, a port could involve significant redesign and implementation work. On the other hand, if you don't need fancy multitasking capabilities and your program has minimal direct interface to the operating system or BIOS, you might only need to recompile and relink your source code.

Paradox is a high-end relational database management system. It is quite a large and elaborate program, so we ended up dealing with many of the issues that would arise in porting other applications.

These issues fall into two categories: external and internal. External issues arise by virtue of new or different features in OS/2 that are apparent to the user. Internal issues, by contrast, are implementation concerns that have no bearing on functionality or performance and are therefore transparent to the user of the program.

External Issues

The more interesting considerations in porting to OS/2 have to do with taking advantage of its new functions, such as multitasking. These are the ones that users will notice; they're also the ones most likely to vary from application to application.

In the case of Paradox, we wanted a user to be able to run multiple copies (called *instances* in OS/2 parlance) of the program simultaneously. In fact, we wanted to make it possible for these instances to access the same tables simultaneously. For example, a user should be able to query a table at the same time that the program is printing a report for that table in the background.

OS/2's session manager automatically handles scheduling among multiple instances of a program(s). It does not, however, automatically manage concurrent access to data. But since Paradox 2.0 was written as a multiuser (i.e., networked) application, it already had the built-in mechanisms needed to synchronize multiuser access to tables. We had only to adapt these mechanisms so that multiple sessions would be treated in the same way as multiple users.

continued

The most difficult technical problem we needed to resolve to obtain this effect involves Paradox's "private directory" machinery. In a multiuser configuration of Paradox, each user designates a certain directory as his private directory. It stores temporary tables (such as the Answer table) that other users cannot access. It is essential that no two users specify the same private directory, and, in fact, this directory is usually chosen to reside on each user's local hard disk.

An OS/2 program must be better behaved than a DOS program.

In order to handle multiple sessions in addition to multiple users, we needed to provide a unique private directory for each session. To obtain maximum transparency to the user, we opted to use a mechanism that would automatically create a new subdirectory for each session a user initiates. The mechanism depends on OS/2's support of global shared memory, allowing different program instances to communicate with one another.

Other external issues we needed to deal with had to do with sharing memory and CPU resources among OS/2 tasks. Under DOS, applications (other than terminate-and-stay-resident [TSR] programs) typically grab all the memory when they're loaded. Applications also assume, of course, that they have exclusive use of the CPU. Under OS/2 and other multitasking or multiuser operating systems, programs must be better behaved. In particular, they must be careful to allocate only as much memory from the operating system as they actually need. They must also be written in a way that does not tie up the CPU unnecessarily; for example, a tight keyboard-check loop could needlessly hog the CPU. Under OS/2, you need to give control back to the operating system periodically so it can dispatch other tasks while your task is waiting for input.

Internal Issues

The most obvious difference between programs written for OS/2 and those written for DOS is the way programs make calls to the operating system. In DOS, an operating system call is made by loading up some registers with arguments to the call, then issuing INT 21h (hexadecimal). In OS/2, programmers must replace these INT 21h calls with calls to a set of named routines known as the OS/2 Application Programming Interface (API). You can think of the API as a function library of the kind normally provided with languages such as C and Pascal. The main difference is that references to functions in the API are resolved not at program-link time, but at load time, using OS/2's dynamic-linking capability. Arguments pass to the API routines on the stack, just as with high-level languages.

Most DOS function calls have an exact correspondent in the API, though the arguments or error-handling conventions may be somewhat different.

The API also has functions to replace the BIOS interrupts that DOS applications typically call. Owing to its multitasking capabilities, OS/2 needs much more control over devices such as the screen and keyboard than does DOS, so tasks don't interfere with each other. Indeed, these devices and the mouse are treated as first-class system devices. With OS/2, gone are the days when you could write directly to screen memory at B800. Of course, this is a benefit rather than a restriction, because it resolves the compatibility issues associated with BIOS-level primitives and provides greater device independence.

Be aware that OS/2 programs use Pascal calling conventions to call API functions, with the consequence that the arguments are popped off the stack by the API function itself, not by the caller. Many C compilers use the "caller pops" convention as the default, which means you might need to use a compiler option to get the right effect. You should also make sure your compiler does not truncate the names of external references to eight characters, since many of the API functions have longer names.

If, like Paradox, your program is written at least partly in assembly language, you need to be aware of a number of other minor internal issues. Assembly language for OS/2 needs to be written more carefully than for DOS in a number of respects. First, OS/2 requires that every segment be given a class name of either `CODE`, `DATA`, or `STACK`; in DOS, on the other hand, class names are largely unimportant.

Another restriction is that segments in class `CODE` cannot contain self-modifying code. The reason is that OS/2 permits code segments to be shared among different instances of the same program, or even different programs. If the first instance of an already-loaded program changes its code, the second instance (which will be a copy of the instance already residing in memory) would not be a true copy of the original code.

A further constraint is that segment registers cannot be used as general-purpose scratch registers for 16-bit quantities, as they can under DOS. Since OS/2 programs run in protected mode, you can load the segment registers only with valid memory handles, called *selectors*. If you load a segment register with an arbitrary 16-bit datum, you are likely to trigger a protection violation.

Still another internal issue we came across in porting Paradox is the difference in how the system handles the Control-Break key combination. Under DOS, applications that detect Control-Break typically trap interrupt 1Bh, which is triggered by the BIOS when that key combination is pressed. Under OS/2, a Control-Break key press generates a *signal*. Signals are asynchronous event notifications, much like software interrupts, which an application can trap using the `DosSetSigHandler` API primitive. OS/2 will also generate signals when the user presses Control-C or when a process is terminated.

Better Than Expected

As you can see, our port required the consideration of many technical issues, though most of them were fairly minor in scope. The process was greatly facilitated by the protection features of OS/2, which make debugging C code much easier. Since references to invalid memory addresses are caught instantly by the operating system, bugs manifest themselves in OS/2 much sooner than they do in DOS.

Upon completing the job, we were delighted to discover that the resulting product—Paradox for OS/2—performed even better than we expected. Not only does it offer true multitasking, but it also runs faster than the DOS version, owing to OS/2's support for large amounts of physical and virtual memory.

Robert E. Shostak, formerly chief scientist for Borland International, is the cofounder of a new company, Mira Technology. He is the co-creator of the popular Paradox database management system, and cofounder of the product's parent company, Ansa, a subsidiary of Borland. He can be reached on BIX as "editors."

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GUIDES TO PORTING, PORTING GUIDES

John Socha and Linda Dudinyak

Our first impressions of OS/2 weren't exactly positive. After all, here was an operating system whose manuals filled 2 feet of shelf space, compared with the single manual for MS-DOS 2.0. We weren't thrilled at having to master such a complex operating system. But once we cracked the manuals, we changed our minds.

Our task was to convert the Norton On-Line Programmer's Guides—a pop-up reference program for programmers—from a TSR program running under MS-DOS to a protected-mode OS/2 program that could run concurrently with other programs. TSR programs like the Norton Guides are often difficult to write under DOS. But not under OS/2.

TSRs under OS/2

OS/2 handles most of the hard work of writing a pop-up program under OS/2, making such programs almost a joy to write. There are three main areas where OS/2 proves quite helpful: monitoring the keyboard for the hot key, saving the current screen contents, and switching screen modes. Since MS-DOS is not a multitasking operating system, TSR programs for MS-DOS need extra code to switch screen modes and to determine when the programs can make DOS calls. Both problems vanish entirely under OS/2 because they're handled by the operating system, which leaves only the issue of how to monitor the keyboard.

Under OS/2, this function is supported by *device monitors*, which allow programs to monitor raw keystrokes before they're passed on to the keyboard services. Any program that registers itself as a device monitor can monitor the keyboard buffer (looking for a hot key), change key sequences, or add key sequences (which is useful for macro programs). The Norton Guides monitors the buffer looking for Shift-F1 and pops up on the screen as soon as it sees this key combination.

Writing the device monitor for a single screen group was easy. What we wanted, however, was to register the Norton Guides as a global device monitor, which can monitor keystrokes in all screen groups. In this way the Guides could pop up in any screen group, not just the screen group from which Guides was installed. We discovered several interesting things about screen groups in the process.

Now Appearing on Multiple Screens

OS/2 has 16 independent screen groups; this allows multiple programs to run at the same time, each with its own virtual screen. Strictly speaking, a screen group refers to all the threads that are attached to a given virtual screen. The physical screen (the monitor) displays only one virtual screen and can be switched between the different screen groups at will. So far, so good.

What isn't obvious is that the first four screen groups (0 through 3) are reserved for use by OS/2: 1 is unknown, 2 is for the session manager, 3 is for the DOS-compatibility box, and 4 is for detached processes. Registering a device monitor with all these screen groups can cause OS/2 to lock up. Only screen groups 4 through 15 are available for OS/2 programs.

As it turns out, we were able to register our device monitor with screen group 1 without any ill effects; the Guides popped up over the session manager. But registering with screen groups 2 or 3 caused OS/2 to lock up. Registering with screen group 0 caused no visible problems, but we still weren't able to determine what it's for. In the end, we decided to register the Guides with only screen groups 4 through 12. This allows you to run the Guides as a pop-up on top of an application in any of those windows.

A Problem with Threads

Another sticky issue had to do with the thread priorities. The Norton Guides starts a separate thread for each of the 12 screen groups it monitors. Each thread goes through a very tight loop that reads one character (from its screen group), checks to see if it's the hot key (in which case it calls `pop_up_ng`), and writes the character to the next keyboard monitor in the chain (or `KbdCharIn` and `KbdPeek` if there are no more monitors).

We had a problem, however. When we typed characters on the keyboard, they appeared very slowly on the screen. We soon found that the individual threads didn't have high enough priorities. For some reason, the 12 threads weren't receiving enough of the system time to be able to pass on keystrokes efficiently.

Our first thought was to increase the priority on each of the 12 threads we created to *time-critical*. We suspected that increasing each thread's priority shouldn't slow down the system, since each thread would receive CPU time only when a new keystroke became available. We tried this method, and it seemed to work—that is, until we ran a program that used the mouse.

Programs that use the mouse can't afford to sit around until `KbdCharIn` returns a keystroke, since they must also constantly poll the mouse. As a result, they must loop until either there is a mouse event, or there is a keystroke waiting in the buffer. This looping consumes more CPU time than a program that simply waits until `KbdCharIn` returns a keystroke. This means that less CPU time is left over for background tasks. We didn't understand why this should cause a problem; having set the priority of our 12 threads to time-critical, we assumed that our threads would receive time when—and only when—new keystrokes became available. But for some reason, this wasn't the case for programs that used the mouse.

Thanks to Microsoft's technical support, we finally found a solution that seems to work in all cases: We set the priority on the main thread (thread 1), rather than the individual threads, to time-critical. This in turn set all the child threads used to monitor the 12 screen groups to time-critical as well. We still don't understand why the other method didn't work and this method does, though it almost certainly has to do with the algorithms used in the OS/2 scheduler, which Microsoft has not made public.

Optimizing Screen Performance

The other area that required some attention was optimizing screen performance. Most programs in the DOS world write directly to the screen to obtain fast screen updates because both the DOS and ROM BIOS calls for writing to the screen are very slow. OS/2, on the other hand, provides a number of different procedures for writing to the screen that are fairly fast—as long as you follow a few basic rules. These procedures include writing to the physical screen (which is possible, but discouraged), writing to a logical screen, and using the `VioWrtxxx` calls.

We first considered writing directly to the physical screen, since our code was fine-tuned for writing directly to screen memory, but we quickly abandoned this idea since OS/2

continued

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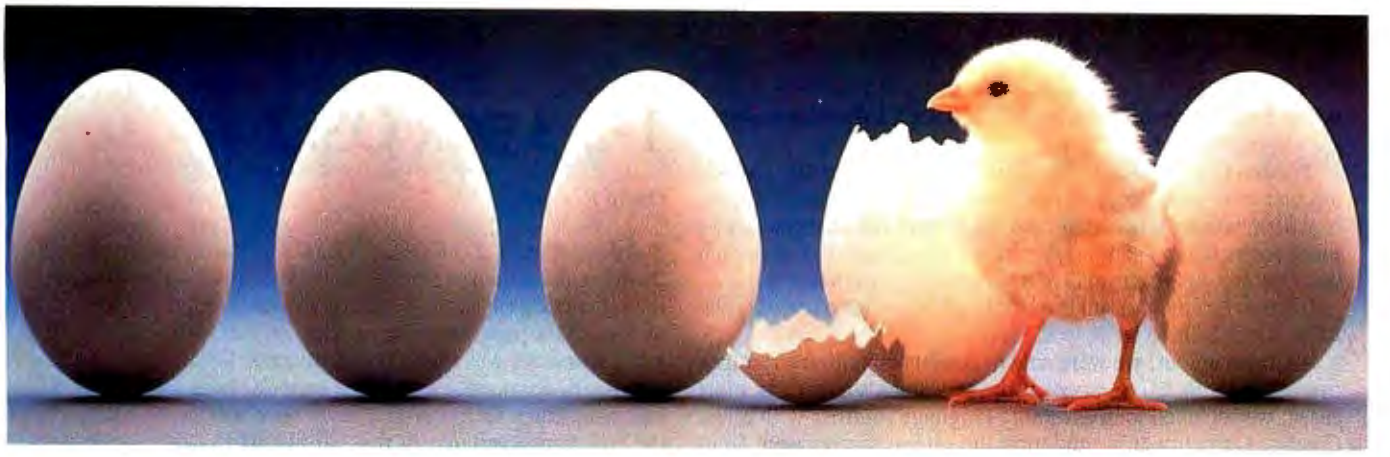

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doesn't allow pop-up programs (which use `VioPopup`) to access the physical screen.

The next option was to use the logical screen buffer, which lets you write to a screen buffer as if it were the physical screen. You then have to call `VioShowBuf` to display the changes you've made to the logical screen. Again, we abandoned this approach because pop-up programs are not allowed to use these calls.

In other words, pop-up programs are allowed to use only the `VioWrtxxx` calls to write to the screen.

As it turned out, we were able to convert our library routines over to calls to `VioWrtxxx` easily and quickly since, in most cases, we replaced long assembly language routines with a few C calls. Unfortunately, updating the screen display went from very fast (in the DOS version) to painfully slow. Something was wrong.

The Case of the Missing Cursor

The original assembly language code for the Norton Guides used a virtual cursor for writing characters and strings to the screen—the system kept track of where the virtual cursor was last positioned, and it recalled this offset from the screen buffer when placing new characters on the screen. This let us write one character at a time almost as quickly as writing a string.

OS/2, on the other hand, has no virtual cursor for writing. Instead, whenever you want to write a character or string to the screen, you have to pass the row and column where you want to start writing on the screen. So when we converted our assembly language routines in the Guides over to OS/2 calls, we often asked OS/2 to write a single character at a time. Each time we asked it to do that, it had to calculate the offset in the screen buffer from the row and column values. This calculation takes time, which accounted for the slow screen updating in our initial conversion of the Guides.

The solution was to write an entire line (or at least large chunks of a line) at a time, rather than a single character at a time. Once we rewrote several routines to buffer their output for transfer in large chunks, screen performance increased to the point where the OS/2 version of the Guides was nearly as fast as the DOS version.

Helping Ourselves

We were delighted with the ease of converting the Norton Guides from a TSR program running under MS-DOS into an OS/2 protected-mode pop-up program. The conversion was much smoother and quicker than we could have hoped for; it took a total of about 2 months from first opening the OS/2 box until we shipped the OS/2 version of the Norton Guides.

Thanks to OS/2's DOS-compatibility box, we were able to use the Norton Guides itself to help us convert the Guides to OS/2. As we were starting the conversion, we had a 900K-byte Guides database to the OS/2 API that was nearing completion. The database has a DOS-to-OS/2 equivalency chart that helped us learn OS/2 and convert the Guides software. To access the database, we ran the original version of the Guides in OS/2's DOS-compatibility box. The database is cross-referenced electronically, and we found using it to be faster than looking things up in the manual.

John Socha is director of R&D at Peter Norton Computing and creator of the Norton Commander and the Norton Guides software. He is also coauthor of Peter Norton's Assembly Language Book. *Linda Dudinyak, a programmer with Norton Computing, converted the Norton Guides into an OS/2 program. Before joining Norton Computing, she worked at Lotus Development on Lotus Metro. They can be reached on BIX as "editors."*

1-2-3 FOR OS/2

David P. Reed

In developing 1-2-3 Release 3 for OS/2, the development team at Lotus learned a number of useful things about programming for OS/2 that would benefit anyone about to embark on a serious OS/2 programming project. One of our objectives for 1-2-3 Release 3 was that it be the ultimate Family API application—with common, compatible code for both DOS and OS/2 versions, down to the binary level—without being limited by the functions available in the Family API. Other objectives, such as high quality, performance, and portability, made the picture more complex.

Realizing these objectives required, first, that we go beyond the standard Family API by emulating OS/2 functions in DOS to enhance the Family API and bring it closer to OS/2's functionality; second, that we get directly at the graphics functions of the EGA, VGA, and other special devices; and finally, that we use OS/2's dynamic-link library (DLL) facility for configurability.

The Family Way

The Family API, a subset of the OS/2 system API, is designed to allow construction of applications that run equally well in DOS (versions 2.0 and higher) and OS/2. The Family API subset lets you do nearly anything you would have done in MS-DOS and BIOS calls.

One advantage this facility provides to the designer is that programs that stick to the Family API can be linked and bound into "dual-mode executable" files that can run either in MS-DOS or in OS/2. The `BIND` utility combines the OS/2 program with a special stub loader that takes over at program start-up in MS-DOS, replacing the calls to OS/2 system routines with stubs that emulate those calls with their MS-DOS equivalents. An additional advantage is that each system loads only those portions of the bound executable file that are of interest to that particular system.

These dual-mode programs are great for those little (and not so little) utilities, such as installation programs and file utilities, that you don't want to maintain separately on each operating system.

But there's more value to this mechanism than might be obvious right away. For example, suppose you want to write a program that behaves well in DOS but, when running in OS/2, uses some of the new features of OS/2, such as starting up a program as a background task, loading a DLL, or changing the size of memory segments. You can still tell whether these features are available at run time by using the `DosGetMachineMode` call (included in the Family API subset), which returns a 0 if you are running under DOS, and a 1 if under OS/2.

Or, you can extend the Family API. Imagine a typical OS/2 call (say, `DosSetMeUpAndKnockMeDown`) that wasn't included in the Family API subset. You can add new routines to the library of emulators that are substituted by OS/2. All you need to do is write your own `DosSetMeUpAndKnockMeDown` call that works in DOS and add it to a library that you bind in with your program. When you run the program in OS/2, it will call the OS/2 version, and when you run in DOS, it will call the substitute version.

In 1-2-3 Release 3, we built our own simple multitasking system that is implemented in OS/2 by using threads (which are not in the Family API), and in DOS by hooking various BIOS inter-

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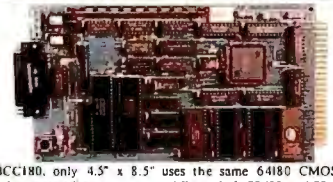

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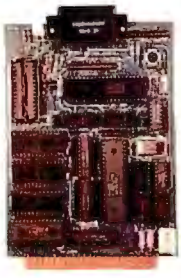

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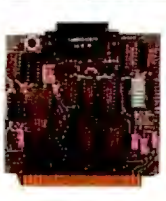

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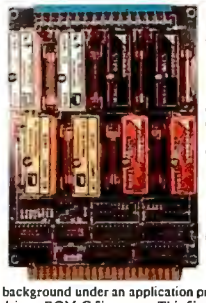

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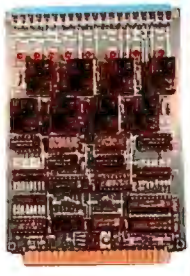
* Dual-ported module addressing
* LED on/off indicator on each channel
* Can be used concurrently with BCC40R and other BCC-bus peripherals
* Operates on +5V
* Operating conditions: temperature, 0-50°C (32-122°F) relative humidity: 10-90% non-condensing
* 4.5" x 6" board
* dual 22-pin (0.156") edge connector
* 16-terminal screw connector (#14 wire)

BCC40D/0 without modules $139.00
BCC40D/4 with 4 modules $189.00
BCC40D/8 with 8 modules $229.00

OEM 100 Quantity pricing starts at $95.00

Announcing BCC40R — $169.00
8-Channel Relay Output Board



The Micromint BCC40R is an 8-channel relay output expansion board designed for use with Micromint's family of BCC-bus Computer/Controllers. Using efficient mechanical relays, the BCC40R provides contact-closure on/off control of eight AC- or DC-powered devices for data acquisition and control applications.

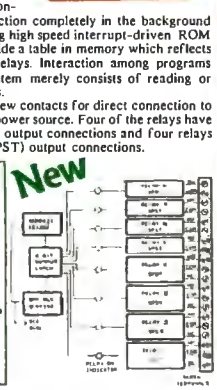
Up to 16 BCC40R boards can be used together in a single system to provide a total of 128 relay output channels. The relays are controlled by writing to a board-specific I/O address. The relays on a BCC40R board can be controlled either as a set of eight relays at a single I/O address or individual relays at eight separate I/O addresses.

The BCC40R can be directly controlled from BASIC or it can function completely in the background under an application program using high speed interrupt-driven ROM C firmware. This firmware sets aside a table in memory which reflects the status and setpoints of the relays. Interaction among programs within a multiboard BCC40x system merely consists of reading or setting these memory table values.

The eight relay outputs have screw contacts for direct connection to the controlling device and/or the power source. Four of the relays have single-pole-double-throw (SPDT) output connections and four relays have single-pole-single-throw (SPST) output connections.

SPECIFICATIONS
* Contacts rated for: 1/10 HP, 3A 120V resistive, or 3A 30VDC
* Latched relay outputs
* LED on/off indicator on each channel
* Power on/off failsafe: No arbitrary closures on power up/down
* Can be used concurrently with BCC40D and other BCC-bus peripherals
* Operates on +12V
* Operating conditions: 0-50°C (32-122°F) relative humidity: 10-90% noncondensing
* 4.5" x 6" board
* dual 22-pin (0.156") edge connector
* 20-terminal screw connector (#14 wire)

New



BCC40R 8-Channel relay output board $169.00
OEM 100 Quantity price $124.00

Announcing BCC18 — $175.00
Dual-Serial Board

The BCC18 is a general-purpose dual-serial-port interface board for use with the Micromint BCC-bus. Optional support software is available for the BCC52 and BCC180 computer/controllers.

The BCC18 Serial Board contains two serial interfaces. Each interface can be either a 110/300/1200-bps modem, or a hard-wired RS-232C/RS-422/RS-485 interface. The modem interface uses a Xecom XE1201/XE1203 MOSART (MOdem Synchronous/Asynchronous Receiver/Transmitter), capable of 110, 300, or 1200 bps communication and compatible with Bell 103 and Bell 212A standards. The hard-wired serial interface uses an industry-standard 8251A USART (Universal Synchronous/Asynchronous Receiver/Transmitter), capable of supporting asynchronous serial communications at speeds up to 19.2 kbps and synchronous serial communications at speeds up to 64k bps.

The BCC18 can be configured with two MOSARTs, two 8251As, or one of each. Up to 16 BCC18s can be used in a single system (for a total of 32 serial ports).

MOSART
- Connects directly to any phone line
- DTMF or pulse dialing
- DTMF reception and decoding
- Call progress monitoring
- Parity generation/checking
- Sync byte detection/insertion
- Extensive built-in diagnostics
- Telephone-line diagnostics
- Synchronous and asynchronous operation
- Voice synthesis capability (XE1203 only)

8251A
- Full-duplex, double-buffered transmitter and receiver
- Fully programmable with several speed and character modes
- Error detection for parity, overrun, and framing
- False start bit detection; automatic break detect and handling
- Supports bisync
- Bit rate is software programmable using an on-board 8253 counter/timer
- RS-232C, RS-422, and RS-485 supported

Software
- MOSART and 8251A use the same program interface, so most software will work with both
- Optional support software for the BCC52 and BCC180 is available that makes it easy to access and use most of the features of the MOSART and 8251A from within user-written programs

BCC18S OEM configuration fixed dual 8251 RS-232 only serial port board $175.00

BCC18S OEM 100 Quantity Price $134.00

BCC18U-1	8251/8251 Dual RS-232/485 serial	$209.00
BCC18U-2	8251/1201 Modem and serial port	$359.00
BCC18U-3	1201/1201 Modem /Modem board	$499.00
BCC52/18	BCC52 serial port utilities software	$75.00

BCC-BUS
Expansion Products

		Single Qty. Price
BCC08	Single Channel UART Serial Board	$149.00
BCC13	8-bit, 8 Channel A/D Board	$129.00
BCC30	12-bit, 16 Channel A/D Board	$197.00
BCC22	25-line, 80 Character Terminal Board	$249.00
BCC25	LCD Board (4x20) or (8x40*)	$159.00
BCC55	Fully Decoded & Buffered Prototyping Board	$ 79.00
BCCxx	X-10 Power Line Controller	$ 59.00
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MB04	4 Slot Mini-Motherboard	$ 69.00
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rupts. Using the Family API and dual-mode executable file tools made it a straightforward project.

A Peripheral Issue?

The wide variety of peripheral equipment, such as printers, plotters, video displays, and math coprocessors, made possible by the IBM PC's open architecture is a boon to users. However, dealing with that variety in a programming environment involves a great deal of planning. For Release 3, we decided to break the code up and have one major portion—the *core*—that would always be the same no matter what peripherals were present, and a set of replaceable parts—the *drivers*—that could be chosen by the core, depending on the environment. For example, depending on the presence or absence of a math coprocessor, the core could load a hardware-optimized or software-emulated math library.

OS/2 provides a nice tool for implementing these replaceable modules in the form of DLLs. Although OS/2 provides several different ways to use DLLs, our development team chose one that was particularly appropriate for handling the case of replaceable modules.

One form of dynamic linking allows you to use *ordinal entry points* to select the entry points of a DLL. To define the interface to a replaceable module, we assigned ordinal numbers to each of its entry points (e.g., 1=INIT, 2=TERMINATE, 3=ADD, 4=SUB, and so on). Then each version of a replaceable module received its own unique name: FLT87.DLL, FLTSOFT.DLL, and FLT1167.DLL, for example.

At start-up time, we decide which modules to use (depending on which peripherals are available) and load them. To use a particular version of the module, we initialize a table of pointers to each of the ordinal entry points of the desired module. First, we call DosLoadModule to get a module handle for the module of the right name. Then for each integer *n* from 1 to N, we call DosGetProcAddr to get the address of the entry point to put into the entry-point table.

Finally, to call the entry point at run time, we use the C macro facility to make the procedure look just like a regular C call:

```
#define floating_add/
        (*((void (*) (void)) entrypoint[2]))
```

where entrypoint[2] is the pointer to the desired floating-point add procedure that we obtained. The user of floating_add( ), then, never needs to know that it is a DLL.

One more key point: If a DLL must be written in C (only a few of ours were in the Microsoft Macro Assembler [MASM]), it must be compiled with special options under the Microsoft C 5 (or IBM C/2) compiler. The option /Au specifies that entry points are to load the 80286 segment register DS with the DGROUP group address belonging to the DLL itself, and that the segment register SS will not equal DS. Few of the standard C libraries can be safely called from such DLLs because of this special memory option. See the C compiler manual for further details.

Minimal-Fuss Graphics

Although OS/2 will eventually have the full graphics functionality available in the Presentation Manager, OS/2's initial support for graphics is limited. On the other hand, 1-2-3 has always had graphics, so we had to find a way to make graphics work under OS/2—something that is not obvious at first.

The major block to doing graphics right is that I/O operations (IN and OUT instructions) to EGAs and VGAs must be done frequently (every few instructions) in the course of drawing lines, symbols, and characters. In OS/2 protected mode, IN and OUT instructions cause an illegal instruction trap. However, you can bypass this restriction by using the linker's definition (.DEF) file facility to make one or more code segments run at the processor's I/O privilege level (IOPL).

In this situation, the required graphics code will usually be written in assembly language. Since the code cannot be debugged with a debugger and can cause the whole operating system to crash (just like a device driver), it is a good idea to keep these IOPL routines short and simple. We recommend passing arguments in registers (though you can use the stack if you specify the right information in the .DEF file). For example, a routine that does an OUT to port 3D5h of the current value of AL might be written as follows:

```
RISKY SEGMENT BYTE PUBLIC 'CODE'
PUBLIC OUT3D5
OUT3D5 PROC FAR
  MOV DX,3D5H
  OUT DX,AL
  RET
OUT3D5 ENDP
RISKY ENDS
```

The segment RISKY would be declared as an IOPL segment in the .DEF file, and the entry point OUT3D5 would be declared as IOPL as well.

With all the work done at assembly and link time, the payoff comes when OS/2 loads this program. OS/2 loads the segment RISKY so that it runs at IOPL level, and an 80286 call gate is set up for the procedure OUT3D5. When some program calls OUT3D5, it actually calls the call gate, which causes the processor to switch modes to the IOPL, switching to a new stack reserved for that purpose. Here, it is perfectly acceptable to execute OUT instructions, and so forth. Then, when the RET instruction is executed, another mode switch and stack switch happens, so that you are now back at the caller's level.

One more note about saving and redrawing: If you create your own graphics, you lose OS/2's screen-group switching features and have to spawn a separate thread to handle saving and redrawing the screen. Unfortunately, such a thread is nearly impossible to debug!

Lots to Learn, Lots of Benefits

Fashioning 1-2-3 Release 3 so that it will run equally well under OS/2 and DOS has, thus far, been easier than we expected. OS/2 has fewer bugs than we anticipated from the initial release of a major operating system. Its documentation is also better than we thought it would be—certainly better than the first generation of MS-DOS manuals—though still lacking in its tutorial aspects.

The programmer who wants to explore OS/2 will find lots to learn, discover, and invent with this new environment. OS/2 has a tremendous amount of power and flexibility that we're all only just learning to use. Over time, we'll learn even more sophisticated things to do with it, from which users and programmers alike stand to benefit. ■

David P. Reed, vice president for R&D with the Software Products Group at Lotus Development, heads up the team that designed the forthcoming 1-2-3 Release 3. He has an MS and a Ph.D. in computer science from MIT. Dr. Reed came to Lotus from Software Arts, the developers of the original VisiCalc spreadsheet. He can be reached on BIX as "editors."

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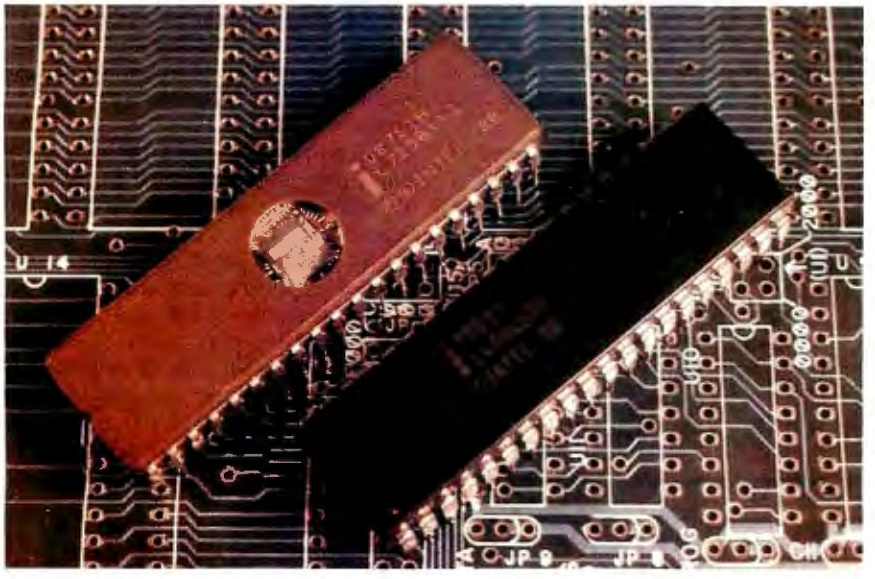
Part 1

WHY MICROCONTROLLERS?



Microcontrollers are used in keyboard and disk interfaces and in numerous other devices. Here's a tutorial on the 8031/8051 microcontroller family.

Photo 1: *Two versions of the Intel MCS-51 family: the 8031 ROMless microcontroller and the 8751 programmable (EPROM on-chip through the quartz window) microcontroller.*

Gone are the days when a complex project required a suitcase full of TTL ICs and a wire-wrap gun. As with most of the recent Circuit Cellar designs, under the hood there are a few carefully chosen discrete ICs controlled by a microprocessor. The trade-off is simple: Hardware is expensive and software is cheap—once you get it right.

Many of you have noticed that I have been using two popular microcontrollers from Intel—the 8031 and the 8051—as the control elements in Circuit Cellar designs. I've received many requests for general information about these microprocessors and for guidance in applying them elsewhere. With that as an incentive, I decided to present this combination tutorial/development system project.

In this first part of a two-part article, I'll introduce the members of the 8031/8051 chip family and describe using them as embedded microcontrollers. The second part will present all the elements of a useful development system intended to simplify the process of designing systems using the 8031/8051 family.

The Difference in a Name

It's important to be clear on the distinction between microcomputers, microprocessors, and microcontrollers. That way, you'll understand where the 8031/8051 family fits in the big picture.

A microprocessor is just the CPU part of a computer, without the memory, I/O, and peripherals needed for a complete system. For example, 8088 and 80286 chips are microprocessors (the "micro" prefix designates that this CPU element is at the chip level). All other chips in an IBM PC are there to add features not found within the microprocessor chip itself. The hardware designer can choose different chips to implement those features in different ways, although a designer has little room for choice if the end result is supposed to be an IBM PC clone.

When a microprocessor is combined with I/O and memory peripheral functions, the combination is called a microcomputer. Of course, vendors anxious to designate that their computer is more powerful than others often shed the "micro" prefix, but it's still a microcomputer given today's definition. Ultimately, good economic sense suggests that all computers, including minicomputers and mainframes, will utilize the same basic elements, just differentiated by quantity.

The fact that combining a CPU with memory and I/O produces a microcomputer also holds true at the chip level. Many companies add these peripheral functions onto the same substrate with the CPU to make a complete microcomputer. These devices are called single-chip microcomputers to differentiate them from their big-cousin desktop microcomputers.

Generally speaking, microcomputer chips are designed for very small computer-based devices that don't need all the functions of a full computer system. In cost-sensitive control applications,

continued

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even the few chips needed to support a CPU like an 8088 or Z80 are too many. Instead, designers often employ a single-chip microcomputer (or a slightly expanded circuit using one) to handle control-specific activities. When single-chip microcomputers are designed or used in industrial control systems, they are often called single-chip microcontrollers. Basically, there is no difference between microcomputers and microcontrollers; the name depends on how we use them.

Frequently, microcontrollers are used to replace circuit functions that ordinarily require many low-level chips or need the main CPU's attention each time the circuit is active. The IBM PC keyboard-interface circuit is a prime example of the use of a microcontroller chip. In the PC, a half dozen chips (excluding I/O addressing and decoding) are necessary to receive and decode the serial clock and data bit stream from the keyboard. In the IBM PC AT (and the CCAT I presented in September and October 1987), this low-level circuitry is replaced with an 8742 microcontroller that completely simulates the old circuit and incorporates additional features in one chip.

The Intel 8051 Family

The Intel 8051 is a classic microcontroller (a generation more advanced than the 8742) and a true single-chip microcomputer containing parallel I/O, counter/timers, serial I/O, RAM, and EPROM or ROM (depending on the part type). The 8051 family contains several members (Intel refers to it as the MCS-51 family), each adapted for a specific type of system.

The different versions are outlined in table 1, and a block diagram of the 8051 is shown in figure 1. The 8051 has two close relatives, the 8751 and the 8031 (see photo 1), and a cousin, the 8052. All versions contain the same CPU, RAM, counter/timers, parallel ports, and serial I/O. The 8051 contains 4K bytes of ROM, which must be custom-masked when the chip is manufactured. In the 8751, the ROM is replaced with EPROM that you can program (the schematic for an 8751 programming adapter for the Circuit Cellar serial EPROM programmer presented in October 1986 is available by writing to me).

The 8031 is meant for expanded applications and uses external memory. The 8031 uses three of the four on-chip parallel ports to make a conventional address and data bus with appropriate control lines.

You might wonder why you'd choose a single-chip microcomputer in the first place if you end up converting it back to function as a CPU with other peripheral chips. Basically, it depends on the degree of expansion required. Since the 8031 still contains RAM, a parallel port, and a serial I/O port—even when functioning as the CPU core of an expanded circuit—the eventual number of chips necessary to expand the I/O or memory is still considerably less for the same ultimate capability than with a straight

Table 1: *Members of the 8051 microcontroller family tree.*

Device name	ROMless version	EPROM version	ROM bytes	RAM bytes	16-bit timers
8051	8031	(8751)	4K	128	2
8051AH	8031AH	8751H	4K	128	2
8052AH	8032AH	8752BH	8K	256	3

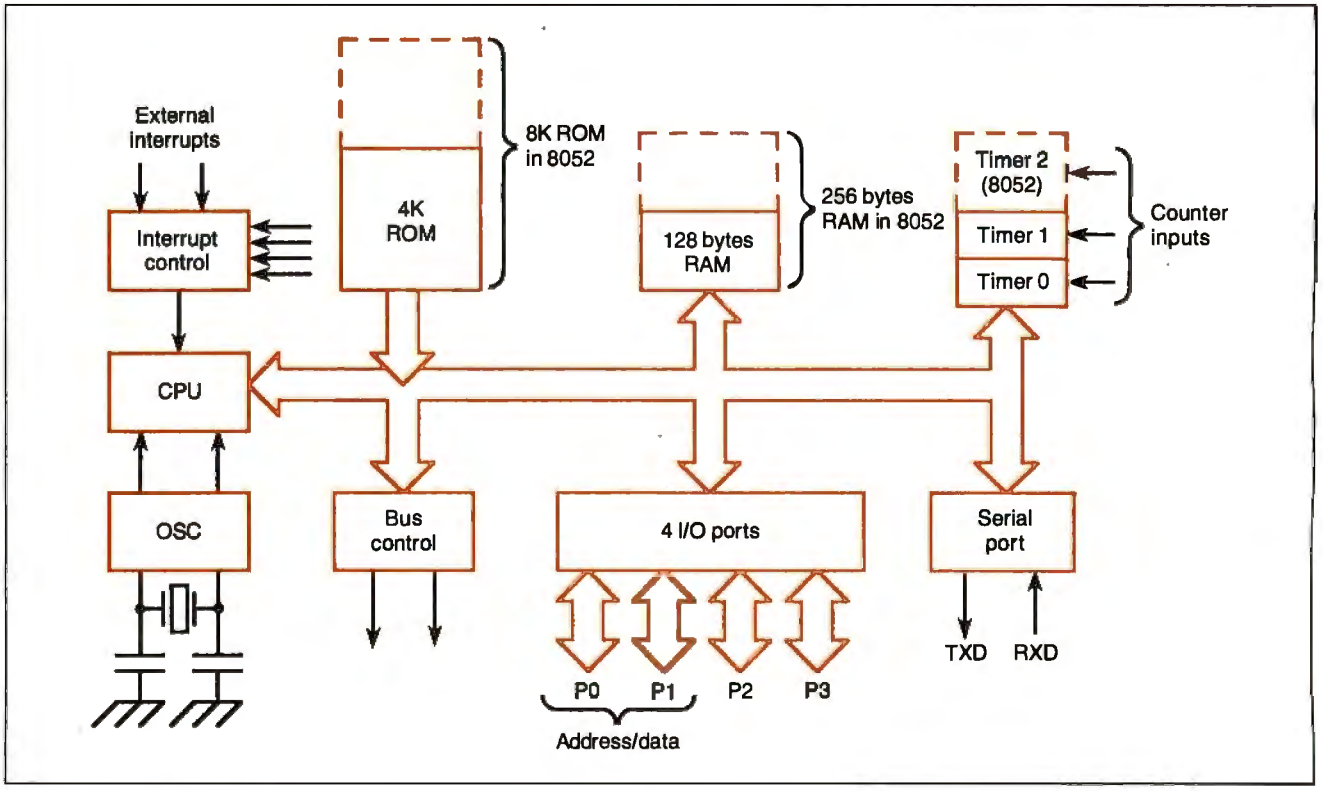


Figure 1: *Inside the 8051.*

microprocessor and peripheral chips. I'll go into the possible expansion techniques later.

Intel and other companies sell variations of the 8051 family with more internal memory, more I/O, lower power, and so forth. An 80C31 is a CMOS low-power version of the 8031, for example. The 8052, which I have also used in projects, is the same as the 8051, except that it has another counter/timer and additional RAM and ROM.

Using an 8051 is as simple as hooking up the power supply and clock crystal. Unlike the 8031, however, you have to supply Intel with a program for the 8051 so it can create a chip mask defining the internal ROM. (If your program is not quite right, it's time for another mask.)

As you might expect, both mask making and chip building take time and money. (Since I did this for a recent project, I thought you might be interested in some manufacturing information. If you plan on making an 8051 microcontroller and need to mask your own chip, the one-time masking charge is about $3000, with a minimum order of 1000 chips.) Mask programming makes sense for an application that uses thousands of identical 8051s a year, but it is not practical for low-volume systems and prototypes.

The 8751 has all the features of the 8051, except that an on-chip EPROM replaces the ROM program storage. Making a program change is as simple as erasing the EPROM with ultraviolet light and burning another program. Many developers use 8751s until the code works, then commit to a large 8051 order with the program in ROM. If the product volume is low enough, it's often worthwhile to use 8751s in the final product. An 8051 costs about $4 to $5 apiece in thousands; an 8751 is about $25 to $40.

The 8031 has no on-chip program storage at all. The system must include an external EPROM and an address latch. Considering the falling prices of EPROMs and the heavy costs of using either 8051s or 8751s in low volumes, the 8031 is a viable alternative despite the additional chips. For many small systems, the 8031/EPROM combination is far more cost-effective than an 8051. (This is the type of system I'll describe in my examples.)

As I mentioned before, all members of the 8051 family have the same core hardware and therefore use the same core instruction set. While some members have one or two additional instructions for features unique to the particular chip, I'll use the term "8051" to describe the "8051 chip family," unless I'm talking about a specific version with unique requirements.

Making It Real

With all that in mind, let's look at configuring a usable "computer/controller" using an 8031 microcontroller chip as part of the system. Remember that in a single-chip microcontroller, internal hardware replaces all the digital logic you'd normally add for control, timing, and so forth. You need add only the keyboard, display, relays, switches, and user-specific I/O that actually makes up the final product.

Figure 2a shows the bare-bones 8031 microcontroller system: the 8031, a 2764 EPROM to hold 8K bytes of program, and a 74LS373 latch to demultiplex the address/data bus. The system has 128 bytes of RAM on the 8031, a bidirectional parallel I/O port, a bidirectional serial port, two counter/timers, and two external interrupt inputs. With a 12-MHz crystal (most often, we select 11.0592 MHz for communications rate compatibility), it executes most instructions in one machine cycle—a peak rate of 1 million instructions per second. Not bad for three chips, is it?

A single I/O port can scan a 16-key matrix. With an additional output bit, it can drive a 2-line by 20-character smart liquid crystal display at the same time. The remaining I/O bits can handle triacs or power field-effect transistors for AC or DC control. Burn a program into the EPROM, and you have a real-time power controller. Run the serial port through a MAX232 RS-232C level converter, and you have a standard serial port for remote control or status monitoring at your master computer.

If you don't need the serial port, counter/timers, and external interrupts, the 8031 can use those special bits as a second parallel I/O port, so the minimum system can have up to 16 I/O bits. Each bit can be tested, set, and cleared individually under program control.

If one or two parallel I/O ports aren't enough for your application, figure 2b (an expansion of figure 2a) shows what's needed to get three more: Add a single 8255 programmable peripheral interface. The 8255's port C can be set up for automatic handshaking, so now you have the basis for a serial-to-parallel (and back) format converter or 24 more I/O bits for a bigger controller. Notice that no "glue" chips are needed between the 8031 and the 8255.

Because the 8255 uses the RD\ and WR\ bits, the second I/O port isn't completely free. The 6 remaining bits can still handle either general I/O or their individual special functions, though.

If your application requires more than 128 bytes of RAM, figure 2c (figure 2a expanded to include 2b and 2c) shows how to get 8K bytes of RAM by adding a 6264 static RAM chip. Now you can build a fancy buffering format converter, a data logger, or a serial-programmable power controller. A 62256 RAM would give 32K bytes with no more effort, still with no glue chips!

Finally, for those of you who need lots of RAM and I/O, figure 2d (figure 2a expanded to include the circuitry of 2b, 2c, and 2d) shows how to connect multiple I/O chips. The 74LS138 decoder generates chip select signals from the 8031's output addresses, with each select covering an 8K-byte range. The system shown has 16K bytes of RAM and seven bidirectional I/O ports. Pretty nice for seven chips.

The point of all this is that the "computer" part of your control system need not require elaborate hardware. For a unit of any reasonable size, you'll spend most of your hardware design time on the I/O devices rather than on the 8031 circuits, which is exactly as it should be.

Perhaps now you understand why I have been using the 8031 frequently. The main benefit of a microcontroller is the ease of adding new features to your system, just by changing the program, not changing the circuit-board connections. A new EPROM can give the hardware a completely new personality. Try doing that by rewiring a board of TTL control logic!

The Software Swamp

Every microprocessor has an instruction set exhibiting the conflict between all the instructions that could possibly be useful and the few that fit on the chip. The 8051 has many bit-manipulation instructions and few general instructions, reflecting its design as a controller rather than as a computer.

Most 8051 instructions are 1 or 2 bytes long, with the remainder requiring 3 bytes. All instructions except `MUL` and `DIV` execute in one or two instruction cycles. An instruction cycle is 1 microsecond (μs) at a 12-MHz clock rate. `MUL` and `DIV` lag along at 4 μs.

If you've written assembly language programs for any other microprocessor, you'll find some of the same instructions in the 8051's code. To understand the 8051's instructions, you must be familiar with the three main address spaces defined on the chip: 64K bytes of pro-

continued

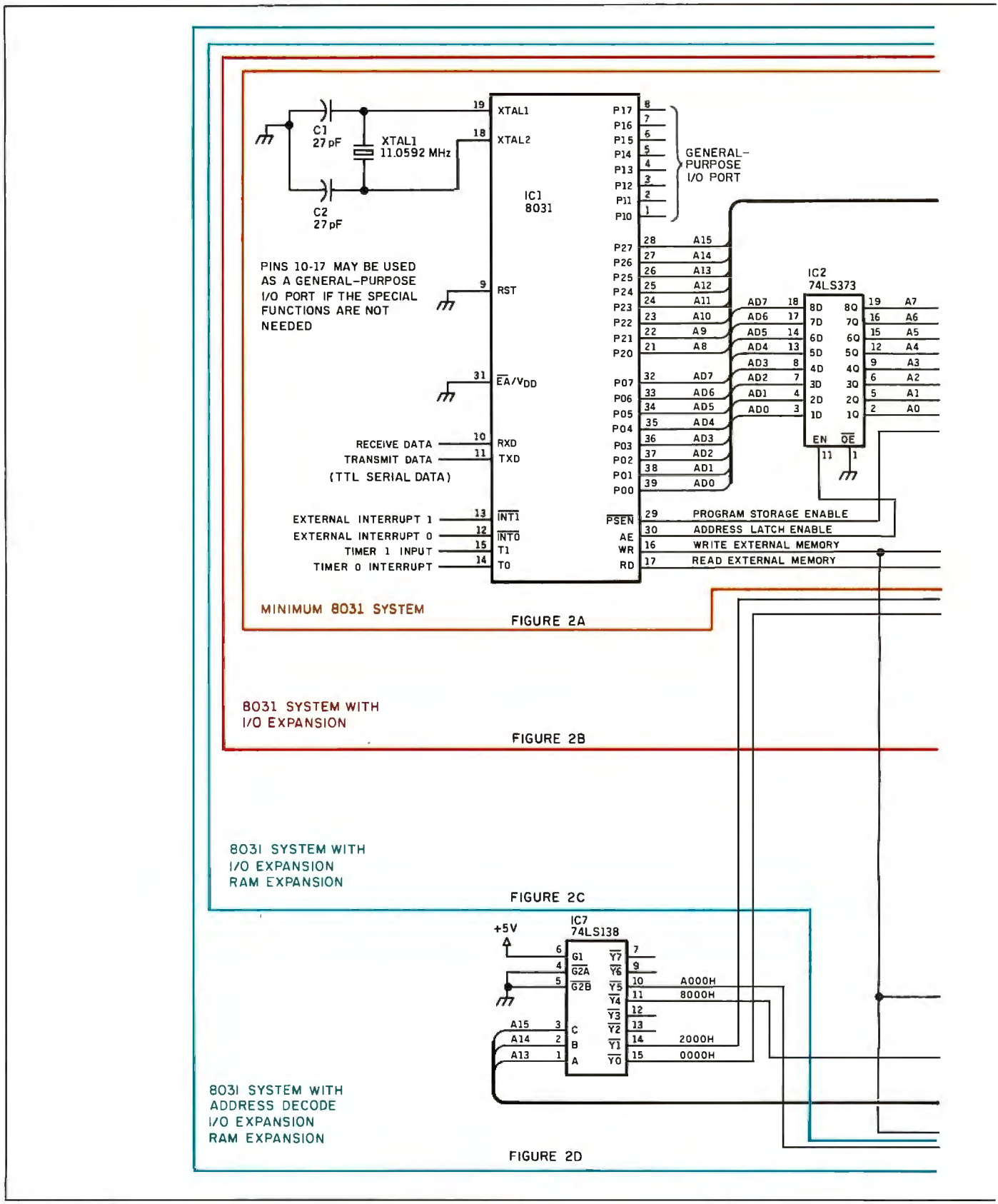
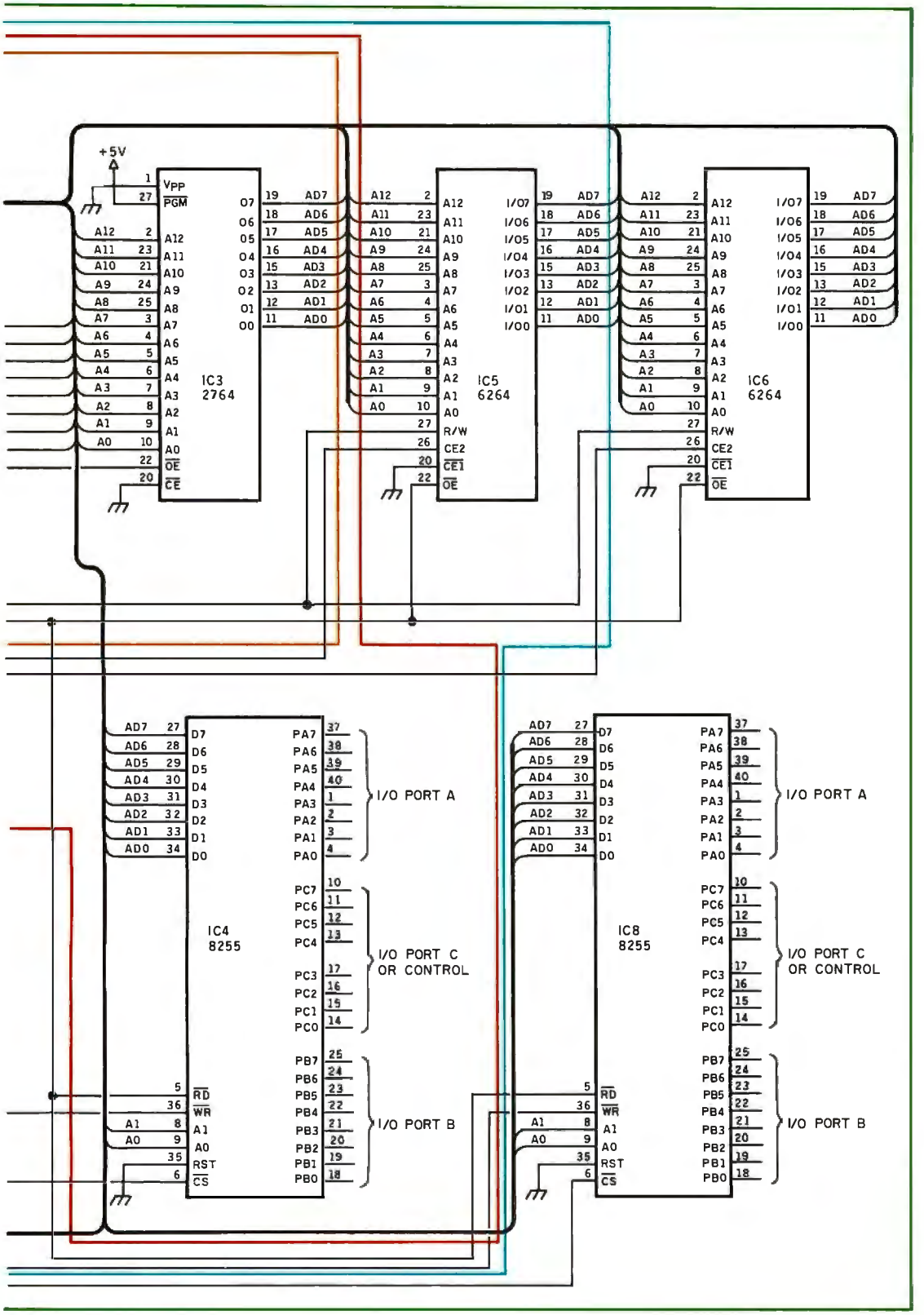


Figure 2: *Growing an 8031 system.* **(a)** *A minimum configuration,* **(b)** *minimum system with I/O expansion,* **(c)** *system with I/O and RAM expansion, and* **(d)** *system with address decode logic and even more RAM and I/O.*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I/O PORT C
OR CONTROL
I/O PORT B

gram memory addressed by the program counter (PC), 64K bytes of external data memory addressed by the data pointer (DPTR), and the on-chip internal data memory addressed in several different ways. Each instruction implies a particular address space, so you have to know where your data resides to select the right instruction.

There is a sharp distinction between internal and external data addresses. Internal addresses refer to locations on the 8051 chip, which can be accessed in a variety of ways. External addresses are located off the chip, in the 64K bytes of external data memory, and can be accessed only with MOVX instructions.

The four main internal data memory-addressing modes are direct, immediate, register, and register indirect. Direct mode embeds an internal RAM address in the instruction. Immediate mode uses the data value itself. Register and register indirect modes use a register number, with indirect addressing taking the contents of that register as a direct address to access the data.

The MOVX instructions transfer a single byte between the accumulator and external data memory. The DPTR register contains a 16-bit external data memory address, which can be either loaded by a single MOV or incremented. Unfortunately, there aren't any other 16-bit instructions.

The 8051 has a single accumulator, called ACC or A depending on the instruction. Nearly all instructions use the accumulator in one way or another. An auxiliary accumulator (called B, of course) is used by MUL and DIV. Many data-manipulation instructions can move data to or from one of the active banks of eight "working registers" in internal RAM. Four register banks are available.

Because most controller applications require handling at least a few I/O bits, the 8051 has a rich selection of bit-manipulation instructions that are completely separate from the standard byte instructions. A single instruction can set, clear, complement, or copy any bit in internal data memory. The on-chip I/O ports show up in that address space, so there's no need for the "read, mask, set, combine, write" instructions found in most other microprocessors.

Unlike the Intel 8088 or Z80 microprocessor families, the 8051 has no explicit I/O instructions. The on-chip I/O ports are mapped into the internal data memory-address space and accessed with the same MOV instructions used for other transfers. You have to map off-chip I/O into the external data memory-address space and access it with MOVX instructions.

Rather than belaboring the various instructions in detail, I'll introduce them next month in short chunks of code that do useful tasks as we build some hardware. With those examples as a base, you should have little trouble designing your own system.

Ugly Reality

The trade-off for not wiring up a board of TTL gates is writing a program for the EPROM. That program tests the inputs, computes the outputs, and handles all the timing to make the system work correctly. Unless you are much better than average, your program won't do the right thing the first time you try it out.

The ugly reality of microcontroller systems is getting the software to work. It's made considerably more ugly by microcontrollers buried inside specialized systems—those never intended to look or act even vaguely like a computer.

For example, which system would you rather debug: an IBM PC AT with a full keyboard, EGA display, hard disk drive, and state-of-the-art editors and debuggers, or a microcontroller in a 3- by 5- by 4-inch box with four push buttons and two LEDs, cabled to a heater in a vat of photographic solution?

The traditional way to debug microcontroller programs is called "burn and crash." You burn the program into EPROM, plug it in, turn it on. . . and then try to figure out why it crashed. Doing a Sherlock Holmes on the listing is the only way to find bugs in the program, although a logic analyzer and an oscilloscope help a lot.

The major problem with burn-and-crash debugging is the damage caused by a crash if you are trying to debug a program when the controller is attached to actual machine hardware. Imagine what happens when your new 10-story hammerhead crane controller goes "full speed counterclockwise" and refuses to reset.

Obviously, burn and crash has its limitations. An 8051 simulator program running on a host computer development system removes most problems and simplifies finding program bugs. The simulator reads the EPROM's data and interprets the 8051 program one instruction at a time. Because all the 8051's registers, I/O ports, and memory are provided by simulator variables, you can display and modify memory contents at will. Even better, because the simulator's software replaces the 8051's hardware, there's no way that an errant program can damage anything.

With the simulator, you can use program breakpoints to stop execution at specific 8051 instructions or when a given condition occurs. Also, since the simulator records how the 8051 program got to a particular instruction, you can undo each step back to the source of the problem at the press of a key.

Unfortunately, while a simulator is a great step up from burning and crashing, it is not a true real-time test. Because the execution of each 8051 instruction requires the execution of many program instructions in the development system, the

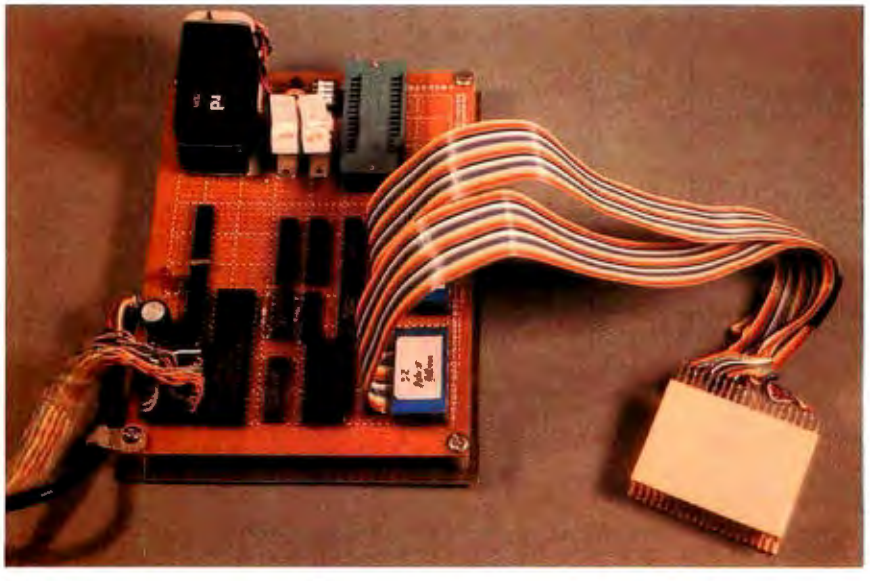

Photo 2: *A prototype of the DDT-51 development system. Note the DIP clip at the end of the cable for attaching onto the target system's processor.*

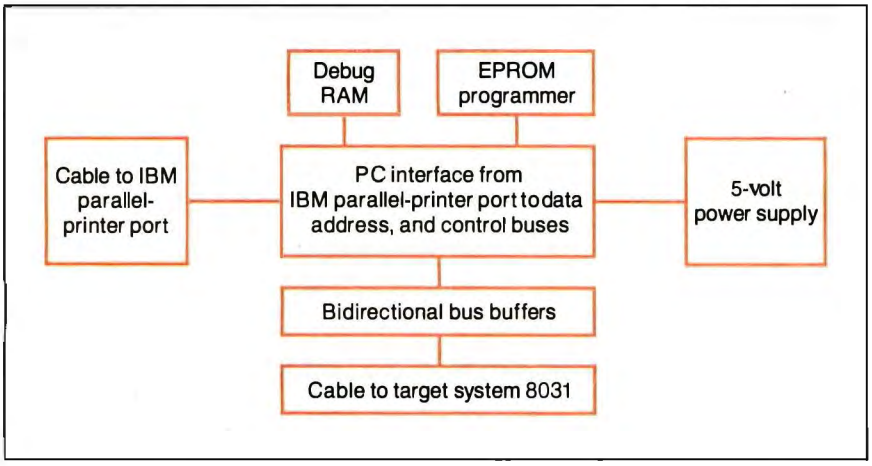

Figure 3: *A block diagram of the DDT-51 8031/8051 development system.*

simulated run time is much slower than the real-time rate on the actual hardware. A further complication is that interrupt timing is not easily duplicated on a simulator.

The ultimate solution is an in-circuit emulator (ICE), which is a special development system peripheral plugged into the 8051's socket in the actual hardware (called the target system). From the target's point of view, the ICE is an 8051 running at full speed. From the user's perspective, the ICE provides many of the features of a simulator, along with the ability to run programs at full speed using the real hardware.

Ideally, an ICE will have no effect on the target system, because all the 8051's features are provided in high-speed hardware. The 8051's internal registers and I/O ports are visible because the ICE uses discrete logic rather than a single chip. The development system directly monitors what's going on, logic comparators control the breakpoints, and there's no interference until the ICE stops at the selected instruction.

All this hardware makes ICE systems rather expensive. If you are developing many 8051 designs, an ICE is the only way to go. As a practical matter, however, an ICE is far beyond the typical user's budget and is generally reserved for the corporate lab.

A More Modest System

There is a middle ground between personal computer–based software simulators and hardware ICE systems. It's often enough to stop at a breakpoint and single-step through instructions while watching the target system's LEDs blink and relays click. By trading off some speed and hardware for time and money, a much simpler program development system can provide many features of an ICE at a fraction of the cost.

The DDT-51 system is an IBM PC–based 8031/8051 development and dynamic debugging tool (see photo 2). It uses a modified parallel printer port and a small circuit board to give the IBM PC complete control over the target system's hardware. The DDT-51 downloads the 8051 program into 8K-byte static RAMs, thus eliminating the need to burn an EPROM for each program change. An on-board 2K-byte static RAM holds the small amount of 8051 code required to support single-stepping and breakpoints. A disassembler shows the current 8051 instruction on the IBM PC's display while single-stepping, as well as the current 8051 registers and internal data memory values.

This system connects between the IBM PC and the target system (see figure 3). It has only about a dozen chips, including the world's simplest (and slowest) 2764 EPROM programmer.

The DDT-51 won't handle all possible 8051 target systems, but it will give you a good start. With that in hand, we can continue on with other interesting Circuit Cellar project designs.

Experimenters

As is the custom with Circuit Cellar projects, the software for the DDT-51 development system is available for downloading from my multiline bulletin board free of charge. The number is (203) 871-1988. Of course, this downloaded software is limited to noncommercial personal use unless licensed otherwise.

Next Month

The hardware and software specifics of the DDT-51. ■

continued

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Special thanks for the technical contributions provided on this article from Jeff Bachiochi and Ed Nisley.

Diagrams specific to the Intel 8031/8051 architecture are reprinted by permission of Intel Corp.

'ces

One advantage of using an industry standard like the 8031 is that it's easy to obtain. The following companies are a few possibilities:

'p., P.O. Box 677, Thief River
6701, (800) 344-4539
55 Shoreway Rd., Belmont, CA
) 592-8121
levices, 110 Knowles Dr., Los
5030, (800) 538-5000
:hnology, Inc., 2219 South 48th
AZ 85282, (800) 245-2235

The 8051 family doesn't have the wealth of publications you're used to seeing for the IBM PC. Fortunately, Intel prints a few useful and surprisingly readable manuals covering the tricky hardware and software details. These manuals are available from your local Intel office for a reasonable fee, or contact Intel Corp., Literature Dept., 3065 Bowers Ave., Santa Clara, CA 95051.

The order numbers include the latest revision after the dash, so you may find that here's a new edition out:

Embedded Controller Handbook, number 210918-005: The straight dope on all Intel's microcontrollers, from the 8096 to the 8048, including the 8051 family. It includes many hardware details, along with quite a bit on 8051 software and applications.

Microsystem Components Handbook, number 230843-004: This two-volume set gives assorted Intel microprocessor and peripheral chip data sheets. These are the definitive words on how the chips are supposed to work: heavy-duty specs, not for beginners.

Hardware

Although the DDT-51 development system includes a simple 2764 EPROM programmer, you'll eventually need a "real" EPROM burner. You need look no further than the Circuit Cellar serial EPROM programmer available from CCI, 4 Park St., Suite 12, Vernon, CT 06066, (800) 635-3355.

Software

The single most essential program is a cross assembler that runs on your IBM PC, eats assembly language files, and spits out hexadecimal files for the EPROM burner. You can spend as much or as little on these as you see fit, but doing assemblies by hand is not much fun. I speak from experience.

The shareware Pseudo-SAM 8031 cross assembler is available on the Circuit Cellar BBS under the name PS51A123.ARC. It has most of the useful features, few frills, and is quite serviceable. A newer version is available from PseudoCode, P.O. Box 1423, Newport News, VA 23601, BBS phone (804) 898-7493.

Avocet Systems (120 Union St., Rockport, ME 04856, (207) 236-9055) produces excellent "industrial-strength" assembler and simulator programs for a variety of microprocessors and microcontrollers. The AVMAC51 assembler and AVSIM51 simulator have contributed to many recent projects. They give excellent results. I recommend using one or both of these as the best way to optimize the performance and cost benefits of the DDT-51 development system and an excellent way to get a system up and running in a short time.

Editor's Note: Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in book form from BYTE Books, McGraw-Hill Book Co., P.O. Box 400, Hightstown, NJ 08250.

Ciarcia's Circuit Cellar, Volume I covers articles in BYTE from September 1977 through November 1978. *Volume II* covers December 1978 through June 1980. *Volume III* covers July 1980 through December 1981. *Volume IV* covers January 1982 through June 1983. *Volume V* covers July 1983 through December 1984. *Volume VI* covers January 1985 through June 1986.

Circuit Cellar Ink

It's virtually impossible to provide all the pertinent details of a project or cover all the designs I'd like to in the pages of BYTE. For that reason, I have started a bimonthly supplemental publication called Circuit Cellar Ink, which presents additional information on projects published in BYTE, new projects, and supplemental applications-oriented materials. For a one-year subscription (6 issues), send $14.95 to Circuit Cellar Ink, P.O. Box 3378, Wallingford, CT 06494. Credit card orders can call (203) 875-2199.

There is a multiline Circuit Cellar bulletin board system (running TBBS 2.0M) that supports past and present projects in BYTE and Ink. You are invited to call and exchange ideas and comments with other Circuit Cellar supporters. The 300-/1200-/2400-bps BBS is online 24 hours a day at (203) 871-1988.

To receive information about the Circuit Cellar Ink publication for hardware designers and developers, please circle 100 on the Reader Service inquiry card at the back of the magazine.

Steve Ciarcia (pronounced "see-ARE-see-ah") is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, and product development. The author of several books on electronics, he can be reached on BIX as "sciarcia."

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

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Part 2

THE PITFALLS OF PORTING

Moving from an MS-DOS "glass teletype" into the windowed world of the Macintosh

The IBM PC grew up in a text-oriented world. Its confusing array of video modes and the fact that you have to settle for text or graphics but not both make it seem like graphics on the PC was an afterthought—and programmers are still paying for it. A program on an MS-DOS machine must create its own environment, and that environment may be as simple as a series of commands entered a line at a time, or as complex as mouse-activated windows and pull-down menus.

In contrast, the seamless integration of graphics and text was most important from the Mac's very inception...and programmers are still paying for it.

On the Mac, a program's environment has largely been predefined. This situation is fine for the Mac user, who can expect a high degree of consistency in the user interfaces of all Macintosh programs. For programmers, it's a mixed bag: You don't have to work out the details of how user interface components (such as windows and menus) operate—the Mac designers have done that already. But you do have to deal with starting friction that's orders of magnitude greater than that found on MS-DOS machines. In other words, the Mac has all these built-in tools, and the programmer has to figure out how they work.

The programmer's travails are exacerbated when faced with porting an existing MS-DOS application to the Macintosh. You don't have the luxury of designing the program from scratch with the Mac's user interface in mind. To avoid a massive redesign of the entire program (unless you can afford it), you must perform reconstructive surgery and graft Macintosh windows and menus onto your program. Such was the case as Small-C made its journey across the gulf from MS-DOS to the Macintosh.

On an Even Keel

The two largest problems in taking Small-C to the Macintosh were the 68000 processor and the Finder. Once I had located code for a run-time library, the latter was easy compared to the former (see the text box "Small-C Run-Time Library" on page 250). Dealing with the 68000 meant coping with one feature that I knew would be a pleasure and another I knew would be a problem. Let's get the problem out of the way first; it's called alignment.

If the 68000 accesses a word or a doubleword in memory, it *must* do so at an even address. When a program on the Macintosh attempts to grab anything other than a byte from an odd address, you get that infamous system-error bomb box with `ID=2` in the corner.

Now, keep that "feature" in mind as you consider that Small-C dynamically reserves space on the stack for a function's local variables. What happens if you define a function with a mix of `int` and `char` variables as local variables? Examine the following code:

```
func1()
{   int a;
    char b;
    int c;
    ..code...
}
```

Variables `a`, `b`, and `c` are local and require 9 bytes of space on the stack. Their offsets into the local block of storage are 0 for `a`, 4 for `b`, and 5 for `c`. See the speed bump coming up? Since Small-C sets aside only 1 byte for `b`, `c` ends up at an odd address. And `c` is an integer (i.e., a doubleword). Oops.

The way out of this dilemma requires adding an unused byte here and there to keep local `int` variables on an even byte alignment. The Small-C compiler's `declloc()` routine determines how much stack space a given function's local variables require. As `declloc()` scans the list of a function's local variables, it adds to an accumulating variable (called `declared`) an amount that depends on the variable's type (1 byte if `char`, 4 bytes if `int` or pointer) and whether or not the variable is an array.

The `declloc()` routine also has the job of keeping track of each local variable's offset into the function's local stack space (so when an expression references a local variable, the compiler knows what code to emit). To correct for alignment, I modified `declloc()` so that, if it is reserving space for an `int` variable, it checks the total space that has already been reserved for local variables. If `declloc()` determines that it has already reserved an odd amount of space (so the `int` variable would end up at an odd address), it adds 1 byte to the local variable space, correctly aligning the integer.

Actually, the alignment problem gets much more subtle. You cannot set the 68000's stack pointer—the A7 register—to an odd address; you can only push and pop words and doublewords. Consequently, if a function defined only a `char` as a local variable, Small-C would emit `SUBQ.L #-1,SP` to reserve 1 byte on the stack—and blooey. I corrected that by modifying the compiler so that it does not allow a function's local variables to allot a net odd amount on the stack.

All this means that you can end up with some wasted bytes in a function's local variable space. How many depends on how `int` and `char` definitions are interleaved. Minimizing wasted bytes would involve adding more intelligence to the compiler than I thought necessary.

continued

Small-C Run-Time Library

The amount of effort that you must put into simply displaying a character on a Macintosh is simply staggering. This is thanks to the complexity of the Mac's ROM routines; it is as though you have to crack a software barrier in order to execute the most rudimentary operations, but once you've crossed that threshold, even complex graphic and disk I/O operations become simple.

I knew that if I began working from scratch to create screen I/O routines, file I/O routines, event handlers, a window handler, and so on, porting Small-C would be just a dream (or maybe a nightmare). I therefore invoked that most sacred of all programming dicta, "Don't reinvent the wheel," and went in search of a set of packaged routines. That's when I discovered Steve Williams's book *Programming the Macintosh in Assembly Language* (Berkeley, CA: Sybex Books, 1985).

This book contains the complete source code listings for the run-time library routines I needed: window handling, text display, disk I/O, and more. (There are functions in Williams's library that Small-C never uses; I kept them in, anyway, in case you wanted to extend the language in some direction that I haven't thought of.) I set about modifying those routines to interface with Small-C, and I had a working run-time library in weeks' less time than I would have if I had started from scratch. In addition to all this, it's a great book, and it's worth the $24.95 price if you're serious about Macintosh assembly language.

(It would actually mean having the compiler rearrange the order in which `char` and `int` variables are stored in the local stack space. Some Macintosh C compilers, having run into the same problem, add this technique of variable rearrangement as an option. It's an option because rearranging variables makes debugging harder: You can't look at the source code and get a clear picture of where variables are stored.)

On the subject of variables, let's talk about initialization. Most C compilers let you initialize a variable at declaration time with instructions like these:

```
int j=4;
int k[3]={0,1,2};
char c='F';
```

These instructions would compile to assembly language that, for the 8088, might look like the following:

```
j DW 4
k DW 0,1,2
c DB 'F'
```

This is fine for the 8088/80286. When the executable file for this program is brought into memory, the proper values for `j`, `k`, and `c` are automatically loaded. Not so for the Macintosh.

When you launch an application on the Mac, the system moves the code into memory and makes data space available to the application in a global data area (normally set to 32K bytes). Unfortunately, you cannot initialize the contents of this area; you can only reserve space in it. (If you're using the Macintosh Development System [MDS] assembler, you use the `DS` directive to define storage space in the global data area.)

You can initialize locations in the code space (the memory where the application's executable file resides) using the `DC` directive. However, you should use the `DC` directive only for defining constants, so that the code segment stays read-only. (Strictly speaking, you can use `DC` to define variables, but this gets you into a host of problems, particularly on future processors such as the 68030, where the separation of code and data is strictly enforced.)

What this all boils down to is that BYTE's 68000 Small-C does not let you initialize variables at declaration time. This can get messy if you have, say, a large array to initialize and you're faced with having to create a long string of assignment statements. A good solution is to create a fast assembly language routine that reads from a table and "mass-loads" the array from the table entries.

The Good Part

The real blessing I was looking forward to in porting Small-C to the Mac was that the 68000 would allow me to break the 64K-byte barrier: 32-bit registers meant 32-bit integers and 32-bit pointers. It's true that there would be a limit of 32K bytes to global data space, but there was no theoretical limit to data storage local to functions, or storage you could acquire through `malloc()` and related functions. Besides, 32K bytes is nothing to sniff at for any language called "small."

The jump to 32-bit integers required only that I alter routines in the compiler that dealt directly with the size of integers in the target code. In other words, I had to change those parts of the compiler that handled code like the following:

```
int i,j,k[14];
...
j=k[i*3];
```

For the `int` declaration code, the 68000 compiler reserved $4 \times 16 = 64$ bytes: 4 bytes of code per integer, rather than 2 as on the 8088 version. Also, when the compiler encounters the assignment statement and generates code for the index portion (`i*3`), it has to add code to multiply the result by the number of bytes per integer so the index into the array is resolved into a true byte offset. The 8088 version of Small-C simply doubled the index (as did the original Small-C); the 68000 version quadruples it .

Memory Management

Remember the memory map last month? The MS-DOS version of BYTE Small-C handled the memory management functions (`alloc()` and `free()`) by simply reserving space in physical memory above the user's program. This scheme was simple and consequently resulted in an obvious restriction on `alloc()` and `free()`—namely, that you had to free blocks of memory in reverse order to how they were allocated (see figure 1).

Well, the Macintosh memory manager routines `_Newptr` and `_DisposPtr` changed all that. If you're already familiar with these trap routines, you'll see the connection right off: They do exactly what `alloc()` and `free()` are supposed to do. Consequently, whereas the MS-DOS version of BYTE Small-C must maintain the run-time library variable `_Umemptr` to keep track of free memory, the Macintosh handles everything automatically. And for gravy, the Macintosh routines regularly compact memory, so Macintosh Small-C programs needn't free memory blocks in reverse order.

Let's be careful here. Notice that the memory management routines I'm using allocate *pointer* blocks, not *handle* blocks. As programs make calls to the Mac memory management system, the operating system will, as required, purge

continued

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unused blocks and move relocatable blocks to create large contiguous free space (a process referred to as "defragmentation"). Blocks accessed via handles are relocatable unless you specifically tell the operating system otherwise (by "locking a memory block"). Since the handle is a double-indirected pointer, the block can be moved and the second pointer modified without affecting the handle. However, blocks accessed via pointers are nonrelocatable, because moving the block would require modifying the pointer.

Since BYTE Small-C's `alloc()` function reserves nonrelocatable blocks only, it is conceivable that a BYTE Small-C program that makes repeated calls to `alloc()` and `free()` might deplete memory by fragmenting it so badly that the operating system can't create a usable free block (see figure 2). In spite of this restriction (and for most programs you can ignore it), the Macintosh version's memory management routines are far better than the MS-DOS version's.

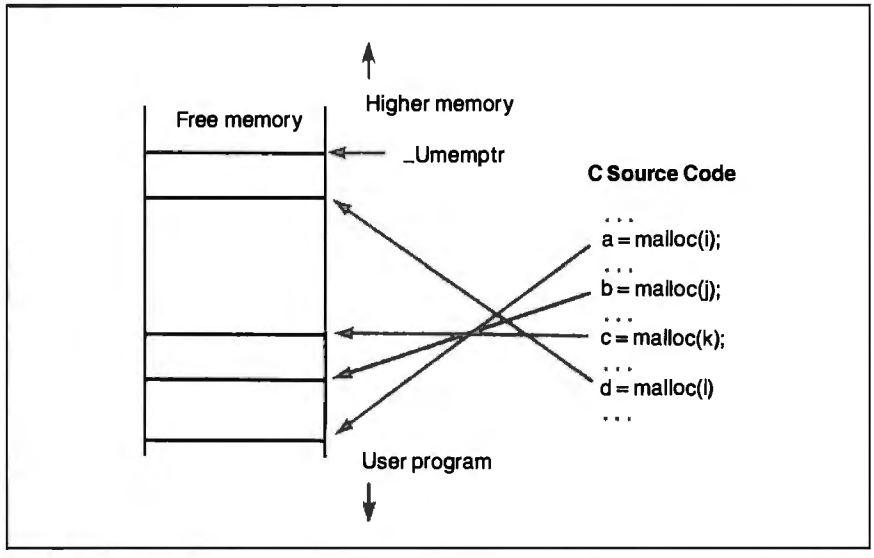

Figure 1: *The 8088 version of BYTE Small-C handles memory allocation as an upward-growing stack tracked by the global variable* `_Umemptr`. *Memory blocks (left) allocated by the source code (right) must be freed (using the* `free()` *function) in the reverse order to how they were allocated (i.e., the block that* `d` *points to must be released before the block that* `c` *points to). BYTE's Small-C for the Mac removes this restriction.*

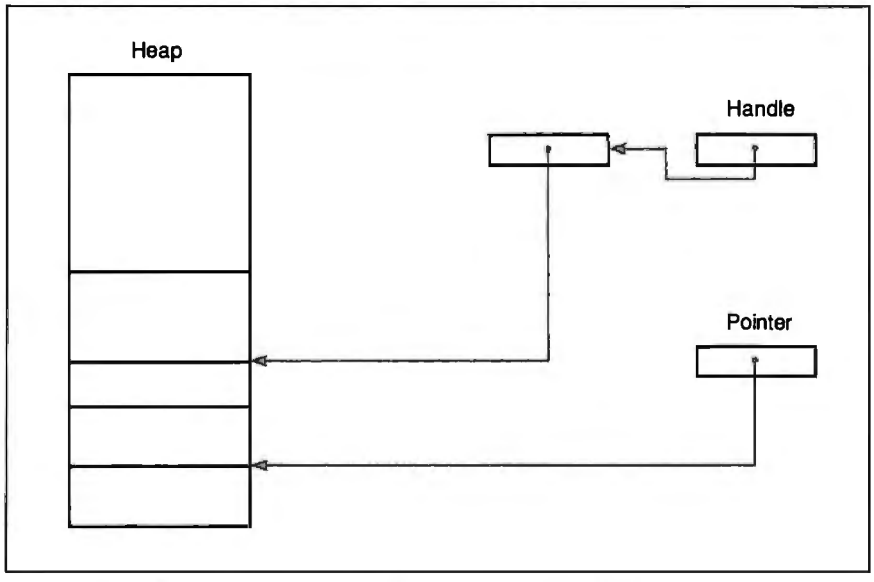

Figure 2: *On the Mac, a pointer is a 32-bit entity that holds the address of a block of memory. A handle is a pointer to a pointer to a block. Notice that the system can relocate the upper block without altering the contents of the handle; not so with the lower block.*

Life with the Finder

There's a fundamental difficulty in crowbarring a language originally developed on the "glass teletypes" into the windowed world of the Macintosh. In my port, the difficulty appeared cloaked in the guise of the system variables `argc` and `argv[]`. C programmers will recognize `argc` as the system variable that indicates the number of arguments on the command line; `argv[]` is an array of pointers to each of the argument strings.

But wait: This is on the Macintosh. You don't execute programs, you launch them by double-clicking on an icon. There *is* no command line. What, then, do you do with `argc` and `argv[]`?

Macintosh C compilers use various ways to skirt the problem of the command-line arguments. For example, Lightspeed C simply does not support them; Aztec C provides a shell program that creates a Unix-flavored line-oriented environment. I took a hybrid route. When you launch a BYTE Small-C program, it opens a window and prompts with `Command line:`. Whatever you type in response to this prompt is passed on to `argc` and `argv[]`.

I realize that, although this approach makes porting programs from MS-DOS Small-C to the Mac easier, the technique is slightly inelegant. However, the source code for the compiler is available in *Programming the Macintosh in Assembly Language* (see the text box on page 250). If you don't like the way I've handled command-line arguments, you're welcome to alter the compiler appropriately.

Exit(0)

Throughout the porting of Small-C to the Mac, I asked myself over and over what compromises I was willing to live with. I'm sure that, for a commercial product, these questions translate to the determination of trade-offs between deadlines and lost features. The silver linings are whatever additional goodies a new architecture lets you attach to your program. ■

Rick Grehan is a BYTE senior technical editor at large. He has a BS in physics and applied mathematics and an MS in computer science/mathematics from Memphis State University. He can be reached on BIX as "rick_g."

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10 MHz Optional

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640 Pixels for Hercules Graphics Mode
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BUS Portable EGA

BUS 286

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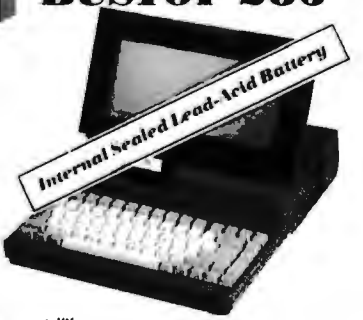

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7407	.39	.29	74121	.45	.35
7408	.35	.25	74123	.55	.45
7410	.29	.19	74125	.55	.45
7414	.49	.39	74126	.69	.59
7416	.39	.29	74143	3.95	3.85
7417	.39	.29	74150	1.35	1.25
7420	.35	.25	74154	1.35	1.25
7430	.35	.25	74158	~~1.50~~	.99
7432	.39	.29	74173	.85	.75
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7445	.79	.69	74176	~~.99~~	.69
7446	.89	.79	74181	1.95	1.85
7447	.89	.79	74189	1.95	1.85
7448	2.05	1.95	74193	.79	.69
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7473	.39	.29	74221	.99	.89
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74LS14	.49	.39	74LS221	.69	.59
74LS27	.35	.25	74LS240	.69	.59
74LS30	.29	.19	74LS243	.69	.59
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Z80-PIO	~~1.79~~	.99
Z80A		1.69
Z80A-CTC		1.79
Z80A-DART		4.95
Z80A-PIO		1.69
Z80A-SIO/0		5.75
Z80B		3.49
Z80B-CTC		3.95
Z80B-PIO	~~4.29~~	3.95

6500/6800/68000 SER.

6502		2.65
65C02(CMOS)	~~9.95~~	7.75
6520		1.95
6522		3.95
6532	~~6.49~~	5.49
6551	~~4.49~~	2.95
65C802 (CMOS)	~~19.95~~	15.95
6800		1.95
6802		3.95
6810		1.25
6821		1.75
6840	~~9.95~~	3.49

6500/6800/68000 Cont.

6845	~~9.95~~	2.95
6850		1.95
6852	~~1.49~~	.75
6854	~~1.49~~	1.19
MC68000L8	~~11.95~~	9.95
MC68000L10	~~13.95~~	11.95
MC68010L10	~~49.95~~	29.95
MC68020RC12B	~~169.95~~	99.95

6000 SERIES

8031		3.95
80C31		9.95
8035		1.95
8073		9.95
8080A	~~2.95~~	2.49
8085A		2.49
8086	~~5.95~~	4.95
8086-2		6.95
8087 (5MHz)		99.95
8087-1 (10MHz)		229.95
8087-2 (8MHz)		159.95
8088	~~6.49~~	5.75
8088-2	~~9.95~~	7.75
8116		4.95
8155		2.49
8155-2		3.49
8156		3.95
8202	~~5.95~~	4.95
8203	~~9.95~~	6.95
8212		2.29
8224		2.25

6000 SERIES Cont.

8228		2.95
8237-5	~~4.95~~	4.49
8243	~~2.25~~	1.75
8250A		6.49
8250B (For IBM)		6.95
8251A		1.89
8253-5		1.95
8254		4.95
8255A-5		2.95
8259-5		2.25
8272	~~4.95~~	3.95
8279-5		2.95
8741		9.95
8742	~~29.95~~	19.95
8748 (25V)		7.95
8748H (HMOS) (21V)		9.95
8749		9.95
8751 (3.5-8MHz)		39.95
8751H (3.5-12MHz)		44.95
8755		14.95

DATA ACQUISITION

ADC0804LCN	~~3.19~~	2.79
ADC0808CCN		5.95
ADC0809CCN	~~8.95~~	3.69
ADC0816CCN	~~14.95~~	8.95
ADC1205CCJ-1		19.95
DAC0808LCN		1.95
DAC1008LCN		4.95
AY-3-1015D		4.95
AY-5-1013A		2.95

MICROPROCESSOR SALE!

Part No.		Price
8052AHBASIC	CPU w/BASIC Interpreter	$29.95
MC68008L8	32-Bit MPU (8-Bit Data Bus)	~~$16.95~~ $9.95
MC68701	8-Bit EPROM Microcomputer	$14.95
MC68705P3S	8-Bit EPROM Microcomputer	~~$14.95~~ $9.95
MC68705U3S	8-Bit EPROM Microcomputer	$10.95
80286-10	16-Bit Hi Performance MPU	$99.95
80287-8	Math Co-processor (8MHz)	$245.95
80287-10	Math Co-processor (10MHz)	$309.95
80387-16	Math Co-proc. (16MHz) GRID ARRAY	$494.95
80387-20	Math Co-proc. (20MHz) GRID ARRAY	$795.95

DYNAMIC RAMS

Part No.			Price
*4116-15	16,384 x 1	(150ns)	1.09
4128-20	131,072 x 1	(200ns) (Piggyback) ~~9.25~~	2.75
*4164-100	65,536 x 1	(100ns)	4.25
*4164-120	65,536 x 1	(120ns)	3.75
*4164-150	65,536 x 1	(150ns)	3.25
*4164-200	65,536 x 1	(200ns)	2.75
*TMS4416-12	16,384 x 4	(120ns)	9.95
*41256-80	262,144 x 1	(80ns)	14.95
*41256-100	262,144 x 1	(100ns)	14.49
*41256-120	262,144 x 1	(120ns)	13.95
*41256-150	262,144 x 1	(150ns)	12.95
*50464-15	65,536 x 4	(150ns) (4464)	10.95
*511000P-10	1,048,576 x 1	(100ns) 1 Meg	~~49.95~~ 39.95
*514256P-10	262,144 x 4	(100ns) 1 Meg	89.95

STATIC RAMS

*2016-12	2048 x 8	(120ns)	4.95
2018-45	2048 x 8	(45ns)	6.95
2102	1024 x 1	(350ns)	.89
2114N	1024 x 4	(450ns)	.99
2114N-2L	1024 x 4	(200ns) Low Power	1.49
21C14	1024 x 4	(200ns) (CMOS)	.49
5101	256 x 4	(450ns) CMOS	1.95
*6116P-3	2048 x 8	(150ns) CMOS	6.49
*6116LP-3	2048 x 8	(150ns) LP CMOS	6.95
*6264LP-12	8192 x 8	(120ns) LP CMOS	13.95
*6264P-15	8192 x 8	(150ns) CMOS	10.49
*6264LP-15	8192 x 8	(150ns) LP CMOS	12.95
6514	1024 x 4	(350ns) CMOS	3.49
*43256-15L	32,768 x 8	(150ns) Low Power	12.95

EPROMS

TMS2516	2048 x 8	(450ns) 25V	~~6.95~~ 5.95
TMS2532	4096 x 8	(450ns) 25V	~~6.95~~ 6.49
TMS2532A	4096 x 8	(450ns) 21V	~~5.95~~ 4.49
TMS2564	8192 x 8	(450ns) 25V	~~9.95~~ 7.95
TMS2716	2048 x 8	(450ns) 3 Voltage	~~9.95~~ 6.95
1702A	256 x 8	(1 µs)	~~6.95~~ 4.95
2708	1024 x 8	(450ns)	4.95
2716	2048 x 8	(450ns) 25V	3.75
2716-1	2048 x 8	(350ns) 25V	4.25
27C16	2048 x 8	(450ns) 25V (CMOS)	5.49
2732	4096 x 8	(450ns) 25V	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
27C32	4096 x 8	(450ns) 25V (CMOS)	5.95
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.75
2764A-25	8192 x 8	(250ns) 12.5V	3.95
2764-45	8192 x 8	(450ns) 21V	2.95
27C64-15	8192 x 8	(150ns) 21V (CMOS)	6.49
27128-20	16,384 x 8	(200ns) 21V	6.95
27128-25	16,384 x 8	(250ns) 21V	5.95
27128A-25	16,384 x 8	(250ns) 12.5V	5.25
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	6.95
27256-20	32,768 x 8	(200ns) 12.5V	6.95
27256-25	32,768 x 8	(250ns) 12.5V	5.95
27C256-25	32,768 x 8	(250ns) 12.5V (CMOS)	7.95
27512-20	65,536 x 8	(200ns) 12.5V	13.49
27512-25	65,536 x 8	(250ns) 12.5V	~~11.95~~ 11.25
68764	8192 x 8	(450ns) 25V	13.95

EEPROMS

2816A-25	2048 x 8	(250ns) 5V Read/Write	5.95
2817A	2048 x 8	(350ns) 5V Read/Write	7.95
2865A	8192 x 8	(250ns) 5V Read/Write	9.95
52B13 (21V)	2048 x 8	(350ns) 5V Read Only	1.49

COMMODORE CHIPS

Part No.		Price
LAG570	~~40.95~~	9.95
WD1770	~~11.95~~	9.95
SI3052P	~~2.49~~	1.25
6504A	~~1.95~~	1.19
6507	~~4.99~~	2.95
6510		9.95
6525	~~4.95~~	2.49
6526	~~14.95~~	12.95
6529		2.95
6545-1	~~4.95~~	3.25
6560		10.95
6567		19.95
6569	~~24.95~~	15.95
6572	~~8.95~~	6.95
6581 (12V)		14.95
6582 (9V)	~~14.95~~	6.95
8360		14.95
8501	~~10.95~~	8.95
8502	~~7.95~~	4.95
8563		15.95
8564	~~9.95~~	4.95
8566	~~24.95~~	15.95
8701		9.95
8721	~~14.95~~	11.95
8722	~~9.95~~	6.95
*251104-04	~~10.95~~	8.95
310654-05		9.95
318018-03	~~10.95~~	8.95
318019-03	~~10.95~~	8.95
318020-04	~~10.95~~	8.95
325302-01		10.95
325572-01		14.95
*82S100PLA**		15.95
901225-01	~~11.95~~	9.95
901226-01		11.95
901227-03		11.95
901229-05		11.95

*No specs. available
**Note: 82S100PLA = U17 (C-64)

74C CMOS

74C00	.29	74C174	.79
74C02	.29	74C175	.79
74C04	.29	74C221	1.79
74C08	.35	74C240	.69
74C10	~~.35~~ .19	74C244	1.79
74C14	.59	74C373	1.95
74C32	.35	74C374	1.95
74C74	.59	74C912	.89
74C85	1.49	74C915	.99
74C86	.35	74C920	4.95
74C89	~~4.95~~ 3.95	74C921	4.95
74C90	.99	74C922	3.95
74C154	2.95	74C923	3.95
74C173	~~1.65~~ .59	74C925	5.95

MISC. COMPONENTS

TANTALUM CAPACITORS

TM.1/35	.1µf @ 35V	TM4.7/35	4.7µf @ 35V. .45
TM1/35	1µf @ 35V. .18	TM6.8/35	6.8µf @ 35V. .49
TM2.2/35	2.2µf @ 35V. .24	TM10/35	10µf @ 35V. .69

POTENTIOMETERS

Values available (insert ohms into space marked "XX"): 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1MEG

43PXX ¾ Watt, 15 Turn .99 | 63PXX ½ Watt, 1 Turn .89

TRANSISTORS AND DIODES

PN2222	.13	PN2907	.13	1N4004	.12
2N2222A	.35	2N4401	.12	1N4148	.07
2N3055	.65	1N270	.25	1N4735	.25
2N3904	.12	1N751	.15	C106B1	.49

SWITCHES

JMT123 SPDT, On-On 1.19 | 206-8 SPDT, 16-pin DIP 1.29

MPC121 SPDT, On-Off-On 1.19 | MS102 SPST, Momentary .39

D-SUB CONNECTORS

DB25P Male, 25-pin .75 | DB25S Female, 25-pin .79

LEDS

XC556R T1¾, Red .12 | XC556Y T1¾, Yellow .15

XC556G T1¾, Green .15 | XC556C T1¾, Clear/Red .15

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #3	
8LP	.11	8WW	.59
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.25	24WW	1.19
28LP	.27	28WW	1.39
40LP	.29	40WW	1.89

Soldertail Standard (Gold & Tin) & Header Plug Sockets Also Available

74HC HI-SPEED CMOS

Part No.		Price	Part No.		Price
74HC00	~~.25~~	.19	74HC175	~~.69~~	.49
74HC02	~~.25~~	.19	74HC221	~~1.19~~	.89
74HC04	~~.29~~	.19	74HC240	~~.99~~	.69
74HC08	~~.29~~	.19	74HC244	~~.99~~	.69
74HC10	~~.29~~	.19	74HC245	~~.99~~	.79
74HC14	~~.49~~	.29	74HC253	~~.59~~	.39
74HC30	~~.29~~	.19	74HC259	~~.89~~	.39
74HC32	~~.29~~	.25	74HC273	~~.99~~	.69
74HC74	~~.39~~	.29	74HC373	~~.99~~	.65
74HC75	~~.39~~	.35	74HC374	~~.99~~	.65
74HC76	~~.45~~	.35	74HC595	~~1.29~~	1.09
74HC85	~~.79~~	.55	74HC688	~~.99~~	.79
74HC86	~~.39~~	.35	74HC943		8.95
74HC123	~~.89~~	.69	74HC4040	~~.99~~	.79
74HC125	~~.49~~	.39	74HC4049	~~.59~~	.39
74HC132	~~.69~~	.39	74HC4050	~~.59~~	.39
74HC138	~~.49~~	.39	74HC4060	~~.99~~	.89
74HC139	~~.49~~	.39	74HC4511	~~1.29~~	.99
74HC154	~~1.49~~	1.19	74HC4514	~~1.79~~	.99
74HC163	~~.65~~	.39	74HC4538		.89
74HC174	~~.69~~	.49	74HC4543	~~1.19~~	.89

74HCT — CMOS TTL

74HCT00	~~.29~~	.17	74HCT139	~~.59~~	.35
74HCT02	~~.29~~	.17	74HCT157	~~.69~~	.19
74HCT04	~~.29~~	.17	74HCT174	~~.69~~	.35
74HCT08	~~.29~~	.17	74HCT175	~~.69~~	.39
74HCT10	~~.29~~	.17	74HCT240	~~.89~~	.89
74HCT32	~~.29~~	.21	74HCT244	~~.99~~	.39
74HCT74	~~.49~~	.25	74HCT245	~~1.19~~	.79
74HCT86	~~.49~~	.19	74HCT373	~~1.19~~	.55
74HCT138	~~.59~~	.35	74HCT374	~~1.19~~	.49

LINEAR

DS0026CN	1.95	LM1458N	.39
TL074CN	1.19	LM1488N	.49
TL084CN	.99	DS1488N (CMOS)	1.19
AF100-1CN	8.95	LM1489N	.49
LM307N	.45	DS1489N (CMOS)	1.19
LM309K	1.25	LM1496N	~~.99~~ .69
LM311N	.45	MC1648P	~~8.49~~ 1.95
LM317T	.79	LM1871N	1.95
LM318N	.99	LM1872N	1.95
LM319N	1.29	LM1896N-1	~~1.49~~ .79
LM323K	3.95	ULN2003A	.79
LM324N	.39	XR2206	3.95
LM338K	4.95	XR2211	2.95
LM339N	.49	XR2243	1.95
LF347N	1.79	26LS29	~~.95~~ 2.95
LM348N	.69	26LS31	1.19
LM350T	2.95	26LS32	1.19
LF351N	.39	26LS33	1.49
LF353N	.49	LM2901N	~~.39~~ .15
LF355N	.79	LM2907N	1.29
LF356N	.89	LM2917N (8 pin)	1.95
LF357N	1.09	MC3419CL	~~6.95~~ 3.95
LM358N	.49	MC3446N	~~1.69~~ .99
LM360N	2.19	MC3450P	~~1.95~~ .49
LM361N	1.79	MC3470P	1.95
LM380N-8	~~.99~~ .85	MC3471P	~~1.95~~ .75
LM386N-3	.89	MC3479P	4.79
LM387N	.99	MC3486P	1.69
LM393N	.39	MC3487P	~~1.69~~ .99
LM399H	2.95	LM3900N	.49
LF411CN	.79	LM3905N	1.19
TL497ACN	~~1.49~~ .99	LM3909N	.99
NE540H (C540H)	~~2.95~~ 1.49	LM3914N	1.95
NE555V	.29	LM3916N	1.95
XRL555	.59	NE5532	.69
LM556N	.49	NE5534	.69
NE558N	.89	7805K (LM340K-5)	1.29
LM565N	.99	7812K (LM340K-12)	1.29
LM567V	.79	7815K (LM340K-15)	1.29
NE592N	~~.99~~ .69	7805T (LM340T-5)	.49
LM741CN	.29	7812T (LM340T-12)	.49
LM747CN	.59	7815T (LM340T-15)	.49
MC1350P	~~1.09~~ .89	7905K (LM320K-5)	~~1.35~~ .99
MC1372P	~~1.95~~ .99	7905T (LM320T-5)	.59
MC1377P	2.29	75472	~~.59~~ .49
MC1398P	~~8.95~~ 4.95	75477	~~.89~~ .49
LM1414N	~~1.29~~ .49	MC145106P	~~2.49~~ 1.95
		MC145406P	2.95

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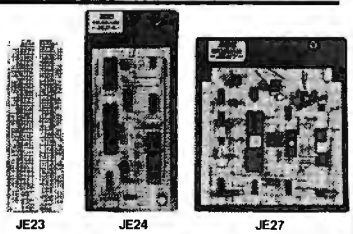
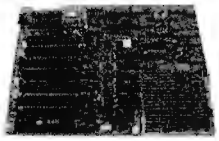


JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6½ x ¾	200	0	$ 2.29
JE21	3¼ x 2⅛	400	0	$ 4.49
JE22	6½ x 1⅜	630	0	$ 5.95
JE23	6½ x 2⅛	830	0	$ 7.49
JE24	6½ x 3⅛	1,360	2	$14.95
JE25	6½ x 4¼	1,660	3	$22.95
JE26	6⅞ x 5¾	2,390	4	$27.95
JE27	7¼ x 7½	3,220	4	$37.95

COMPUTER PERIPHERALS

Jameco IBM PC/XT/AT Compatible Motherboards

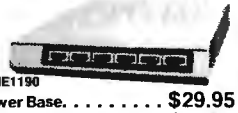


JE1001

- Award BIOS ROMs included

JE1001 4.77/8MHz (PC/XT) .... $ 99.95
JE1002 4.77/10MHz (PC/XT) ... $119.95
JE1007 6/8/10/12MHz (AT) $349.95

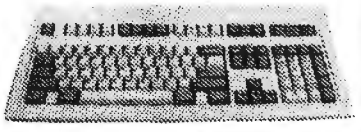
Jameco Computer Power Protection



JE1190

JE1190 Power Base. $29.95
JE1191 6-Outlet Power Strip $11.95

Jameco IBM PC/XT/AT Compatible Keyboards



JE1016 Pictured

JE1015 Standard AT layout (XT/AT) .. $59.95
JE1016 Enhanced layout (XT/AT) ... $79.95

Jameco Extended 80-Column Card for Apple *IIe*

- 80 Col./64K RAM • Doubles amount of data your Apple *IIe* can display as well as its memory capacity • Ideal for word processing • Complete with instructions

JE864 $39.95

ADD12 (Disk Drive II, II+, *IIe*) **$99.95**

DATA BOOKS

400041	NSC Linear Data Book-Vol. I (88).	$14.95
400042	NSC Linear Data Book-Vol. II (88).	$ 9.95
400043	NSC Linear Data Book-Vol. III (88).	$ 9.95
210830	Intel Memory Handbook (88).	$17.95
230843	Intel Microsystem Hndbk. Set (88).	$24.95

IBM AT COMPATIBLE KIT Mini-286 6/8/10/12MHz Kit

JE1007	Baby AT Motherboard (Zero-K RAM — includes Award BIOS ROMs).	$349.95
JE1015	XT/AT Style Keyboard.	$ 59.95
JE1017	Baby AT Flip-Top Case.	$ 69.95
JE1022	5¼" Hi-Density Disk Drive.	$109.95
JE1032	200 Watt Power Supply.	$ 89.95
JE1043	360K/720K/1.2M Floppy Controller Card.	$ 49.95
JE1065	Input/Output Card.	$59.95

Regular List $789.65

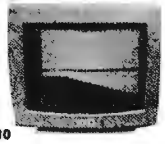
SAVE $99.70! JE1059 $519.95 (EGA Monitor and Card not included)

JE2009* IBM AT Compatible Kit. **$689.95**
JE286M JE2009 Technical Manual. $29.95
*RAM not included — Minimum RAM configuration 512K (18 Chips 41256-120, see left)

IBM COMPATIBLE DISPLAY MONITORS

12" Amber Monochrome — TTL Input, High Resolution (PC/XT/AT)
AMBER. $99.95

14" RGB Color — CGA Compatible Amber/Green/Color Switchable, 640 x 200 Resolution (PC/XT/AT)
TTX1410. . . . . $279.95



TTX1410

14" EGA Color - EGA/CGA Compat., 720 x 350 Max. Resolution (PC/XT/AT)
TE5154. . . . . $399.95

14" EGA Monitor and EGA Card - EGA compatible, 720 x 350 Max. Resolution — displays up to 16 colors (PC/XT/AT)
JE1059. . . . . $519.95

14" Multiscan Color - VGA/PGC/EGA compatible, 800 x 600 Max. Resolution (PC/XT/AT)
CTX1435. . . . . $549.95

IBM PC/XT/AT COMPATIBLE CARDS

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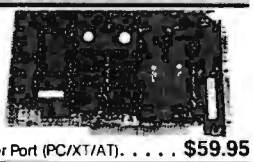

JE1050

JE1050	Mono Graphics Card w/Printer Port (PC/XT/AT).	$59.95
JE1052	Color Graphics Card w/Printer Port (PC/XT/AT).	$49.95
JE1055	EGA Card with 256K Video RAM (PC/XT/AT).	$169.95
JE1071	Multi I/O with Drive Controller and Mono Graphics (PC/XT).	$119.95

Multifunction, I/O and Expansion Cards

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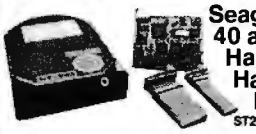

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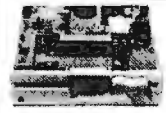

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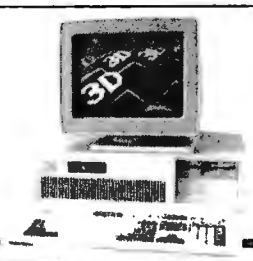

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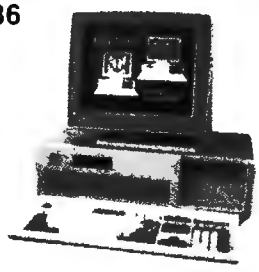

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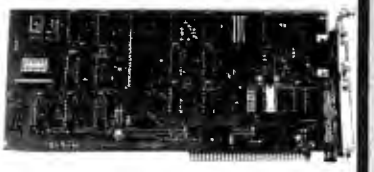

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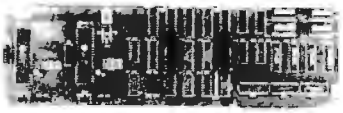

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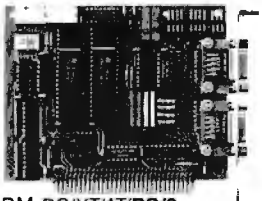

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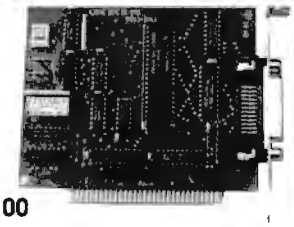

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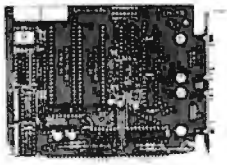

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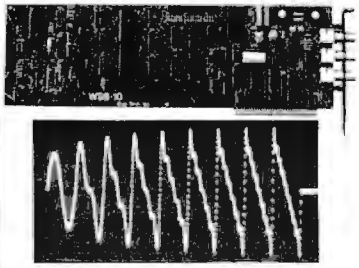

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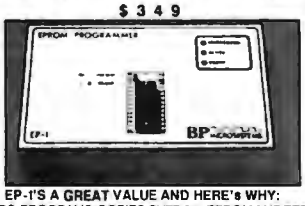

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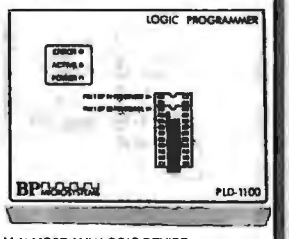

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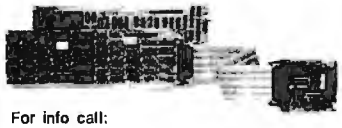

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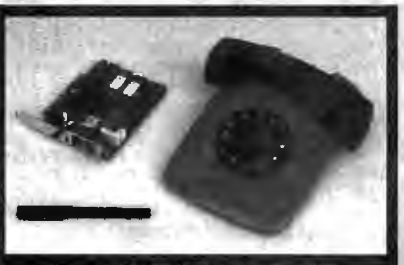

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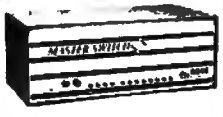

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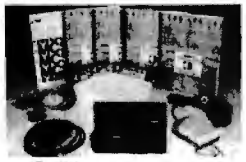

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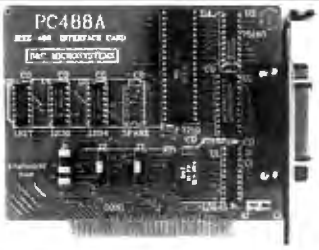

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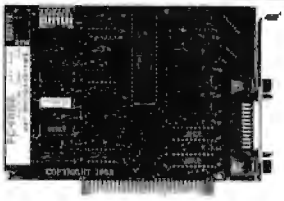

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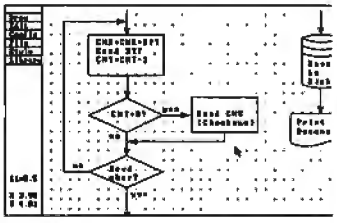

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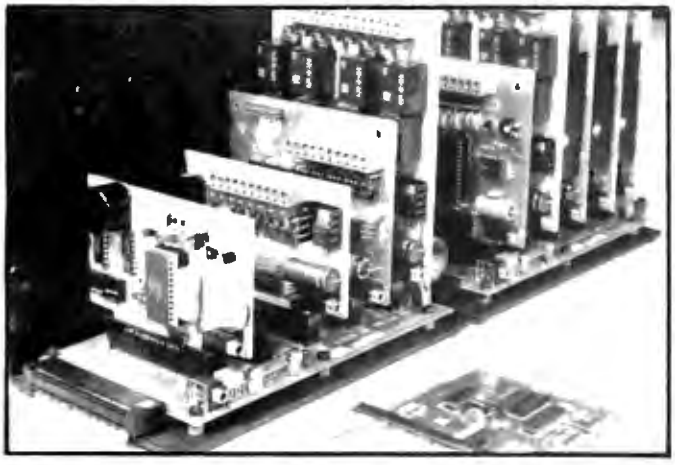


An A-BUS system with two Motherboards
A-BUS adapter (IBM) in foreground

Plug into the future

With the A-BUS you can plug your PC (IBM, Apple, TRS-80) into a future of exciting new applications in the fields of control, monitoring, automation, sensing, robotics, etc.

Alpha's modular A-BUS offers a proven method to build your "custom" system today. Tomorrow, when you are ready to take another step, you will be able to add more functions. This is ideal for first time experimenting and teaching.

A-BUS control can be entirely done in simple BASIC or Pascal, and no knowledge of electronics is required!

An A-BUS system consists of the A-BUS adapter plugged into your computer and a cable to connect the Adapter to 1 or 2 A-BUS cards. The same cable will also fit an A-BUS Motherboard for expansion up to 25 cards in any combination.

The A-BUS is backed by Alpha's continuing support (our 11th year, 50000 customers in over 60 countries).

The complete set of A-BUS User's Manuals is available for $10.

About the A-BUS:

- All the A-BUS cards are very easy to use with any language that can read or write to a Port or Memory. In BASIC, use INP and OUT (or PEEK and POKE with Apples and Tandy Color Computers)
- They are all compatible with each other. You can mix and match up to 25 cards to fit your application. Card addresses are easily set with jumpers.
- A-BUS cards are shipped with power supplies (except PD-123) and detailed manuals (including schematics and programming examples).

Relay Card — RE-140: $129

Includes eight industrial relays. (3 amp contacts. SPST) individually controlled and latched. 8 LED's show status. Easy to use (OUT or POKE in BASIC). Card address is jumper selectable.

Reed Relay Card — RE-156: $99

Same features as above, but uses 8 Reed Relays to switch low level signals (20mA max). Use as a channel selector, solid state relay driver, etc.

Analog Input Card — AD-142: $129

Eight analog inputs. 0 to +5V range can be expanded to 100V by adding a resistor. 8 bit resolution (20mV). Conversion time 120us. Perfect to measure voltage, temperature, light levels, pressure, etc. Very easy to use.

12 Bit A/D Converter — AN-146: $139

This analog to digital converter is accurate to .025%. Input range is −4V to +4V. Resolution: 1 millivolt. The on board amplifier boosts signals up to 50 times to read microvolts. Conversion time is 130ms. Ideal for thermocouple, strain gauge, etc. 1 channel. (Expand to 8 channels using the RE-156 card).

Digital Input Card — IN-141: $59

The eight inputs are optically isolated, so it's safe and easy to connect any "on/off" devices, such as switches, thermostats, alarm loops, etc. to your computer. To read the eight inputs, simply use BASIC INP (or PEEK).

24 Line TTL I/O — DG-148: $65

Connect 24 input or output signals (switches or any TTL device) to your computer. The card can be set for: input, latched output, strobed output, strobed input, and/or bidirectional strobed I/O. Uses the 8255A chip.

Clock with Alarm — CL-144: $89

Powerful clock/calendar with: battery backup for Time, Date and Alarm setting (time and date); built in alarm relay, led and buzzer; timing to 1/100 second. Easy to use decimal format. Lithium battery included.

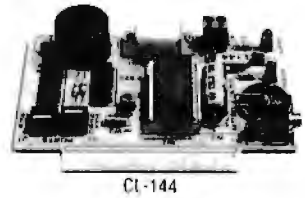
Touch Tone® Decoder — PH-145: $79

Each tone is converted into a number which is stored on the board. Simply read the number with INP or POKE. Use for remote control projects, etc.

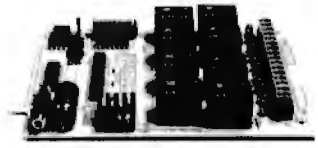
A-BUS Prototyping Card — PR-152: $15

3½ by 4½ in. with power and ground bus. Fits up to 10 I.C.s

ST-143

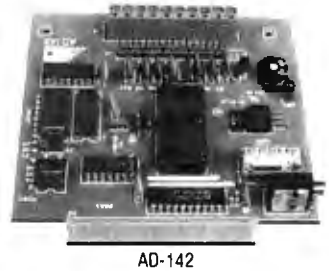


CL-144



RE-140

IN-141



AD-142

Smart Stepper Controller — SC-149: $299

World's finest stepper controller. On board microprocessor controls 4 motors simultaneously. Incredibly, it accepts plain English commands like "Move arm 10.2 inches left". Many complex sequences can be defined as "macros" and stored in the on board memory. For each axis, you can control: coordinate (relative or absolute), ramping, speed, step type (half, full, wave), scale factor, units, holding power, etc. Many inputs: 8 limit & "wait until" switches, panic button, etc. On the fly reporting of position, speed, etc. On board drivers (350mA) for small steppers (MO-103). Send for SC-149 flyer.

Remote Control Keypad Option — RC-121: $49
To control the 4 motors directly, and "teach" sequences of motions.

Power Driver Board Option — PD-123: $89
Boost controller drive to 5 amps per phase. For two motors (eight drivers).

Breakout Board Option — BB-122: $19
For easy connection of 2 motors. 3 ft. cable ends with screw terminal board.

Stepper Motor Driver — ST-143: $79

Stepper motors are the ultimate in motion control. The special package (below) includes everything you need to get familiar with them. Each card drives two stepper motors (12V, bidirectional, 4 phase, 350mA per phase).

Special Package: 2 motors (MO-103) + ST-143: PA-181: $99

Stepper Motors — MO-103: $15 or 4 for $39

Pancake type, 2¼" dia, ¼" shaft, 7.5°/step, 4 phase bidirectional, 300 step/sec, 12V, 36 ohm, bipolar, 5 oz-in torque, same as Airpax K82701-P2.

Current Developments

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A-BUS Adapters for:

IBM PC, XT, AT and compatibles. Uses one short slot.	AR-133...$69
Tandy 1000, 1000 EX & SX, 1200, 3000. Uses one short slot.	AR-133...$69
Apple II, II+, IIe. Uses any slot.	AR-134...$49
TRS-80 Model 102, 200 Plugs into 40 pin "system bus"	AR-136...$69
Model 100. Uses 40 pin socket. (Socket is duplicated on adapter).	AR-135...$69
TRS-80 Mod 3,4,4D. Fits 50 pin bus. (With hard disk, use Y-cable)	AR-132...$49
TRS-80 Model 4P Includes extra cable. (50 pin bus is recessed).	AR-137...$62
TRS-80 Model I. Plugs into 40 pin I/O bus on KB or E/I.	AR-131...$39
Color Computers (Tandy). Fits ROM slot. Multipak, or Y-cable.	AR-138...$49

A-BUS Cable (3 ft, 50 cond.) — CA-163: $24

Connects the A-BUS adapter to one A-BUS card or to first Motherboard.

Special cable for two A-BUS cards: CA-162: $34

A-BUS Motherboard — MB-120: $99

Each Motherboard holds five A-BUS cards. A sixth connector allows a second Motherboard to be added to the first (with connecting cable CA-161: $12). Up to five Motherboards can be joined this way to a single A-BUS adapter. Sturdy aluminum frame and card guides included.

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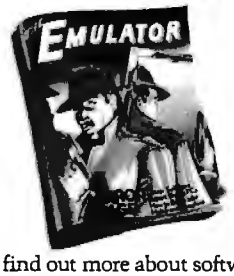

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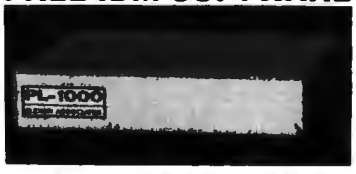

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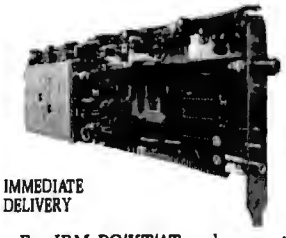

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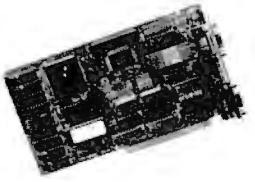

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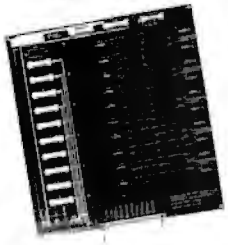

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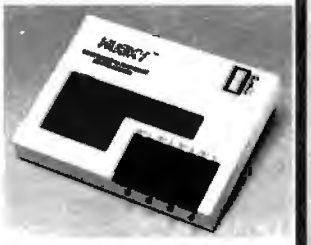

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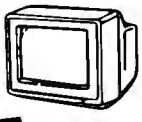
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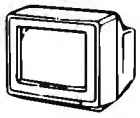

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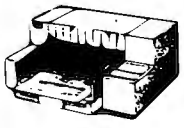
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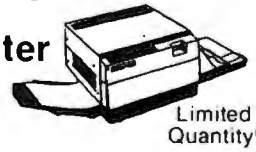
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3.2768MHz	2.25	10.000MHz	2.25	24.000MHz	2.25
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4.000MHz	5.50	12.000MHz	5.50	22.000MHz	5.50
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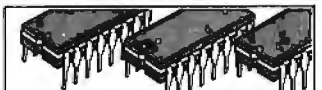

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74LS01	.18	74LS122	.45	74LS242	.69
74LS02	.17	74LS123	.49	74LS243	.69
74LS03	.18	74LS124	2.75	74LS244	.69
74LS04	.16	74LS125	.39	74LS245	.79
74LS05	.18	74LS126	.39	74LS251	.49
74LS08	.18	74LS132	.39	74LS253	.49
74LS09	.18	74LS133	.49	74LS257	.39
74LS10	.16	74LS136	.39	74LS258	.49
74LS11	.22	74LS138	.39	74LS259	1.29
74LS12	.22	74LS139	.39	74LS260	.49
74LS13	.26	74LS145	.99	74LS266	.39
74LS14	.39	74LS147	.99	74LS273	.79
74LS15	.26	74LS148	.99	74LS279	.39
74LS20	.17	74LS151	.39	74LS280	1.98
74LS21	.22	74LS153	.39	74LS283	.59
74LS22	.22	74LS154	1.49	74LS290	.89
74LS27	.23	74LS155	.59	74LS293	.89
74LS28	.26	74LS156	.49	74LS299	1.49
74LS30	.17	74LS157	.35	74LS322	3.95
74LS32	.18	74LS158	.29	74LS323	2.49
74LS33	.28	74LS160	.29	74LS365	.39
74LS37	.26	74LS161	.39	74LS367	.39
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74LS74	.24	74LS173	.49	74LS393	.79
74LS75	.29	74LS174	.39	74LS541	1.49
74LS76	.29	74LS175	.39	74LS624	1.95
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74LS90	.39	74LS194	.69	74LS682	3.20
74LS92	.49	74LS195	.69	74LS688	2.40
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7400	.19	7447	.89
7402	.19	7473	.34
7404	.19	7474	.33
7406	.29	7475	.45
7407	.29	7476	.35
7408	.24	7483	.50
7410	.19	7485	.59
7411	.25	7486	.35
7414	.49	7489	2.15
7416	.25	7490	.39
7417	.25	7493	.35
7420	.19	74121	.29
7430	.19	74123	.49
7432	.29	74125	.45
7438	.29	74150	1.35
7442	.49	74151	.55
7445	.69	74153	.55
		74154	1.49
		74157	.55
		74159	1.65
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74F32	.35
74F64	.55
74F74	.39
74F86	.55
74F138	.79
74F139	.79
74F253	.89
74F157	.89
74F240	1.29
74S00	.29
74S02	.29
74S04	.29
74S08	.35
74S10	.29
74S32	.35
74S74	.49
74S86	.35
74S112	.50
74S124	2.75
74S138	.79
74S153	.79
74S157	.79
74S158	.95
74S163	1.29
74S175	.79
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4011	.19	4069	.19	74HC157	.55
4012	.25	4070	.29	74HC244	.85
4013	.35	4081	.22	74HC245	.85
4015	.29	4093	.49	74HC273	.69
4016	.29	14411	9.95	74HC373	.69
4017	.49	14433	14.95	74HC374	.69
4018	.69	14497	6.95	74HCT00	.25
4020	.59	4503	.49	74HCT02	.25
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4028	.65	74HC00	.21	74HCT139	.55
4040	.69	74HC02	.21	74HCT161	.79
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4044	.69	74HC08	.25	74HCT244	.89
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4047	.69	74HC14	.35	74HCT273	.99
4049	.29	74HC32	.35	74HCT373	.99
4050	.29	74HC74	.35	74HCT374	.99
4051	.69	74HC86	.45	74HCT393	.99
4052	.69	74HC138	.45	74HCT4017	1.19
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Circle 116 on Reader Service Card

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1.0µf	15V	.12	1.0µf	35V	.45
6.8	15V	42	2.2	35V	.19
10	15V	.45	4.7	35V	.39
22	15V	.99	10	35V	.69

DISC

10pf	50V	.05	.001µf	50V	.05
22	50V	.05	.005	50V	.05
33	50V	.05	.01	50V	.07
47	50V	.05	.05	50V	.07
100	50V	.05	.1	12V	.10
220	50V	.05	.1	50V	.12

MONOLITHIC

.01µf	50V	.14	.1µf	50V	.18
.047µf	50V	.15	.47µf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µf	25V	.14	1µf	50V	.14
4.7	50V	.11	10	50V	.16
10	50V	.11	22	16V	.14
47	35V	.13	47	50V	.19
100	16V	.15	100	35V	.19
220	35V	.20	470	50V	.29
470	25V	.30	1000	16V	.29
2200	16V	.70	2200	16V	.70
4700	25V	1.45	4700	16V	1.25

VOLTAGE REGULATORS

7805T	.49	7812K	1.39
7808T	.49	7905K	1.69
7812T	.49	7912K	1.49
7815T	.49	78L05	.49
7905T	.59	78L12	.49
7908T	.59	79L05	.69
7912T	.59	79L12	1.49
7915T	.59	LM323K	4.79
7805K	1.59	LM338K	6.95

DISCRETE

1N751	.15	4N28	.69
1N4148	25/$1.00	4N33	.89
1N4004	10/$1.00	4N37	1.19
1N5402	.25	MCT-2	.59
KBP02	.55	MCT-6	1.29
2N2222	.25	TIL-111	.99
PN2222	.10	2N3906	.10
2N2907	.25	2N4401	.25
2N3055	.79	2N4402	.25
2N3904	.10	2N4403	.25
4N26	.69	2N6045	1.75
4N27	.69	TIP31	.49

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.1 µf	CERAMIC DISC	100/$6.50
.1 µf	MONOLITHIC	100/$12.50

RESISTOR NETWORKS

SIP	10 PIN	9 RESISTOR	.69
SIP	8 PIN	7 RESISTOR	.59
DIP	16 PIN	8 RESISTOR	1.09
DIP	16 PIN	15 RESISTOR	1.09
DIP	14 PIN	7 RESISTOR	.99
DIP	14 PIN	13 RESISTOR	.99

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EXT-32	MICROCHANNEL 32-BIT	99.95

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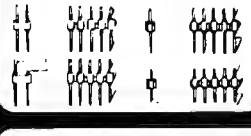

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IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS					
		10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	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	4.45	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' GREY RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS. BELOW

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Model	Timer	Chip Capacity	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS					
			9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.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	---
HOOOS	METAL	MHOODxx	1.05	1.15	1.25	1.25	---	---
	GREY	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

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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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GENDER-JB	JUMPER BOX	8.95
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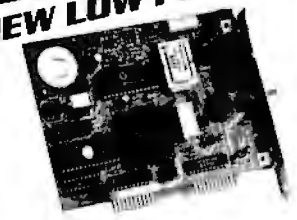

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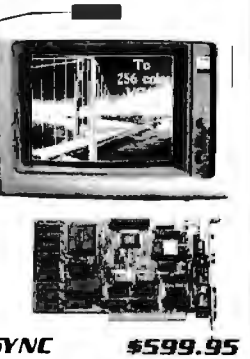

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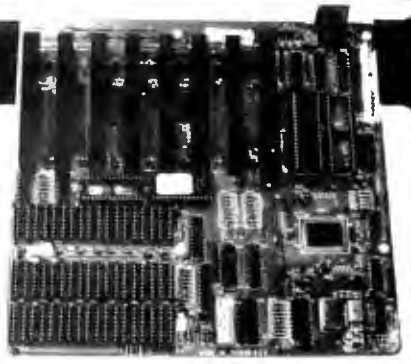

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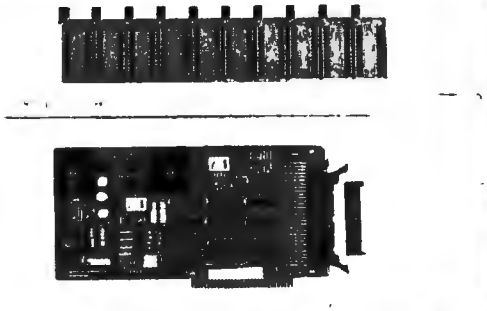

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PRODUCTS IN PERSPECTIVE:

The **Product Focus** for September will zero in on 600-dot-per-inch PostScript-compatible laser printers. Testing of 13 such machines by our laboratory staff has brought out some interesting and surprising features.

System reviews include 80386-based laptop machines from both GRiD and Toshiba and a desktop 80386 from AST Research.

A **hardware review** will look at 10 facsimile transmit/receive boards for the IBM PC and compatibles.

In **software reviews**, first on the list will be a look at Ada—as implemented on the Macintosh. Next comes a look at two **application reviews**. One is Dataplex, a new data-entry and format-conversion program from Tools and Technologies; the other is Total Word from Lifetree Software, a product that straddles the line between word processing and desktop publishing.

Possible **Short Takes** for September include two 25-MHz accelerator boards for the Macintosh—from Radius and Novy Systems, respectively. Also in for scrutiny will be a new product from Borland International: Turbo Prolog 2.0. Konan has a new disk drive controller with built-in memory. Proximity Software has released Choice Words, a Merriam-Webster dictionary on a disk. An extended Short Take will look at a card-size motherboard replacement from Sota.

Our expanded **columns** section has contributions from Jerry Pournelle, Ezra Shapiro, Wayne Rash Jr., Don Crabb, Mark Minasi, and Brock N. Meeks. In their own ways—and from their own perspectives—each presents a thoughtful look at the products and technologies that make up the whole world of microcomputing.

IN DEPTH:

The most obvious component of most computers, regardless of how they're used, is the screen. Now that we've looked at monitors in a previous Product Focus, we're going to take a look at the **technology that underlies the display interface**. In September, we'll have an overview of the current state of the art, followed by a detailed discussion describing how some of the most striking displays in the industry are developed and created.

FEATURES:

In our new Hands On section, Steve Ciarcia presents the second part of his microcontroller project, and Rick Grehan presents the next installment of Some Assembly Required—floating-point without a coprocessor. We also have articles available on power protection for microcomputers, new user interfaces, parallel Prologs, and an OS/2 communications program.

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B. How many people does your company employ?
1 ☐ 25 or fewer
2 ☐ 26-99
3 ☐ 100-499
4 ☐ 500-999
5 ☐ 1000 or more

C. Reason for request: (Check all that apply).
1 ☐ Business use for yourself
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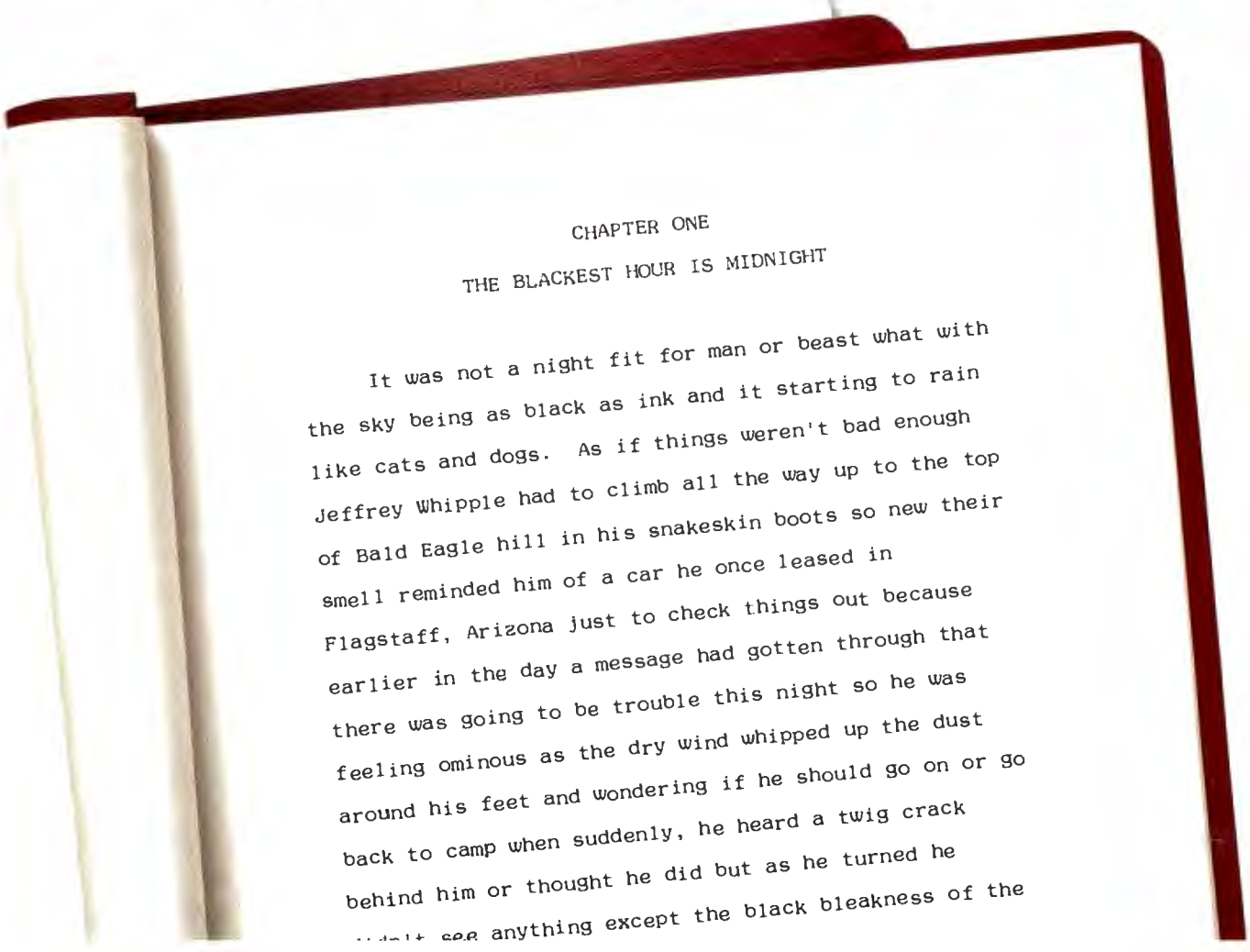

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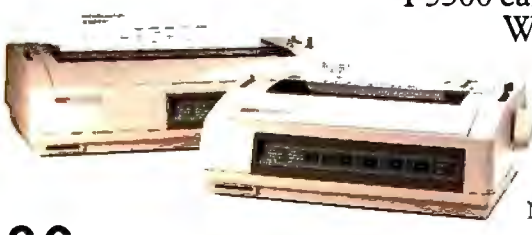

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