BYTE

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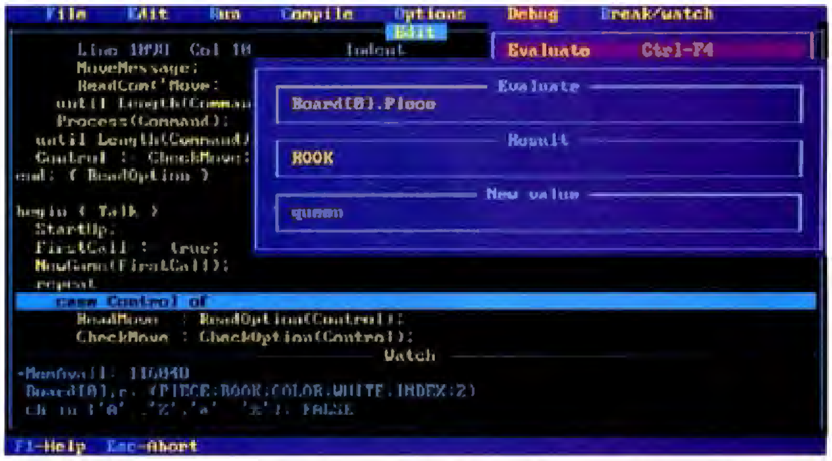

Shown here is the Evaluate/Modify window of Turbo Pascal: look at expressions, examine structured data types, change variables on the fly.

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TURBO PASCAL 5.0	TURBO PASCAL 5.0	Turbo Pascal 4.0
SIEVE BENCHMARK		
.EXE size (bytes)	1440	1504
Execution time (seconds)	6.15	7.25
FEATURE COMPARISON		
Integrated debugger	Yes	No
Overlays, including EMS support	Yes	No
8087 floating-point emulation	Yes	No
Turbo Debugger support	Yes	No
Procedural types, variables, parameters	Yes	No
Smart linking of code and data	Yes	No
Constant expressions	Yes	No
EMS support for editor	Yes	No

Benchmark (25 iterations) run on an IBM PS/2 Model 60

Feature highlights

- Includes the compiler, editor, and debugger, all rolled into one
- Integrated source-level debugger lets you step code, watch variables, and set breakpoints
- Overlays, including EMS support
- 8087 floating-point emulation
- Support for Turbo Assembler and Turbo Debugger
- Procedural types, variables, and parameters
- Smaller, tighter programs: Smart Linker strips both unused code and data
- Constant expressions
- EMS support for editor
- Only $149.95

Debugging: The inside story

Turbo Pascal's new integrated source-level debugger takes you inside your code to fix errors fast. Don't worry about errors, everyone makes them; but with the right debugger, this one, it's a fast fix.

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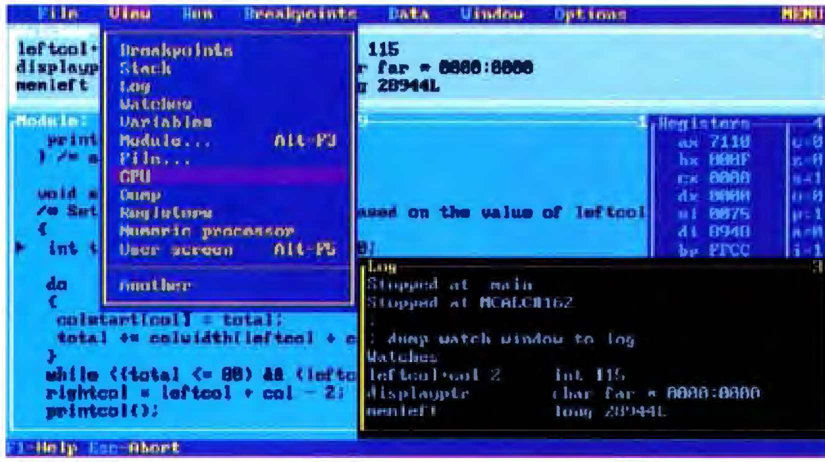
With EMS support, remote debugging, and 386 virtual machine debugging, there's no limit to the size of program you can debug. In fact with 386 virtual machine mode, debugging takes *zero*, bytes of conventional memory!

See what's happening

Overlapping windows give you multiple views of the program you're debugging: source code, variables, CPU registers, call stack, watches, breakpoints, memory dump, and more. And a new "session-logging" feature tracks and records your every move.

You're in control

Our breakpoints give you more control than anyone else's. Ordinary debuggers only get you to a stop, then they stop. When our breakpoints are triggered you can simply stop, or you can print expressions, run code, send messages to the session log, or even evaluate an expression with user-defined function calls. And *all* our breakpoints are conditional.



Shown here are views of source code, CPU registers, watch expressions, and a session log.

Unique Data Debugging

Plain Vanilla debuggers can only give you *code* debugging. Our new Turbo Debugger give you *data* debugging too. You can browse through your data from the simplest byte to the hairiest data structure, inspect arrays, and walk through linked lists. All by point and shoot.

Feature highlights

Breakpoints

- Actions: stop, run code, log expression
- Break on condition, memory changed
- Software ICE capabilites
- 386 debug register support
- Support for hardware debuggers

Debug any program

- Turbo Pascal, Turbo C, Turbo Assembler
- EMS support
- 386 virtual machine and remote machine debugging
- Supports CodeView® and .MAP-compatible programs

Data Debugger

- Follow pointers through linked lists
- Browse through arrays and data structures
- Change data values

New Turbo Assembler® lets you write the tightest, fastest code

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Turbo Assembler is designed for easy interfacing with high-level languages like Turbo Pascal and Turbo C. We use Turbo Assembler on Quattro,® our best-selling spreadsheet program; now you can write your own best-seller with Turbo Assembler!

Feature highlights

- Faster than other assemblers
- MASM compatible (4.0, 5.0, and 5.1)
- Significant new assembly language extensions
- Easy interfacing with high-level languages including Turbo C and Turbo Pascal
- Full 386 support

TURBO DEBUGGER

FEATURE COMPARISON	TURBO DEBUGGER	CodeView®
Multiple overlapping views	Yes	No
386 virtual-86 mode debugging	Yes	No
Remote debugging	Yes	No
Data debugging	Yes	Partial
Generalized breakpoints	Yes	No
Session logging	Yes	No
Conventional memory used—80386	Zero K	230K
Conventional memory used—remote	15K	N/A

Turbo Debugger version 1.0, Microsoft CodeView version 2.2.

TURBO ASSEMBLER

BGIDEMO BENCHMARK	TURBO ASSEMBLER	Microsoft® Assembler
Assembly time (seconds)	9.34	27.46
Link time (seconds)	4.15	10.51
FEATURE COMPARISON		
MASM compatible (4.0, 5.0, 5.1)	Yes	No
Thorough type checking	Yes	No
Nested structures and unions	Yes	No
Multimodule cross reference	Yes	No
Assemble multiple files	Yes	No

Run on IBM PS/2 model 60 using Turbo Assembler version 1.0, Turbo Linker version 2.0, Microsoft Macro Assembler version 5.10, Microsoft Overlay Linker version 3.64.

)ebugger, Turbo Pascal 5.0

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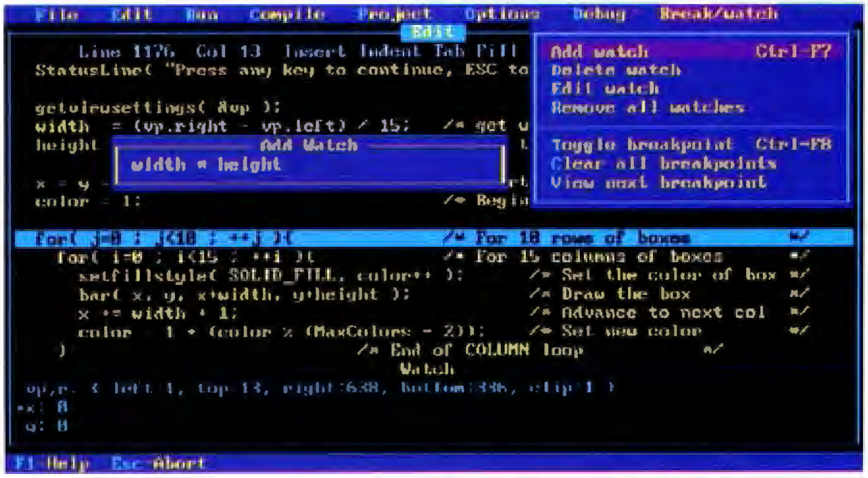
Make bugs bug off

Nice bugs are dead bugs, and Turbo C 2.0's integrated source-level debugger lets you find them and flatten them in a flash. You can set multiple breakpoints, watch variables and evaluate expressions—all from inside your integrated C environment.



Debugging in the Turbo environment: shown here an expression is being added to the Watch window in Turbo C. The Execution Bar highlights the next line the debugger will execute.

TURBO C 2.0		
HEAPSORT BENCHMARK	TURBO C 2.0	Microsoft® C 5.1
.OBJ size (bytes)	843	945
.EXE size (bytes)	6896	7731
Execution time (seconds)	8.1	12.2
FEATURE COMPARISON		
Integrated debugger	Yes	No*
Inline assembly	Yes	No
Auto dependency checking	Yes	No
EMS support for edit buffer	Yes	No
Device-independent graphics	Yes	No
Number of memory models	6	5
Price	$149.95	$450.00

Heapsort compiled with full optimization. Benchmark run on an IBM PS/2 Model 60.
*Integrated debugger included with Quick C.

Minimum system requirements: For the IBM PS/2™ and the IBM® family of personal computers and all 100% compatibles. PC-DOS (MS-DOS) 2.0 or later. Turbo Debugger minumum 384K. Turbo Assembler minimum 256K. Turbo C and Turbo Pascal minimum 448K (256K comment line version).

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3 ☐ Turbo Pascal with 5.0 upgrade manual and disks	N/A	49.95
4 ☐ Turbo C with 2.0 upgrade manual and disks	N/A	49.95

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OCTOBER 1988 VOL. 13/NO. 10

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THE RUSSIANS ARE COMING

And they're looking to do business with some very interesting software

On a steamy Friday in New York late last summer, some members of BYTE's staff met with a group of senior Soviet computer scientists. The purpose was to learn about the state of the art in Russian computer technology and to see demonstrations of IBM PC AT-based software that they hope to export to the West.

Almost the entire Soviet delegation was made up of members of the USSR Academy of Sciences. Attendees included Boris Batalov, head of the Scientific Research Institute; Lev Bogdanov, chief of the Department of Applied Physics and Mathematical Sciences for the Presidium; Vadim Kotov, deputy director of the Siberian Computer Center; and Alexander Vasenkov, head of the State Committee for Computer Technology.

Their software demonstration is a self-running "film" (their word)—sort of a Dan Bricklin-like demonstration: a fast-moving, sound-and-color canned presentation of mock-up screens that are meant to reflect the actual product. Lots of colored windows pop up everywhere, with native Russian explanations of what's going on translated (and, sometimes, confusingly transliterated) into English. In all, it's very interesting.

The demonstration includes a powerful equation solver; a simpler, for-fun program for solving mathematical puzzles; a database you can query in natural language to find out (using their examples) when *Good Night, Little Ones* is playing on State TV; a time planner/project management package (interestingly, they call it "plan" management); a macroeconomics modeler (their demonstration actually models the Russian State economy through the year 2000); and lots of information on the expert-system technology they used to construct these programs from "modules."

Vadim Kotov, who did most of the talking for the group, stressed that their system was not just a set of tools, but a "factory" of interconnected applications that can be used to create complex programs in a very short time.

It all looks very flexible and modular; it's written in a powerful hybrid of Prolog and Smalltalk—sort of an object-oriented Prolog.

The whole demonstation is clever, flashy, and unabashedly commercial—they're looking for American companies to market their "software factory" technology. (And vice versa: DataEase International set up their visit to the United States and as a result will be selling a database program in Russia.)

Because the demonstration software gives a glimpse into a heretofore largely unknown portion of the microcomputing community, we'll make the program available in the listings area of BIX so you can see it for yourself: Look for RUSSIAN1.ARC, RUSSIAN2.ARC, and RUSSIAN3.ARC in the FromBYTE area. You'll need a computer with EGA to see all the demonstration, although some parts of it will work on monochrome systems.

We also saw another program separately demonstrated: Lexikon is a Russian word processor similar to WordStar but not a clone. Kotov said he was particularly proud of the thesaurus included with this product; Russian uses a number of declensions, so a thesaurus has to be clever to work well.

Kotov's group has been busy. For example, it designed the typesetting system for *Pravda* (with a circulation of 10 million, it's one of the world's largest publications). The *Pravda* system uses multiprocessing, and it has a "flat" structure (i.e., one layer of modules rather than a hierarchy of modules and submodules).

Kotov's group also recently designed the first Soviet 32-bit microcomputer: It looks more like a PDP-1140 than a desktop system. At its heart is a basic multiprocessing chip with reduced-instruction-set-computer-like architecture. The processor is "something like a Transputer," but they do not use Occam, the multiprocessing programming language developed for the Transputer by INMOS. Nor do they use the asynchronous communication bus developed by INMOS. Instead, they use a FIFO synchronous channel.

By coincidence, we had brought along a Definicon two-Transputer board to show them; the chips occupied barely half of one AT-style card. Kotov said the equivalent Soviet silicon and support circuitry would fill a volume about half that of an entire AT *system*.

One of the Russians mentioned that there were 200,000 personal computers in the Soviet Union, most of them Russian-made clones of the IBM PC and AT. They would like to buy or build 80386-based systems, but the most advanced chip that can be legally sold to them is an 80286 running at 12.5 MHz or slower.

The most popular programming language in the Soviet Union is C, followed by Pascal and Modula-2. The Soviets use C primarily under the Unix operating system.

Most computers are in offices, but a small number of programmers are able to take their computers home to work there.

Because of a shortage of Western currency, most Soviet institutions get only one copy of BYTE, which goes in the library. When the issue arrives, Kotov says, a line of people forms to sign up to read it. Kotov says he and his colleagues refer to the magazine as "PlayBYTE, because it has so many interesting things to look at."

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

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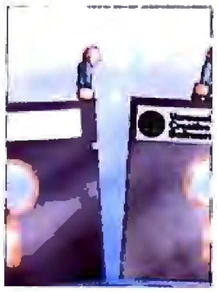

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Staff-written highlights of developments in technology and the microcomputer industry

Language Lets Anyone Do Windows, Develop Programs with Modern Look, Graphics Interface

Developers at Carnegie-Mellon University in Pittsburgh say they've got a computer language that will let nonprofessional programmers write programs that use those hot graphics-oriented features characteristic of today's operating systems, such as windows, pull-down menus, and multifont text. The language is cT, short for CMU Tutor. Tutor was originally part of the PLATO educational system at the University of Illinois, but according to Bruce Sherwood, associate director of Carnegie-Mellon's Center for the Design of Educational Computing and one of cT's developers, this new language goes far beyond the original.

The language is "really designed for any kind of computer programming, including research computing. It's a general-purpose language for any situation where you're going to have a modern user interface," Sherwood said. It's also highly machine-independent, he said, because cT implementations are designed for font and graphics rescaling; the same cT source code will run on a Mac, a Sun, an IBM RT PC, and a microVAX—and on most of those machines, Sherwood said, cT is the only language that lets ordinary people program using graphics and multifont text.

"One way of describing Tutor languages is to say that their goals and methods are reminiscent of a very good BASIC," Sherwood said, but cT begins "from the expectation that you're writing a program for somebody else to use." For example, Tutor's input statement lets the program not only get input from the user, but also make sure it's the right kind of input. "The programmer doesn't have to do all the analysis to make the validity checks. You're encouraged to look," Sherwood said.

"There are five things any language has to do. Calculate, display, sequence, analyze input, and read and write files. Where cT is strong is display, sequence, and analysis."

A cT program consists of a set of root-level procedures called "units"; these can accept parameters by value or address and return a result. Units are linked with the commands **next** and **previous**: A user can pull down a menu and click on **previous** and review the previous unit. "With Tutor-class languages, a program is really a whole archipelago of these unit islands, and there are some interesting structures between the islands," Sherwood said.

Source and execution windows are both active; because fonts and graphics can be scaled, you can see a miniature version of your execution window if you like. A programmer can select a source-code coordinate by clicking the mouse at a point in the execution window. There's also an on-line reference manual, complete with working examples that you can cut and paste into the source window and execute. "It's a fabulous situation for programming by example," Sherwood said.

At Carnegie-Mellon, cT has been in use for a year, but it's only now becoming commercially available. The Macintosh version, which runs on the Mac Plus, the Mac SE, or the Mac II, is $92.50 from cT Distribution, Center for the Design of Educational Computing, Carnegie-Mellon University, Pittsburgh, PA 15213, (412) 268-5638. An IBM PS/2 version will follow shortly, and a Unix version (running under X-Windows) should be available later this year.

Texas Instruments Mixes GaAs and Silicon on Same Chip

In the chip-making business, silicon and gallium arsenide (GaAs) are like water and oil—they just don't mix. The standard ways to make chips from each substance are almost completely incompatible; silicon chips use TTL-level inputs and outputs, for example, while GaAs typically runs at microwave frequencies. It's only recently that one company, Gazelle, has created a GaAs chip that can be used in conjunction with conventional silicon chips.

But Texas Instruments researchers have now demonstrated the first ICs that contain both silicon and GaAs transistors on the same piece of silicon. Ac-

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NANOBYTES

• "Computer Chip Saves Nation from Attack of Killer Bees." We might be seeing that headline sometime in the future if researchers at a Martin Marietta lab in Oak Ridge, Tennessee, succeed in a project that will use **a chip** to track the infamous **killer bees**. The device, which a spokesperson said weighs "about as much as a grain of salt," will transmit an infrared signal that can be picked up as far as a mile away. Researchers, who want to monitor the mating and foraging habits of the aggressive creatures, have managed to glue the chips to captured bees, and the bees have been able to fly with the chips stuck to their bellies. The engineers hope to have a working transmitter by next year. The deadly buzzers are projected to cross the Texas border into the U.S. in the next few years.

• The new **MathStation** program from **MathSoft** (Cambridge, MA) not only cuts coding chores but also lets you laser-print a screenful of equations and formulas and get a page that looks like it came from a typeset textbook. The program, which is an interesting combination of page-layout and equation-solving software, converts the material on screen (displayed in WYSIWYG style) to PostScript.

You control the fonts and spacing. But the pro-

continued

NANOBYTES

gram also parses and compiles the equations you input, using the host system's FORTRAN compiler. MathStation, which company VP and MathCAD creator Allen Razdow said is based on the concept of an incremental compiler, interprets equations as mathematical objects and generates executable FORTRAN code, which can be used in other applications. Any equation can be converted into a FORTRAN77 routine, he said, freeing the user from such chores as coding and debugging. Although the first version ($9500 per license) runs only on Sun 3 and 4 workstations, the company intends to do an edition for the Sun 386i. A Mac II version will have to wait until the machine supports X-Windows, Razdow said.

• Despite U.S. software companies swooping like Chuck Norris into Far East countries where piracy is said to be rampant, the problem of **illegal copying** is probably going to get worse, says one attorney who has studied the problem. You can go to Hong Kong and get Lotus 1-2-3, dBASE, Word, or other programs for about **$6 a package**, Los Angeles lawyer Mike Scott told us after a fact-finding mission to Hong Kong and China, neither of which has laws protecting software copyrights. Software pirating is worse in Hong Kong, where it's an industry controlled by organized crime, he said. Customers from the U.S., Australia, and Singapore buy suitcases full of software, Scott said. And a contact in

continued

cording to Hisashi Shichijo, who developed the new process along with Richard Matyi, "This means we can take advantage of the merits of gallium arsenide and silicon on the same chip."

Shichijo said the new process is significantly more complicated than the Gazelle approach, which will allow designers to mix GaAs and silicon chips on the same circuit board. The new TI process mixes the materials on the same chip. "A chip designer traditionally has to choose between the two," Shichijo said. "Gallium arsenide is faster, but it has problems—it's small, it's fragile, it breaks, it has defects—so it's not possible to build large-scale circuits. What we've done is to deposit localized gallium arsenide films on a silicon substrate, so you can add GaAs devices or circuits to silicon circuits."

This makes large-scale GaAs circuits practical, but because the silicon and GaAs circuits can be mixed on a chip, large-scale GaAs won't usually be necessary, Shichijo said. "You can put the GaAs where you'd really like to have speed, and use silicon for the rest of it." For example, silicon memory could incorporate GaAs control logic for better response time; a dense silicon microprocessor might have an integrated GaAs register file or cache.

In developing the GaAs-on-silicon epitaxial growth technique, the TI researchers aimed to develop a process that could be applied directly to high-volume production. According to Richard Matyi, "Because silicon processing is extremely sensitive to the presence of impurities—and GaAs essentially represents an impurity—we completed silicon processing before we added the GaAs. And although it would have been simpler to grow the GaAs atop the silicon in layers 2 to 3 micrometers thick, we decided to embed the GaAs islands in the wafer to produce a coplanar surface. Devices with such flat surfaces are easier and more cost-effective to manufacture in high volume, and they're more reliable."

Shichijo said GaAs optical devices, such as lasers, could be included on silicon chips to speed up chip-to-chip communication by a factor of 10. To demonstrate the new chip, the researchers produced several ring oscillators that mixed silicon CMOS and GaAs metal semiconductor field-effect transistor circuits.

But some designers say GaAs has a long way to go before it's a commercially viable component of desktop computers. They think it will be a long time before chip makers can produce GaAs on silicon substrates at good yields, and they may never overcome problems inherent in GaAs circuitry.

DCA/Intel Spec Could Mean Communications without Bit-Twiddling

The new DCA/Intel Communicating Applications Specification (CAS), put into the public domain in August, could simplify electronic communications if enough hardware and software vendors use it to develop communications interfaces for use in their applications.

CAS is a specification for writing code that intermediates between an application and a communications service. Using CAS, applications can transparently direct output to the communications device in much the same way that data is transparently sent to a printer. The initial release of CAS supports communications only via facsimile modem hardware (such as Intel's new Connection CoProcessor). However, subsequent releases will support Hayes-compatible modems and PC-mainframe communications boards.

A software developer can use the CAS to write a communications program, which can be integrated with the primary application. Symantec has already integrated CAS functions with its Q&A software, allowing Connection CoProcessor users to transparently send Q&A files to other fax machines by selecting a menu option from within Q&A. Other software vendors, such as WordPerfect, Borland, Lotus, and Ashton-Tate, said that they will support the CAS.

The CAS consists of two hardware-independent software components. The Resident Scheduler controls the destination and scheduling of file transmissions between the sender and the recipient. The Transfer Agent, similar to a device driver, handles the details of connecting to the recipient, ensuring accurate data transmission, and disconnecting from the communications session. CAS provides rules, codes, and functions for implementing the scheduling and device driver tasks.

Widespread support of CAS could have a major impact on the often-incompatible world of electronic communications. One company is working on using CAS and the Connection CoProcessor as a gateway to allow remote users to access LANs at 9600 bps. With

continued

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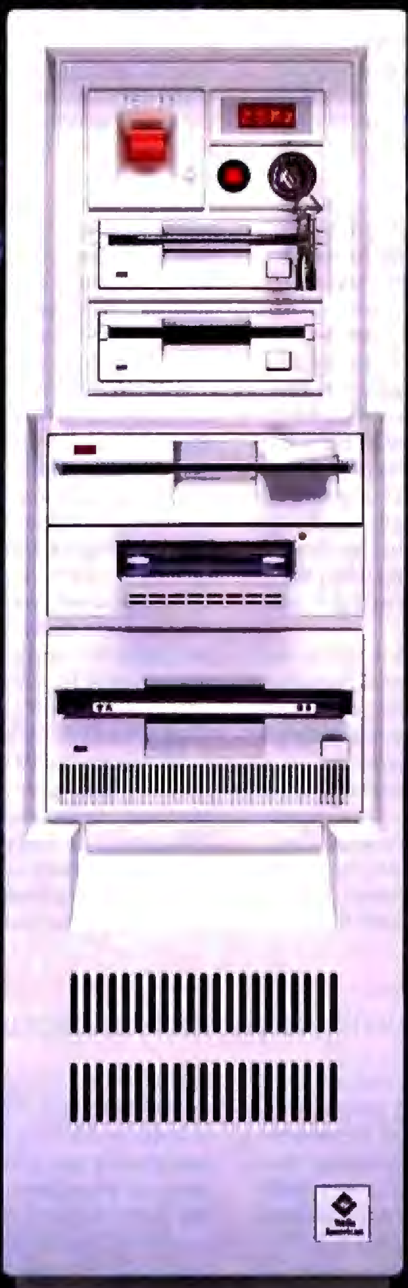

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NANOBYTES

Singapore said residents there can easily go to Malaysia and pick up pirated products. Relentless legal pressure could make it too expensive for pirates to operate, Scott said. "Doing one raid and having a news conference won't solve the problem."

• **Unix** and **OS/2** will be the prevalent operating systems in **server environments**, according to a new report from Forrester Research (Cambridge, MA). And why's that? Primarily because they stay basically the same across different vendors' hardware and free users of client/server systems from proprietary designs, a Forrester researcher said. By 1992, Unix will be the big operating system on **high-end database** and **fault-tolerant machines**, and OS/2 will be used with more than half the file and print servers, the researchers say.

• Unix is also the best environment for **electronic publishing**, says another research group, because of its multitasking, multiuser features. "Efficient handling of graphics is the name of the game," said Ajit Kapoor, vice president of CAP International (Norwell, MA). And Unix does that better than any other operating system currently available, he said. Unix skeptics, though, say it lacks the applications to woo new users. But Kapoor said all that will change. And how about that user interface? According to CAP, Unix proponents expect that the cosmetic surgery proposed by AT&T/Sun and the Open Software

continued

built-in support of CAS in software applications, transparent file transfers and electronic messaging will be possible between incompatible or remote systems. As Borland's Rob Dickerson put it, "You won't have to be a bit-twiddler to use communications."

Contact Intel PCEO at Mail Stop CO3-07, 5200 Northeast Elam Young Pkwy., Hillsboro, OR 97124 or call (800) 538-3373.

Memory Chips Have Brains, Do Processing Jobs

After hitting too many snags and nixing a project to build a massively parallel matrix-multiplication analog chip for pattern-recognition applications, Oxford Computer (Oxford, CT) founder Steven Morton hit upon the idea of what he calls "intelligent memory chips." With Morton's design, adding memory also adds processing power. The chips, which are strung together in a module that fits in the palm of a hand, do more than serve as memory devices; they also take care of some of the processing chores, which gets around the slowdown caused by moving bits back and forth between memory and the central processor.

In an interview at the International Conference on Neural Networks, Morton said that standard memory is inefficient for matrix-intensive applications, such as three-dimensional graphics and pattern recognition, because data must be moved out of memory to a separate processor for computations and then returned to memory for output of the results. Intelligent memory chips have the capacity to perform "intense computations and work cooperatively," he said. The capability to perform on-board matrix manipulation also distinguishes the chips from so-called smart memories, such as video dynamic RAMs, that include on-board shift registers.

Morton points out that his chips are not suited for applications that don't require intense matrix manipulation—so don't plan to replace your conventional memory chips and expect a blazing performance increase with your word processor. And he's currently looking for financial support to manufacture the chips and expects availability in the third quarter of 1989.

The chips can be configured in "intelligent memory modules" that contain from 64K bytes to 1 megabyte of storage to provide 1.28 billion 8-bit multiplications and additions per second for image processing; 40 million 32-bit multiplications and additions per second for 2-D fast Fourier transforms and real-time 3-D graphics; or 80 million floating-point operations per second.

Each chip provides its part of the matrix solution; the partial results are then accumulated to come up with a final solution. A control chip manages the partial results and provides interfacing to the host bus. All this occurs without transporting blocks of data in and out of memory, tying up the bus, and slowing down the central processor. Morton envisions a graphics board with his special chips that plugs into a system's bus.

Morton claims that his approach skirts the Von Neumann bottleneck encountered when intense computational activity can clog the data bus and overload the processor. "With memory actually manipulating the matrix information, the central processor can go off and do other things," he said.

Program Will Help with Conceptual 3-D Design

Most CAD and solid modeling programs today are intended for preparing detailed, completed designs. However, conceptual and preliminary design tools are mainly limited to 2-D drawing programs. Most designers still do most of their preliminary work on paper and then transfer the design to the computer. One of the main problems with conceptual design on the computer is the difficulty of locating and specifying points or features of the object in 3-D space. Of course, you can specify any point if you know its coordinates, but in the early stages of design, you're not thinking about dimensions or coordinates. You want to be able to intuitively locate the point on the screen.

To facilitate conceptual design on computers, researchers at Stanford University are working on a geometric editor called a "cut-plane solids editor." Instead of using a cursor to locate a point on the screen, the cut-plane editor uses a transparent plane that you can move through space with a mouse or some other pointing device. The plane provides a perspective in relation to other points on a 3-D object. According to grad student Larry Edwards, "the objective is to enable the user

continued

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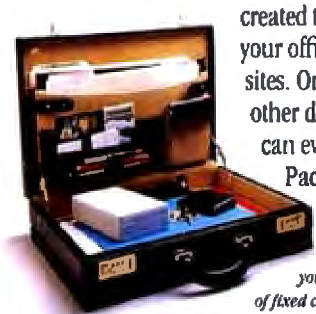

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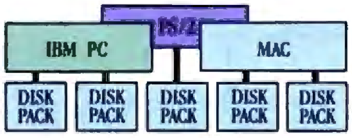

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Foundation will make Unix more attractive to people baffled by grep and awk. As for another multitasking system, CAP said those Unix users surveyed say OS/2 won't affect their commitment to Unix.

• If you think **LCDs** are used only in watches and laptop computers, check this out. Hitachi America (Sunnyvale, CA) has a new LCD-based display that measures 2 meters across, has a resolution of 2000 by 2000, and has three lasers projecting the primary colors through high-resolution LCD light valves. The display is controlled by its own computer, which has a serial port and hard disk

continued

to see visual clues between the cursor and the object in question."

The plane can be translated and rotated in real time to intersect an object at any location or angle, thereby eliminating the need for multiple views and giving the user more of a feeling of actually working with a 3-D object.

Once you have positioned the plane, all manipulations (line drawings, intersections, addition of object primitives) are constrained to occur within the plane. Currently, the cut-plane editor uses a polyhedral model to represent objects. The researchers can rotate and manipulate points in the cut-plane/object intersection, rotate the object independently or in conjunction with the cut-plane, rotate about an edge or intersection line, or extrude a cross section of the object.

Eventually, the editor will have other object primitives, such as curved surfaces, granularity, and visual features needed for conceptual design. The current version is written in C and runs on a Silicon Graphics 1400. Edwards said that Lisp would have been ideal, since the program involves the manipulation of lists, but that performance would have been too slow. The cut-plane project is under the supervision of the Stanford Institute of Manufacturing and Automation.

Prototype "3-D Computer" Stacks Processors

The prototype for a 3-D integrated circuit that packs 1024 processors into a single chip has been developed by scientists at Hughes Research Laboratories (Malibu, CA). The so-called 3-D computer is the first step in developing an ultrafast machine that squeezes supercomputer power into a processor about the size of a tuna can.

"The 3-D computer is an array processor, architecturally and behaviorally," Hughes staff scientist Mike Little told Microbytes Daily (available weekdays on BIX). "That means it has a certain range of applications—for example, image processing, radar signal

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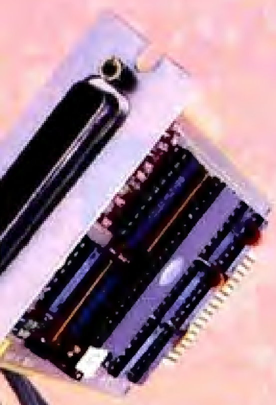

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drive. The cost is $300,000.

• To help solve the problems involved in dealing with massive amounts of information, the National Science Foundation has awarded grants to several universities with top-notch computer science departments. At the University of California at Berkeley, they'll be working on a hierarchical storage system based on an experimental "super information server" that has an 80-million-instruction-per-second processor, 1 gigabyte of primary memory, 1 terabyte of optical disk storage, 100 high-capacity disk drives, and a fiber-optic network.

processing, weather modeling, and finite-element analysis."

The chip consists of a set of stacked silicon wafers. Each wafer contains an array of 32 by 32 processor segments, each of which is connected to its four neighbors on the wafer as well as to the other wafers in the stack. "We developed two technologies," Little said. "One involves connections through a wafer; the other involves the connections from wafer to wafer. The new technology allows us to rethink how to partition circuits."

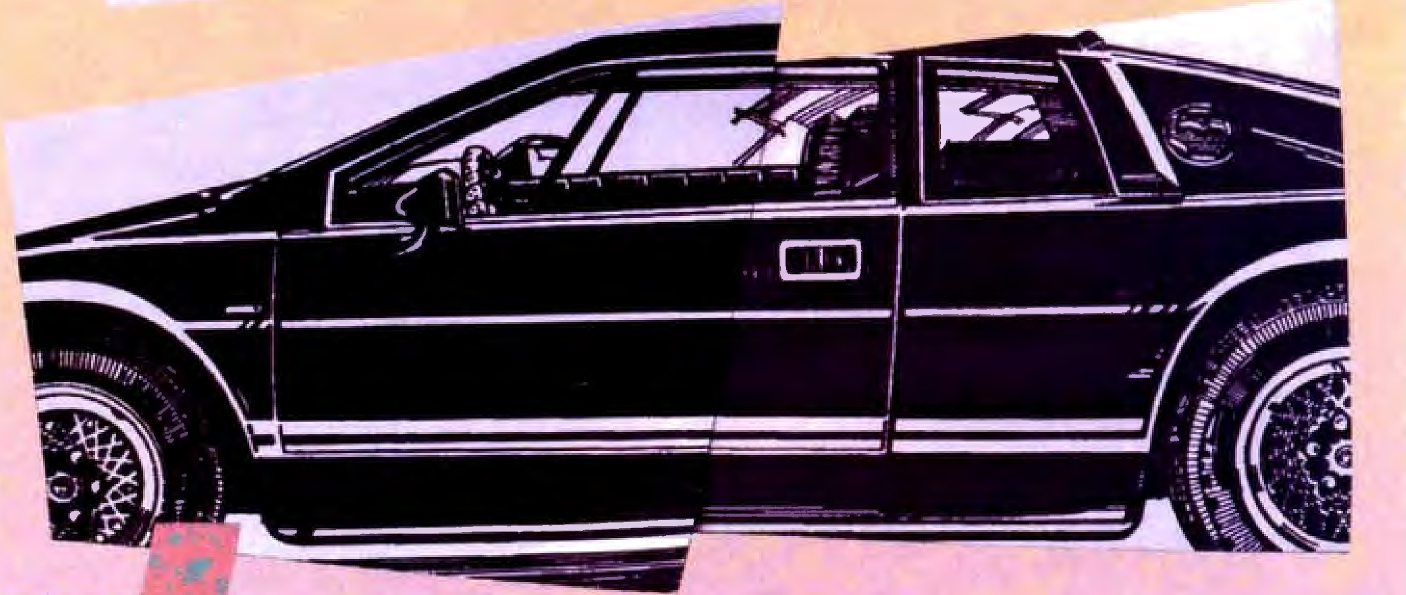
To make a connection from one wafer to another, Little's team uses a "microbridge": an inverted U on top of one wafer and on the bottom of another. "When you stack the wafers, the pair of U's intersect and form the connection between the two wafers," Little said. To make connections through a wafer, the Hughes scientists use an innovative form of thermal migration to create 10,000 channels at a time in each wafer.

TECHNOLOGY NEWS WANTED. *The news staff at BYTE is interested in hearing about new technological and scientific developments that might have an impact on microcomputers and the people who use them. If you know of advances or projects relevant to microcomputing, please contact the Microbytes staff at (603) 924-9281, send mail on BIX to Microbytes, or write to us at One Phoenix Mill Lane, Peterborough, NH 03458. An electronic version of Microbytes, which offers a wider variety of computer-related news on a daily basis, is available on BIX.*

To make the 3-D computer, Little explained, "First we put the channels in, then we add the circuits—conventional circuit fabrication from a commercial foundry." Instead of putting a complete processor on each wafer, only one section of the processor appears on each wafer; when the wafers are stacked, each column forms a complete processor. As a result, "the complexity of the processor is how deep it is, not its lateral extent," Little said; a more complex processor could be constructed by stacking more wafers on top of those already there.

The current 3-D computer contains 1024 processors in a 32- by 32-processor array; it's a fixed-point, 16-bit computer in a chunk of silicon 3 inches square and a half-inch high.

These unretouched print samples show the superior print quality of QMS-PS 810 over printers using first-generation print engines.



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LETTERS

Lab Lift

Your lab staff has been a magnificent help over the past months. I'm brand new to the microcomputer world, and the lab staff has been instrumental in helping me map that world. Their assistance on general questions, benchmarks, and video has allowed me to take a lead role in the Air Force Small Computer Office.

Please pass along my thanks to your entire staff for their help and for bringing me an incredibly good magazine every month.

Johnathan M. Wilson, *2d Lt., USAF*
Computer Systems Test Engineer
Gunter AFS, AL

Where Credit Is Due

The companion articles "The CPU Wars" and "What They Did Wrong" (May) were excellent nostalgia pieces for me. However, both articles attributed the 6502 to Mostek, a Dallas-area firm. The 6502 was originated by some ex-Motorola designers and first produced by MOS Technology, a silicon foundry later purchased by Commodore.

I started with personal computing about the time the 6502 was introduced, and my first "personal computer" was a KIM-1. I still have that computer, and it's in working condition. This machine has a six-digit LED display, a 24-key keyboard, and 1K byte of static RAM.

In 1977, at least one computer scientist rated the KIM-1 as having the "most bang for the buck" in terms of classroom hands-on applications. This capability was generated by the two PIA-style support chips, one 6530-5 (operating system in masked ROM) and one 6530 (no ROM). To this day, more than 12 years after its introduction, the KIM-1 remains a strong example of the effectiveness of dedicated support chips in computer design.

Ralph Tenny
Richardson, TX

Everyone into the Spool

In "Weighing the Options" (July), Brett Glass states that "spool" stands for "simultaneous peripheral operation on-line." That acronym seems to be a recent ad hoc creation. In the old mainframe days, output could be sent to a "spool" of tape to be printed later. That is the origin of the terms "spool" and "spooling." Well, it could have been called "reeling."

Jud McCranie
Valdosta, GA

Environmental Impact Statement

I have a comment regarding "A Turbo TSR" by Scott Robert Ladd (July). While he correctly notes that a terminate-and-stay-resident (TSR) program should free up the environment segment, his program should not wait until de-installing itself to do this. A TSR program should free the environment when it installs itself.

One of the seemingly little known aspects of writing TSR programs under DOS is the proper handling of the environment segment. Unless the resident part of your program uses the environment segment, it should be released during the installation process, before making the TSR call. Unfortunately, many programs—including a lot of commercial TSRs—do not do this; thus, each one I install gobbles up another 600 bytes for a copy of the environment that it never uses. It seems especially strange that programmers waste space in this way when I see some of the tricks some of them do to try to save a few bytes in a TSR program.

The process that Mr. Ladd outlined for releasing the environment block is

continued

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correct. He just should have made his program do it upon installation, rather than upon deinstallation. I hope you will pass this tip on to your readers and that they, in turn, will use it to write better-behaved TSRs that don't use up more of our precious RAM than they need.

It seems likely to me that DOS dies with a memory allocation error when Mr. Ladd tries to deinstall QT because he is trying to deallocate memory that belongs to a different program. Since his TSR is no longer the running program, DOS probably regards its attempt to release memory as coming from whatever program QT interrupted, which does not own the segment in which QT resides; hence, the `memory allocation error`. I have never written a TSR that tries to release its memory on deinstallation, so I don't know the fix for this.

Michael Hanson
Seattle, WA

Another Option to Weigh

I have a comment regarding the letter from Dan Mick ("Multiplying Integers," July) and the article entitled "Weighing the Options" by Brett Glass (July).

First, a flaw exists in Mr. Mick's recommended solution. Merely adding the multiplication by (floating-point) 1 is not guaranteed to prevent the integer overflow. The parsing algorithm used by the compiler may detect (and generate code for) the integer-integer multiplication and then perform the promotion to floating point for the "1.0" multiplication. At the very least, place the "1.0" factor between the two integers. Even better, use parentheses to force the floating-point conversion first. For example,

```
20 A = (1.0 * B%) * B%
```

The best solution would be to use an intrinsic conversion function, which should be supplied with the compiler and/or run-time system—something on the order of the following (the actual function name may vary with the compiler and language):

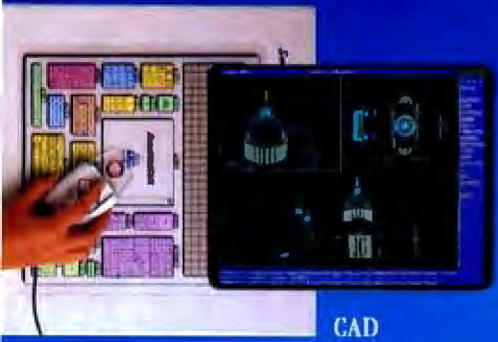
```
20 A = B% * CSNG(B%)
```

Now for a comment on Mr. Glass's comparison of Amiga signals to semaphores. As the owner of an Amiga A-1000, I could not let this mistake stand, especially as KickStart 1.2 implements both signals and semaphores.

Amiga signals are closer in nature to the event flags of VAX/VMS. Each Amiga task has its own set of signal bits;

continued

Desktop Publishing



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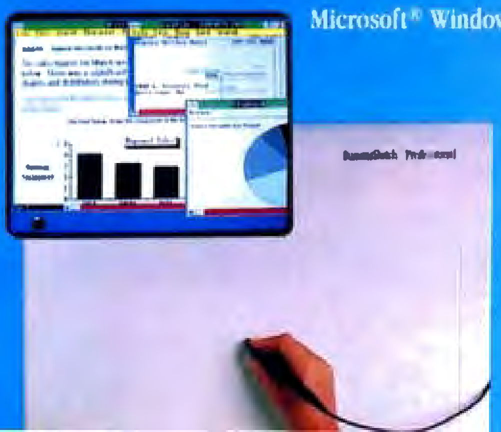

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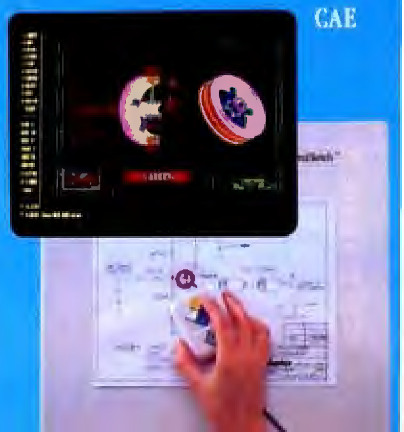

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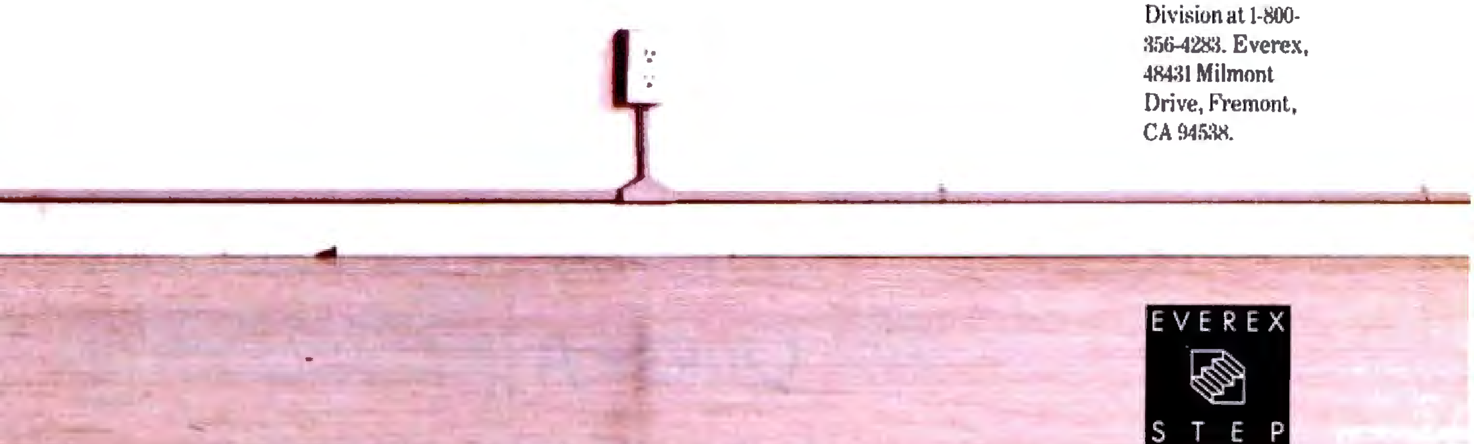

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in use, a bit will be allocated to some event that the task is interested in (mostly I/O completion), and the task then waits for the bit to be set. Semaphores, on the other hand, tend to be global to the system, where multiple tasks can obtain access to a single semaphore.

In fact, the Amiga implements two different types of semaphores. An immediate bit-test form allows for a simple test-and-set call (which returns immediately, with a success/failure status) or an unconditional wait-for-semaphore call (which does not return until the semaphore has been obtained). The message-based form allows for semaphore requests to be queued; a task can submit a request for the semaphore, continue processing, and, at a later time, test (or even wait) for the availability of the semaphore.

A bit of humor appears here. The Amiga calls `Procure(s)` and `Vacate(s)` bear a suspicious resemblance to the classical `P(s)` and `V(s)` semaphore primitives of Dijkstra—which *Principles of Concurrent Programming* (M. Ben-Ari, Prentice-Hall International) claims are derived from the Dutch words for Wait and Signal, respectively (Wait and Signal already having been taken up by earlier releases of the Amiga Exec).

Dennis Lee Bieber
Sunnyvale, CA

Going from .MAC to .ASM

First, I'd like to thank Rick Grehan and all the people responsible for the Small-C compiler. Rick's suggestion about changing the output of the compiler from `.MAC` files to `.ASM` files is a good one, since I'm basically lazy and don't like typing the extension when I'm assembling the files.

If any of your readers want to make the change from `.MAC` to `.ASM`, the code is contained in the `CC11.C` file under the `openfile()` function. Simply change `strcpy(outfn + j, ".MAC");` to `strcpy(outfn + j, ".ASM");`.

While in the `CC21.C` file, users might want to fix a small problem with the usage line. When cc86 and any invalid character is typed, a usage line is presented that informs the user of the options available to the compiler. For example, if you type cc86, the response usage will be `cc [file]...[-m] [-a] [-p] [1#] [-o]`.

The usage will give you all this and a few garbage characters. To fix it, you simply look at the end of the `ask()` function after the last `#endif` and change `sout(NEWLINE, stderr);` to `sout("\n", stderr);`. The explanation of this is that sout is expecting a string, and although `NEWLINE` is a linefeed (character 10), sout has a problem with this. It really goes deeper; it has to do with the way fputc expects `"\n"` to escape for a new line, while `NEWLINE` is a raw linefeed.

Enough of that. Thanks again for the compiler. I'm having a blast with it.

Gary Flynn
San Gabriel, CA

Practically Speaking

Peter Wayner's remarks on "Error-Free Fractions" (June) are correct from a theoretical point of view. Practical application, however, will be difficult, even if special processors and compilers could be realized for calculating the way he suggests.

The problem is the degree of precision that can be obtained, in relation to memory use and execution time. For in-

continued

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stance, for a precision equivalent to 64 bits, or 19 decimals, only rational numbers can be used whose denominators contain no prime factors larger than 22. Prime-number denominators of more than 5 digits can't be gotten through, not even on the biggest computers, within an acceptable lapse of time.

I think an easier, but less interesting, way of exact calculation with fractions is to simply store the numerator and denominator separately. Memory use and execution time then remain of the same order (say, 3 or 4 times as much) as with normal floating-point calculation.

Even then, error-free fraction calculation is not useful, because the improved precision is of no importance compared to the loss of speed—except in very special projects. Mr. Wayner's examples of errors in floating-point calculation are rather far-fetched, whereas his results by using factorial-base notation deal with denominators that are composed of very small prime factors only.

The article is interesting for two reasons. First, the mathematical theory is explained in a clear-cut way. Second, it illustrates an amazing lack of contact, on the whole, between mathematics and computer programming, apart from small circles of super specialists. In high school and college, very little is done on behalf of this (I'm speaking of Holland, but I suppose it's the same in the U.S.).

Derk Boonstra
Amstelveen, The Netherlands

You Can't Be Too Careful

I have a few comments on articles in the June issue.

Regarding "Computers on the Brain, Part 1" in Ciarcia's Circuit Cellar: Warnings notwithstanding, an electrical device attached to the human body should include isolation as close to the signal source (i.e., flesh) as possible. Burns have been documented resulting from battery-powered, FDA-reviewed, professionally manufactured medical devices; the potential is certainly greater in the case of a hobbyist-constructed (and possibly hobbyist-modified) device. Would opto-isolation be possible before the preamps?

Now on to my second comment. Peter Wayner's "Error-Free Fractions" asserts that "it's hard to tell if 501/1024 is greater or less than 5203/10456 without calculating the quotient." In fact, comparing ratio-represented real numbers simply requires a common-denominator cross-multiplication and comparison:

Given $r_1 = n_1 / d_1, d_1 > 0;$
$r_2 = n_2 / d_2, d_2 > 0;$

Let $p_1 = n_1 \times d_2,$
$p_2 = n_2 \times d_1;$

If $p_2 > p_1$, then $r_2 > r_1$,

Else if $p_2 < p_1$, then $r_2 < r_1$,

Else $r_2 = r_1$.

In this case, $p_1 = 501 \times 10456 = 5238456$, and $p_2 = 5203 \times 1024 = 5327872$; $p_2 > p_1$, so $r_2 > r_1$. By stipulating that the sign is carried in the numerator and the denominator is always positive, this operation works for arbitrary real numbers. Thus, the cost of comparison is two integer multiplies (with double-precision products) and one double-precision compare.

James L. Reuss, Ph.D.
Boca Raton, FL ■

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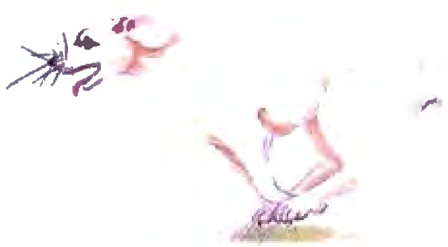

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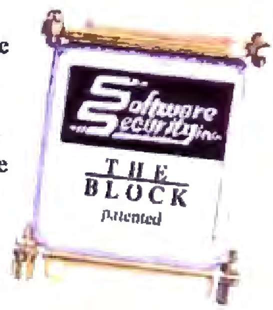

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CHAOS MANOR MAIL

Jerry Pournelle answers questions about his column and related computer topics

The European Market

Dear Jerry,

In your February column ("Life after Las Vegas," page 182), you seemed surprised that in Europe the Atari ST has gained a "serious machine" status, which perhaps it lacks in the U.S. In fact, most Americans don't realize that the computer market here in Europe is quite different from what they're used to. Prices here tend to be much higher for most brand-name machines, and some interesting products are hard to find.

To give you an example, I recently bought an Atari Mega ST2. Its list price, including a 20-megabyte Atari hard disk drive, was about $2700 here in Italy. Such a price might sound expensive in the U.S., but, for reasons beyond my comprehension, Apple is selling a comparably equipped Macintosh SE (with 1 megabyte of RAM and a 20-megabyte hard disk drive) for $5700. And dealer margin is low enough that you can't get a discount of more than 10 percent (which is comparable to what you can get on the Atari). As you can see, over here the Atari—even the Mega series—still gives you the most computer for your buck, at least in the 68000 world. In fact, I can buy an Atari Mega ST2 with a hard disk drive and the Atari laser printer for less than I'd have to pay for the Apple laser printer alone.

Given this, if you decide to get off the MS-DOS or OS/2 bandwagon and you don't have a little fortune to spend on the Mac, the Atari seems a good choice. As a result, many small businesses, professionals, consultants, and independent offices are turning to the Atari as a system that is inexpensive and easy to use. The Atari also lets them do their tasks (e.g., word processing, desktop publishing, and communications) at a reasonable price.

Why Apple is pursuing such a policy is a mystery to me, but I think Atari's big success is partly due to Apple's absurd pricing policy. If Macs here sold for what they do in the U.S., the market might be different. But in the current situation, the Atari is very strong, especially in England and in West Germany, where there's an impressive range of locally written software for the Atari computers.

As for the 80x86 world, the business here is lagging behind the U.S. developments; people are still buying 8088 machines as their first machines, not realizing that those are already obsolete. People are also very confused about the whole OS/2 story—whether it is real, whether it will be real some day, and so on. In fact, with so many hardware and software standards, doing system integration in the PC-compatible game is something short of a nightmare—more so here, because many things that would make your life easier just aren't available here. Often, if you decide to go with MS-DOS, you're stuck between either true-blue IBM (it costs a little less than $10,000 for a PS/2 Model 60 with a dot-matrix printer) or Taiwanese equipment, which is often sold by dealers with very little competence. Clone machines are usually a good deal, but you'd better know what you're doing, because no dealer will be out there to help you.

Macs are easily available (not so for the software, though, and I know of some official Apple dealers who make good money on pirated software), but at their high prices they have found their natural niche in the academic market.

As you see, the market situation here is quite different, and that explains why some machines—such as the Commodore 64—have been big hits in Europe. On the other hand, the American market tends to be provincial; both users and companies think nothing exists beyond the U.S. Good products (especially software) get developed in Europe, too.

Fabio Favata
Palermo, Italy

continued

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

Thank you for the report. One reason Atari and Amiga sell in Europe is because they don't have to pay so much attention to certifications by the FCC. I do wonder if the FCC's real purpose here is to help the administration deal with the "too strong" dollar. If so, I have news; they've been wildly successful.—Jerry

The Trouble with MIS Professionals

Dear Jerry,

I'm writing about the letter Charles Hahn wrote you attempting to defend the behavior of corporate data-processing departments ("In Defense of DP Departments," March, page 36). When I first read the letter, I dismissed it as just another point of view that raised some interesting points even if I didn't fully agree with it. However, after more thought, it strikes me that Mr. Hahn's letter is a classic case of what's wrong with many MIS (and managerial) professionals. I also can't help but think that there's another side to his story, and I'd like to hear it.

On one hand, Mr. Hahn is upset about the lack of initiative shown by the people in his company, since they don't like to work voluntary, unpaid overtime and won't learn how to use their machines on their own time. (I suspect what he means is that people won't take the often boring manuals home to study them to a point just short of memorization. Has he ever tried letting people take both machines and manuals home to experiment with? I've found that technique works.) On the other hand, Hahn is angry that his ex-director, who actually showed some initiative, used his own programs and hardware instead of Lotus and WordStar, which are apparently the only two MIS-approved programs.

I can't help but wonder what the situation would have been if Mr. Hahn's company had a policy of listening to its employees and had actually bought the director an IBM PC AT and first-rate software to go with it in the first place. I also wonder what it was that caused the director to leave the company. Corporate attitudes, perhaps?

Frankly, I think the fundamental problem is that many managers forget that no matter what sort of equipment and hardware they may buy to improve productivity, the people who run the machines still determine the ultimate success and/or failure of the operation. While it may be unfortunate for business, the fact is that the people running the machinery aren't machines themselves.

George P. Nelson
Springfield, VA

Well, I had much the same thought myself; the purpose of small computers is to enhance productivity, and I doubt very seriously if even the cleverest MIS director has thought of all the ideas. Giving intelligent people good tools and watching to see what they will develop with them has always seemed to me a much better idea.—Jerry

Users versus Businesspeople

Dear Jerry,

I'm writing in response to Richard H. Goodyear's letter ("No Mac Clones," August 1987). He says that while users have written a lot about the Macintosh, businesspeople have spoken "eloquently by their silence," as there are no Macintosh clones.

It was, as you remarked, an "interest-

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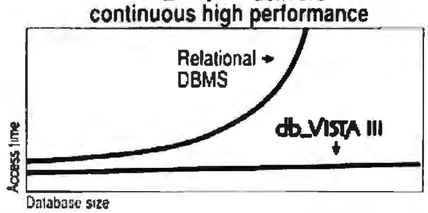
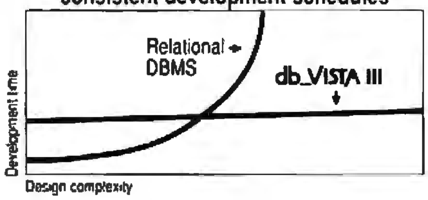


db_VISTA III provides consistent development schedules



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BY108

ing observation."

I don't like to be judgmental, but I fear Mr. Goodyear is guilty of leading the gullible down that well-known garden path. What makes "users" and "businesspeople" mutually exclusive? If you accept that premise, then you enter the garden.

The absence of Mac clones is another misleading premise. What are GEM and Microsoft Windows if not user interfaces that copy the look and feel of the Mac's operating system?

What inspired the Commodore Amiga and Atari ST series?

And what is all this about an OS/2 for the new IBM systems that has something called the Presentation Manager? Could it be that it will use a mouse and have the look and feel of a Mac interface?

Looks like some businesspeople are about to become users.

Brian Farley
Saipan, Mariana Islands

Actually, it will have a mouse and the look and feel of the Lilith, or perhaps early Xerox systems. . . .

I keep trying to start the rumor that Apple is going to sue Xerox for look and feel.—Jerry

Computing on the Go

Dear Jerry,

I'm writing in response to the letter from Bren Jacobson ("Floatable Computer?" March, page 36), who wants to use a computer in a boat. I can't offer much about corrosion problems, but I use computers in motor homes.

People have tried 12-volt DC battery voltage for the drives, plus a few resistors for the 5-V circuitry. And I've found problems because cheap power supplies often depend on one load to balance out another. Then there are all those voided warranties.

My ancient CP/M machines would run on a one-lung light plant, albeit with a flickering CRT that could provoke terminal mal de mer. But when I went to a hard disk, a mechanically governed alternator just couldn't hack it. Nor could a hard disk endure prairie summers with power lines harvesting every lightning strike from Vancouver to Halifax. Problems were exacerbated by RV parks with inadequate wiring. Somebody plugs in one more coffee maker, and there go the last 10 pages. . . .

Five photovoltaic panels and four deep-cycle batteries just about break even for boondocking in the desert. This, of course, also maintains lights, swamp cooler, TV, CB, water pumps, furnace fans, and all the usual hardships of wilderness life.

The 1-kilowatt Vanner inverter turns 12-V DC into 110-V, 60-Hz, pulse-width modulation with 87 percent efficiency, and it will drive any small computer more dependably than most electric companies. It will also drive kitchen appliances for short periods. It cost $1000 2 years ago, and now it sells for $500.

G. C. Edmondson
Lakeside, CA

From what I've seen you do over the years, you probably have more experience at mobile computing than anyone else in the world. Thanks for sharing it with us.—Jerry

Should We Worry about Viruses?

Dear Jerry,

My wife and I work at home in southern France, and, having just bought two 20-MHz Compaq 80386 computers, we are wary of installing French Minitel internal modem cards for fear of malicious computer virus programs that spread through networks and destroy data on hard disks.

We heard about viruses in a *Herald Tribune* article (February 1, 1988) that mentioned a preventive program called Data Physician, edited by Digital Dispatch in Minneapolis, Minnesota.

How serious is this problem, and does the program work?

Peter Clark
Forcalquier, France

Well, computer viruses are indeed real enough, but the best preventive is to be sure you don't put unknown software into your machine. There are also a number of companies that sell virus protection programs; just how badly you need one is a matter of judgment.—Jerry

QuickBASIC 3.0 versus 4.0

Dear Jerry,

I can't agree with your praise of the QuickBASIC 4.0 debugger (Computing at Chaos Manor, March). You did note its weakness—you can't see the trace and the output at the same time. What you probably fail to realize is the intense inconvenience this causes, with seemingly dozens of strokes to go between tracing and viewing the output and back. When tracing, the output does appear for a fraction of a second with each PRINT, as you note, but you didn't emphasize how visually annoying it is. Further, it is too fast to serve any purpose at all.

I wrote an impassioned letter to Bill Gates about this problem, and I even received a telephone call in response (though not from him). I simply refuse to use version 4.0 until this is corrected. (The 3.0 trace is quite workable. In fact, version 3.0 is quite good.)

I just tried to use the 4.0 debugger once again, but it's still terrible. I'll just have to forgo the goodies like the record structure until Microsoft fixes the crucial debugging operations.

There are some factual errors in your column. First, QuickBASIC will accept the one-line IF...THEN...ELSE structure you worked so hard to eliminate. Granted, it's unreadable, but the compiler rejection is limited to Turbo Basic and is a drawback to using that language if you're running old programs.

Second, QuickBASIC (including 4.0) still supports use of the same name assignments to different types of variable. Thus, you can indeed declare TEACHER, TEACHER$, TEACHER#, and so on. Your problem was that the error duplicate definition is a bug. The correct error, which I found by using 3.0 with your problem, is `missing =`. Add the =, and the error changes or disappears.

Peter J. Lunde
West Simsbury, CT

I haven't had the debugging problems you have, and with QuickBASIC 4.0's ability to step through code, set breakpoints and history, and the rest of the goodies, I much prefer it to QuickBASIC 3.0; but everyone to his own taste.

You're right: QuickBASIC will take one-line statements; I'd already cleaned them up to get them through Turbo Basic, so I never even tried them on QuickBASIC. Your other point is correct, too, as I found out just after I approved the galleys of the article. Oh, well.—Jerry ■

ASK BYTE

Circuit Cellar's Steve Ciarcia answers your questions on microcomputing

Mac to PC, Over

Dear Steve,

I am experiencing a disturbing problem as I try to connect my IBM PC XT to my Macintosh 512KE through the RS-422 serial communication port. Although Apple claims that the Mac's serial communication port conforms to the RS-422 standard, I find that the Mac has fewer handshaking lines than the PC. I have no problem connecting data signal lines, but what about the handshaking lines? The Mac has only "handshaking in" and "handshaking out," while the PC has both "+" and "−" for every in and out handshaking line. How can I connect them directly without burning my circuit board?

Chester H. Lin, M.D.
Taipei, Taiwan, Republic of China

For years, computer users have been struggling with the nonstandard RS-232C serial interface protocol. There is much less uniformity than the designation "standard" implies. The newer RS-422 protocol has come along and isn't being implemented with any more consistency than the older standard. With both methods, workable connections are frequently dictated by individual software packages—for example, some software watches the RTS/CTS pair for handshaking and ignores DTS/DSR, while other software may do the reverse. Other programs do both or neither, ignoring handshaking entirely or doing it in software with XON/XOFF.

As with many RS-232C situations, the solution to your problem of connecting a Macintosh and an IBM PC XT is a null-modem cable or adapter. That's the easy part, without the handshaking connections. Connect the transmitted data pins on each computer with the received data pins on the other. The handshaking connections are a bit uncertain, and a bit of trial and error with a breakout box may be needed to determine the exact configuration. I'd suggest you first try tying the Mac port's pin 6 to the PC's 17 and 18, and the Mac's pin 7 to the PC's 9 and 16. If that doesn't work, try the Mac's pin 6 to the PC's 5 and 6, and the Mac's pin 7 to the PC's 4 and 20. As a last resort, you may be able to tie all handshaking inputs true and use the system without hardware handshaking (do it in software).

Serial interfacing is more a black art than a logical science. Determining the correct connections is often a matter of systematically trying each of the possible hookups until something works. The buffers and level translators used in serial interfaces, such as the 1488/1489 ICs, are designed to withstand connections between two outputs pulling in opposite directions. There is little likelihood of your damaging your computers by experimenting.—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

Ask BYTE
One Phoenix Mill Lane
Peterborough, NH 03458

Due to the high volume of inquiries, we cannot guarantee a personal reply. All letters and photographs become the property of Steve Ciarcia and cannot be returned.

The Ask BYTE staff includes manager Harv Weiner and researchers Eric Albert, Tom Cantrell, Bill Curlew, Ken Davidson, Jeannette Dojan, Jon Elson, Frank Kuechmann, Tim McDonough, Edward Nisley, Dick Sawyer, Robert Stek, and Mark Voorhees.

Include Schematics, Please

Dear Steve,

For about a year, I've been trying to get a schematic and parts for an IBM AT-compatible board without success (the board is the same one JDR Microdevices calls MCT-ATMB). I own two of these boards, but one has a bad programmable array logic (PAL). The good PAL cannot be copied because the security link has been burned away.

I have talked to many wholesalers and retailers, including JDR Microdevices. None of the dealers I talked to can get schematics or parts for the boards. All boards are exchanged and sent to Taiwan for repair.

I am worried about the future of consumer electronics in the country if foreign countries are allowed not to supply data and parts for repairing their products. Has this country come to the sad state of affairs that we will now be dependent on other countries for repairing our products? It wouldn't cost much to include a schematic with a product. Has it come to the point that we need a law requiring all imported electrical products to include a schematic?

What's going to happen two years down the road when the dealer you bought your board from is out of business and you don't know where he got it, as in my case?

Wayne Anderson
Mesa, AZ

The situation you've run into isn't unique. Unfortunately, the solution isn't quite the one you're looking for.

I suspect that the reason you're having trouble getting parts is simply that it's not economical to repair very low-cost electronics. Look at it this way: That motherboard retails for about $350. The actual manufacturing cost is under 30 percent—let's say $100. Repair technician time, counting overhead and test equipment, is about $100 per hour, and diagnosing problems can take more hours than you can shake a stick at.

Figuring your time at $100 per hour, how many system boards did you waste while tracking the problem down to that PAL?

I don't think we need more laws regarding imports on the books. After all, you had a clear choice: Buy a stock IBM system from an established IBM dealer, with all the support and repair built into the price, or buy a clone with no support. You get exactly what you pay for, and I think that's exactly the way it should be. Folks who need the support are buying IBM; the rest of us aren't.

continued

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Circle 208 on Reader Service Card

But look at the economics again. If that $6000 IBM system dies, the company will swap the board and get you back on the air. The defective board isn't repaired; it's scrapped. After the warranty runs out, you're in the same boat: IBM doesn't supply schematics for its boards any more, either, and the company doesn't repair them. You might have to replace a $2000 system board instead of a $350 one.

All in all, I think the only way out is to buy another system board and use the one you've got for a wall hanging. It's expensive, but any other choice is more expensive still.—Steve

Programming Embedded Microprocessors

Dear Steve,

I am an electrical engineer looking after the operation and maintenance of some of the sophisticated equipment in power stations and substations—equipment like sequential event recorders, digital fault recorders, microprocessor-based alarm systems, and programmable logic controllers. These come under the category of microprocessor-embedded systems.

Last year I subscribed to BYTE to improve my proficiency in troubleshooting and maintenance work. I have had some introductions to microprocessors during my postgraduate education, and I am conversant in 8085 assembly language. While studying BYTE, I felt its contents and coverage were beyond my level, so I decided to seek your guidance.

Please let me know the names of some good books and microprocessor journals dealing with 8-bit microprocessor products being used in industry as embedded controllers. I would specifically welcome books related to troubleshooting procedures, because the documents provided by the manufacturers are invariably sketchy and incomplete. Also, please let me know of any books dealing with the design and application of programmable logic controllers.

Lal Singh
Najran, Saudi Arabia

Listed below are several books that I can recommend to help you with applying and programming embedded microprocessors. In addition to the microcontroller handbook, Intel publishes a complete series of guides and application notes describing the various microprocessors that the company manufactures. Contact Intel at the address listed below to receive a complete catalog of Intel books and literature.

Z-80 and 8080 Assembly Language Programming *by Kathe Spracklen (Rochelle Park, NJ: Hayden Book Co., 1979).*

8080 and Z80 Assembly Language *by Alan R. Miller (New York: John Wiley & Sons, 1981).*

Intel Embedded Controller Handbook *(Intel Literature Sales, P.O. Box 58130, Santa Clara, CA, 95952).*

In addition to my monthly column in BYTE, I have begun publishing a magazine entitled Circuit Cellar Ink, *which specifically deals with applying electronic solutions to real problems. Subscription information is available at the end of my recent columns in BYTE.*—Steve

A Circuit Struck Dumb

Dear Steve,

I'm a longtime reader and fan of Circuit Cellar, and I've learned a lot from reading about your projects over the years. From time to time, I've even built some of my own projects after being influenced by your designs.

Back in June of 1981, your project of the month was a low-cost speech-synthesizer interface using National "Digitalker" components. I obtained such a chip set and built a slightly modified version of the circuit to go on the home-brew bus extension I had placed inside the video monitor of my trusty TRS-80 Model 1. It worked flawlessly from the start. Over the years, I've come to appreciate the clearly enunciated warnings and messages that my computer would speak to me while I was looking in another direction reading data statements, keying in bank transactions, or whatever.

Two years ago, I finally became MS-DOS-compatible when I bought a new Tandy 1000A. At last, I had a built-in bus for projects. Alas, I now have a young family, so I can't spend as much time pursuing hardware projects. One that I really wanted to accomplish, though, was to equip the new machine with voice capabilities. Since nobody seems to be writing articles for simple projects for these new machines, I opted to try and modify my old design for the Tandy's PC-ROM vocabulary that I had purchased. I used the Tandy 1000 technical reference manual and your article entitled "Build the Circuit Cellar MPX-16 Computer System," Parts 1 and 2 (November and December 1982) as guidelines for the circuit I came up with.

Unfortunately, the circuit doesn't work. I get no sound from the speaker.

continued

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CACHE MEMORY SIZE	64KB	64KB	32KB	–
KBD. SELECTABLE SPEEDS	YES	YES	YES	YES
COPROCESSOR SUPPORT	80287/387	80387	80287	80287
32-BIT SLOTS	–	1	–	–
16-BIT SLOTS	6	5	6	6
8 BIT SLOTS	2	1	2	2
SERIAL PORTS	2	2	2	2
PARALLEL PORT	1	1	1	1
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BASIC calls to the port address produce nothing on OUT instructions, and INP instructions seem to indicate that the bus is still "floating." It's as though the port address is not being decoded. I have limited test equipment, but supply voltages seem correct on the card. I swapped all duplicated components with the old working card from the TRS-80, which continues to work, leading me to believe that the components are fine. I've even checked the point-to-point wiring I used on the project; nothing seems amiss.

Since this is my first (and only) project on the PC-bus, I'm not sure about the logic I used. I suspect I may be overlooking some glaring design error. When I first tried the circuit, I didn't decode the AEN (address enable) line. The computer failed to boot properly, which showed me the importance of that line. Are there any other important things I need to consider?

Victor H. Klein II
Newton, PA

Debugging logic at long range is always a little tricky, particularly if you don't have a scope to see what's going on. Without going back through the specs again, I bet that old speech generator just can't keep up with the new bus speeds. Probably the best way to get your circuit working is to hitch it to a parallel port where it's isolated from the bus and you can use a voltmeter to check the voltage levels.

The idea is fairly simple: The data inputs come from the printer data outputs, the WR signal is the printer's strobe, and the INTR bit goes back into the printer's BUSY line. In your case, you can use one of the printer port's control outputs to directly select which ROM bank to use. See table 1 for a diagram of the connections.

Table 1: *Port connections for MM54104.*

Printer port pin	Description
1	WR to MM54104 pin 1
2	D0 (least significant bit)
3	D1
4	D2
5	D3
6	D4
7	D5
8	D6
9	D7 (most significant bit)
11	INTR from MM54104 pin 6
17	ROM select to LS139 pin 3
18	Logic ground

Remember to disconnect your existing circuitry from the pins that connect directly to the printer port. You'll also need to come up with a power supply, but a simple wall transformer with a 9- or 12-volt DC output will suffice. Wrap a box around the whole affair and stick the speaker on top.

The next trick is to figure out the printer port address. The fastest and least ambiguous way is to use DEBUG, which is an experience everyone should have at least once. Fire up DEBUG, type D40:8L6, *and press the Enter key. You'll see something like this:*

```
0040:0008 BC 03 78 03 78 02
```

Each pair of hexadecimal numbers after the address corresponds to a printer port address. The above string of pairs shows three printer ports: LPT1 uses 03BCh, LPT2 uses 0378h, and LPT3 uses 0278h. Your system addresses may differ, but the ports are always LPT1, LPT2, and LPT3, in that order. Any ports that aren't installed will be 0—you can't use such ports for output.

Decide which printer port you want to use, and write down its address. Most people use LPT1 for a real printer, so you'll probably want to use LPT2 and LPT3. Buying a printer card just for the speech system might be a good idea if you've got only one now. (I'm pretty sure the Tandy 1000 will take a standard printer card.)

Let's suppose you set up the address and word number like this (I haven't checked this BASIC code out, but it should get you started):

```
MMPORT = &H0278
MMWORD = 0
```

Then, to get the system to say the word, use

```
OUT MMPORT,MMWORD
OUT MMPORT+2,1
OUT MMPORT+2,0
```

The ROM banks are selected by bit 3 in port MMPORT+2, *so to select the other bank, use* MMROM = 8, *and say the word using*

```
OUT MMPORT,MMWORD
OUT MMPORT+2,1+MMROM
OUT MMPORT,MMROM
```

I'll avoid telling you which bank is which, because that bit gets inverted at least once between BASIC and the decoder. The odds are that I'll be wrong no matter what I say.

To check the status bit and loop until it's 0, use

```
1000 IF INP(MMPORT+1) AND &H80
     GOTO 1000
```

There's also a 50-50 chance I've messed up the BUSY *bit, so if that gives bizarre results, try checking for a 0 bit instead of a 1 bit. The same logic applies if you write the code in Pascal, C, or assembly language: Put the word number out to the port, then toggle the strobe bit. All the usual PC languages can handle direct port I/O, so you shouldn't have any trouble.* —Steve

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Dear Steve,

I am looking for a program that will enable me to print a page of text (eventually with some pictures) in reflected type (using a laser printer or dot-matrix printer). I need reflected type because the output is printed on a particular type of film that is exposed afterward. Currently, my colleagues and I simply print the usual way and reverse the film after encountering the characters.

If the type were reversed, we could place the film right, and since the light would pass through the film before encountering the characters, no distortion would occur.

I've sent inquiries to several CAD firms and have been told that their programs wouldn't be able to handle text, because of problems with "reference points"—whatever that means.

Desktop Publishing packages like PageMaker and Ventura can't help me out, either, at least not here in Belgium. Have you ever heard of a software program that could help me?

Paul Verbinnen
Brussels, Belgium

I have not seen software that will print reflected type in a way you need. I have seen ads for graphics programs that do this in a limited way, but it appears to me that you need two things: a program that will transmit the characters to the printer in reverse order, and a set of reversed fonts for your printer. Since you are worried about the distortion caused by transmitting the image through the film, I assume you won't be satisfied with the relatively low-quality fonts you could make and download to an Epson or compatible printer. Even the 24-pin models only accept characters defined in an 18 by 24 dot, about half the number available in laser printers.

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Printing the characters in reverse order from a straight text file is easy: I'll get to that later. Reversing the characters is the task that will require work. I don't know of any software that can do this. There are some font-editing programs available that might help. Here are some that work with bit-mapped fonts:

SoftCraft Font Editor
SoftCraft
16 North Carrol St., Suite 500
Madison, WI 53703
(800) 351-0500

FontGen IV
VS Software
209 West Second St.
Little Rock, AR 72216
(501) 376-2083

Publishers Type Foundry
ZSoft
1950 Spectrum Cir., Suite A-495
Marietta, GA 30067
(404) 428-0008

An alternative to creating reversed fonts using a font editor is to write a program that reverses an existing font by reversing the order of the bytes. For example, an R in an 8 by 9 dot-matrix printer download font would be stored as in table 2a. Table 2b also shows the result after swapping bytes so that byte 1 becomes byte 8, 2 becomes 7, and so on.

Table 2: *Reversing the font definition for an "R."*

	(a)	(b)
byte ->	12345678	12345678
	01111100	00111110
	01000010	01000010
	01000001	10000010
	01000010	01000010
	01111100	00111110
	01000100	00100010
	01000010	01000010
	01000001	10000010
	00000000	00000000

Reversing the order of bytes is simply a matter of reading them into an array and writing them back out to a new file in reversed order. That is, fill the array from 1 to 8, and write the bytes from 8 to 1. I'm not sure that laser printer bit-mapped fonts are stored the same way, but if they're not, the operation of reversing the bits is still possible, but more complicated.—Steve ■

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BOOK REVIEWS

The Conquest of the Microchip
by Hans Queisser

Harvard University Press, Cambridge, MA: 1988, 272 pages, $24.95 (hardcover)

Reviewed by Hugh Kenner

Nature's wonders include rocks you can see through—pieces of clear quartz. But how did they get here? Our forebears guessed that these clear rocks had once been chunks of ice that mysteriously survived in an altered state. So, borrowing Homer's word for clear ice, *krystallos*, our ancestors taught us to speak of crystals. These had something to do with symmetry; that was soon obvious. Look at the orderly shapes salts will assume as they "crystallize" out of water.

By 1723, crystallography was a name for a highly mathematical science. And since order seems a special case in a random universe, what better window onto future happenings than a seer's crystal ball? (No, I'm not being facetious; that was really the crystal ball's theme.)

Crystalline wonders kept multiplying. Around 1630, in Bologna, Italy, a shoemaker/alchemist named Casciarolo chanced to make heavy stones glow with cold light. ("He had reduced barium sulfate to a sulfide, but that would not be understood for centuries," says author Hans Queisser.) What he had discovered we now call phosphorescence and fluorescence. Today, "phosphors" coat an annual 100 million square feet of new television tubes, and glass gets treated with crystallite powder to make a billion fluorescent tubes besides. That's one way to indicate how much seeming magic we subject to routine control.

We can do that because we've merged quantum theory with solid-state physics, and so we've worked ourselves free of an era when tinkerers, in the manner of Casciarolo, kept chancing on curious effects no one could explain. A main site of that crucial merger was Goettingen University, where Queisser got his education. Later, he worked with William Shockley in Silicon Valley. At present, he directs the Max Planck Institute for Solid State Research in Stuttgart, West Germany. Such credentials make his *Conquest of the Microchip* very much an inside story.

The book could not be more engagingly written. Its narrative commences with Guglielmo Marconi, in 1914, disliking the fact that his iron-filing "coherer" (chanced upon in 1890 and not at all understood) was an unreliable foundation indeed for the coming wireless industry. The future, it seemed, lay in a German discovery, the crystal detector, which wasn't understood, either. How did it manage to defy Ohm's law? And why did some crystals work and others not?

In fact, so mysterious was crystal behavior that Marconi's industry would soon be heading off on a long, clumsy vacuum-tube detour. Tubes used brute force; to get any result at all, you had to heat a filament red-hot. If that used up Niagaras of power, at least the tubes were reliable until they burned out—and they always burned out. The men who fired up the ENIAC computer (a base-10 machine, incidentally) could never really guarantee that all 18,000 tubes were functioning at once. The one thing certain was the electric bill, based on a steady flow of 150 kilowatts.

Crystal radios did stay around, cheap toys for attic tinkerers. I remember buying a kit for about a dollar. Today I'm typing these words on a computer, vastly more powerful than ENIAC, that curbs ENIAC's appetite for wattage by a factor of 1000—for the crystal did return.

Its comeback began at post-World War I Goettingen, where Richard Pohl, unable to

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ALSO REVIEWED

An Introduction to Solid Modeling

Programs and Data Structures in C

C as a Second Language

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BASIC Mathematical Programs for Engineers and Scientists

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get liquid air, had to forgo experiments with the tubes that liquid air could help evacuate, and wryly turned to crystals as second-best. Then a lab mistake that shattered a costly diamond sent him after techniques for growing pure artificial crystals. By 1930, much mystery had been penetrated. Anomalous crystal behavior, wanted and unwanted alike, proved to turn on the presence of minute impurities—local irregularities in the lattice. We now "dope" our lab-grown crystals with the irregularity that gets just the effect we seek.

In World War II Britain, the cat's-whisker crystal detector, long discarded by the radio industry, proved just the thing for ultra-short-wave radar. That brought germanium on-stage, and the point-contact transistor (Shockley et al. at Bell Labs, 1947) was essentially a germanium crystal with *two* cat's whiskers. Finicky cat's whiskers plagued it with reliability problems, and though the junction transistor soon got rid of whiskers, in 1955 the military was still wishing that better than a quarter of the units delivered might fall within spec.

Next, silicon replaced germanium (I'm hurrying through this). Soon, companies that had spun off from Shockley's (who had long since left Bell Labs for California) were into microprocessors, microchip circuitry. . . . You've probably heard much of this information presented before, but Hans Queisser's version is more vivid and insightful.

By halfway through his book, Queisser is orchestrating so many themes with such dexterity that it's breathtaking. Something that he never forgets is the sociocultural ground bass—the way, for instance, German science, remembering the coercions of two wars, kept aloof from industry and practice. Then there's the invaluable Western tradition of "skepticism, self-awareness, and independent work," which produced the great breakthroughs of the 1940s and 1950s but would later erect barriers, unknown in Japan, "between the universities, the factories, and the research laboratories." Consider, lastly, the Japanese genius for basing mass production on mass experiments, testing "every imaginable combination of manufacturing processes" and investigating "every type of foreign admixtures in the silicon crystal." Western observers at first found that amusingly antlike. Later on, they got nervous, rightly.

For already, by the 1960s in Silicon Valley, says Queisser, "a field in which a few individuals had paved the way was turning into the anonymous work of a number of experts. Every form of technology takes a similar route when it leaves the laboratories for the factories." In Japan, he also notes, "They do not consider basic research and applications as opposites. In their terminology, the opposite of 'basic' is not 'applied,' but simply 'not basic'; the opposite of 'applied' would be something like 'not applicable.' " This last they have learned to shun.

Just such "impurities" as make junction transistors work also create what was noticed far earlier: the colors of gemstones. When nature does anything to catch our attention, it's by generating something we can observe. And the line between "observable" and "applicable" is thin, each being an interruption of the bland. Save for our long pursuit of applicability, we'd still be surviving by smashing clamshells with rocks.

Man's microcosm once, Queisser concludes, was simply Man, a vexed model of universal harmonies. Today, that microcosm is the silicon crystal lattice, which we're probing for "the secrets of creation and destruction, as well as harmony and symmetry." Now it is "the macrocosm of

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society" that "seeks the harmony of the microcosm of the atom." And that is nothing less than the present state of our ages-long romance with ordered crystals.

BRIEFLY NOTED

An Introduction to Solid Modeling *by Martti Mäntylä, Computer Science Press, Rockville, MD: 1988, 401 pages, $42.95.* Plenty of books will teach you about computer graphics, particularly about manipulating and displaying images. Textbooks abound describing algorithms for hidden-line and hidden-surface removal. Journal articles will further direct you to esoterica regarding the interaction of light with material objects to produce shadows, reflections, and refractions (ray tracing). And conference proceedings will give you the latest techniques on modeling solid-surface properties, such as color and texture.

On the other hand, learning techniques for describing the shapes of objects is more difficult. Clearly, graphics programmers need good ways to represent shapes. Typically, however, procedures for rendering an image on-screen require a preexisting description of the shape as "input." In short, discussions of representation issues are much harder to come by than discussions of rendering issues.

An Introduction to Solid Modeling remedies this deficiency significantly by focusing on a very important class of representational methods—solid modeling. The book is at once comprehensive and accessible to readers without a strong background in computer graphics.

The first section surveys the current techniques and presents topics such as boundary representations, curved surface patches, and volumetric methods like solid geometry and octrees. The second section describes in detail the author's own solid modeling system, the Geometric WorkBench.

The explication of this technique makes the book far more than just a roundup of existing knowledge. The Geometric WorkBench is capable of modeling polyhedrons. It employs a boundary representation of solids: It describes a solid object by describing each piece of the object's surface. Specifically, the program recognizes a polyhedron as a collection of flat faces. The complete solid model includes a description of each of the faces. Each face is a polygon and so can be specified by the list of straight edges that bound it and the list of vertices at which the edges meet.

Not every collection of polygons constitutes a valid solid model; the polygons must fit together in a way that leaves no holes and no overlaps. The Geometric WorkBench guarantees a model's validity at each step of construction. This guarantee is the program's most important feature.

The system protects a model's integrity in two ways. First, the modeler stores geometrical and topological information separately. Geometry relates to dimension. The geometry of a shape specifies the position of each vertex, the length of each edge, and the size and orientation of each face. Topology relates to connectedness. The topology of a shape lists which edges meet at each vertex and which faces border one another. The topology therefore also tells whether all of a model's parts fit together in a sensible way. The program is able to more efficiently check integrity on one hand and to scale the size of the model on the other, because it deals with topology and geometry separately.

Second, the Geometric WorkBench restricts the users to a small selection of operators that provide them with the means to modify a solid model. Each application of an operator corresponds to one

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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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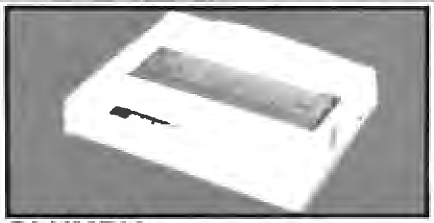

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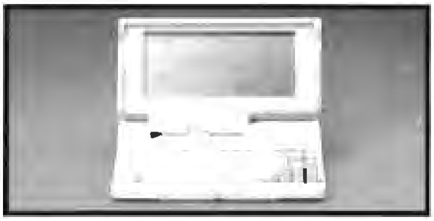

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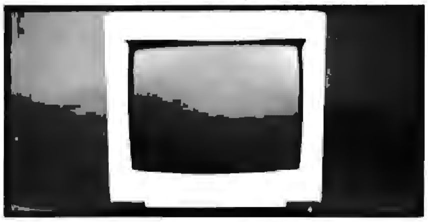

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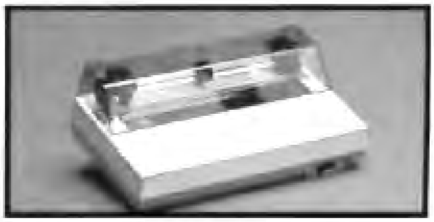

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A110

step in the incremental construction of a solid model. Each operator changes the number of vertices (V), edges (E), and faces (F) in a way that maintains equality in Euler's formula: $V - E + F = 2$. This equality guarantees the topological validity of the model.

Solid modeling programs like the one described in this book are necessarily large and complex. Software engineers, even those not particularly interested in solid modeling, might enjoy reading this book just to learn more about how to write a large program. The author explains many of his decisions, including his selection of data structures and his design of a user interface.

Many listings of C code illustrate the book. While the syntax of C enables clever programmers to use tricks and shortcuts, Martti Mäntylä avoids those in favor of clear code. An experienced programmer who knows Pascal would have no trouble following the examples.

The exercises in the book offer readers a means of going beyond the text. Many are substantial projects. They constitute a guide for those who are interested in constructing their own solid modeling program, and a jumping-off point for those who are intent on developing their own program of research.

The bibliography lists 137 references, mainly to major journals. That in itself is a major attraction to the book for anyone seriously interested in the subject.

I enjoyed Martti Mäntylä's writing style and presentation. *An Introduction to Solid Modeling* is especially attractive because you can read it quickly or at your leisure, all at once or in bits and pieces. The author has constructed a very effective introduction to solid modeling, which at the same time challenges those who are experienced in the field.

—Leon Tabak

Programs and Data Structures in C *by Leendert Ammeraal, John Wiley & Sons, New York: 1987, 206 pages, $24.95 (softcover).* Leendert Ammeraal's book is a broad but not exhaustive introduction to data structures and algorithms using C.

After briefly defending C as an appropriate *language* for teaching and defending functioning programs as the best *vehicle* for teaching, Ammeraal plunges into a grab bag of tricks and techniques. The initial chapter on programming style discusses search sentinels, global variables, and recursion. Ammeraal's sometimes gruff text goes on to cover basics such as sorting, searching, and list manipulation; more advanced topics, such as doubly linked lists, B-trees, and interpreters/compilers; and esoteric topics like dynamic programming, tries, and graph representations. Example programs are workable for students but are not particularly general or extensible for professionals.

—Darrow Kirkpatrick

C as a Second Language *by Tomasz Muldner and Peter W. Steele, Addison-Wesley, Reading, MA: 1988, 588 pages, $27.95 (softcover).* This is a comprehensive introduction to standard C, with some ANSI extensions included. Written primarily for those who were raised on Pascal, it provides clear discussions of the basics—data types, control structures, file I/O, functions, and strings—with very helpful and concise summaries of the most important points.

The book moves well beyond the basics with probing discussions of C features like pointers, bit fields, structured file I/O, enumerated types, and preprocessor instructions. Muldner and Steele include code to manage abstract data types such as graphs, lists, sets, and stacks. They also include a hearty calculator program featuring variables; a memory-management system with compaction; and a

continued

database using an external binary search tree.

—Darrow Kirkpatrick

Perceptrons *by Marvin L. Minsky and Seymour A. Papert, MIT Press, Cambridge, MA: 1988, 292 pages, $12.50. Perceptrons* has been the classic textbook on connectionist learning machines since its publication in 1969, and the recent surge of interest in artificial neural systems makes the printing of an expanded edition welcome.

Initially, owners of the previous edition of this work may be disappointed by the new book. It turns out to be a reprint of the old edition sandwiched between about 45 pages of a newly written prologue and epilogue.

The short prologue, entitled "A View from 1988," is an overview of the history of artificial neural systems and the authors' commentary on why the state of the art has progressed little since the book was first published.

The epilogue, which accounts for the lion's share of the new text, is an interesting essay entitled "The New Connectionism," which includes discussion of the significant Rummelhart and McClelland work on parallel distributed processing. Minsky and Papert do a good job of tying the theory and application of perceptrons to other paradigms coming into vogue in the science of neural networks.

While billing the new *Perceptrons* as an "expanded edition" may be overdoing things, the authors' additions are important enough to justify putting the book on the shelf next to the older edition. With or without the additions, of course, *Perceptrons* will always remain a classic in its field.*—Eric Bobinsky*

BASIC Mathematical Programs for Engineers and Scientists *by H. Guggenheimer, Petrocelli Books, Princeton, NJ: 1987, 233 pages, $19.95.* This new addition to the large body of literature on numerical computing offers welcome relief from both the code-starved mathematical textbooks on numerical analysis and the simple-minded cookbooks that provide code but little or no useful explanations.

The author, a university mathematics professor, has put together 40 BASIC programs covering such diverse topics as vector geometry, roots of equations, integration and differentiation, ordinary differential equations, linear algebra, Fourier analysis, and gamma and Bessel functions. As important as the code itself, each program is accompanied by a readable and thorough treatment of the theory behind the algorithm.

The book's conversational style and expert presentation make it enjoyable to read, and, although the author states that the text is for "anyone who is not a computer scientist or mathematician," many practicing professionals will nonetheless find it useful.

The only negative aspect of the book is its use of Microsoft GWBASIC. Much more elegant and understandable programs would have followed from the use of any of the new, structured BASIC dialects. Fortunately, Pascal-like pseudocode versions of each routine are presented, and they make the book valuable even to those who write code in something other than BASIC.

At $19.95, this excellent little paperback is a bargain.

—Eric Bobinsky ■

CONTRIBUTORS

Critic and author **Hugh Kenner** lives in Baltimore, MD. **Leon Tabak** is a visiting lecturer in computer science at Worcester (MA) Polytechnic Institute. **Darrow Kirkpatrick** is a freelance writer and computer consultant living in New Paltz, New York. **Eric Bobinsky** is a mathematician at NASA's Lewis Research Center in Cleveland, Ohio.

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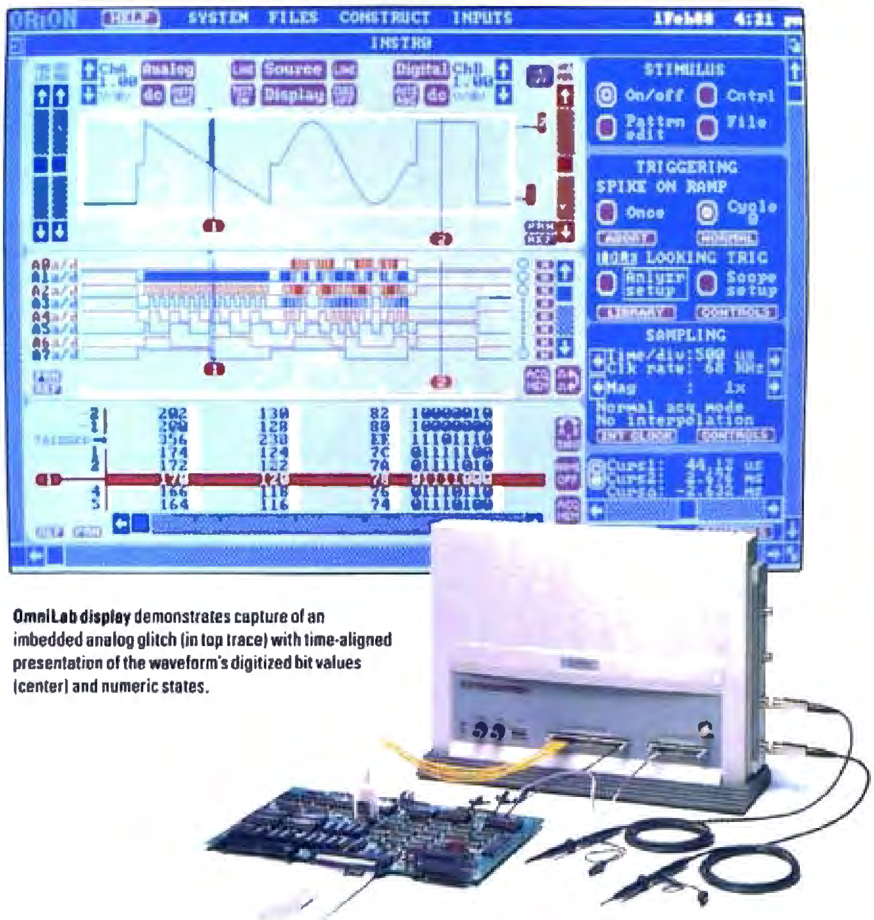

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■ The 9240 is based on an innovative new instrument architecture that merges high-speed universal hardware and seamlessly-integrated software to create high-performance capabilities not available in separate instruments. Analog and digital traces are always time-correlated in a unique, single screen display. SELECT™ triggering bridges scope and analyzer techniques. And OmniLab's stimulus generators can playback captured or edited signals.

■ At the heart of the 9240 is SELECT triggering, the most straightforward and complete solution **ever** to triggering dilemmas. It's one system, operating with synchronized analog and digital views of your data. By combining conventional oscilloscope and analyzer triggering with powerful RAM truth tables — plus min/max time qualification as needed — SELECT triggering helps you analyze hardware, debug software, and integrate systems more easily.

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PRODUCTS IN PERSPECTIVE

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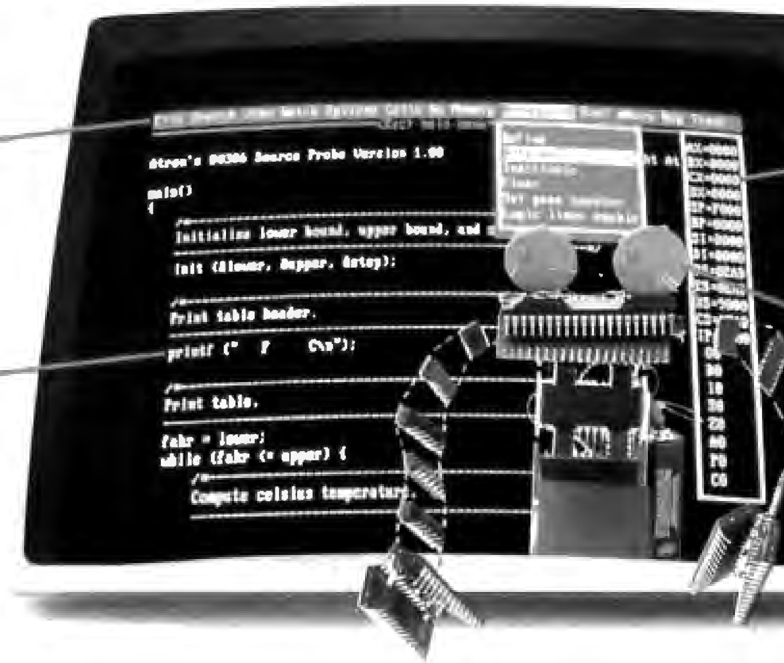

Welcome to your nightmare. Your company has bet the farm on your product. Your demonstration wowed the operating committee, and beta shipments were out on time. Then wham!

All your beta customers seemed to call on the same day. "Your software is doing some really bizarre things," they say. Your credibility is at stake. Your profits are at stake. Your sanity is at stake.

THIS BUG'S FOR YOU

You rack your brain, trying to figure something out. Is it a random memory overwrite? Or worse, an overwrite to a stack-based local variable? Is it sequence dependent? Or worse, randomly caused by interrupts? Overwritten code? Undocumented "features" in the software you're linking to? And to top it off, your program is too big. The software debugger, your program and it's symbol table can't fit into memory at the same time. Opening a bicycle shop suddenly isn't such a bad idea.

THIS DEBUGGER'S FOR YOU

Announcing the 386 PROBE™ Bugbuster,*from Atron. Nine of the top-ten software developers sleep better at night because of Atron hardware-assisted debuggers. Because they can set real-time breakpoints which instantly detect memory reads and writes.

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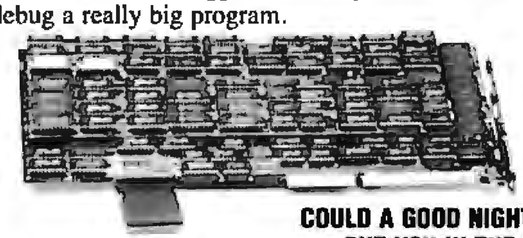
Then, so you can look at the cause of the problem, the 386 PROBE automatically stores the last 2K cycles of program execution. Although other debuggers may *try* to do the same thing, Atron is the only company in the world to dequeue the pipelined trace data so you can easily understand it.

Finally, 386 PROBE's megabyte of hidden, write-protected memory stores your symbol table and debugger. So your bug can't roach the debugger. And so you have room enough to debug a really big program.



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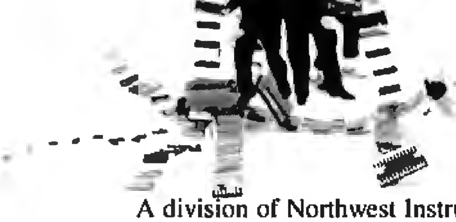

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Circle 25 on Reader Service Card

Switchable CPUs and a Dual Bus, Too

Wells American's CompuStar is actually a "convertible" computer that can switch between an IBM PC AT bus and a Micro Channel bus. In addition, you can set it up to use any of four central processing modules: 8086, 80286, 80386, or 80386SX (which is scheduled to ship in mid-October). The snap-in processor modules, which plug into the motherboard, are interchangeable, the company claims.

All CompuStar models, regardless of the CPU or bus configuration, are equipped with a parallel port, a mouse port, a keyboard and keyboard port, two serial ports, an EGA port, a VGA port, a disk controller, and a 220-watt power supply. The BIOS is by Wells American.

For file-server applications (which increase the possibility of overheated components), each version has two fans—one for pressurizing the hard, floppy, and optical disk drives, and one for creating a vacuum within the printed circuit board areas.

Wells will sell the CompuStar much like a pick-the-component system. Besides an operating system (MS-DOS, OS/2, or Unix), you can choose from a selection of video interfaces, drives (including, later, a Maxtor erasable optical drive), keyboards, and so on.

Price: Basic 8086 machine, $995; 80286 machine, about $20,000; full-featured 80386 machine, up to $25,000.
Contact: Wells American Corp., 3243 Sunset Blvd., West Columbia, SC 29169, (803) 796-7800.
Inquiry 781.

CompuStar includes everything but the kitchen sink.

Apollo Launches First 68030-based System

In its base configuration, Apollo Computer's Series 3500 is a Motorola 68030-based diskless microcomputer that will run at 4 million instructions per second (MIPS).

The 68030 processor makes the 3500 compatible with previous 68000-series machines, resulting in faster and more cost-effective workstations. Clock speed on the 3500 is 25 MHz with no wait states. The standard 4 megabytes of RAM can be expanded to 32. There are 7 16-bit AT slots and three serial ports, and the BIOS is by Phoenix Technologies.

The operating system is Apollo's Domain/OS version of Unix. But "off-the-shelf" MS-DOS applications are supported either by an optional 80286 coprocessor or with a software emulator. The coprocessor, an add-in card, can be purchased and installed on a file server and used by all.

Price: $7990; 80286 coprocessor add-in, $1990; MS-DOS software emulator, $500; 19-inch monochrome monitor, $1000; 15-inch color monitor, $2000; 155-megabyte ESDI hard disk drive and controller, $4500; 348-megabyte drive, $7500.
Contact: Apollo Computer, Inc., 330 Billerica Rd., Chelmsford, MA 01824, (617) 256-6600.
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The Desktop and Portable 80386SXes

Intel's new low-cost 80386SX chips have made an appearance in NEC's newest machines—the PowerMate SX and the PowerMate Portable SX. Both machines feature 16-MHz clock speeds and 2 megabytes of RAM, expandable to 16 megabytes.

Additional features of the standard SX machine include a 1.2- or 1.44-megabyte floppy disk drive and a 42-megabyte hard disk drive. The BIOS is by Phoenix Technologies. One RS-232C serial port, one parallel port, and one 8-bit and five 16-bit expansion slots are standard. There's room for two 5¼-inch and one 3½-inch (optional) disk drives. ESDI hard disk controllers are also available.

The Portable SX comes standard with a 360K-byte or 1.2-megabyte floppy disk drive and a 42-megabyte hard disk drive.

Price: $4495 for the PowerMate SX; $6595 for the PowerMate Portable SX.
Contact: NEC Information Systems, Inc., 1414 Massachusetts Ave., Boxborough, MA 01719, (508) 264-8000.
Inquiry 783.

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If you need multiple fonts for your HP LaserJet II or Cannon printers and don't want to buy and swap dozens of cartridges, Pacific Data has the solution in five multi-font cartridges.

The new "25 Cartridges in One" font cartridge includes all 25 fonts that are available on HP LaserJet cartridges, including the S1, S2, and Z1A, Pacific Data reports.

Four other cartridges offer similar multiple-cartridges-in-one performance for HP and Canon laser printers. The Six-Pack cartridge combines all seven of HP's compatible monospaced fonts and symbol sets and is designed for applications where column alignment is important.

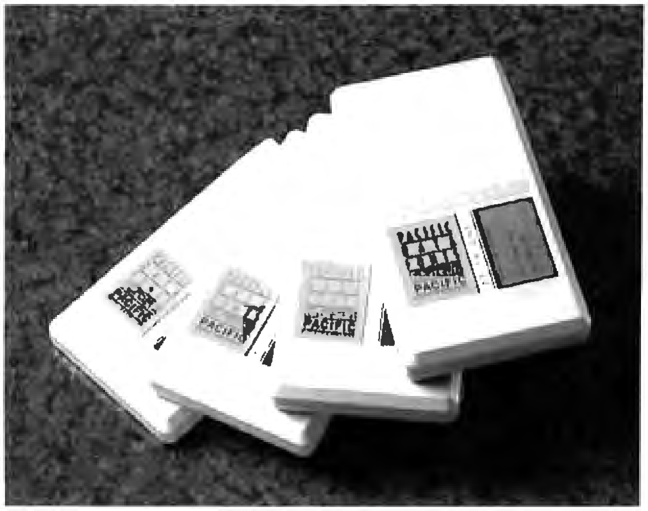
Up to 240 characters per line in both portrait and landscape mode (the Lotus maximum) can be printed with the Spreadsheet cartridge. It includes five different point sizes, including a size for titles and headings. The Z cartridge, containing typographic masters to match the look of PostScript, is designed for such word processing programs as Microsoft Word for typeset-quality documents with proportional spacing.

Also for word processing and desktop publishing, the F cartridge includes a fixed-pitch line-printer font for monospaced word processing applications. And it's compatible with PageMaker and Ventura Publisher.

Price: 25 Cartridges in One, $399; Six-Pack, $99; Spreadsheet, $199; Z cartridge, $99; F cartridge, $99.

Contact: Pacific Data Products, 6404 Nancy Ridge Dr., San Diego, CA 92121, (619) 552-0880.

Inquiry 793.



25 Cartridges in One packs five fonts into each cartridge.

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Standard equipment includes a multiplexer adapter card to split the controller signal, 3Five Software, and a 3½-inch floppy disk drive in a 5¼-inch frame, plus internal cabling. The software allows XTs, ATs, and compatibles to support the 3½-inch disk drive and includes a device driver and a format program that offers either 720K bytes or 1.44 megabytes of storage (depending on which type of drive you've installed). It is compatible with all desktop systems using DOS (including PS/2s and HP 150 systems) and most laptops such as Toshiba, IBM, Zenith, Tandy, and GRiD.

Price: With 720K bytes of storage, $299; with 1.44 megabytes of storage (works with 720K, 360K, or 180K bytes as well), $340.

Contact: Manzana MicroSystems, Inc., 7334 Hollister Ave., Suite B, P.O. Box 2117, Goleta, CA 93118, (805) 968-1387.

Inquiry 795.

Optical Gigabytes for Your PC

Need ultra-large, high-speed data storage for your IBM PC, XT, AT, or compatible? Two optical disk subsystems, featuring 1.2 and 2.4 gigabytes of capacity in a WORM (write once, read many) format, are available from N/Hance Systems.

TextScan, a document-storage and text-retrieval software package, allows you to access data in under 90 milliseconds, on average. Data transfer rate is 6.5 megabits per second. It also uses multitrack buffering to keep up with even the fastest 80386-based systems.

An internal single-drive system, the Model 5120, includes a drive, controller, installation software, and cabling. An external single-drive version of Model 5120 includes a dedicated power supply, a cooling fan, a controller, cabling, and installation software.

Model 5120/2 provides the 2.4 gigabytes of capacity in a single cabinet. The first 1.2 gigabytes is on one side of the cartridge, and the second 1.2 gigabytes is on the flip side.

Price: Internal Model 5120, $6188; external 5120, $6388; 5120/2, $9688.

Contact: Symphony Systems, Inc., N/Hance Systems Division, 908R Providence Hwy., Dedham, MA 02026, (800) 289-9676; in Massachusetts, (617) 461-1970.

Inquiry 794.

Printer Flexes Paper-Handling Muscles

The IBM QuickWriter 24-wire dot-matrix, bidirectional printer is specifically designed to offer impact printing solutions for your word processing, spreadsheet, graphics, and carbon-copy needs.

The optional bin feeder—which automatically adjusts to paper thickness—lets you print pin-feed paper, single sheets, forms, or envelopes without having to manually change the forms.

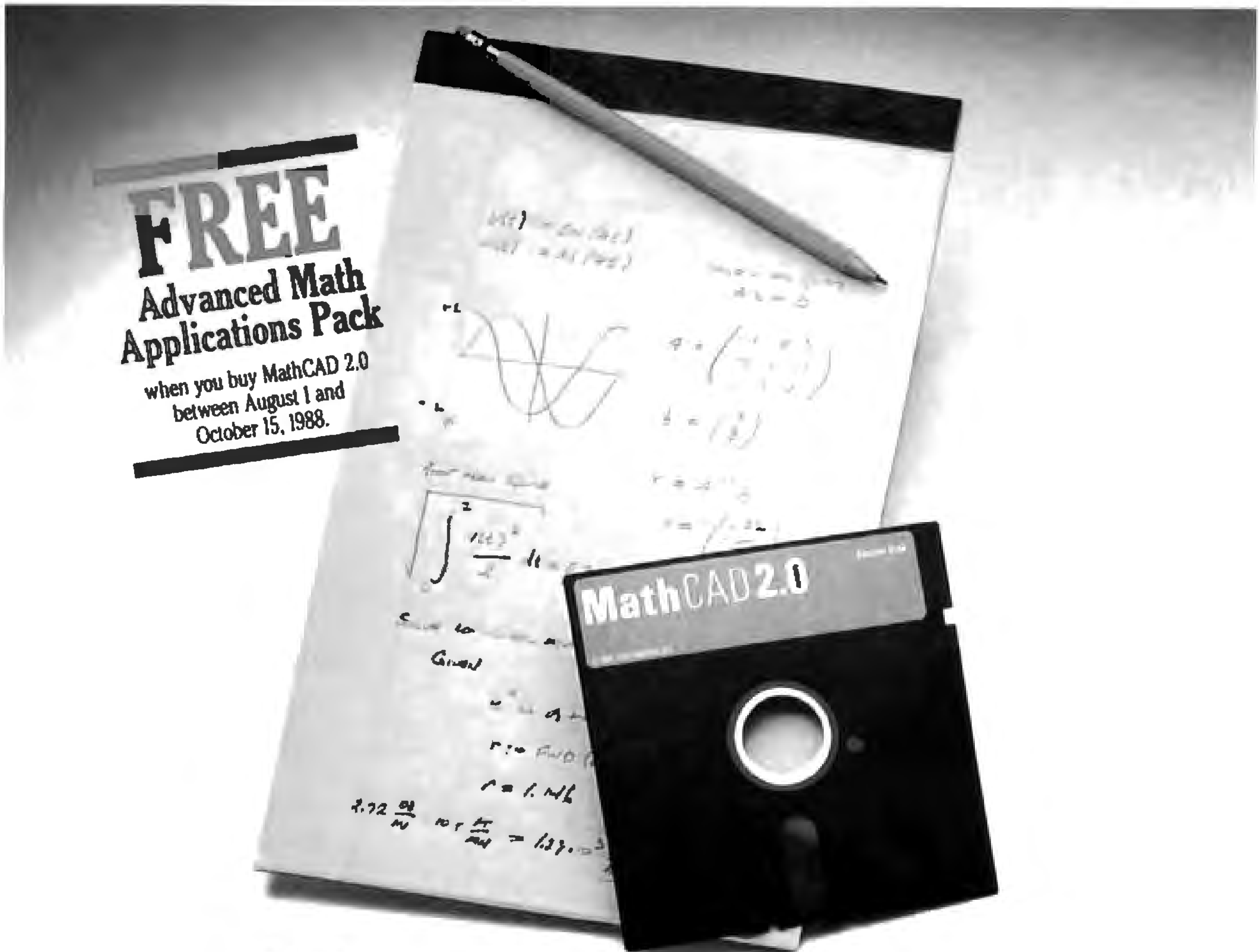
Quickness is indeed a virtue with a draft speed of 330 characters per second at 10 characters per inch. Letter-quality speed is 110 cps at 10 cpi. The QuickWriter works in five pitches—10 cpi, 12 cpi, 15 cpi, 17.1 cpi, and proportional.

Price: $1699; pinwheel forms feed, $129; single-bin cut-sheet feed, $349; dual-drawer cut-sheet feet, $849; envelope feed, $299.

Contact: IBM Corp., U.S Marketing and Services Group, 900 King St., Rye Brook, NY 10573, (201) 930-5192.

Inquiry 796.

continued

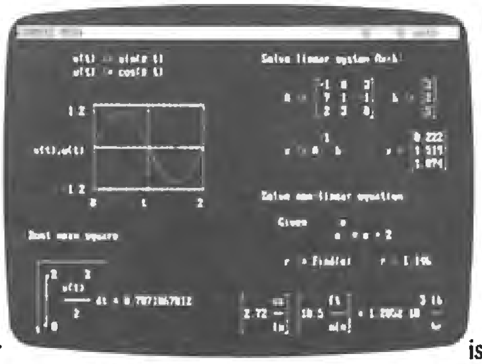


Your pad or ours?

If you perform calculations, the answer is obvious.

MathCAD 2.0.

It's everything you appreciate about working on a scratchpad – simple, free-form math – and more. More speed. More accuracy. More flexibility.



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

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

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

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

What more could you ask for? How about the new **Advanced Math Applications Pack**? A $55 value, it's yours *free* when you purchase MathCAD between August 1 and October 15, 1988. The Advanced Math Pack includes a custom binder, software and documentation for 16 advanced applications such as:

- Runge-Kutta Solution of First Order Differential Equation
- Solution of Second-Order Differential Equation
- Eigenvalues and Eigenvectors of a Symmetric Matrix
- Convolution and Correlation of Sequences
- Convolutions using FFT's
- And many more!

If you're tired of doing calculations by hand or writing and debugging programs, come on over to MathCAD.

For more information contact your local dealer or call **1-800-MATHCAD, ext. 2775** (In MA: 617-577-1017, ext. 2775).

Requires IBM PC® or compatible, 512KB RAM, graphics card.

IBM PC® International Business Machines Corporation.
MathCAD® MathSoft, Inc

MathCAD®

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

Circle 154 on Reader Service Card

Coprocessor Connectivity Convenes

The Connection Coprocessor board from Intel provides for telecommunications within any compatible data-processing application you now run on your IBM PC, XT, AT, or compatible. Symantec, Microsoft, WordPerfect, and several others have announced that they will be writing a Digital Communications Associates/Intel specification into new versions of their software to make their applications compatible.

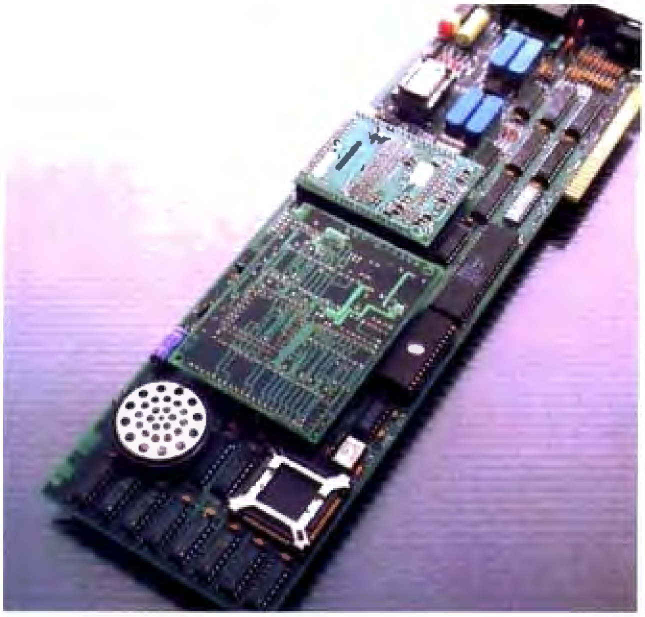
With the Connection Coprocessor, you'll be able to continue work on your computer immediately after you've commanded the 10-MHz 80188 coprocessor and 256K bytes of memory to handle facsimile, electronic mail, or other telecommunications file-transfer applications. All you need to do is address the information and press a hot key, according to the company. You can then go back to your application while the board takes care of the communications. Intel says this bypasses the hassle of multitasking operating systems (where background applications can slow or halt foreground applications).

Each Connection Coprocessor has an 8K-byte EPROM to grab the downloadable firmware, a direct memory access (DMA) coprocessor interface to talk to the host, and an expansion socket for a modem in addition to its microprocessor and RAM. An option is a piggyback card containing a Hayes-compatible 2400-bit-per-second modem.

Price: $995; modem option, $295.

Contact: Intel Corp., Mail Stop C03-07, 5200 Northeast Elam Young Pkwy., Hillsboro, OR 97124, (503) 629-7354.

Inquiry 784.



Connection Coprocessor multitasking board from Intel.

Proprietary software and the Face Card coprocessor let you perform unattended file transfers between any IBM PC, XT, or AT using a modem or cabling within the office.

The Face Card is based on the Hitachi Z80 8-bit microprocessor. It includes 256K bytes of RAM, a 32K-byte EPROM, 300- to 19,200-bps data transfer rates, and an adapter for AC or a backup battery power supply.

The coprocessor lets you do simultaneous telecommunications and data-processing applications; a separate power-source access allows file transfer and receipt even when the computer is turned off.

Price: $699.

Contact: Face Technologies, Inc., 3711 Plaza Dr., Suite 1, Ann Arbor, MI 48108, (313) 662-8008.

Inquiry 785.

Mac II Betters Disk and DAT

Southworth Music Systems announced three cards for the Mac II NuBus. They make use of parallel-processing Motorola 56000 signal-processing chips, which enhance A/D (and D/A) applications on a Mac II by 700 times, according to the company.

The boards support compact-disk sample rates of 44.1 kHz and digital audio tape (DAT) sampling rates of 96 and 192 kHz.

The Max Audio Analog card performs all A/D conversion using a proprietary 20-bit A/D and D/A converter, which provides 104-decibel signal-to-noise ratio on playback. The conversion is performed by a custom circuit that samples the input signal 24 million times per second and integrates the data to 192 kHz. The Analog card includes direct-to-disk recording and playback software and real-time stereo spectral analysis software with 64 to 256 bands.

The Max Audio Quad 56000 DSP (digital signal processing) card has shared memory optionally available, including 3 megabytes for storage and audio samples. The enhanced memory aids in applications such as reverberation and effects processing, frequency-domain audio processing, and sample playing and additive synthesis.

The Digital Audio/SMPTE (Society of Motion Picture and Television Engineers) card can send and receive data in AES/EBU digital audio format for CD and DAT applications.

Price: Analog card, $1400; Quad DSP card, $1400; SMPTE card, $995.

Contact: Southworth Music Systems, Inc., 91 Ann Lee Rd., Harvard, MA 01451, (617) 772-9471.

Inquiry 786.

Flipping Four Floppies Further

Omni-Bridge is a half-length board that acts as a floppy disk drive controller to support up to four additional IBM PC, XT, AT, and compatible floppy disk drives.

Data transfer rates are 250K, 300K, or 500K bps, allowing for support of any combination of 720K-byte and 1.44-megabyte 3½-inch floppy disk drives, 360K-byte and 1.2-megabyte 5¼-inch floppy disk drives, and QIC-40 standard streaming-tape drives for backing up your hard disk. With your system's existing controller, this controller allows support for a total of six floppy disk drives.

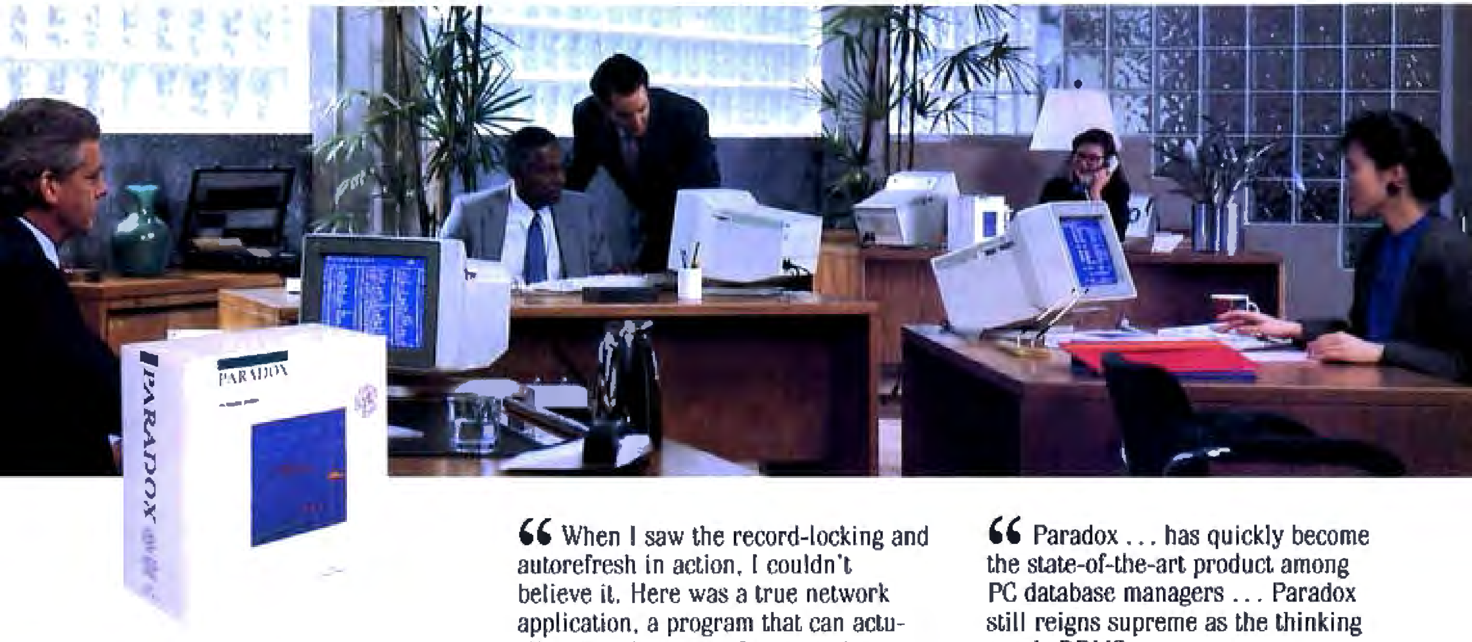
Price: $95.

Contact: Sysgen, Inc., 556 Gibraltar Dr., Milpitas, CA 95035, (408) 263-4411.

Inquiry 788.

continued

Why Paradox 2.0 makes your network run like clockwork



Paradox® runs smoothly, intelligently and so transparently that multiple users can access the same data at the same time—without being aware of each other or getting in each other's way.

With Paradox news travels fast and it's always accurate

Paradox *automatically* updates itself with a screen-refresh that ensures that all the data is up to date and accurate all the time. Record-locking, Paradox-style, safeguards data integrity by preventing for example, two different users from making changes to the same record at the same time.

How to make your multiuser network work

To run Paradox 2.0 or the Paradox Network Pack on a network, you need

- Novell with Novell Advanced Netware version 2.0A or higher
- 3Com 3Plus with 3Com 3+ operating system version 1.0, 1.1 or higher
- IBM Token Ring or PC Network with IBM PC Local Area Network Program version 1.12 or higher
- Torus Tapestry version 1.45 or higher
- AT&T Starlan version 1.1 or higher
- Banyan VINES version 2.10
- Other network configurations that are 100% compatible with DOS 3.1 and one of the listed networks

System Requirements for the Network Workstation

- DOS 3.1 or higher
- 640K RAM
- Any combination of hard, floppy, or no disk drives
- Compatible monochrome, color, or EGA monitor with adapter

*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.

“When I saw the record-locking and autorefresh in action, I couldn't believe it. Here was a true network application, a program that can actually take advantage of a network to provide more features and functions, things that can't be done with a stand-alone PC.

Aaron Brenner, LAN Magazine

With Version 2.0, Paradox becomes a sophisticated multiuser product that boasts an impressive selection of data-production features and password-security levels.

Rusel DeMaria, PC Week”

Paradox responds instantly to "Query-by-Example"

The method you use to ask questions is called Query-by-Example. Instead of spending time figuring out *how* to do the query, you simply give Paradox an example of the results you're looking for. Paradox picks up the example and automatically seeks the fastest way of getting the answer.

Queries are flexible and interactive. And in Paradox, unlike in other databases, it's just as simple to query more than one table as it is to query one.

“The program elegantly handles all the chores of a multiuser database system with little or no effort by network users.

Mark Cook and Steve King,
Data Based Advisor”

“Paradox ... has quickly become the state-of-the-art product among PC database managers ... Paradox still reigns supreme as the thinking user's DBMS.

Jim Seymour, PC Magazine”

You don't have to be a genius to use Paradox

Even if you're a beginner, Paradox is the only relational database manager that you can take out of the box and begin using right away.

Because Paradox is driven by the very latest in artificial intelligence technology, it does almost everything for you—except take itself out of the box. (If you've ever used 1-2-3® or dBASE,® you already know how to use Paradox. It has Lotus-like menus, and Paradox documentation includes "A Quick Guide to Paradox for Lotus Users" and "A Quick Guide to Paradox for dBASE users.") Paradox, it makes your network work.

60-Day Money-back Guarantee*

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Call (800) 543-7543

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Circle 41 on Reader Service Card (DEALERS: 42)

ESDI File Servers Get Powerful

Following an industry trend to bring more file-server capabilities to 80386-based systems, Comterm introduced a system with an ESDI controller that powers an 80386-based series of file servers to minicomputer-like networking versatility.

ESDI with Comterm controllers allows you up to 2.6 gigabytes of hard disk storage with a sustained throughput of 990K bps and an average access time of 19 milliseconds.

Using Novell's NetWare as the operating system and the industry-standard ARCnet, Ethernet, or token-ring protocols, each machine serves as many users as the respective protocols will support. Each of the three models has 1.2-megabyte floppy disk storage capacities and four enclosed LAN software packages: ComShell, E-Mail, LAN Tools, and Notemaker. All the CPUs are 16-MHz 80386s with no wait states.

There's also an AT-standard 101-key keyboard, a 14-inch monochrome monitor, and at least one hard disk drive. Model 4 has 330 megabytes of fault-tolerant disk storage (expandable to 660 megabytes) and 3 megabytes of system and cache RAM. There are two parallel ports, two serial ports, and one ESDI disk controller.

Model 8 has 5 megabytes of system memory plus cache memory, two ESDI disk controllers, one parallel port, and 660 megabytes of formatted capacity.

Model 12 has 7 megabytes of system memory plus cache memory, three ESDI disk controllers, 1.98 gigabytes of formatted capacity, and one parallel port. Model 12 can have an expanded formatted capacity of up to 2.6 gigabytes, and the company is working on expanding that memory to 4 gigabytes with 10 slots.

Price: ARCnet Model 4, $28,495; Model 8, $42,995; Model 12, $76,995. Ethernet models are $29,495, $43,995, and $77,995, respectively. Token-ring models are $29,995, $44,495, and $78,495, respectively.

Contact: Comterm, Inc., 110 Hymus Blvd., Pointe Claire, Quebec, Canada H9R 1E8, (514) 694-4332.

Inquiry 790.

LANpac II repeaters lets you network up to 10,000 feet away.

Coaxial Repeater Goes the Distance

LANpac II repeaters from Racore Computer Products extend the distance between networking nodes up to 10,000 feet. "Electronics, power, and a timing shift" allow for sequential placing of up to 10 repeaters every 1,000 feet, the company claims.

The repeater works with the proprietary network LANpac II, which the company says is the fastest network hardware using the most popular networking operating system, Novell NetWare. LANpac II network architecture is either linear, bus, or star.

Data transfer rate is 16 megabits per second over coaxial cabling with a proprietary "high-speed polling scheme," which eliminates the data collisions and the retransmission of data packets made necessary by such collisions in Ethernet networks, for example. The polling can be set at the repeater for every 10, 20, 30, 40, or 50 microseconds.

You select the setting to compensate for propagation delay in the cable, which is partly dependent on cable length. In addition, the repeater can be configured to poll 32 or 64 nodes at once.

Each LANpac II system allows you to connect up to 254 nodes. The repeaters are either stand-alone versions or full-length adapter cards that plug into standard IBM PC, XT, AT, PS/2 Micro Channel, and compatible interfaces, usually within the file server.

Price: Stand-alone version, $495; PC card version, $395.

Contact: Racore Computer Products, Inc., 170 Knowles Dr., Los Gatos, CA 95030, (408) 374-8290.

Inquiry 791.

AT&T Enhances Starlan

AT&T's Starlan 10 gives you the choice of networking with the already-installed telephone wiring in your building or with the more traditional coaxial cable. All you need is a full-length PC, XT, AT, or compatible card (or a Micro Channel card for PS/2 connectivity) and a hub.

Adapters, repeaters, and bridges are sold separately, based on your specific networking needs.

Early next year, you'll be able to upgrade all this 10-megabit-per-second Ethernet wiring with optical fiber cabling, increasing the maximum possible distance between your PCs and your hub to 3280 feet. Already available are interhub fiber adapters that increase the distance between hubs to 9800 feet (compared to the 328 feet offered by unshielded twisted-pair).

But regardless of your wiring choice, Starlan 10 will give you 10-megabit-per-second data rates, links to 1-megabit-per-second Starlan networks, links to other Starlan 10 networks, and your choice of operating systems. DOS users will want the DOS Server Program version 3.1.

Software options include a remote PC gateway, an asynchronous gateway, gateways for connection to IBM Standard Network Architecture (SNA) mainframes, network routers for connection to remote networks over X.25 facilities, and certain terminal-emulation programs for connectivity to proprietary terminals.

Price: Network hub unit, $1895; twisted-pair or coaxial PC or PS/2 board, $495; adapter for twisted-pair connection from an Ethernet card, $200; fiber interhub adapter, $500; each 1:10 bridge, $4500; each 10:10 bridge, $7000.

Contact: AT&T Data Systems, One Speedwell Ave., Morristown, NJ 07960, (800) 247-1212.

Inquiry 789.

continued

Emulate The Best With The Brightest.

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.

Based on the feedback we've received from SmarTerm® users, our family of terminal emulation software has met the challenge, passed every test, and surpassed, in the opinion of a host of enthusiastic users, the performance of the host system terminals being emulated.

The reasons why we shine are fundamental.

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.

Every SmarTerm emulation is easy to use. It's one thing to make software do what hardware does. It's another challenge to minimize software's human wear. The people designing our products understand the nature of the people using them.

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.

persoft®

MFLOPS Help Mac II Process Digital Signals

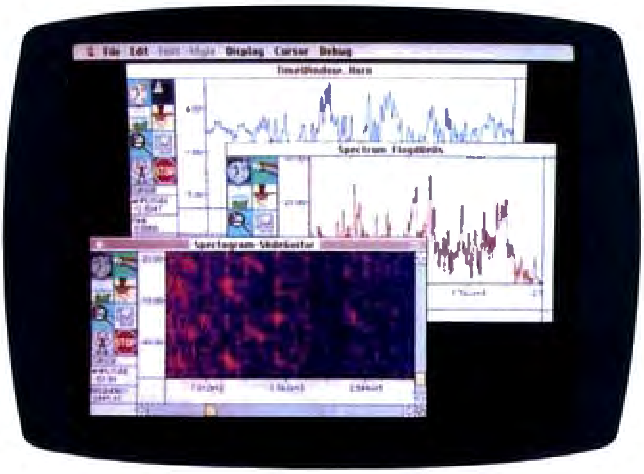
A floating-point accelerator card for the Mac II allows it to acquire data at up to 125 kHz and can operate on that data using signal-processing functions and display the results in real time. For example, a spectrogram function can display the "bending" frequency components of a slide guitar in real time while you listen to a compact disk recording.

The MacDSP board (with accompanying software) is available in three speeds: 8 MFLOPS, 12.5 MFLOPS, and 25 MFLOPS. It's based on AT&T's DSP32 floating-point digital-signal processor, and it lets you observe the functions as they're applied.

The board supports more than 10 signal-processing functions, including fast Fourier transforms, spectral averaging, and elliptic IIR filters. The functions can be applied to incoming data, data stored in main memory, and data on your disks. Data can be manipulated in both analog and digital formats.

You can display data in several formats, including magnitude, phase, color spectrogram, and waterfall. Log scaling, zoom, and maximum amplitude hold are features that can be performed with standard Macintosh menus. Multiple windows allow you to compare the results of a variety of operations.

AT&T's DSP32 C compiler and simulator provide software suppport, and the board uses firmware for access to processor registers from Macintosh driver functions. Custom signal processing can also be developed and directly downloaded onto the card.



Acquire data at 125 kHz with the MacDSP board.

Price: 8-MFLOPS version with driver software and 64K bytes of RAM, $2249; 12-MFLOPS version, $2745; 25-MFLOPS version, $3241; 125-kHz programmable 16-bit A/D and D/A card, $486; DSP software package, unbundled, $496.
Contact: Spectral Innovations, Inc., 292 Gibraltar Dr., Suite A-4, Sunnyvale, CA 94089, (408) 734-1314.
Inquiry 798.

Digital Waveform Analysis on the PC

Up to 20 million samples per second can be taken with the R2000M, a 128K-byte PC-based oscilloscope. An IBM PC, XT, AT, or compatible needs only 640K bytes of RAM, graphics support of CGA, EGA, or Hercules (with color graphics emulation), and a free expansion slot.

The R2000M is particularly useful, the manufacturer claims, in applications requiring high-speed A/D conversion. It can replace traditional oscilloscopes for transient, vibration, modal, and shock waveform analysis.

Features include an 8-bit A/D converter for each channel with a low front end; 50-ohm input switchable to one million ohms; software-selectable gains from 10 millivolts per division to 50 volts per division; and an optional real-time fast Fourier transform and general-purpose interface bus (GPIB) interface.
Price: $3995.
Contact: Rapid Systems, Inc., 433 North 34th St., Seattle, WA 98103, (206) 547-8311.
Inquiry 811.

Virtual 80386s Run from Host CPU

The UnTerminal, an add-in board from Advanced Micro Research, and PC-MOS/386, a virtual MS-DOS from The Software Link, together allow you to run multiple multitasking workstations from a single 80386-based machine.

Such a distributed concept is based on the fact that the Intel 80386 chip, when combined with specialized software, creates a virtual PC for running multiple DOS applications under the Unix operating system. Unix provides the platform for multiuser applications such as database management, word processing, and communications.

PC-MOS/386 allows the host CPU to run all off-the-shelf DOS applications for any of the virtual PCs. The boards take the multitasking capabilities of the 80386 microprocessor and distribute them via 25-pin copper cabling to as many as 16 virtual PCs in the form of keyboard/monitor units. You can locate each keyboard/monitor unit as far as 500 feet from the 80386 host to obtain 16-megabit-per-second connectivity.

A single full-length board (with as many as three daughterboards) fits an AT or compatible slot and supports four keyboard/monitor units as workstations adjunctly to the main CPU. With a 20-MHz system, four adjunct users and a host user taking full advantage of each workstation will slow down each person's virtual processing to about 4 MHz.

As many as four full-length boards can be placed in a single 80386, supporting a total of 12 daughterboards, with each board supporting one workstation. Supporting this maximum of 16 users would slow down a 16-MHz CPU to virtually 1 MHz at a theoretical maximum load.
Price: Full-length DOS UnTerminal board, $745; DOS daughterboard, $379; full-length Unix UnTerminal board, $895; Unix daughterboard, $425. Boards that fit Unix CPUs are also available, as are the 80386-based systems from which you can network the workstations.
Contact: Advance Micro Research, Inc., One Lagoon Dr., Suite 100, Redwood City, CA 94065, (415) 594-9991.
Inquiry 810.

continued

A RAT for A/UX

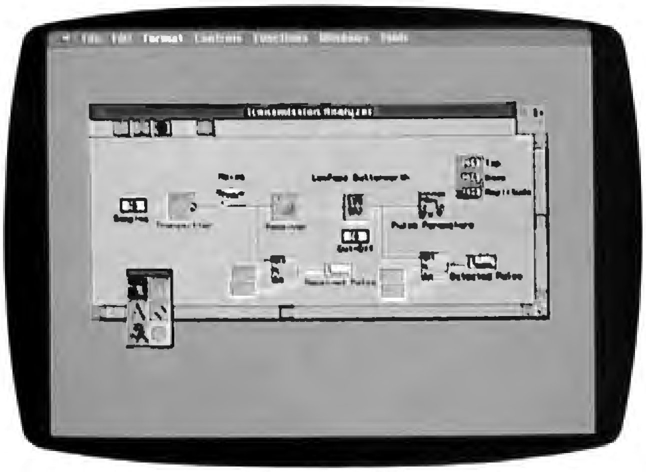
A new FORTRAN compiler for Apple's A/UX Unix environment uses a technology originally developed for the Motorola 88000 that Absoft has dubbed "RAT" (for RISC Architecture Technology). The company claims that the compiler takes maximum advantage of the Mac II's 68020 register set and executes programs an average of 30 percent faster than other Unix-based FORTRAN compilers.

It's called MacFortran/AUX, and Absoft says it meets full ANSI FORTRAN 77, IEEE P754, and military standard 1753 specifications. It also supports most VAX/VMS FORTRAN extensions, as well as many of the extensions of FORTRAN 8X, Complex*16, and Namelist.

The compiler gives you full access to Unix and the Macintosh Toolbox. It also supports interlanguage calling with C. Although MacFortran/AUX has a standard Unix-style command-line interface, it also comes with a Macintosh-style graphical interface that's written completely in FORTRAN. Absoft even provides the source code, which includes over 150 Toolbox calls.

The company also says it's working on a version of the RAT compiler that will run under Macintosh Programmers' Workshop 3.0 on 68020/68030-based Macs. Absoft claims the current and future versions of the RAT compiler will be 100 percent source-compatible with prior versions of FORTRAN and with each other.

Price: $495.
Contact: Absoft, 2781 Bond St., Auburn Hills, MI 48057, (313) 853-0050.
Inquiry 751.



Develop and Debug SQL Databases

If you're an MS-DOS programmer who's working on developing structured query language (SQL)-based database applications, Informix has a "fourth-generation" product that will make your life easier. The Informix-4GL Rapid Development System and Interactive Debugger, as its name implies, lets you do both the development and the debugging.

According to the company, the product reduces your application development time because it eliminates the need for a C compiler. It compiles the 4GL code into a p-code that you can execute with an included p-code runner. You can then use the interactive debugger to find and correct any programming errors. There's also a built-in option that lets you take advantage of up to 16 megabytes of extended memory for creating larger applications.

The development system includes features that let you customize the end-user environment with pop-up windows, selectable colors, and help screens. There's also a flexible report writer. The interactive part of the package lets you set breakpoints, display the contents of variable arrays, and trace functions.

The Informix-4GL Rapid Development System and Interactive Debugger runs on the IBM PC, XT, AT, PS/2s, and 100 percent compatibles.

Price: $1495.
Contact: Informix Software, Inc., 4100 Bohannon Dr., Menlo Park, CA 94025, (415) 322-4100.
Inquiry 752.

A Bumper Crop of C Functions

For those C programmers who don't want to keep reinventing the wheel, Greenleaf Software is offering SuperFunctions, a library of nearly 400 functions for advanced programmers. All functions come with complete source code.

SuperFunctions features routines that give you access to as much as 32 megabytes of Lotus/Intel/Microsoft (LIM) expanded memory version 4.0, and access to high-level DOS functions such as the critical error handler. There's also an advanced set of time-and-date functions that include project-scheduling support, as well as bit-field structures that compress temporal variables into 16- or 32-bit words for saving space when you're doing database development work.

There are also device-independent menu-creation options that include overlaid windows with automatic screen refresh when the windows are removed.

You can use SuperFunctions with any IBM PC, XT, AT, PS/2, or compatible. You'll also need MS-DOS 2.0 or higher.

Price: $265.
Contact: Greenleaf Software, Inc., Bent Tree Tower Two, Suite 570, 16479 Dallas Pkwy., Dallas, TX 75248, (214) 248-2561.
Inquiry 754.

Fast Prolog for Your Mac

Applied Logic Systems has ported its ALS Prolog to the Macintosh environment, retaining its incremental interactive compiler. When you're using ALS Prolog, the compilation step is completely transparent; you interact with the system using text editor windows just as if you were using an interpreter. There's also a built-in debugger.

For Mac aficionados, the company has added a programmer's interface to QuickDraw and a graphics window for making pictures with Prolog.

To run ALS Prolog, you'll need a Mac Plus, SE, or II, Apple's 128K-byte ROM, and a minimum of a megabyte of RAM. A hard disk drive is recommended.

Price: $349.
Contact: Applied Logic Systems, Inc., Box 90, University Station, Syracuse, NY 13210, (315) 471-3900.
Inquiry 753.

continued

Five easy ways to boost your BASIC

ProBas™
Professional Basic Programming Library

ProBas is a library of 232 routines that kicks BASCOM and QuickBASIC into 5th gear and gives you powers and abilities far beyond those of mortal men. So much for the hype, now down to brass tacks:

- **600 page 3-part manual**
- **Full-featured windowing**
- **Screen snapshots**
- **Virtual screens in memory**
- **Lightning-fast file I/O**
- **Full mouse support**

Plus over 200 essential services from directory and equipment routines to handy string, date, time, and input routines. For all versions of QuickBASIC and BASCOM including BASCOM 6.0 for OS/2. **Just $99.00!**

ProBas™ ToolKit

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The **ProBas TeleComm ToolKit** is a collection of high-level communications modules that you plug into your code to provide popular file transfer protocols, terminal emulations, login scripts and baud rates up to 57,600 bps. You get:

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Why use clumsy SHELLs to complex terminal programs when you can plug just the communications routines you need into your code? Implement just the features, and commands you want. Requires **ProBas**. **Just $75.00!**

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ProRef is a pop-up help system for the 232 routines in **ProBas**, pop-up help for your routines, and an extension of the QuickBASIC programming environment. See the calling syntax and help for any **ProBas** routine, or any of your routines, with just a few keystrokes or mouse clicks. Pop-up and ASCII chart, calculator, keyboard scan code module or almost any DOS program via hot-key. **Just $50.00!**

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ProScreen is a full-featured screen generator/editor that will save you more design and coding time than you ever thought possible. **ProScreen** works with screens like a word processor works with text to provide complete control over screen characters, placement and colors. **ProScreen** comes with subroutine source, extensive on-line help and a 285 page manual with tutorial and reference. **Just $99.00!**

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Circle 108 on Reader Service Card

LabView Forges Ahead

Version 2.0 of National Instruments' LabView system for the Macintosh has added a number of new features. Designed as a general-purpose tool for data acquisition, analysis, and instrument control, LabView is an icon-based graphical programming system.

Among the new features are color support, a run-time system for distributing applications, integer data type support, and MultiFinder background execution. Also added is a compiler, which the company claims makes LabView run up to 10 times faster than the previous version. Unlike version 1.2, which interpreted the graphical program, version 2.0 generates machine code directly from the block diagram. National Instruments claims that I/O-intensive applications execute three times faster, and computation-intensive benchmarks run up to 60 times faster.

LabView 2.0 also has perked up editing capabilities that include diagram rubberbanding, complete Clipboard cut and paste, multiple-object selection, and the ability to drag objects between windows. To increase flexibility in evaluating graphical results, there's an interactive pan and zoom with cursor control. On a Mac II, you can set the color of plot traces, icons, backgrounds, and scroll areas.

LabView 2.0 has added Chebyshev and Butterworth low-pass and high-pass filters and additional numerical methods routines to the existing digital signal processing and statistical analysis routines in the library. The program runs on the Mac Plus, SE, and II. If you already own LabView 1.2, you can upgrade to version 2.0 at no charge.

LabView 2.0 has a raft of new features.

Price: $1995.
Contact: National Instruments, 12109 Technology Blvd., Austin, TX 78727, (800) 531-4742; in Texas, (800) 433-3488.
Inquiry 757.

FANSIM Works with Frequency

FANSIM is short for frequency analysis and simulation. It provides frequency analysis of open-loop and closed-loop response, finds transfer functions of real or simulated systems, and also finds poles or zeros.

With FANSIM, you can take real data, simulated data, or internally synthesized functions to find overall frequency response. The program will also accept or output different forms of frequency response functions.

FANSIM runs on the IBM PC and compatibles. It requires a math coprocessor and a Hercules, CGA, or EGA display. You'll also need at least 330K bytes of free RAM, although 512K bytes is recommended.
Price: $395.
Contact: Tutsim Products, 200 California Ave., #212, Palo Alto, CA 94306, (415) 325-4800.
Inquiry 760.

A Solid Diet for AutoCAD

If you've had enough of wire-frame CAD and want something more substantial, Autodesk is now shipping AutoSolid, a solid-model CAD package that uses both constructive solid geometry (CSG) and boundary representation modeling techniques. The package is based on PADL, the University of Rochester's Parts and Assembly Description Language. Autodesk has rewritten PADL in C, making it, the company claims, portable and more efficient.

Autodesk says that because of its intuitive user interface and CSG modeling techniques (analogous to the way mechanical designers work), AutoSolid is easy to use. Pop-up menus guide you through system operations, and you can get on-line help at any point. You can construct a model using solid primitives that you combine using Boolean operations. The finished model is then generated by using sweep techniques.

AutoSolid has DXF and IGES file-transfer capabilities that let AutoCAD and other design packages use its data. The link is bidirectional, letting you transfer solid models to AutoCAD for design detailing and drafting. You can also transfer AutoCAD two-dimensional profiles to AutoSolid, where you can use them to create solid models with the package's revolution and extrusion capabilities.

To use AutoSolid, you'll need an IBM PC AT, Compaq 386, or compatible hardware running Santa Cruz Operations' version 2.2 Xenix. Autodesk says future releases of the product will support other hardware and operating systems, including Sun and Apollo.
Price: $5000.
Contact: Autodesk, Inc., 2320 Marinship Way, Sausalito, CA 94965, (415) 332-2344.
Inquiry 758.

An Algebra Library for C

If you're an engineer or scientist who does extensive programming in C, C-LIN will make your job easier. It's a library of linear algebra subroutines that, according to its maker, have been written specifically to take advantage of the array-manipulation characteristics of C.

The C-LIN library consists of 42 functions, 40 of which come in both single- and double-precision versions. It's available in both compiled and source code versions. The compiled versions are available for Borland Turbo C and Microsoft C.
Price: Compiled version, $69; source code version, $140.
Contact: JAYAR Systems, 253 College St., Suite 263, Toronto, Ontario, Canada M5T 1R5, (416) 751-3284.
Inquiry 761.

continued

You can rely on a file server for LAN communications...

All you need is patience. And faith.

You're getting the drift of this message already. File servers aren't designed to solve the PC user's communications problem. But now there's a system that is.

Now there's COMMIX™ 32.
It's a general purpose local area network for PCs and minicomputer hosts. It connects you with the host, other PCs, and peripherals such as printers, plotters, or modems through simple, pop-up menu commands.

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Almost any PC user can install and connect with COMMIX. With each connection, you're saving time and money. Because each COMMIX connection costs as little as $150.

Then take advantage of expansion possibilities. With our optional Ethernet® Link Module, you can create larger LANs with thousands of users. And through our optional Wide Area Network Module, distant COMMIX LANs can appear as one network.

If you're lost at sea.
And looking for solid LAN. The COMMIX 32 is available now. Send us a message: ITRON, a Division of Infotron Systems Corporation, 130 Gaither Drive, Suite 116, Mount Laurel, NJ 08054.
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The Model 200 Series are **OS/2 compatible,** 80286 based systems. They are available in either 8 or 10 MHz versions to fit your specific needs. These economical, yet full featured AT compatibles are perfect for any applications such as spreadsheets and word processing.

Model 200 Series Features & Pricing

Intel 80286 CPU -208/208S-6/8MHz, 210/210S-8/10MHz, 211-8/10MHz '0' wait state, 512K DRAM, 1.2MB Floppy Disk Drive, 80287 Math Coprocessor Socket, HD/FL Controller (controller is built-on motherboard for 'S' Models) Keyboard Speed Switchability ('S' Models), 2 Serial/1Parallel Ports (211), 192 Watt Power Supply, 101 Key Enhanced Keyboard, Documentation and more.

200 Series	*with Monitor and Adapter*		
Model with Hard Disk	Mono	EGA	VGA
208 or 208S with 20MB	$1275	$1625	$1875
208 or 208S with 40MB	$1420	$1770	$2020
210 or 210S with 20MB	$1705	$2065	$2305
210 or 210S with 40MB	$1850	$2210	$2450
211 with 20MB	$1805	$2165	$2405
211 with 40MB	$1950	$2310	$2550

CLUB Model 212 Series

With an **effective throughput of 16 MHz,** the Model 212 Series is as fast as many 386 machines at a fraction of the price. Compatibility with the existing AT standard ensures that the Model 212 will run your large databases, and complicated financial software today, as well as **OS/2** applications tomorrow.

Model 212 Series Features & Pricing

Intel 80286-8/12, 1MB of DRAM, 1.2MB Floppy Disk Drive, 1:1 Interleave HD/FL Controller, 80287 Math Coprocessor Socket, Clock/Calendar/Configuration with Battery Backup, Reduced Chassis (212D), 192 Watt Power Supply, 101 Key Enhanced Keyboard, Complete Documentation, and more

212 Series	*with Monitor and Adapter*		
Model with Hard Disk	Mono	EGA	VGA
212 with 40MB	$2250	$2615	$2850
212 with 70MB	$2505	$2870	$3105
212D with 40MB	$2190	$2550	$2790
212D with 70MB	$2445	$2805	$3045

Good Golly, It's Molly

Do you need historical stock market information? Do you not want to bother with the time and expense of tracking it down through an on-line database? Molly can help. Molly is a historical financial database that contains about 100,000 prices—about 3 megabytes of information.

Molly consists of disks with data in Lotus WK1 format for the IBM PC, or Microsoft Excel format for the Macintosh.

It includes the Dow Jones Industrial Average daily close since 1920; the S&P 500 Composite Index daily close since 1928; the S&P price/earnings ratio and yield on a daily basis since 1940; the Dow Jones transportation and utility averages since 1970; short-term interest rates on a weekly basis since 1970; and intermediate, long-term, and Eurodollar weekly interest rates since 1977. There's also the Nikkei Index, the Value Line Index, the S&P 100 Composite Index, advancing and declining issues on the New York Stock Exchange, and the NYSE advancing and declining volume.

Molly runs on the IBM PC and compatibles with 384K bytes of RAM or on the Macintosh. You'll also need Lotus 1-2-3 for the IBM PC and Excel for the Mac. You can order monthly or quarterly updates for an annual fee.
Price: $199.95; monthly updates, $79.95; quarterly update, $49.95.
Contact: MarketBase, Inc., 250 West 90th St., Suite 12K, New York, NY 10024, (800) 627-5385.
Inquiry 764.

@RISK does risk analysis and simulation.

@Risk Reduces Risk

Question: Which program (along with Lotus 1-2-3 and WordPerfect) is required for all incoming students at the Harvard Business School? Answer: @Risk (pronounced "at risk"), a Lotus 1-2-3 add-in designed for risk analysis and simulation modeling.

@Risk is designed for situations where there is uncertainty in the values you enter in your spreadsheet. The program handles uncertainty by letting you enter a range of values. It then uses probability distributions and simulation techniques to evaluate the situation. @Risk uses Monte Carlo–type simulations, where uncertain cell values are varied across the probability distribution. Each simulation calculates hundreds or thousands of what-if scenarios, and then the program tells you the probability of each outcome occurring.

The output from @Risk's calculations is displayed graphically as probability distributions by @RiskGraph's high-resolution graphics routines. You can display the output in a variety of formats, including histograms, cumulative curves, summaries over ranges of cells, or overlays. All graphics outputs are in a standard .PIC format. @Risk supports VGA, EGA, CGA, and Hercules graphics. It comes with a 30-day money-back guarantee.
Price: $395.
Contact: Palisade Corp., 2189 Elmira Rd., Newfield, NY 14867, (607) 564-9993.
Inquiry 763.

PackRat Mobilizes Personal Information

Polaris calls PackRat a personal information manager and says it's a direct competitor to Lotus' recently shipped Agenda. PackRat is described as a text and graphics database that lets you enter free-form data.

PackRat runs under Microsoft Windows, and the company says Windows' interface and mouse support make PackRat particularly easy to use. For example, you can simply point to a date on a Windows calendar instead of having to type in something like "the day after tomorrow."

PackRat consists of several facilities, including a phone book, phone log, expense log, calendar, agenda, task list, index cards, and disk log file. Each of the facilities has its own local database, but depending on how you store it, the same information can be displayed on more than one list.

The package also has a tickler function that lets you enter reminders. PackRat can give you a full range of reports that you can select and sort in a variety of ways. The program runs on any system that runs Microsoft Windows.
Price: $395.
Contact: Polaris Software, 613 West Valley Pkwy., Suite 323, Escondido, CA 92025, (619) 743-7800.
Inquiry 765.

TaxCalc Plans Your Taxes

Worried about the implications of tax reform on your personal or business nest egg? TaxCalc can help. TaxCalc Multi-Year Tax Planner is the latest incarnation of the company's popular spreadsheet template. Now it's also available as a standalone run-time version.

The program gives you 3-year tax analysis through 1990, multiple alternative analysis of the same year, the ability to put up to 12 calculations on-screen at one time, and separate schedules for detail input. TaxCalc also calculates a special report that follows IRS Form 8582, which allocates unused passive losses and activities.

The template version of the program works with all popular spreadsheets, including Lotus 1-2-3, SuperCalc, and PC-Excel. It's also available for Excel on the Macintosh. If you have a previous version of TaxCalc, you can update to the new version for $150.
Price: $395.
Contact: TaxCalc Software, Inc., 4210 West Vickery Blvd., Fort Worth, TX 76107, (800) 527-2669; in Texas, (817) 738-3122.
Inquiry 767.

continued

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— *Kent Porter, Dr. Dobbs Journal*

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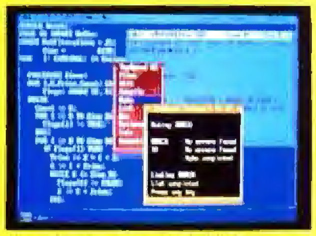

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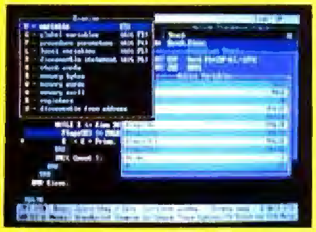
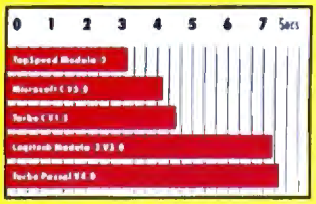


VID (Visual Interactive Debugger): power without complexity.



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

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Donnelley Marketing

In England and Europe contact:
Jensen & Partners UK Ltd., 63 Clerkenwell Road, London EC1M 5NP Phone (01)253-4333. Compiler Kit £59.95, TechKit £34.95, VID £34.95, 3-Pack £109.95

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

Introducing VID: The easy-to-use, source-level debugger. Single-step and trace through source in multiple modules. Examine and modify all variables in symbolic form, including arrays, records, enumerated types and pointers. Point and shoot breakpoints including "One-shot," "Sticky," "Delayed," and "Monitor." Watch both variables and Modula-2 expressions during execution. Automatic variable trace of all variables accessed, and assembler, registers and procedure call-stack trace windows. Package includes symbolic disassembler and execution profiler. 72-page manual.

The Compiler Kit Includes: High-speed optimizing compiler (3,000-5,000 lines/min. on a PC AT 8MHz), 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 available RAM, two floppy drives (hard disk recommended).

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Compiler Kit $99.95
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A Communications Program for All Systems

If you have different computers running under different operating systems and want a consistent user interface for communications, a program called Term could be just the ticket. The program runs identically under Unix, Xenix, MS-DOS, VMS, and BTOS. Term's developer, Century Software, claims it is keystroke-for-keystroke-compatible with more than 50 computer systems, ranging from micros to superminis.

Term emulates the VT-100, VT-102, VT-52, TeleVideo 925 and 912, WY-50, ANSI 3.64, and Teletypewriter for every terminal attached to a system. It also has a proprietary file-transfer protocol called TermCRC (Term cyclical redundancy check) that lets you do file transfers at up to 115.2K bits per second. It supports XMODEM, Kermit, Modem7, ASCII, Binary, XON/XOFF, ETX/ACK, and line-by-line protocols.

The program uses Lempel-Ziv Welch data compression, which the company claims results in an average 45 percent to 50 percent speed improvement in file-transfer times. Term automatically converts text-file formats when you're transferring files between different operating systems.

Term includes a full-featured script language that you can use to build full-screen data-entry forms, mail gateways, and completely automated remote communications sessions. It's shipped with 35 prebuilt script applications.
Price: Single-user version, \$195; multiuser version, \$350.
Contact: Century Software, 5284 South 320 W, Suite C294, Salt Lake City, UT 84107, (801) 268-3088.
Inquiry 769.

TERM has a powerful script language.

Manage Files with the Bridge

White Crane Systems' newest version of its Brooklyn Bridge system-to-system file-transfer package has a number of new features, including a dual-directory display, a file manager, and special DOS utilities. It runs on all MS-DOS-compatible systems and transfers data at up to 115,200 bps.

Using installable device drivers, Brooklyn Bridge 2.0 lets you quickly transfer individual files or groups of files with direct commands. But like its competitors—such as LapLink—the new version also has a dual-directory display that lets you see the directories of both machines at once. You use the dual directory along with a 1-2-3-like menu to choose your transfer options.

The new version also has several DOS utilities, such as `BACKUP`, that copy only files that have been created or changed since the last time you used Brooklyn Bridge. There's also `MOVE`, which deletes the original file once it's transferred; `COPY`, which lets you work with multiple files using a single command; and `REMOVE`, which has a security option that ensures that deleted files are unrecoverable.

Brooklyn Bridge 2.0 lets you share hard disks and peripherals between two systems. It has a `RUN` command that gives you multiprocessing by letting you run programs on a slave system at the same time you're doing something else with the master. The program comes with both 3½-inch and 5¼-inch disks, along with an 8-foot universal serial cable. A 50-foot cable is also available.
Price: \$139.95; upgrade from previous version, \$35.
Contact: White Crane Systems, Inc., 6889 Peachtree Industrial Blvd., Suite 151, Norcross, GA 30092, (404) 394-3119.
Inquiry 772.

NetWare Lands the Mac

Along with MS-DOS and OS/2, Novell's NetWare local area network (LAN) software now supports the Apple Macintosh. If you're using your Mac in an AppleShare network, NetWare's newest version lets you be fully compatible. Because each system continues to use its native operating system, Macintosh, IBM PC, and PS/2 users can continue to see and use the environment they're most comfortable with, while sharing files and data across the network without the need for conversion.

Designed for use with NetWare version 2.15 or higher, NetWare for the Macintosh gives you the fault tolerance, security, and high performance of Novell's network and lets you use a lower-cost IBM-compatible file server. Macs use the standard AppleShare client software to access the NetWare file server. NetWare provides full support of AppleTalk protocols within the server.
Price: \$200.
Contact: Novell, Inc., 122 East 1700 S, Provo, UT 84601, (800) 526-5463; in Utah, (801) 379-5900.
Inquiry 770.

Carbon Copy Now Handles Graphics

Carbon Copy Plus, a remote-control communications package for the IBM PC and compatibles, is now available in version 5.0. This newest version adds background file transfer and a universal graphics translator.

The background file-transfer feature lets you transmit a file to another Carbon Copy-equipped computer without interrupting the application you're working on. With the universal graphics translator, the program supports EGA, VGA, Hercules, CGA, and extended CGA cards. All of these are interchangeable, which lets you and the Carbon Copy user on the other end see and interact with the same graphical screen image.
Price: \$195; upgrade from previous version, \$50.
Contact: Meridian Technology, Inc., 1140 Hammond Dr., Suite A-1125, Atlanta, GA 30328, (404) 390-9152.
Inquiry 771.

continued

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Microsoft Takes You for a Ride

Four years in the making, Microsoft's long-awaited update to its popular Flight Simulator is ready for takeoff. Version 3.0 has many new features, including the ability to run on high-speed AT clones and support full 640- by 350-pixel, 16-color EGA and VGA displays.

Besides the old familiar Cessna 182 and Sopwith Camel, you can now add more than a little spice to the experience with a Gates Lear Jet and a Crop Duster. Flight Simulator 3.0 now uses pull-down windows to control navigation and communications, flight analysis, environmental conditions, and flight scenarios.

There's also a new learning mode that gives you basic and advanced flight training, aerobatics, and navigation instruction. These are prerecorded flight sessions designed for pilots from beginner's rank all the way to advanced. A flight analysis package tells you how well you've done.

If you're the adventurous sort, you can try a night landing on an aircraft carrier, the ultimate test of flying skill. You can also fly together with other Flight Simulator 3.0 users through a null modem cable or through telephone lines.

Flight Simulator 3.0 runs on the IBM PC, XT, AT, PS/2s, and 100 percent compatibles. You'll need at least 256K bytes of RAM, DOS 2.0 or higher, and a CGA, EGA, VGA, or Hercules adapter.
Price: $49.95.
Contact: Microsoft Corp., 16011 Northeast 36th Way, P.O. Box 97017, Redmond, WA 98073, (206) 882-8080.
Inquiry 775.

Flight Simulator 3.0 steps closer to reality.

Forge a Few Fantastic Fonts

Version 1.1 of Z-Soft's Publisher's Type Foundry includes numerous new features that make electronic publishing packages faster and easier to use. The package, which runs under Microsoft Windows, lets you design and modify type fonts for laser printers.

The biggest new feature is a Windows screen font translator. This lets you see the final version of the font you've designed on-screen, as well as use it in other applications. Other new features include a virtual memory manager for handling large and complex images without performance degradation; data compression; and an editor that lets you set character height and width guidelines. This makes it easier to create uniform-looking fonts.

Version 1.1 now includes full support for the Hewlett-Packard LaserJet II, including both portrait and landscape modes. A DOS utility is included that lets you download your fonts to HP printers without having to use Windows.

Finally, the new version of Publisher's Type Foundry includes several new bit-map and outline fonts. Best of all, if you're a registered owner of the current version, you can get the new version gratis.
Price: $495.
Contact: Z-Soft Corp., 450 Franklin Rd., Suite 100, Marietta, GA 30067, (404) 428-0008.
Inquiry 776.

Describe Files with Words

Ever run into situations where those eight-character-plus-extension DOS filenames become incomprehensible gibberish in a few weeks? Would you remember what you meant by SAPM4755.TXT or APP-2REV.WK1? Extend-A-Name can help. It lets you use filenames or descriptions that are up to 60 characters long.

Extend-A-Name is RAM-resident and uses from 39K bytes to 65K bytes of memory. If you have LIM version 4.0 expanded memory, the program takes only 3K bytes in your base RAM. The program continually scans the screen for your application program's load prompt. It then pops up with a library screen where you can choose a previously created file or make a new one.

The program lets you create libraries, which are logical divisions of subdirectories. They let you further organize your files. Extend-A-Name also has a number of additional features, including copy, delete, assign, rename, tag, and untag. You can perform all these functions without having to leave your application.
Price: $79.95.
Contact: World Software Corp., 124 Prospect St., Ridgewood, NJ 07450, (800) 962-6360; in New Jersey, (201) 444-3228.
Inquiry 778.

On Cue Fights Window Buildup

If you're one of those Macintosh users who keeps switching from application to application, having to return to the Finder (or MultiFinder) every time can be a pain. It can also result in "window buildup" of numerous stacked windows on your Mac desktop. A new program called On Cue claims to solve all these problems.

On Cue gives you a pull-down menu that shows your most frequently used applications. You can move among them simply by clicking on the application you want to use. You won't have to move between overlapping windows on the desktop or wait for folders to open and close.

The program works with all Macs from the 512KE on up. It's easy to configure to your specific needs, and installation is a simple matter of dragging On Cue's icon to your system folder.
Price: $59.95.
Contact: ICOM Simulations, Inc., 648 South Wheeling Rd., Wheeling, IL 60090, (312) 520-4440.
Inquiry 777.

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Statistical Analysis Software for the Mac

StatView SE+Graphics features presentation-quality graphics with MacDraw-like tools to draw shapes, lines and arrows, pattern fills, and axes. A mini-text editor lets you insert captions anywhere on a graph and assign different font styles and sizes to any word or character.

The types of graphs you can make with the program include scatterplots; line, bar, and pie charts; histograms; box plots; percentiles; univariate charts; and error bars. StatView SE+Graphics can also perform statistical operations.

The program runs on the Mac SE and Plus with 1 megabyte of memory.
Price: $399.95.
Contact: Abacus Concepts, Inc., 1984 Bonita Ave., Berkeley, CA 94704, (415) 540-1949.
Inquiry 811.

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BYTE is expanding its coverage of local events in the Pacific–West Coast region. If you would like your event, conference, special project, or users group covered, please send information to: Regional Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.

Organize Your Ideas on the Mac

Inspiration is an idea organizer that lets you organize your thoughts into modifiable free-form diagrams and outlines. You can use them to write speeches and articles, plan trips, take notes, or organize your thoughts.

You can work in outline or diagram view—the program updates both views when you work in either one.

You can export diagrams to drawings or presentation products using PICT files or the Clipboard. If you want to incorporate your thoughts with other work, you can export your outline to a word processor.

You can select from eight colors and a variety of patterns, symbols, and line thicknesses, with which you construct the diagrams. Or, you can use the default symbol and link.

Symbols grow or shrink, depending on the amount of text they must enclose. All you need to do is press Enter after each new thought. Link connections can also have text on them.

Inspiration is MultiFinder-compatible and works on the Mac 512KE, Plus, SE, or II. The program supports ImageWriter and LaserWriter printers.
Price: $149.
Contact: Ceres Software, 9498 Southwest Barbur Blvd., Suite 103, Portland, OR 97219, (503) 245-9011.
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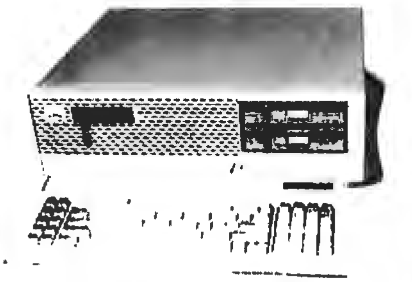

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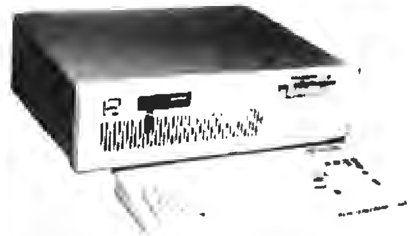

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Proteus features a built-in debugger. You can choose to display a status line that tells you the name and number of the slide you are viewing, for easier debugging. You can also add musical tones and simple tunes to your demos. And an operating system shell command lets you run DOS commands without leaving Proteus.

To create demos with Proteus, you'll need an IBM PC or compatible with at least 384K bytes of RAM and a color or monochrome display adapter.

Price: $99.

Contact: Helios Software, P.O. Box 22869, Seattle, WA 98122, (800) 634-9986; in Washington, (206) 324-7208.

Inquiry 813.

Computer Group Advises Parents

The Disabled Children's Computer Group (DCCG) sponsors workshops on computer systems and peripherals that can help disabled children and their parents. Through Kids on Keyboards, the center helps children learn how to get online and communicate with each other via the DCCG bulletin board system.

DCCG also publishes a quarterly newsletter, *The Real Times*. The center has about 1000 members. The membership fee is just $20 a year.

Contact: DCCG, 2095 Rose St., Berkeley, CA 94709, (415) 841-3224.

CASE Seminar

The Computer-Aided Software Engineering Symposium will focus on the key concepts, trends, and successful implementations of CASE in organizations. It is a three-day symposium: The first day's activities will consist of lectures and discussions, and the last two days are slated for vendor demonstrations.

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Price: $895 (group discounts are available).

Contact: Digital Consulting, Inc., 6 Windsor St., Andover, MA 01810, (508) 470-3880.

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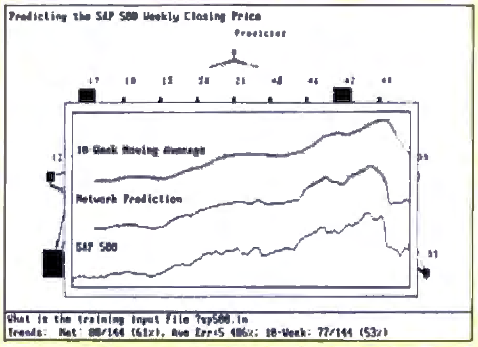

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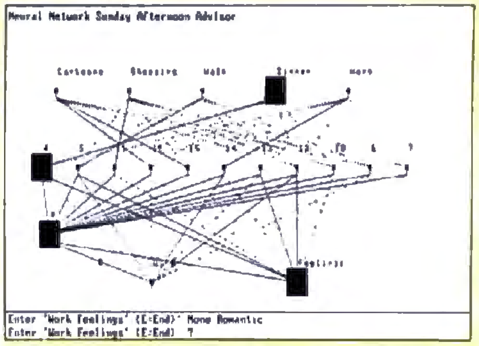

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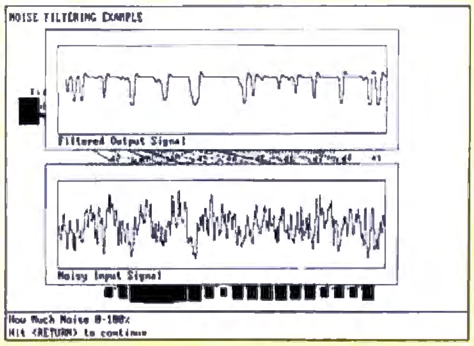

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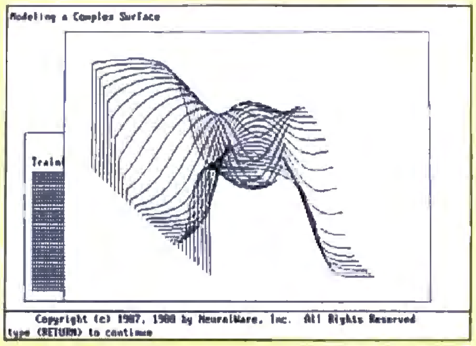

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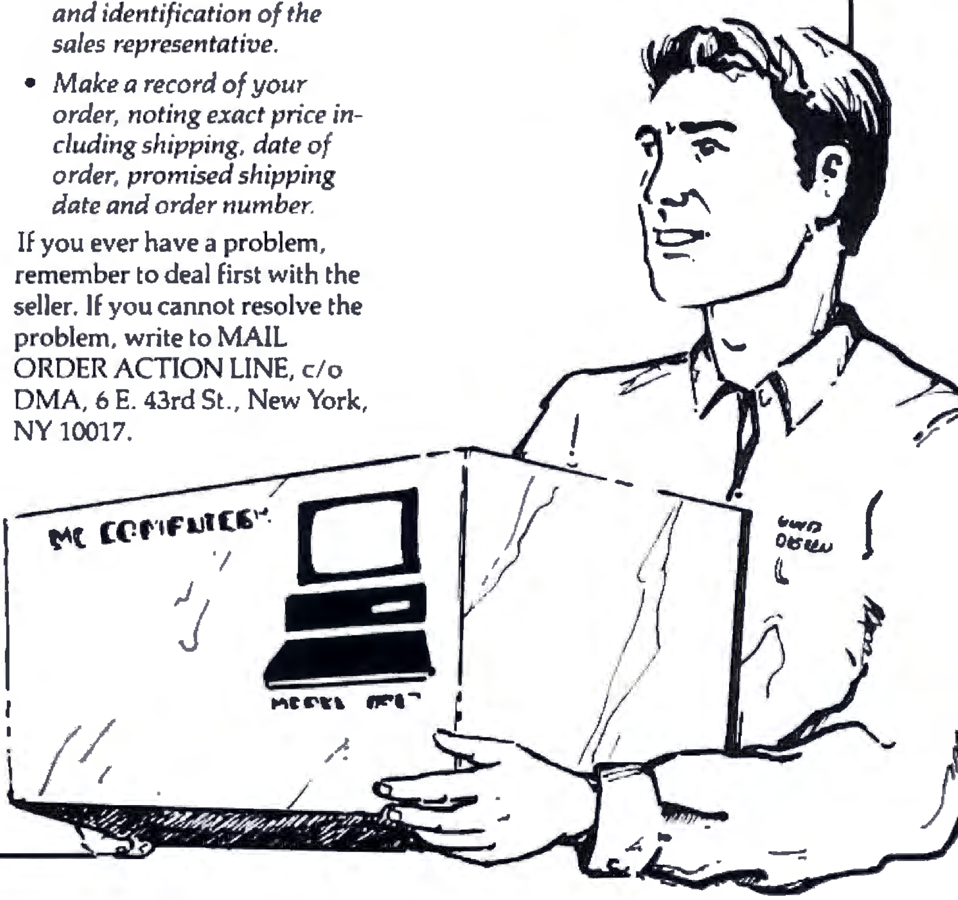

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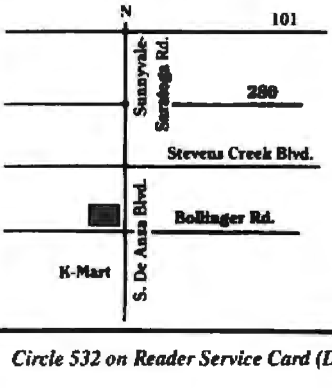

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Solve tough systems problems too
Soft-ICE is ideal for debugging TSRs, interrupt handlers, self booting programs, DOS loadable device drivers, non-DOS operating systems, and debugging within DOS & BIOS. Soft-ICE is also great for firmware development because Soft-ICE's break points work in ROM.

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Soft-ICE uses the power of the 80386 to surround your program in a virtual machine. This gives you complete control of the DOS environment, while Soft-ICE runs safely in protected mode. Soft-ICE uses 80386 protected mode features, such as paging, I/O privilege level, and break point registers, to provide real-time hardware-level break points.

"Soft-ICE is a product any MS-DOS developer serious enough to own a 386 machine should have."
Dr. Dobb's Journal — May 1988

Both require 80386 AT compatible or IBM PS/2 Model 80. MagicCV requires at least 384K of extended memory. CodeView is a trademark of Microsoft Corporation

RUN CODEVIEW IN ONLY 8K!

CodeView is a great integrated debugger, but it uses over 200K of conventional memory. MagicCV uses advanced features of the 80386 microprocessor to load CodeView and symbols in extended memory. This allows MagicCV to run CodeView using less than 8K of conventional memory on your 80386 PC.

Don't let 640K be your limit!
If you are closing in on the 640K limit and would like the power of CodeView, MagicCV is for you.

Don't let the debugger hide the bug!
Even if you're not closing in on the 640K limit, running CodeView with MagicCV makes your debugging environment much closer to the end user's program environment. You can use CodeView to locate subtle bugs that only occur when there is plenty of free memory, or those difficult bugs that only occur when your program is running with a couple of TSRs loaded.

How MagicCV works
MagicCV uses the 80386 to create a separate virtual machine for CodeView. MagicCV uses between 4K & 8K of conventional memory as a bridge between the DOS environment and CodeView.

MagicCV is easy to use
If you are a CodeView user, you already know how to use MagicCV too. Just type MCV instead of CV, everything else is automatic.

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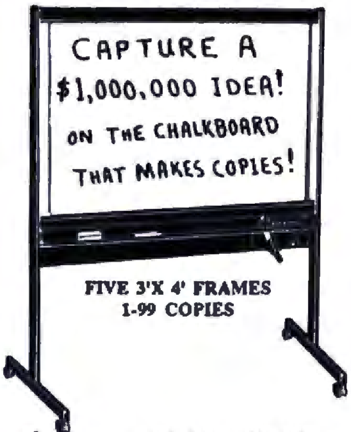

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COMPATIBILITY TESTING RESULTS
The Everex System 386 has been evaluated by XXCAL, an independent third party testing house. The test objective, as stated in XXCAL's report of February 16, 1988, was "to reveal any problems or inconsistencies relative 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."

COMPETITIVE BENCHMARK TESTING RESULTS

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

Computer System	MIPS	Landmark	Norton SI Advanced
Everex Step 386/20	4.81	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 Step 286/16	3.27	21.4	18.4
AST Premium 386/20	3.04	20.0	21.0
Wyse 386/16	2.98	20.6	17.6
Acer 386/16	2.99	20.6	16.2
Compaq Deskpro 386/16	2.90	20.0	17.6
IBM PS/2 Mod. 80.16MHz	2.87	20.0	17.6
Everex Step 286/12	2.45	15.9	13.7
AST Premium 286/10	2.02	13.0	11.1
Compaq Deskpro 286/10	1.89	11.7	11.5
IBM PS/2 Models 50, 60	1.58	9.8	9.8
IBM PC AT 8MHz	0.93	8.0	7.7

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OTHER EVEREX COMPUTERS

286 System (Model 1800)

- 80286 CPU
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- 101 Keyboard
- FL/HD Controller
- 6/8/10 Keyboard Selectable
- 195 Watt Power Supply
- Optional 80287 Socket
- FCC UL Approved

8MHz '1' Wait State 80286 Mono System	$990
10MHz '1' Wait State 80286 Mono System	$1239
10MHz '0' Wait State 80286 Mono System	$1339
12MHz '0' Wait State 80286 Mono System	$1575
For an EGA System	add $350

386 System (Model 3000A)

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- FL/HD Controller
- 64K Cache
- 16MHz CPU '0' Wait State
- 195 Watt Power Supply

16MHz '0' Wait State 80386 Mono System	$1975
For an EGA System	$2299

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BYTE editors offer hands-on views of new products

Toshiba 3-in-One: The Colorized Version

Coloring movies has gotten Ted Turner a lot of criticism, but no one can object to what Toshiba has done to its 24-pin dot-matrix printer. Besides being fast and capable of high-resolution printing, the new Toshiba **3-in-One P321SLC** can print in four colors and can produce some remarkable output. Using combinations of the cyan-magenta ribbon, you can get output in up to seven colors, including black. Green, orange, and purple can be simulated.

Assembling the printer and setting up the paper feed takes about 3 minutes, but once the mechanical requirements are taken care of, changing configurations is a breeze. The front panel's four switches and liquid crystal display let you access all the configuration parameters through layers of setup menus. More common parameters (e.g., font, pitch, and emulation) are available in the first layer, while everything from RAM allocation to horizontal registration can be adjusted if you care to delve deeper.

The printer comes with 34K bytes of memory that is shared between the print buffer and downloadable fonts. There are two card slots on the front of the machine for optional 32K-byte RAM modules or font cards. My evaluation system came with two font cards, which let me access a total of five typefaces. Courier, Prestige Elite, and High Speed are the standard ones. Typefaces can be scaled between 10 and 20 points.

Printing speed varies from job to job, but the P321SLC is always noticeably fast. Draft-quality documents zoom by at a rated print speed of 216 characters per second, while letter-quality printing is rated at a respectable 72 cps. I timed one letter-quality sample and found it took about 50 seconds to print a little less than 2000 characters. For the average text job, expect to wait about a minute per page.

Resolution is excellent, as is typical of 24-pin printers. The clarity really shows on fine line graphics and small, narrow typefaces like Prestige Elite. The print head is pin-addressable and can provide graphics at up to 180 by 360 dots per inch.

While printing in color provides you with a versatility you can't achieve in monochrome, it also opens doors to a few problems. The biggest problem I had was finding drivers in my applications that would let me print in color. The P321SLC supports three emulations: Toshiba/Qume, IBM Proprinter, and IBM Color Printer. While applications often include Toshiba drivers, several notable packages—ACAD 2.52 and Dr. HALO III 3.0, among others—support only the monochrome versions, and you are forced to fall back on IBM emulation.

The detailed 268-page user's manual has a technical reference section that describes all the ASCII escape sequences. Using these, I generated color text by embedding the commands in XyWrite. Instructions are included for creating color text using MultiMate and other popular packages. I printed several graphics images using Harvard Graphics 2.10. Narrow line images like maps and mechanical design plots turned out very well, while more filled drawings tended to show lines where the printer had made repeated passes.

The new 3-In-One adds color to a fine line of Toshiba printers. With this and other dot-matrix printers becoming more and more affordable, high-resolution color may well be the common output of the future.

—Steve Apiki

THE FACTS

Toshiba 3-in-One
P321SLC
$949

Interfaces required:
Centronix parallel or
25-pin RS-232C.

Toshiba America Inc.
Information Systems
Division
9740 Irvine Blvd.
Irvine, CA 92718
(714) 583-3000
Inquiry 851.

Illustrator 88: PostScript Drawing Gets Better

Adobe's Illustrator and Aldus's FreeHand are like two great baseball teams slugging it out, with one team going ahead in the top of the inning and the other team coming back to scratch out the tying and go-ahead runs.

Adobe batted first in 1986 and scored impressively with Illustrator, which established a whole new class of drawing program that uses the PostScript language to create artwork made up of lines and Bézier curves. Earlier this year, Aldus tied the score and

continued

went ahead with FreeHand, which does wonders with colors and had on its roster one thing Illustrator lacked: a freestyle drawing tool. And now Adobe has sent up **Illustrator 88**. The score has definitely changed.

The new Illustrator has a freestyle drawing tool, which works like the pencil in MacPaint. This addition to the toolbox gives you considerably more freedom when you're working on an illustration. The program is primarily for producing clean lines and curves—which you do by laying down a series of anchor points and then having the program connect them—but there are times when you need more flexibility than the connect-the-dots approach provides.

Another big change to the Illustrator lineup is an automatic tracing tool, a significant feature lacking in FreeHand. Both programs let you take an image and use it as a template; using different tools, you trace over that template and then use the tracing (the top layer), which looks much more polished than the original, in your illustration. This process is how these PostScript drawing packages, with their skill at producing clean, perfect lines, let you transform a rough sketch into a sharp, well-defined piece of artwork. Illustrator 88's autotrace tool makes tracing a rough image a painless—and very fast—process. A brilliant addition.

Illustrator can now do four-color separations—one area where FreeHand had gone ahead—but uses a separate utility to handle the process, whereas FreeHand does it from within the application. Adobe has added the glorious Pantone palette of colors, which you can also use to make custom colors of your own. If you're lucky enough to have a Macintosh II and a color monitor, you'll be able to produce graphics that are just downright lovely. While a PostScript drawing program like Illustrator can create

THE FACTS

Illustrator 88
$495

Requirements:
A Macintosh Plus with an 800K-byte external hard disk drive and System 4.2 or higher.

Adobe Systems
1585 Charleston Rd.
P.O. Box 7900
Mountain View, CA
94039
(415) 961-4400
Inquiry 852.

superb engineering-type artwork quickly—it's perfect for schematics, diagrams, and models—the addition of color capabilities makes it suitable for softer, nontechnical work as well.

One of FreeHand's nice effects is its shading capabilities, which let you fill an image with graduated color or intensity. Illustrator 88 has a tool that produces similar results, but it is considerably harder to use. In fact, I found this Blend tool to be the most frustrating part of the program.

You'd better have a real good grip on Illustrator's main elements (i.e., paths, endpoints, and anchor points) and terminology before you tackle blending. I made the mistake of just trying to feel my way through the process of blending two different shapes and kept getting hit with error messages like "Please use the Blend tool on a selected endpoint of an ungrouped open path." This is not MacPaint. You can't just pick up a brush and go to work. Save yourself lots of time and frustration by reading the manual.

Illustrator has not improved much in its text tools. You can do some fancy things with characters and fonts—like changing their shapes and filling them with patterns—but you can't mix fonts or sizes within a chunk of text. And some users have criticized the program's lack of kerning control.

While Illustrator 88's preview mode is handy, you can't do any work to the drawing on the screen. You have to switch back to the raw version to make any changes. It took me a while to stop instinctively trying to edit the drawing in preview mode, which is something it is possible to do in FreeHand.

One thing to know before getting into Illustrator is the oodles of memory it can use. You have to pay something for the power of this program, but on a 1-megabyte machine, which is the minimum, you don't have much room to work with.

Criticizing Illustrator 88 is a bit like criticizing Brooks Robinson as a third baseman. How can you argue with something that gets the job done and done gracefully? As for the contest between Illustrator and FreeHand, I'd say Adobe has tied the score, maybe even gone ahead.

—D. Elvis Barker

Listen While You Work: Apple's CD-ROM Drive

The **AppleCD SC** CD-ROM drive gives Macintosh and Apple II users access to applications containing up to 550 megabytes—and the chance to listen to music while working with all that data. Since the CD-ROM drive uses the small-computer-system-interface (SCSI) port to connect to the computer, hooking it up is trivial. Just connect a SCSI cable ($50 at Apple's prices) between the Mac and the AppleCD SC. If it's the only SCSI device on the system, install the SCSI terminator plug ($30) and the AppleCD SC is ready for action. You also need to install the CD-ROM drive software driver, which lets the system recognize the AppleCD SC.

Unfortunately, while I was testing the drive, most CD-ROM software developers had not yet released their products. By the time you read this, however, several CD-ROM applications should be available, and more vendors are expected to announce products for the AppleCD SC this fall and early next year.

I had to content myself with Apple's "learning disc," which presents a number of third-party applications currently under development, all running under HyperCard 1.2 (HyperCard 1.1 does not support the AppleCD SC). These applications to come include Grolier's New Electronic En-

continued

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

How About Low Level Control?

CrossCode C comes with an assembler that has all the features that assembly language programmers require. In fact, you could write your whole application with it:

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

Can It Handle The Link?

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

How Does It Get To ROM?

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

Why Wait?

Once you start using **CrossCode C**, you may just wonder how you ever got the job done before! It's available under MS-DOS for just $1595, and it runs on all IBM PCs and compatibles (640K memory and hard disk are required). Also available under UNIX & XENIX.

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DOWNERS GROVE, ILLINOIS 60515 USA

THE FACTS

AppleCD SC
$1199

Requirements:
Apple Macintosh or Apple II with a SCSI cable; HyperCard 1.2 recommended for use on the Macintosh.

Apple Computer
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
Inquiry 853.

cyclopedia, Stanford University's The Electric Cadaver for studying human anatomy (see the August Microbytes), and samples from The Whole Earth Catalog. Most of the sample applications include lots of graphics and sound and are an impressive demonstration of the potential of the CD-ROM.

Accessing the drive through HyperCard is no different from accessing a HyperCard stack on a floppy disk or a hard disk. The drive appears as an icon on the desktop, and you can open it just like any other folder or stack. The main difference, of course, is that you can't write to the CD-ROM drive or make any changes to the data that's on the disk.

While HyperCard will probably be the main interface for CD-ROM software on the Macintosh, Apple will provide support for the High Sierra ISO disk format, which is dominant in the CD-ROM industry. When the High Sierra system software is available, you can get it by mailing Apple a coupon that comes with the AppleCD SC. (High Sierra will be supported on both the Macintosh and Apple II, Apple says.)

A slick feature of the AppleCD SC is its ability to play standard audio compact disks using a desk accessory called CD Remote, which controls the audio disk. The CD-ROM drive has sockets for connecting earphones, stereo speakers, or a stereo amplifier. To use the AppleCD SC as a stereo system, simply click on CD Remote and insert an audio disk in the drive. CD Remote presents a panel on the screen, where you can click on various buttons to play certain selections, switch tracks, pause, repeat, and so forth. You can also remove the panel from the screen and the CD will continue to play as a background task.

The AppleCD SC drive is an excellent product, but it's pretty expensive at $1199 (add another $80 for cabling). The biggest disappointment is the lack of software at this time. Unless there's an application out there that you've got to have right now, it's probably best to wait until more software is available.

—Nick Baran

Two Great Caching Programs

As processors get faster and faster, disk I/O becomes more and more of a bottleneck. A few major manufacturers (notably, IBM and Compaq) package disk-caching software with their systems to speed up read/write operations.

A disk cache selectively buffers disk reads and writes, substituting fast RAM accesses for unnecessary or repetitious—and slow—disk operations. A cache offers many of the speed benefits of a RAM disk but is easier to use. And it's also safer, because a cache will automatically "write through" to the disk instead of requiring an explicit save or copy command.

I looked at two inexpensive disk-caching programs that widen the bottleneck by speeding up input and output: Multisoft's **Super PC-Kwik** and Polytron's **PolyBoost II**. Both offer blazing speed and impressive bells and whistles.

continued

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THE FACTS

Super PC-Kwik $79.95	PolyBoost II $79.95
Multisoft Corp. 15100 Southwest Koll Pkwy., Suite L Beaverton, OR 97006 (503) 644-5644 **Inquiry 854.**	Polytron Corp. 1700 Northwest 167th Pl. Beaverton, OR 97006 (503) 645-1150 **Inquiry 855.**

Requirements for both: IBM PC, XT, AT, PS/2, or compatible with DOS 2.0 or higher, 5K bytes to 5 megabytes free memory (conventional, extended, or expanded), and a hard disk drive.

Both will accelerate the disk I/O of almost any Intel-based machine, and both can exploit conventional, extended, or expanded memory; users of IBM PC AT-class machines also can put to use the top 384K bytes on their 1-megabyte motherboards without the Lotus/Intel/Microsoft Expanded Memory Specification or any other memory-enhancing scheme.

I tried both caches on a 16-MHz Compaq 386 with 2 megabytes of memory and on a 16-MHz Club American 386 with 1 megabyte of memory. Both programs worked flawlessly and boosted disk throughput from 3 to 7 times that of the same machines without caches. (For workaday applications, a speed increase of 3 or 4 times is typical.) I found that both programs were faster than the caching program Compaq supplied; I've stopped using Compaq's cache.

While both caches are fast, PolyBoost II is marginally faster than Super PC-Kwik. For example, a read/write-intensive operation like decompressing a series of archived text files took 22 seconds with PolyBoost II installed and 24 seconds with Super PC-Kwik installed. (With no cache, the decompression took 39 seconds.)

A few seconds here or there won't add up to early retirement, but if speed is the determining factor (it is for me), PolyBoost II is the better choice. On the other hand, because their performances are close, the bells and whistles each of these programs offer may tilt the balance one way or the other for you.

Super PC-Kwik has a mind-boggling array of options to optimize its operations for your usage patterns. It also runs cooperatively with Multisoft's versatile PC-Kwik Print Spooler (sold separately for $45): The two programs can dynamically share the same memory above 640K bytes. It's pretty slick. In effect, it uses the same RAM to preferentially buffer and accelerate whatever the current *slowest* I/O operation is.

PolyBoost II takes a different tack: It's actually a suite of several programs, including a cache, a keyboard enhancer (which speeds up keyboard response and includes a command-line editor), a screen speedup program (for monochrome or color displays), a disk unfragmenter, and several other utilities. The combination of disk, keyboard, and screen speedups that results when using PolyBoost II is impressive enough to make your computer feel like a new and much faster animal.

Any cache is better than no cache; and these caches are better than some others. You really can't go wrong with either.

—Fred Langa

continued

A Personal Tickler That Runs under OS/2

Despite having to keep track of such things as meetings, deadlines, and my wife's birthday, I've frankly found today's crop of memory-resident personal schedulers a real pain. I don't have the time to learn them, and they take up huge chunks of my limited MS-DOS RAM real estate. So, with all this computing "power" on my desk, I still use pocket- and desk-size calendars to schedule my days.

But that may change pretty darn fast. **Tickler/2** is by far the most powerful personal scheduler I've seen. It has a bunch of handy features and tricks, a simply elegant user interface, and a low price, and it runs only under OS/2.

Tickler/2 is the electronic equivalent of those famous paper-based tickler files that many disgustingly organized people use. A classic tickler file takes up loads of space by using individual file folders, one for each day in the month, along with folders for individual months and upcoming years. You fill these folders with pieces of paper: notes, reminders, letters to follow up, and so on. It can get absurdly crowded and confusing, and you're up the creek if you misfile an important paper.

This program uses OS/2's extended memory capacity and multitasking abilities to offer a huge amount of options. Besides the normal chore of entering appointments, you can set messages to appear on your screen at just about any interval or on any date, even years in advance. It also has a relative scheduling feature that lets you enter a major event and then indicate when and how often you want to be reminded of it. If you tell it to be merciless, Tickler/2's "nag" feature will continually remind you of something you need to get done until you indicate you've done it. It will also count down the days (or hours) until deadline. Features like this are just the thing for foot-dragging editors who put off writing Short Takes until the last minute.

Tickler/2 also lets you attach OS/2 commands to a message. With this feature, you can have Tickler/2 do things like automatically sending a monthly report to the boss or performing a weekly hard disk backup. I used it to automatically log on to BIX overnight, get my electronic mail, and file conference messages. Sure, you can do this with several MS-DOS programs, but the fact that it's integrated with Tickler/2's other features makes it handy indeed.

But the most intriguing feature is something that is called a "named event." You can attach a virtually unlimited list of messages to an event that you can't pin down to one particular time. For example, if you sell computers, you can enter messages that are set to start every time a customer buys a system, doing things like sending a thank-you letter, service reminders, and even a "trade-in time" reminder a few years in the future.

THE FACTS

Tickler/2
$80

Requirements:
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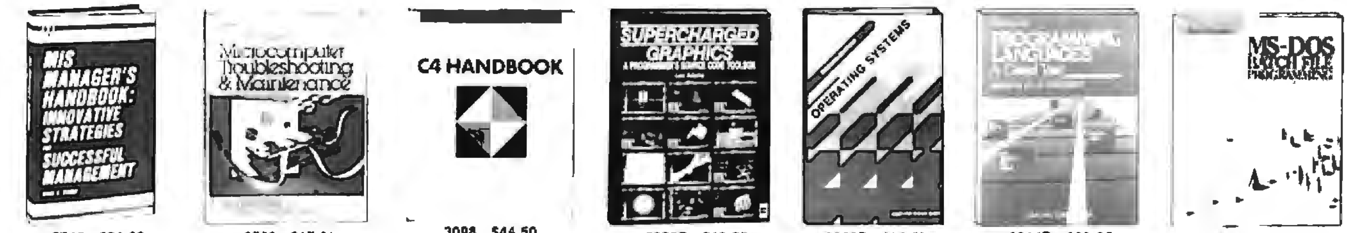

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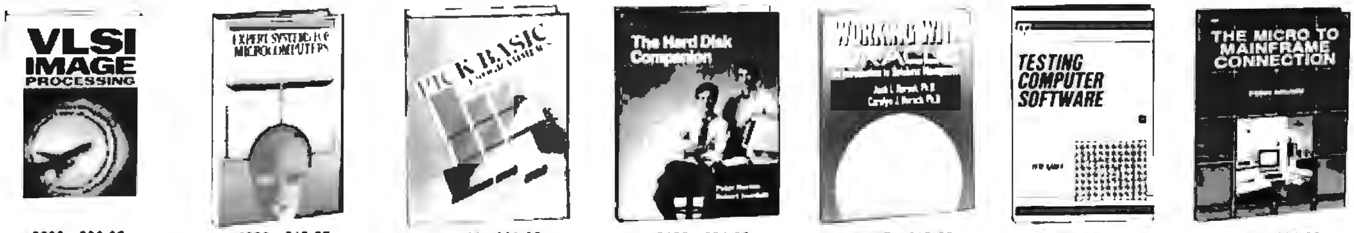

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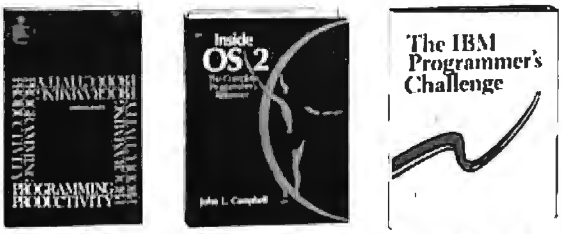

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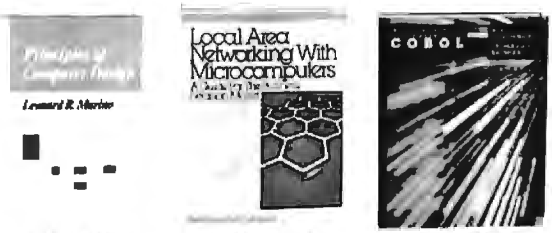

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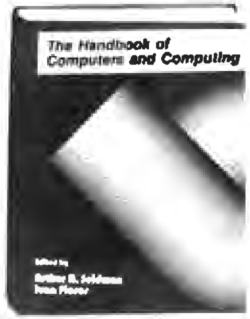

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Circle 63 on Reader Service Card

Tickler/2 is actually made up of two programs: There's a foreground editor/database for entering your messages and schedule, and a 36K-byte program runs as a detached task under OS/2. The latter triggers the reminder messages. And since it's OS/2, there's no "RAM cram" or ill-behaved terminate-and-stay resident programs.

Tickler/2 is one of the easiest-to-use programs I've seen. You don't have to learn esoteric syntax to enter messages and times; in most cases, you just have to type a few keystrokes and highlight a date or time using the cursor keys.

—Stan Miastkowski

Zortech's Comm Kit

Zortech's Comm Toolkit package is an eye-opening collection of programs geared to the programmer involved with serial-port communications and anxious to get on with it. Here you'll find functions that cover the entire range of communications complexities: from rudimentary "send-a-byte-out-the-serial-port" to a single function that implements batch Kermit-protocol transfers. Zortech provides source code compatible with Microsoft C (Quick C), Turbo C, and (understandably) the Zortech C compiler. If your favorite compiler isn't on that list, you can modify the source code so your own compiler will not have an immune reaction.

That's right, Zortech provides the complete source code, right down to the low-level library routines.

If you're going to do any kind of terminal emulation, you're going to need to deal with screen-driver software. Here's where Comm Toolkit scores again. You'll find definitions for a standard display as well as a Windows driver. Also, Zortech includes source code for ANSI, VT-52, and VT-100 emulators.

I linked my XT clone and my AT clone and decided to test Minicom and Maxicom, the two communications programs in the package. I put the Zortech programs on one end and HyperAccess on the other. Zortech's programs had trouble on my Xitses (the MCT-IO multiserial board from JDR Microdevices), but they seemed to do better when I tried them on the AT clone with a stock IBM serial card. Even then, when I changed the data transfer rate from the menu in Maxicom, the system stopped receiving (though, mysteriously, it could transmit).

When things worked, I ran XMODEM and Kermit transfers in both directions up to 9600 bits per second with modest throughput. I attribute the program's unimpressive speed to the fact that the XMODEM and Kermit code appear to do no explicit record buffering and therefore suffer from frequent disk accesses.

I have mixed feelings about the Zortech Comm Toolkit. If the bugs get cleaned out, there's certainly plenty of usable code here. You might need to do some work to get the code compatible with your serial interface—particularly if you're using a nonstandard clone board. But if you've got some communicating to do and don't mind a little low-level programming, you ought to check it out.

—Rick Grehan ■

THE FACTS

Zortech Comm Toolkit
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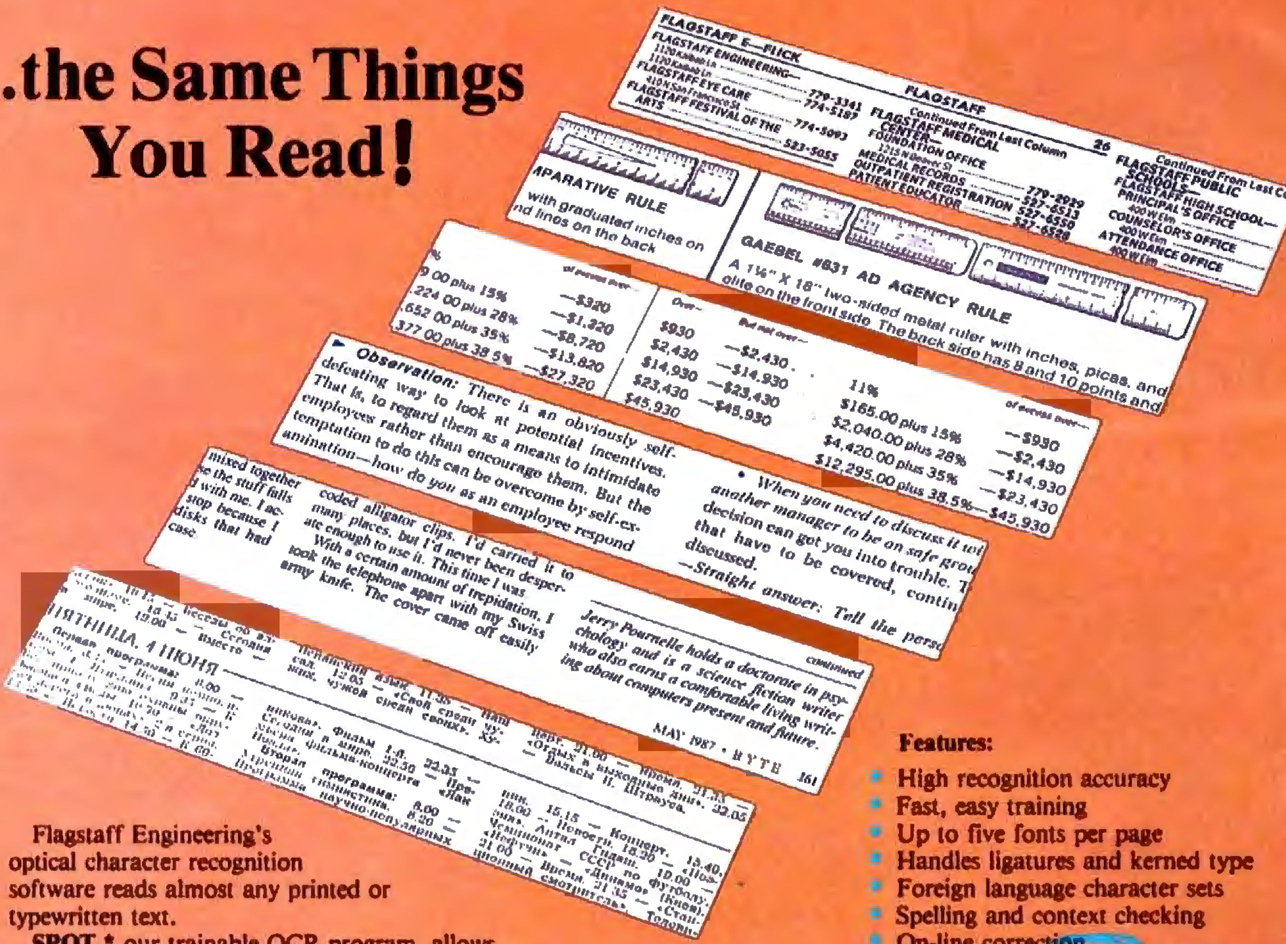

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STICK SHIFT OR AUTOMATIC?

Jerry takes a look at the new version of Windows and delves into the history and functionality of Sprint

The other day, Mrs. Pournelle and I were walking in the hills behind Chaos Manor. When we came down into the back-road area, we saw a young man trying to teach his girlfriend to drive. "That's the real test," Roberta said. "Teaching her to drive, or teaching her to use a computer, it's the real test of true love."

"Stick shift car, too," I said.

She shrugged. "All computers are stick shift."

I've been thinking about that.

Of course, the Macintosh tries to get away from the "stick shift" image, and it has a lot of converts. My youngest boy enters college this fall. He has a Mac Plus. One of his older brothers wants to trade his IBM PC AT for a Mac. Both claim they're not interested in learning about computers, they just want to use them. I remember saying something like that back when I began this column more years ago than I want to admit. My friend and colleague Tom Clancy does all his work on a Mac and isn't vaguely interested in learning about PCs. Perhaps it's valid to think of the Mac as the first automatic shift machine.

If so, then the PC world is beginning to breathe down the Mac's neck.

Windows

I suppose I have to be careful what I say, lest I get myself involved in Apple's silly lawsuit against Microsoft and Hewlett-Packard; but I've just come back from a Microsoft-sponsored Windows exposition, and I can only conclude that Windows is hastening the process of the "Macintoshization" of the PC. If you prefer to say that Windows is now implementing many of the ideas developed at Xerox's Palo Alto Research Center (PARC) lo these many years ago, then partly perfected by Niklaus Wirth, and finally popularized by Apple's Macintosh, feel free. The point is that Windows consciously attempts to make the PC an automatic shift computer.

Of course, automatic shifts need cars that are higher-powered. Same with computers. If you have an ordinary PC or XT, I don't recommend Windows. If you want multiple applications—sort of like the Macintosh MultiFinder—and you have an XT with a hard disk drive and a good bit of RAM disk as well, DESQview is marginally better than nothing. Windows isn't for you; it's just too slow. I don't really recommend either for slow machines.

If you have an AT, you have more choices. Windows/286 is Microsoft's newest. It isn't very good at taking ordinary DOS programs and running them in the Windows environment. Still, Windows/286 version 2.10 is a distinct improvement over the older Windows, and it's not all *that* bad. Windows/286 can run DOS stuff, provided that your AT computer is fairly vanilla, the program isn't too badly behaved, and you hold your mouth right; but it will be slow, even if you've got a fast system. If all you want to do is run standard DOS programs, you'll probably be better off with DESQview.

Windows/386 is better yet. Windows/386 on an 80386 machine is better than DESQview on an 80286 machine. On the other hand, DESQview works spectacularly better on an 80386 than it does on an 80286; and Windows/386 is still slower than I like. There is room for a difference of opinion. People I respect like Windows/386 a lot. It certainly is usable, if slow.

Windows/386 isn't easy to install. It doesn't like a number of EGA cards (Orchid and Paradise seem to be all right). The Setup program takes quite a long time, and if you have to make any changes in your installation, you must start all over again. This can be quite annoying.

When you're installing Windows/386, I advise you to throw away your AUTOEXEC.BAT and CONFIG.SYS files. Windows/386 will construct new ones. Let it. Don't set up any buffers, or environment, or paths, or anything else while you're trying to get Windows/386 going. Then, when you have Windows/386 up and running, you can tweak the start-up files to see what you can get away with.

You want to be real careful about what DOS you're running, too; I'm still getting DOS version incompatibility errors in Windows/386 long after I thought I'd eliminated all possible sources of such errors. I still don't understand that; it could be that I've added something odd to my CONFIG.SYS file or tried to use DOS extensions for the CD-ROM reader.

If you have a very vanilla system and don't use networking, running ordinary programs under Windows does have some advantages. Windows has convenient features, like its own pop-up notebook and calculator (but no calendar), and it does make switching from one program to another a lot easier (although not easier than DESQview). Where Windows—/286 or /386—really shines, though, is running programs developed especially for use with Windows. Some of those work spectacularly well. The Windows screens are laid out well and are as easy to understand as any Mac screen. Windows screens are more customizable, too.

I'm just beginning to collect software that's been specially adapted to work with Windows. Most of it, like Microsoft Excel and MacInTax PC, comes with a run-time package so that you don't really need Windows; but it's much better if

continued

you have Windows and are familiar with it. Windows/386 running programs adapted for Windows runs like lightning, and it does all the things the Macintosh MultiFinder is supposed to do but hasn't quite perfected.

When I'm using Windows to run programs like Excel and MacInTax, I understand why Apple was so terrified of Windows that they brought in the lawyers. The interface is at least as good as Apple's; indeed, many will think Windows does the integration of mouse and keyboard better than the Macintosh does. The various operations are smooth and intuitive. Better yet, you don't give anything up; you can still use DOS with its wild-card commands.

We did notice that, probably because of the lawsuit, Windows no longer has "TRASH" as the place to put deleted files. The legend under the icon (which doesn't look like Apple's Trash) now says "GARBAGE." Roberta suggested they have an icon of the kitchen sink and label it "DISPOSALL," which inspired me to think up a large vortex with the label "BLACK HOLE." Apparently, Apple is adamant about owning the Trash, and nearly everyone is willing to let Apple have it if they want it so bad.

We made that suggestion at the Hewlett-Packard booth at the Windows show. Hewlett-Packard has a Windows adaptation called NewWave. The demonstrator chuckled and called in the icon editor. Within a couple of minutes, he had a kitchen sink labeled "DISPOSALL," and he was starting in on the "BLACK HOLE." I didn't get much chance to look at NewWave, but from what I did see, I was impressed.

I wasn't much of a Windows fan when the program was first introduced, but I can see how I might become one if they can get enough programs adapted for it. Windows doesn't yet do much with devices like CD-ROM drives—Microsoft Bookshelf is a pain to get going in the same window with your word processor, but then it's a pain to get DESQview to handle it, too.

Microsoft tells software developers that the best way to learn to write software for OS/2 and Presentation Manager is to begin with Windows. From what I've seen, if you're developing new software, you might want to seriously consider adapting your stuff for Windows, no matter what you think of OS/2.

They are going to have to speed things up, though. I suspect the way to do that will be with faster video boards. Most of the wait comes from having Windows draw stuff on your screen.

Windows hasn't yet got us out of the stick shift era, but it looks like the next revision just may do it.

Actor

One program that has been adapted for Windows is the Actor language. This is one of the family of languages that includes Smalltalk: you have data classes, and you send messages to them; then they do things, like make new windows with certain features, or put images on the screen, or do calculations. Actor is interactive and compiles as you write it, producing threaded code like Forth; but it's said to be a great deal easier to learn, and to use, than Forth.

I don't know. My only exposure to Actor was in a demonstration at the Windows seminar. I was impressed, but then one is often impressed by demonstrations; the acid test will be to see if I can write programs with it when I get it here. I will say that it sure looked like it understood how to interact with Windows; I watched them create several small programs to my specifications, and it seemed like child's play. More when I know more, but my first impression is that Actor and Windows may be made for each other. If you're a language collector or if you're seriously interested in Windows, take a look at Actor.

Special Days and Footprints in History

An outfit called The Salinon Corporation has a series of programs called the "Life and Times" series. One program is called Special Days: you put in data, say someone's name, birthplace, and birthdate. The program looks things up in its databases, trundles out a printout that wishes the subject a happy birthday, then proceeds to report on things like what happened on that day in history; who else was born in the subject's home state; what popular songs were current the year the person was born; even prices of goods, like eggs and bicycles, back then.

It will do the same for anniversaries: it prints out your names, some congratulations, and then a summary of what things were like at 5-year intervals since you were married. (Incidentally, make sure you have the proper date set in your computer; it uses the system's date in its message calculations.)

I wasn't terribly impressed with the program, but just for the heck of it I fed it Roberta's birthday and our anniversary, printed the results, and gave the printouts to her. Apparently, she rather liked them. I don't know if she'd have liked it so much if I'd paid the full $39.95 they want for the program, but possibly; and of course you can use it to generate birthday cards for all your friends.

There's nothing to using Special Days; there's a manual, but I can't think why you'd want to look into it. Everything is explained on-screen, and if you do get stuck—which isn't easy—there's plenty of context-sensitive help. It's a really neat user interface.

I also have Salinon's Footprints in History. This is a more complicated program with much the same user interface. What you do is input someone's name, date of birth, and any other events (with dates) in the subject's life. The more dated events you can put in (entering school, graduations, marriage, children born, whatever), the better.

The output is a chronological table. The events come out unchanged (except that it tells you what day of the week things happened on); but they're embedded in other events. You might have: July 19, 1969, Alfred E. Neuman flunks third grade again; July 20, 1969, Neil Armstrong is the first man to walk on the moon; and stuff like that. The Alfred E. Neuman (or whomever you're making this up for) events are put in by you; the others come from the program's databases. (Most people would probably be a bit more dignified in picking events in Alfred E. Neuman's life.)

My major criticism with these programs is there's no way to add items to the program's databases. You go with what they furnish. Also, it's not clear to me what algorithm they use to select the order and importance of events: I used the "Special Day" feature of Special Days to prepare a report on July 20, 1969, and while it did tell me this was the day Neil Armstrong walked on the moon, the event it put up first was "Yoko Ono marries John Lennon."

Who knows, maybe Lennon's marriage was more important than the first trip to the moon, but you'll never convince me of that.

FastTRAP

I must have said a hundred times that I'm not fond of mice. I can never *find* the mouse, to begin with. The darned fool things are always getting buried. Once my mouse was completely buried under enough paper that the left-hand key was pressed down by the weight of the stuff on top of it. This caused weird problems when the machine was powered up and the AUTOEXEC.BAT file brought in DESQview. It took me 10 minutes to figure out what was wrong with my computer.

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Mice are inconvenient, and often I've wished for some kind of trackball arrangement. Now I have one.

FastTRAP is a neat little trackball system with three buttons (see "Four Surrogate Mice" by Jeff Holtzman in the August BYTE). It comes with software capable of emulating any mouse you're accustomed to, and it does all that very well. MicroSpeed also encloses a little booklet illustrating 101 things you can do with your old mouse, including using the cord as a noose to hang your cat.

The FastTRAP trackball comes with a DB-25 connector. The MicroSpeed executives seemed nonplussed when I explained that most AT machines come with DB-9s on their serial ports. MicroSpeed does sell, at extra cost, a cable adapter that will let you plug FastTRAP into your AT's DB-9 port.

FastTRAP has a good hefty feel to it. The box is a bit thick for my taste. I'd have preferred it not to stand quite so high off the table, but that's certainly a matter of taste. It's not impossibly high, and indeed I can think of reasons for making it the height it is.

If you're doing CAD-type work, FastTRAP may be exactly what you're looking for. There are two models; one has a wheel in addition to the trackball. The wheel is used for three-dimensional data control, as in a CAD program.

For CAD and similar work, FastTRAP is at least as good as a mouse, and most will probably find it a lot better. Control is smooth and precise, and it's a lot easier to move the cursor across long distances. Just as a trackball is superior to a joystick for many games, it's much better than a mouse for a number of business operations.

What you can't do with a trackball is use it as an ordinary mouse. In my judgment, FastTRAP will never replace the mouse with programs like Windows or Microsoft Word, because it's almost impossible to do click-and-drag operations with a trackball system. I simply cannot hold down one of the FastTRAP buttons and simultaneously maneuver the cursor without using both hands. It isn't just me. No one else at Chaos Manor can do it, either. Human hands just aren't built that way.

It's thoroughly obvious once you think of it, but I confess this discovery surprises me, especially since I've been a strong advocate of trackballs for some time now, and I am still extremely fond of the WICO SmartCat keyboard with its integral trackball. (Alas, WICO couldn't keep the price down to anything reason-

continued

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able and no longer makes that keyboard, which is a real pity.) Of course, the WICO trackball keyboard came out well before click-and-drag became established as a standard mouse operation; I never had to use the WICO keyboard that way, or I'd have discovered the difficulty long ago.

It should be possible to design a trackball that would allow click-and-drag, but the ball would have to sit to the *side* of the buttons, which would preferably be on the side of the box enclosing the trackball; it's hard to describe what I'm talking about, but imagine a keyboard with a trackball in the upper right corner (for right-handed operations) with three buttons on the side of the keyboard where your fingers would naturally rest if your thumb were on the ball. This would be at least as easy to use as a mouse. But I don't know of anyone who makes or plans such a keyboard.

I've just discovered that if you install FastTRAP as a two-button Microsoft Mouse, the middle button toggles drag on and off. This isn't as convenient as mouse click-and-drag, but it is possible to do it, and with time one might find that better than mouse operations. I'll try it for a month and let you know.

Choice Words

A long time ago, Mike Wiener of Microlytics showed me an upcoming product, which turned out to be WordFinder, a synonym program based on algorithms developed at Xerox PARC. Mike thought there was a terrific product lurking in the Xerox algorithms, and since PARC didn't seem interested in developing it, he did under a joint venture agreement.

I've used WordFinder ever since. It works fine with the word processors I like, including Q&A Write; you can even get WordFinder at a discount when you buy Q&A Write. I like WordFinder, so I've paid little attention to other thesaurus and dictionary programs, on the theory that if it ain't broke, don't fix it.

That may have been a mistake.

Proximity Technology's Choice Words, which is based on the Merriam-Webster *Webster's Dictionary* and *Webster's Thesaurus*, is at least as good as WordFinder, and in some ways it is better. Choice Words will tell you what parts of speech your word may be and offer definitions by categories. It gives tenses for irregular verbs. It offers synonyms under different connotations of the word.

Installation of Choice Words is utterly simple. Just run the Install program, which, so far as I can tell, does nothing but create a subdirectory and copy the five disks into it.

Choice Words can be run as a pop-up program from within your word processor or as a stand-alone program. By far the better way to run it is as a pop-up, since that lets you use it while editing documents. There are two ways to do this. The simplest is to go to the directory containing Choice Words and type `PROX` to invoke the program. Once that's done, you can go to your word processor's subdirectory and bring in your text editor. The default pop-up keys are Alt/Left Shift/T for thesaurus and /D for dictionary. You can change those keys to almost anything you like.

The other way to install the program is to put its subdirectory in your `AUTOEXEC.BAT PATH` statement. Either way works fine. You can also put Choice Words into the same directory as your word processor, then bring them both up

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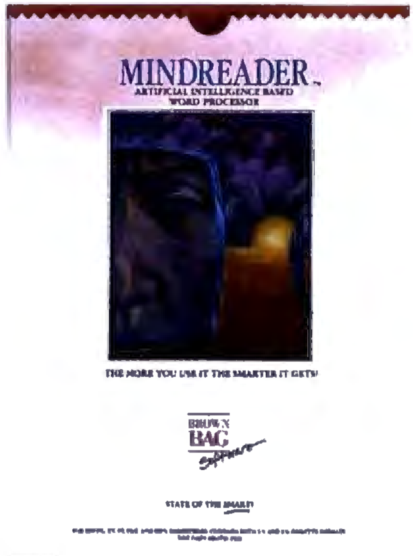

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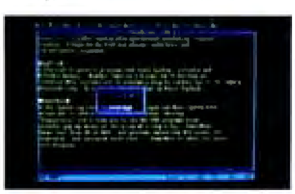

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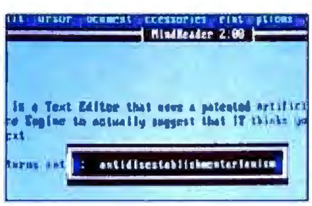

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with a batch file. The important thing is that all the methods work, and I had no trouble doing them. Like WordFinder, it works well with DESQview.

Choice Words works with a variety of word processors, including difficult ones like Q&A (and Q&A Write) and Microsoft Word. It's very fast, at least on my big Cheetah 386, and comparable in speed to WordFinder on all the machines we tried it on.

I find I'm not a big user of thesaurus programs. I practically never use one when I'm actually writing. On the other hand, I always load one into the system when I bring up a text editor, and when I'm doing a final edit on text, I do call up the thesaurus sometimes. If I didn't have one, I'd buy one; but then, my business is words. I don't have to use a tool very often to justify having it.

As to which one I'd buy, WordFinder or Choice Words, I confess I don't know. They're both very good. Choice Words gives you more information, but a consequence of that is it takes you a bit longer to use it. WordFinder is fast and nearly invisible until you want it, and it may give you all the information you need. Unlike WordFinder, Choice Words includes a very good dictionary program; if you have any need for an on-line dictionary (as opposed to a thesaurus), I haven't seen anything nearly as good.

If you do much writing, you'll probably want one of these programs. Choice Words is a good deal more than good enough. It's at least equal to the best.

Sprint

Philippe Kahn has been telling me about Sprint, Borland's new text editor, for over a year. Every few months, he'd offer me a copy; then, just before I got it, there'd be some new improvement they wanted to perfect. After a year of this, I finally got the program from Philippe himself when I visited him in Scotts Valley. We used LapLink to squirt it over from Philippe's Compaq portable to my Zenith Z-183.

That may not be the best way to get the program. I've found that demonstrations by an enthusiast tend to skip over difficulties that inevitably surface later. That was surely the case this time.

I don't have time to go through all the steps that lead me to this conclusion. Let me just state it: Sprint is a contender for the best word processor on the market today. It's fast and extremely powerful. It is almost completely customizable. It works with PostScript and all the other advanced stuff that's coming. It supports darned near every printer known to man and is able to make use of many of the fanciest features, including proportional spacing, automatic kerning, and the lot. It does indexing, and it sort of does outlining, although I would be surprised if a creative writer actually uses the severely limited outline processor in the current version. Sprint will make tables of contents and figures. It will work with short or long documents.

Sprint has a "swap file" system that automatically and unobtrusively saves your work every 30 seconds or so, so that even with a power failure you won't have lost much. I noticed that Philippe routinely shuts down his portable simply by turning it off: no saving his work, no exiting from Sprint. Just pull the plug in full confidence that everything will be there next time you power up. I'm writing this on one of the hottest days in the history of Los Angeles, with power failures everywhere, so I appreciate a feature like that.

Having given my conclusion, let me add some qualifications. Sprint is *not* a text editor for everyone. Some users will love it. A good many others will really hate it. To explain why, I'll have to give some background.

Sprint was originally based on EMACS, one of the world's first full-page text editors. EMACS was written in TECO for big multiuser minicomputers (PDP-10 and PDP-11) at MIT by Richard M. Stallman, generally known as RMS. Stallman, who is famous for his view that software ought to be free, gave EMACS away. If he hadn't, he'd be a rich man. In its day, EMACS was the best programming editor in the world.

EMACS was then modified for microcomputers by an outfit called Mark of the Unicorn, and it appeared as a CP/M commercial product called The Final Word. Later, they put out a PCompatible version. Sprint is two generations later than that.

EMACS was a programmer's editor. It was adequate for writing text—indeed, it was a lot better for that than anything else available at the time—but it wasn't designed by a professional writer. Some additional features were suggested by writers, including me, but RMS is the archetypal hacker, and he included in EMACS everything he could think of. He then added a programming language that would let you do all the things he hadn't thought of.

The result was a hacker's dream—and very nearly a user's nightmare. Every key did something; EMACS was the original source for the joke about programs with Control-Alt-meta-cokebottle commands. The EMACS philosophy was that you could do anything you wanted if you would take the trouble to learn how. Surely you should do some of the work?

I was invited to learn EMACS in the 1970s when I had an ARPANET account at MIT. There was a TeachEmacs program running on the MIT computer, and that plus determination got me familiar enough with the program that I could use it. I even wrote an early BYTE column on-line using EMACS, and for a while there was a notion that Marvin Minsky and I would write a book together, with EMACS as the editor of choice.

The Minsky project died because we both had heavy schedules, and, besides, you can't really do a major project at 300 bits per second. Then I lost my ARPANET account. After that, I had no reason or opportunity to use EMACS until Mark of the Unicorn brought out their CP/M version, and they didn't send me a copy of that for a year or so.

By then, my mad friend MacLean and I had induced Tony Pietsch to customize his WRITE program to our specs. That was good enough that I wasn't much tempted to try anything else as long as I was using CP/M. When I changed from CP/M to PCompatibles, I didn't have MINCE (MINCE is not a complete EMACS), or The Final Word, or whatever EMACS had evolved into by then. Consequently, I haven't really used EMACS for 10 years. Then I got Sprint.

A lot of the rough edges have been knocked off, but Sprint has kept a great deal of the flavor of EMACS. In particular, it retains much of EMACS's flexibility. You don't reprogram Sprint in the same way that you would have programmed EMACS; indeed, Sprint is

continued

more awkward in that respect. There's no miniwindow in which you can run miniprograms.

On the other hand, you can build really elaborate macros, either by putting them together yourself or by putting Sprint in learning mode and simply doing what you want it to learn. There are features it doesn't have that I've got in Q&A Write (just because Q&A Write is easy to use doesn't mean it isn't sophisticated and powerful), but that's quibbling; the bottom line is that Sprint has the most elaborate and powerful macro reprogramming capability of any editor on the market.

Sprint's concession to new users is an elaborate menu system, in which each menu item lets you call a submenu. It's all reminiscent of Wirth's Lilith operating system. There's a fast way to bypass the menus once you're familiar with Sprint. Until then, you can cascade through the menus until you find (sometimes with some difficulty) what you want Sprint to do, and then have it execute the command from within the menu window.

The menus include a truly amazing selection of predefined macros and pragmas (sort of a programming primitive command). There's a `DeleteToLineEnd` pragma, as well as `DeleteLine`. Either one can be assigned to any Alt or Control keystroke you like. There's also `exist [filename]`, which returns `TRUE` if the program can find a disk file called filename. There's `mark`, which will put a mark in your file. There's `SetLeftIndent`, and `DeleteRegion`, and `flags`, and I'm sure you get the idea. There are literally dozens of such pragmas, and in case you can't do what you want with one, you can probably build a macro out of several to do the job.

In addition to all that, Sprint comes with a series of preprogrammed setups that allow it to emulate the command interface of a dozen other popular text editors. Note the emphasis on *command*; Sprint does not, contrary to what you may infer from Borland's advertising, emulate the screen and reporting interface of any other word processor. Sprint looks like Sprint no matter what it's emulating.

Of course, you can do a lot with Sprint's screens, too. Colors are adjustable. So are on-screen margins. Also, you're not stuck with what you see on the screen: Sprint, like Electric Pencil, WordStar, and WRITE, lets you embed print formatting commands into the text, so that what you see isn't necessarily what you get. For some people, that's a feature. Others, however, will consider it a bug.

Sprint's use of embedded formatting commands means that Sprint files are clean, plain ASCII with some control characters. That makes it easy for popular writer-assistant programs, such as Grammatik III and Readability, to access and alter Sprint files. One of my main difficulties with Q&A Write—which is what I'm still using—is that it stores a status word for every line. This gives Q&A Write great power but makes it impossible to use any kind of external program that changes line lengths. Microsoft Word has much the same difficulty. Sprint doesn't.

> *A lot of the rough edges have been knocked off, but Sprint has kept a great deal of the flavor of EMACS, an early full-page text editor.*

The good news, in other words, is that Sprint really has retained the old EMACS flexibility. You can use it to design your own basic interface, then begin to add macros until you've got something that's extremely powerful and uniquely yours, adapted to the kind of work you do. After a while you'll have written your own text editor, one that caters to your every whim and idiosyncrasy.

The bad news is that Sprint isn't really very nice until you've done the customization. Indeed, when you first set the program up, it can drive you half out of your mind. No matter what emulation interface you adopt, Sprint isn't going to work the way you expect it to—not until you get used to it. Vanilla Sprint is pretty god-awful, especially if you're asking it to emulate something else you're accustomed to, because while Sprint in emulation mode may—more or less—do what you expect it to when you give it a command, it sure won't *look* like what you're accustomed to seeing while it does it.

Of course, this all reminds me of XyWrite, which is also easily customized and isn't very useful until you've done that. XyWrite has been around long enough that there are precustomized specialized versions, such as Nota Bene, adapted for particular purposes. Sprint is still new, but I predict it won't take long before third parties will sell you Sprint customization packages.

More important, though, is Borland's upgrade policy. If you buy a copy of Sprint now, you can have confidence that Borland will pay attention to user and reviewer complaints and suggestions, bring upgrades out in a timely manner, and not charge you a fortune for the upgrades when they're released. I've made several suggestions that Philippe Kahn has his people working on, and I'm quite sure I'm not the only critic he pays attention to. As an example, Sprint doesn't yet import and export Atex files, but Borland is working on it.

Sprint makes it pretty easy to change over from your old word processor, in that it will import and export files to and from DisplayWrite, Microsoft Word, MultiMate, MultiMate Advantage, Wang IWP, WordPerfect 4.2, WordStar, and WordStar 2000—and, of course, ASCII. The conversions are quick and painless. Even if you hate Sprint, it may be worth buying for this feature. I have seen conversion programs no better than this sell for more than Sprint does. Of course, it does not convert Q&A Write files, which is one reason I'm not using Sprint to write this column. Maybe a later version will.

My conclusion on Sprint is that if you're a professional writer concerned with your tools, Sprint is more than worth looking into.

If you write a lot and aren't happy with your current text editor, consider Sprint.

If you're just getting started using a computer for writing, don't start with Sprint unless you're prepared to put some time into it. Sprint was written for sophisticated users who are prepared to put some effort into learning it and customizing it. I don't mean that beginners can't use it; but they're likely to be frustrated for a while. Sprint isn't as easy to use as Q&A Write, for example.

If you're responsible for setting up and customizing text editors for a whole bunch of workstations, Sprint is worth looking into. Assuming you know what you're doing, you can customize it for your establishment. Also, suppose you have engineers or analysts who prefer to use their own editor but you want to integrate their work. Sprint can read in all their files, merge them, and write out

continued

Periscope's *New* Version 4

...Gives you all the right stuff for debugging! No matter which model you pick, you have the same powerful software to help you track down hard-to-find bugs fast.

The NEW Periscope I memory board keeps all debugging information out of the lower 640K. Can be used in PCs, ATs, and 386s with both EGA/VGA and EMS boards installed. The Periscope break-out switch enables you to recover from a hung system. Included with Models I, II and III.

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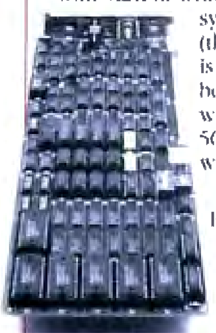
Periscope I has a **NEW** board with 512K of write-protected RAM, user expandable to 1MB, for the Periscope software, symbol tables, and all related debugging information. Normal DOS memory (the lower 640K) is thus totally freed up for your application, and Periscope is protected from being overwritten by a run-away program. The new board's footprint is only 32K, so you can use it in PC, AT, and 386 systems with EGA/VGA and EMS boards installed (not possible with the previous 56K board). It can also be used with Periscope III to provide additional write-protected memory.



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David Nanian, President of Underware, Inc. (of BRIEF fame) says this about the new Periscope Version 4:

"Periscope has always been an unbelievable assembler-level debugger. Version 4 has turned it into a terrific source-level debugger as well. Aside from major enhancements like the source level improvements, all the little changes make a really big difference, too. For instance, symbol lookups and disassemblies are noticeably faster, and highlighting the registers that have changed really makes life easier. Once again, Periscope has raised the industry standard for debuggers!"

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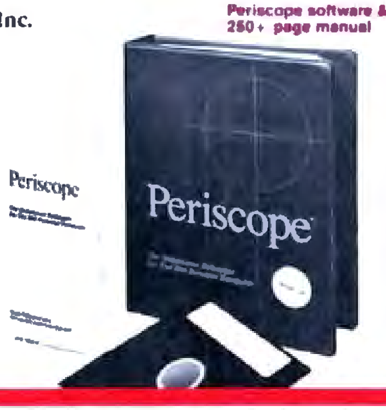

What's New In Periscope Version 4:

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- Debug Microsoft windows applications
- Set breakpoints in PLINK overlays
- Improved source level support
- Monitor variables in a Watch window
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- Debug using a dumb terminal
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- Use mixed case symbols
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- Much more!

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- **Periscope II-X** includes software and manual (no hardware) for $145.
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Due to the volatility of RAM costs, prices on board models are subject to change without notice.

REQUIREMENTS: IBM PC, XT, AT, PS/2, 80386 or close compatible (Periscope III requires hardware as well as software compatibility, thus will not work on PS/2 or 80386 systems); DOS 2.0 or later; 64K available memory (128K at installation time), one disk drive, an 80-column monitor.

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files in an alternate file format.

If you're a programmer, Sprint is very much worth looking into. After all, it was designed by the hacker's hacker. At the moment, Sprint doesn't really "understand" very many computer languages; but the macro capability is powerful enough that it won't be long before people teach it to, say, look for unbalanced parentheses in BASIC, unclosed parentheticals in Lisp, improperly structured procedures in Pascal, and that sort of thing. I know Sprint can do this, because there have been language-specific configurations of EMACS for at least 10 years.

If you write a lot, you're happy with what you have, you don't want to customize, and you'll be blasted before you'll spend the time to learn how to set up and use yet another word processor, ignore Sprint.

If you're furiously busy (as I am), pretty well satisfied with your current text editor (as I am), but wish you could teach it to do other tricks (as I do), then it's worth getting Sprint to play with and begin the—sometimes painful—process of customization (as I am doing).

Borland's new word processor is recommended, with qualifications.

Lascaux: "The Intelligent Calculator"

I get about a hundred programs a week. I can't possibly look at them all, but since I do try to balance this column, I periodically sift through piles. What I'm looking for is something new and different, and preferably published by someone you never heard of. After all, that's the way I discovered Turbo Pascal. Alas, I'm much more likely to discover Lascaux than another Turbo Pascal.

I don't think Lascaux is a potential Turbo Pascal, but it is more interesting than much of the garbage I get. It's a scientific calculator program; what makes it more than Yet-Another-Program is its handling of units (e.g., feet/meters and kilograms/pounds). According to the thin but readable instructions, you can teach Lascaux almost any units you like, after which it will convert as required when it calculates. Since it also does logs, trig, and fractional exponents, this looked like something pretty useful. I don't do as many orbital calculations as I used to, but I do try to keep my hand in.

Back in my aerospace days, we once converted the cruising speed of the TFX fighter (which became the FB-111) into furlongs per fortnight. I thought it might be fun to do that again, and Lascaux looked to be the tool to do it with.

Well, it will do it, but it's more work than I thought it would be. First, you have to install Lascaux. This isn't a matter of copying some files. The silly programmer has made it much more complicated than that. You tell the Install program on the distribution disk what options you want, and it generates a working version of Lascaux for you. The options are with and without math chip, and memory-resident or stand-alone. Why they don't include all four and let you manage by selective copying and renaming files I don't know.

Once you've got this thing installed, you may be tempted to copy the Tutorial program into the same directory as you've put the main program. *Do not do this*. The Tutorial disk contains files that have the same names as Lascaux regular files, but which are brain-damaged. The

continued

unit tables are all scrambled up. After you run the Tutorial program (and you had better run it, because Lascaux's user interface is quite hostile and rude into the bargain) and then try to run the program itself, it won't know what you're doing, and if you try to examine the units it thinks it understands, you'll see only garbage. The only remedy is to go back and run Install again.

After that, you've got to do some definitions. Lascaux understands what a "sec" is, but if you want something per second, you'll have to tell it that 1 second is one sec. It knows "ft" but not "foot." There are other bothersome omissions.

If you're trying to define complex units, you can really go nuts. Although Lascaux has some units that have spaces in them—Light Year is an example—if you want to define something as, say, furlongs/fortnight, you *must not* type in the "/"; instead, you just put in a space and hope that the program infers what you want.

Once you get past the badly designed user interface, Lascaux actually works pretty well. It's fast. There are built-in units and constants. Oddly enough, however, "Speed of Light" is a constant (in meters/second—or as Lascaux would have it, meters sec), not a unit. You can't define the unit "c" as Speed of Light because "C" is defined as a coulomb, and apparently the program isn't case-sensitive unless it wants to be. I see I'm complaining again.

There is a rather badly documented "rename" feature; judicious use of that will solve a fair number of this program's problems. Indeed, the program itself is better than my impressions of it, which proves that if you're going to market programs, you probably ought to put a good bit more time into editing the program documents and smoothing the user interface than most programmers do.

I do find Lascaux useful; perhaps I ought to revive my old classification of "infuriatingly excellent."

Incidentally, the speed of light is 1,802,617,752,326.41 furlongs/fortnight.

MacMadness

We had a party here last night, and my son Alex's friend Clydene Nee brought up some University of California at San Diego public domain programs for my Mac II. (Available on most Mac bulletin boards, or bug Alex to get them onto BIX.) Now when I turn on the machine, I get ruffles of drums, the Twentieth Century Fox fanfare, and barking dogs. It's great sound, amazingly good quality for such a little speaker; indeed, it's good enough that I'm going to treat my Mac II to a real speaker and sound system. There are other fun programs, too.

One of the guests at the party was Kelly Freas, probably the best-known illustrator in the science fiction world. I'm rather proud of the book covers he's done for me. Kelly and his new bride Laura (she's at our local good music station, and on the air right now) were wondering what they should get for a computer, given that they'll need it to run his business. I thought about that all night.

I'm recommending a Mac II. For artistic work, Kelly would probably be better off with an Amiga; but I can't recommend that machine to him for his business. It's not that the Amiga can't do the job, it's just that neither Kelly nor Laura have much experience with small computers, and I'm afraid the Amiga isn't reliable enough unless you know a lot about the machine. The Mac II is just more stable.

I could have recommended a good 80386 PCompatible like the Zenith, especially now that SoftView has put out MacInTax in a PCompatible (Windows) version; but that's a stick shift machine. Mostly though, I think Kelly will just plain have more fun with a Mac.

I did notice that at my party people stood in line to play with the Amiga.

Winding Down

I'm out of space and there's still tons of new stuff. I have a new Vega VGA board from Video Seven that's said to support Windows/386 at blazing speeds; I can't wait to try it. There's Shoebox, a program that's supposed to help you manage small businesses (the kind that stuff receipts and notes into shoe boxes) and is spoken highly of by people I respect. There's a whole raft of scientific and engineering programs from MacNeal-Schwendler. They do practical problems like heat transfer, flight dynamics, and civil engineering, and a number of professionals swear by them.

I've got new facsimile and CD-ROM equipment for my Mac II.

The book of the month is by Robert Forward and Joel Davis, *Mirror Matter* from Wiley. Bob Forward is senior fellow emeritus at Hughes Research Lab-

continued

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oratories and knows more about gravity and antimatter than anyone except Stephen Hawking and Roger Penrose. He also writes some good science fiction.

One computer book of the month is by Nancy Andrews, *Windows* from Microsoft Press. Fair warning: it's an "official guide" and therefore glosses over all the problems. I recommend it as a good introduction to what Windows is all about, but if you want to learn about Windows warts and all, you'll have to go elsewhere. The other computer book of the month is by Gerard J. Holzmann, *Beyond Photography, the Digital Darkroom* from Prentice Hall. It will tell you a *lot* about what can be done with digital image processing and how to do it. Some of it's amazing. I wonder if photographs will be courtroom evidence any longer.

The game of the month remains Strategic Conquest. We still haven't got it to play on the Mac II, but it goes great guns on the Mac Plus. The game of the month would have been F/A-18 Interceptor from Electronic Arts for the Amiga, but there was a problem. Once in a while someone gets lucky and gets to play the game, but most of us can't get past the crazy code-wheel "security" system. It's far more complicated than the game itself. I might even prefer copy protection, except that Electronic Arts is the outfit that had a scheme for the Commodore 64 that caused the machine to bash its disk drives out of alignment. Heaven knows what they could do to an Amiga. We'll tell you more about F/A-18 Interceptor when we can find a cryptographer to help us with their code wheel. ■

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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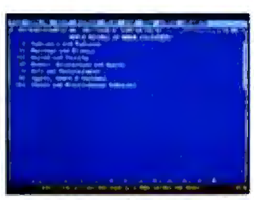

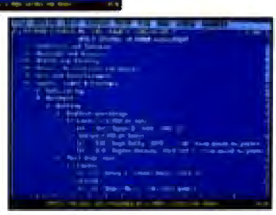

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SPRINT WITH CAUTION

Borland's new word processor doesn't live up to Ezra's expectations; plus, more on project-management software

When Lotus announced that it was pulling the plug on Modern Jazz for the Macintosh, I was somewhat disappointed. The Mac universe could use another strong integrated product; I'd been hoping that the program would be a worthy challenger to Microsoft Works. However, it takes guts (not to mention financial stability) to do what Lotus did, and there's a lot of merit in abandoning a product that simply doesn't measure up, even if it means discarding years of labor and a significant cash investment. Though Lotus has taken heat for its inability to bring Modern Jazz to market, you have to admire the company's commitment to quality. It has sent a strong, comforting message to its customers—past, present, and future.

I am far less troubled than I used to be by companies that fail to meet their announced shipping dates. If it takes a few extra weeks or months to deliver a product that's bug-free and reliable, the wait is a minor inconvenience. I'd rather lose time than data.

But what can be said about big firms that release substandard products? What does it say about their attitude toward their customers? Something to think about, isn't it?

Too Much, Too Late

Sprint: The Professional Word Processor (Borland International, $199.95) should have been a winner. The theoretical appeal of the program is unquestionable: You're promised an editor with powerful formatting capabilities, a selection of user interfaces, and one of the most extensive macro languages ever devised. The price is quite reasonable for a full-featured word processor. And it comes from the company that brings us such jewels as SideKick, Reflex, and Paradox, all of which rank among my favorite programs.

Unfortunately, Sprint is nothing to write home about. It doesn't qualify as a total disaster, but cosmetics are slipshod, and Sprint's most highly touted feature—the ability to switch among a half-dozen "user interfaces"—is far less impressive than Borland's advertising would have you believe. The product seems somehow strangely unfinished; I couldn't escape the sense that I was working with a programmers' prototype rather than with a final release. The menus are unappetizing lists of commands that pop up gracelessly; Borland has given us better-looking word processing in both SideKick and the Turbo Pascal Editor Toolbox.

I was disappointed with Sprint. Though I've tried for over a month to develop some affection for it, I just can't do it. I've come to expect miracles from Philippe Kahn; perhaps I was simply demanding more from Sprint than any MS-DOS word processor could ever give me.

Installation starts out looking easy but turns into a headache. The Setup program opens with a menu that suggests a pleasantly mindless cruise through a series of configuration options. The numbers on Sprint's 11 disks have little to do with the sequence in which their contents are loaded; I had to do a mad dance of disk shuffling.

After installing the main program modules, the Setup program asks if you'd like to have it modify your AUTOEXEC.BAT and CONFIG.SYS files without telling you what it intends to do to them (a practice I despise); you can opt to have

continued

ILLUSTRATION: MARY ANN SMITH © 1988

it make the changes or to copy examples of the two files into your Sprint directory. Since I'm wild about punishment, I decided to let it make the modifications. Instead, the program gave me the examples. When I went back and requested examples, hoping to get the changes, it gave me the examples again.

All hell broke loose when I got to the printer-installation segment. I selected an option that would let me specify the port to which my printer was attached, and found myself locked in an endless loop in which the program kept requesting the Setup disk and refusing to recognize that the disk was, indeed, in drive A. I was able to hit the Escape key and exit back to the main menu, but from that point on, one of the screens having to do with printers kept on appearing in the middle of totally unrelated operations. I tried this several times, choosing different printers, and the result was always the same. I could have Sprint send output to the standard PRN device or to a file; if I wanted to pick a port, I was flat out of luck. Ouch.

After about 10 runs through the Setup program, I figured Sprint was as installed as it was ever going to be. Choosing to let the program give me the dictionary, the thesaurus, and all the user interfaces and file conversions, Sprint was occupying close to 2.5 megabytes of my hard disk drive. (If you choose only one interface and forget about conversions, you can keep it to between 1 and 1.5 megabytes.) Since macros, formats, interfaces, overlays, translation routines, printer definitions, dictionaries, and suchlike are all separate files, I had 59 entries in my directory. I refuse to think about using this program without a hard disk drive.

Anyway, I plowed on without giving the manual more than a quick skim. After all, I know many word processors, right? Sprint unceremoniously flashed a brief copyright notice and dropped me directly into the editing screen of the advanced Borland interface: ruler at the top, status line at the bottom, and not the slightest hint of how to do anything further. A quick check of the reference card led me to the F10 key, and I brought up the main menu. I was amazed to discover that on my EGA monitor/video card combination, the initial letters on the menu, which can be used to invoke commands, were highlighted in *white on white*. I found the Customize menu, changed the colors to something readable, and loaded the WordStar interface, with which I thought I'd be more at ease.

What I See Is Not What I Expected to Get

Borland and I have a difference of opinion on what constitutes a user interface, I guess, because I was expecting to see a screen that looked like good old WordStar. What I got was a screen that looked like the good old advanced Borland interface. No visible difference. And typing the WordStar Control-key command prefixes brought up menus along the right side of the screen, in exactly the same position the Borland interface uses.

Borland and I have a difference of opinion on what constitutes a user interface, I guess.

I hit F1 for help and was treated to an ominous message: "If you are not familiar with WordStar, Borland suggests that you use the more powerful Sprint interface instead." I didn't think this was a good way to instill confidence, but most of the standard WordStar commands appeared to be available, so I began to do some editing.

I typed a few words and then tried to use the arrow keys to back up and correct a couple of typing mistakes. Couldn't do it; the cursor was frozen in place at the end of the line. I had no idea if I had done something wrong or if Sprint was in the process of crashing, but I started punching Control and function keys at random to see if I could produce a response. Nothing but an occasional beep. At that point, I went off and made myself a cup of tea.

When I returned, the cursor had moved to the front end of the line, and a string of *K*'s stretched off the right side of the screen. I tried WordStar commands and cursor keys to move along the line, but they didn't do anything. The up-arrow key worked, however, and I moved up to the ruler line, which I was able to delete, much to my surprise. Then, since I had magically regained access to the help screen, I moved from there to the main Sprint menu and tried to reload the advanced Borland interface. I wanted to see if the cursor would start moving in a different environment.

I accomplished the interface shift, but the text vanished. So much for the autosave feature that protects you from data loss if you stop typing for a few seconds. Needless to say, I have not been able to replicate this experience, although in subsequent trials with the WordStar interface, I've managed to lose large chunks of text without knowing why.

I then spent a few hours reading the documentation, which is both exhaustive and exhausting. The manuals are perfect-bound, which means broken spines if you try to flatten them out, and printed in dense black type. The word "unrelenting" springs to mind.

The next time I tried the program, I went with the Microsoft Word interface. Yes, it looked exactly like the advanced Borland interface, but the menus employed Word's command set. When I began typing, Sprint put in all the symbols Word uses to indicate spaces, returns, tabs, and suchlike. I was impressed until I switched back to pure Borland and noticed that the funny symbols didn't go away. It turns out that loading the Word interface sets preference options that determine the appearance of your text, but the other interfaces aren't bright enough to look for the same options and reset them.

OK. Having had my fill of the imitative interfaces, I did the rest of my testing in Borland mode. On my Tandon PC AT clone, the program was certainly fast enough for me, even throttled down to 6 MHz. Block moves, margin changes, spelling checking, and basic editing operations were quite acceptable, and I hummed along contentedly for a while. As I began to try out more sophisticated features, though, I encountered a series of oddities inherent to Sprint's design.

You can have as many as 24 files open at any one time, with up to 6 appearing simultaneously on-screen. That's nice, until you discover that windows are horizontal only. Forget side-by-side comparisons of narrow columns; can't be done. Windows stretch the full width of the screen, and each displays a status line at the bottom. Let's see: If you try for the maximum of 6 windows on a standard 25-line display, that's 6 lines deducted for status information, leaving you 19 lines to be divided six ways. Unless you can do something useful with 2- and 3-line windows, you'd better forget the maximum and plan for only 3 or 4 files open on the screen.

According to the documentation, you can do complex formatting, like creating

continued

numbered lists, multiple columns, or indented outlines. In practice, because Sprint is not a WYSIWYG program, every time you try something fancy, you're flying blind.

The outline feature is a good case in point. Each time you want to indent a new sublevel, you have to insert the Sprint formatting command BEGIN OUTLINE, which appears as highlighted text. And for every BEGIN OUTLINE, you must provide a matching END OUTLINE command. A standard outline quickly begins to look like a Pascal program (although

Every time you try something fancy, you're flying blind.

flush left), with your lines and Sprint's commands interspersed. It's pretty easy to lose track of where you are because no information appears to tell you anything about position. Numbering is automatically generated to go with the indents, but only at print time; you can't see either indents or numbers while you're editing.

You can get a rough idea of what's happening by calling up Sprint's page-preview mode, which runs your text through the independent formatting program and displays the result. You can't edit while looking at the formatted version, and the documentation warns you that what you're viewing is only an approximation of the final output.

Sprint is an old-fashioned word processor; editing and formatting are accomplished by two separate programs. The editor has additional code to allow it to act as a shell for the formatter, but the two programs don't interact much. As an example, you don't see dynamic page breaks displayed by the editor; that's the formatter's job. The editor doesn't understand much about pages.

If you want to get an idea of how things are breaking, you can push the text through the formatter, which will place visible breaks in the file. These breaks won't respond to any changes you make to the text later; if you do some editing, you have to issue another repaginate

continued

command to relocate the breaks in the file. If you're used to any sort of dynamic formatting (as is found in most other word processors), this is awkward and confusing.

Should you make a mistake entering formatting commands, like forgetting to supply a matching END command for each BEGIN command, you won't find out about it until you run the formatter, either for preview or printout. The effect is like trying to write a program for a compiler without the advantage of a debugger.

Lots of Power; Who's It For?

True, Sprint has a lot of power. If you like to program, you can generate editing macros that will do just about anything you've ever wanted to do in a word processing program. The language is thorough and extensive, and it looks a bit like C. You can perform complicated search and replace operations, manipulate files, and even create new command sets (the user interfaces were all written as macros). There's some slight performance degradation when using macros as opposed to native commands, but it's barely noticeable on an AT-class machine. Similarly, you can program the formatter with a terse, often cryptic formatting language. Commands can reside within your document or in independent "style sheet" files that get sucked in when you run the formatter.

My major question about Sprint is: Who is this program for?

The resulting flexibility is marvelous, but determining how to make Sprint do its tricks is severely hampered by the documentation, which seems to be written mostly for programmers. Longer tutorials would help, particularly for writing macros. Code samples in the manuals are few and short, and the discussion of macro programming techniques is limited to 30 pages.

You do get a good selection of features with Sprint, including excellent spelling correction, a large thesaurus, mail merge, a huge amount of context-sensitive on-line help, good printer support, and the auto-save feature that kicks in when you've left the keyboard idle for a few seconds, but you can get those features elsewhere—which leads to my major question about Sprint: Who is this program for?

I'm not convinced that Sprint is the right tool for novices, though Borland assures me that its interface was carefully developed to appeal to new users. Intermediate users and those used to WYSIWYG will be thrown for a loop. Programmers (who'd appreciate the macro capabilities) would be just as satisfied with Pmate, MultiEdit, or the editor/debugger combos that come with most programming environments. That leaves Sprint appealing to an odd subset of the word processing world.

I accept Borland's contention that it serves the needs of offices that want chameleon interfaces for part-time and temporary employees used to other programs. For anyone else, the collection of surrogate interfaces is merely a transitional pathway into Sprint.

Borland includes an eye-opening pamphlet that details the ways in which its implementations of the interfaces differ from the originals; each interface gets two or three terse pages of exceptions and exclusions. And if you're going to do anything with macros or complex formatting, you're going to have to learn Sprint anyhow.

The program also seems well suited to environments that need heavy-duty formatting for long, complex documents that include many different types of materials. Encyclopedias, almanacs, technical training manuals, and software documentation would be perfect uses for the package. So Sprint would be excellent as the choice for word processing at (surprise!) Borland itself.

So here's a modest proposal: Since Sprint would seem to be a program designed by Borland for Borland, let's let Borland use it.

Project Mismanagement

Recently, I received a delightful letter from Hugh Roth on the subject of project-management software. Hugh has been battling several programs for the past few months, trying to develop scheduling systems for book publishing. The letter was long, articulate, and thought-provoking. With his permission, I've extracted a few of his key points; they're worth remembering if you're attempting to pick your way through the mine field of conflicting claims and in-

continued

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comprehensible specifications that characterize this peculiar niche of the software world.

Like many of us, Hugh sees a desperate need for good project-management tools. "Everywhere in business," he writes, "thousands of essentially unrelated dates are pumped into spreadsheets and databases and then pumped out as schedules. Garbage. One date has no relation to another unless there's some hard code behind the data." Yet most commercial packages are overly complex and, as a result, are rarely used.

Hugh cites poor handling of "tasks without resources that are based on time, rather than resource availability. You can kludge your way around this, but who wants to? The classic case is curing concrete. A certain number of calendar days must pass, independent of any resource. You can bet that most packages will not show the concrete curing on the weekend!"

He also blasts a tendency to assign unrealistic starting dates to tasks without precedents. Let's say your project has one isolated task that must be completed before the end of the second month, and it doesn't depend on any other resource used elsewhere in the project. "Most packages will show the task as starting when the project starts. Where is the person in business so virtuous or so unbusy that he can start a task 50 days early? This is a real flaw, or maybe the programmers don't want to fix it because it means several iterations of the calculation algorithm each time you calculate the schedule. The critical path must first be established, then tasks like this have to be calculated *backward*."

But the most disturbing points he raises relate to the overall design philosophy of project-management programs. "The general outlook of the packages is that a department does a few projects, each with a different set of resources, and these projects rarely overlap. Who wants to learn [the programs] for just a few projects?

The place where you need the power is where you have many projects drawing on a common resource pool. You need to be able to keep each resources calendar up to date and have any changes reflected in the individual projects. If one supplier goes on strike, and I have 50 projects that use this supplier, what do I have to do? Open and load 50 DOS files and scroll to the correct calendar and change it? Yuck!

"The other place that most packages fail is in cross-project reporting. When a department has 250 projects to traffic and develop, 250 individual schedules don't do too much good if I'm a supervisor and I've got one person out sick and another on vacation. I need to know, 'What do I *gotta* get out this week?' I know this is a tough problem. The 640K-byte barrier owns part of it, but most packages don't (by their design) acknowledge that this is a real problem. With much heavy breathing, they tell you 1000 tasks, 1600 with EMS, or some such. Gawd. You're out of runway by the time you link the fourth project.

"This kind of reporting is much more important than resource leveling, because many departments work on a 'do or die' type of schedule. Don't tell me you don't have enough bodies to get the job done! Get it done anyway!"

I realize that I've been troubled by the same questions, but I've never been able to identify the cause for my unease. In the future, I'll keep the "Roth Rules for Evaluating Project-Management Software" firmly planted in the back of my brain.

Hugh concludes by urging me to continue reporting on project-management packages. "They are a good way to keep your salary in others' hands. Some of them offer the opportunity to use a computer and make the job harder (as you pointed out). You get to use nifty things like 6-pen plotters. You get to spend several weeks figuring out the yes/no answer to the following preference-screen question: 'Show negative float on Gantt?' And, not to forget, you get to appreciate really simple, elegant, intuitive packages like Q&A and SuperCalc 4."

Amen. ■

Item Discussed

Sprint $199.95
Borland International, Inc.
1700 Greenhills Rd.
Scotts Valley, CA 95066
(408) 439-1060
Inquiry 934.

Ezra Shapiro is a consulting editor for BYTE. You can contact him on BIX as "ezra." Because of the volume of mail he receives, Ezra, regretfully, cannot respond to each inquiry.

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

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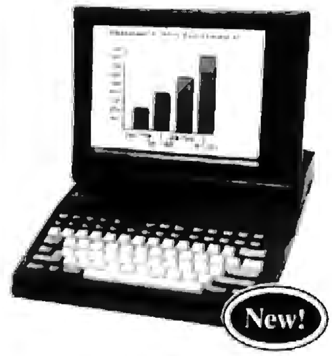

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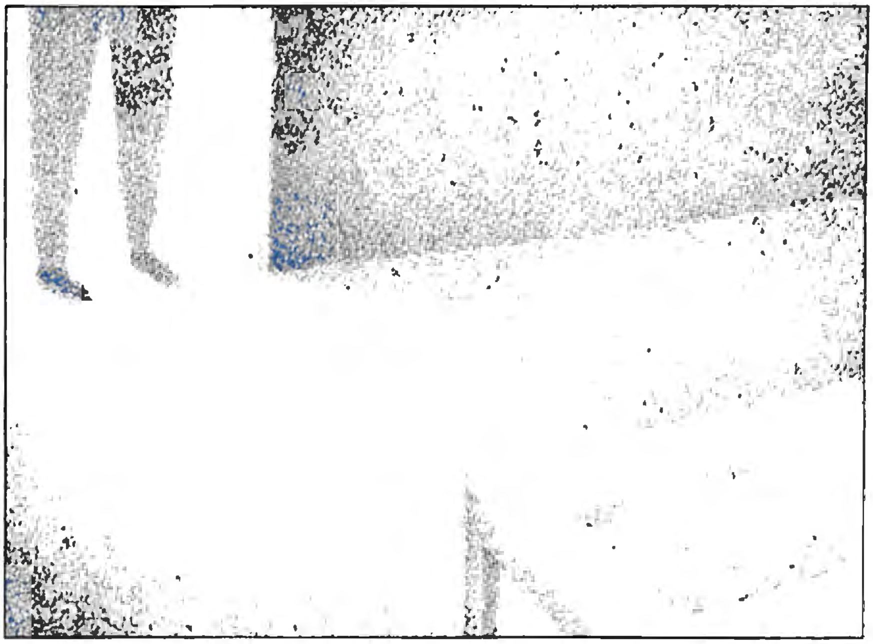

Your hard disk doesn't boot. Or maybe it does boot, but only one file is left, and it seems to be named GOTCHA. Or maybe one of your employees quits suddenly and his or her new employer seems to know who all your customers are. Usually, it takes something like this to get the managers interested in computer security.

Security is not the most glamorous area in computing. Managers don't like it because security systems cost money. Employees don't like it because they think it's too inconvenient. The technical staff doesn't like it because they think it gets between them and the machine.

They're all right, of course. But they're also all wrong. Many things affect security, and not all of them apply to all computer systems. For starters, let's look at why security is important, and why it's worth spending money on.

Time Is Money

While your computers are certainly worth something in themselves, their real value isn't in the hardware. Instead, it's in the information the machine contains and the machine's importance to your operations. If the information had to be located and reentered, how much would that cost you? If the computer is necessary to some facet of your operation, how much would you lose if it were missing and you couldn't do the work without it?

The problem boils down to two areas: the safety of the computer itself and the safety of the information it contains. Because physical security and data security are so different, the solutions to the problems usually seem different also. But, in reality, they are closely related. After all, if someone steals your computer, he or she probably has your data, too.

Physical Security

If you keep people away from your computer, they won't have the chance to steal it or fiddle with the stuff on the hard disk. If you keep it in a safe place, you won't have to worry about anything else happening to it, either. That's the basis of physical security.

Of course, you can't always keep the computer in the safest possible place. The users might not be able to work on it there, for one thing. But you can still keep people from taking the machine or tampering with it. The easiest way is to lock it. The IBM PC AT and most of its clones, as well as the IBM PS/2s, have a built-in lock that is reasonably effective against casual tampering. It secures the case and tells the computer to ignore the keyboard. While a determined person can pry open the case to override this feature, most people won't do that.

Not all computers have a keylock, though. If you can't keep your equipment in a locked room when it's not in use, you can at least lock it inside a cabinet. Again, this provides some security against casual tampering, but some of these cabinets are unwieldy and others provide a convenient way to roll an entire system out the door. If theft is your biggest worry, there are always systems like Anchor Pad that let you lock the computer system to a flat surface such as a tabletop. Then thieves have to steal the table along with the computer—a much more conspicuous act.

Data Security

If your business is like most other businesses, the biggest investment you have in your computer system is the data that's inside it. If that data disappears, you

continued

ILLUSTRATION: DAVE RIDLEY © 1988

could be out of business, or worse. In many cases, the data is worth a great deal more than the computer it resides in.

Protecting that data means preventing people from removing, altering, or copying it, and protecting yourself from losing the use of it through system failure. In the first case, people are the threat to data security. Some people are really out to do you harm. Others are simply careless or not trained properly. And then there's the problem of losing data through ordinary accidents and system failures. In any case, you're out of business, whether you lost your data through the actions of a disgruntled employee or because the head crashed on the hard disk.

Protecting against Loss

Data loss is the easiest problem to protect against. All you need to do is keep a current backup. Then, all it takes is a few minutes to restore your data, and you're back in business. How you back up your data, whether with a software product such as Fifth Generation System's Fastback Plus or a tape drive, makes little difference. What's important is that you do it.

The People Problem

Once you've taken care of protecting yourself against losing the data, then you have to worry about the people. Most instances of data loss that I have come across were the result of accidents. You can reduce the problem of unintentional data loss through training. Once people understand that formatting the hard disk makes it hard to use the data that was on it, they usually won't do it.

However, then there are the people who really want to erase everything or want your information for themselves. This is what most people think of when they think of computer security. This is also the focus of most security products and the area in which password access, encrypted data, and the like become important.

Depending on your type of business, malice may not be a significant threat. Most businesses, however, keep some sensitive information in their computers. It could be related to a firm's bidding process or personnel records, or it could be other data that will give your competition the edge. How do you keep this information secure?

First of all, keep the computer itself in a locked office. It's amazing what people will do out of curiosity, given enough time. Second, lock the computer, if you have one that will lock. Finally, consider some sort of security system.

Items Discussed

Watchdog........................$295.
Fisher International Systems
P.O. Box 9107
Naples, FL 33942
(800) 237-4510
(813) 643-1500
Inquiry 955.

Access II..........................$165.
Access II+
With EPROM ....$175.
With halfcard ....$195.
Kinetic Software Corp.
Distillery Commons 240
Lexington Rd. at Payne
Louisville, KY 40206
(502) 583-1679
Inquiry 956.

Security Systems

There are hardware and software systems that will prevent unauthorized people from using the computer and permit others to perform only certain actions. These programs require users to identify themselves, and they require a password to use the computer.

I've already mentioned machines like the IBM PS/2s, which have a lock on the case. You can also set up the PS/2s so that you must enter a password before you can use the computer.

More thorough systems control nearly every aspect of the computer operation. Normally, they do this through a series of menus that control access to the operating system, restricting most users to a few selected operations. These systems do, however, restrict the flexibility of use. You need to decide if the individual case justifies this loss of flexibility.

A couple of the better-known security systems are Watchdog from Fisher International Systems and Access II from Kinetic Software Corp. Both companies base their security systems on multiple access levels through menus and user passwords. Kinetic includes a board that fits IBM PC-compatible computers and forces the machine to boot only off the hard disk.

Learning about Security

Before you get too deep into setting up security systems, it's probably a good idea to learn a lot about them. One interesting source of help is the National Computer Security Center. This organization operates under the auspices of the super-secret National Security Agency, but it exists to help all computer users learn more about security and to help the computer community cope with security issues.

The Center publishes a number of pamphlets, posters, and books that it will send you. You can pick up some of these materials free at computer shows or purchase them for a nominal fee. You can contact the Center at 9800 Savage Rd., Fort Meade, MD 20755, (301) 688-8744. The Center, along with the National Bureau of Standards, hosts the National Computer Security Conference each year. The conference is open to anyone and has tracks for people of all levels. This year it's in Baltimore, starting October 17 and running through October 20. The price for the conference is $150 before October 7 and $175 thereafter.

Does all this sound like a lot of trouble? Well, maybe. Many systems probably don't need a lot of security because they don't do much. But think about your other computers. What would happen to your business if the information in them disappeared or got to your competitors tomorrow?

OS/2 Update

A businessman asked me about OS/2 the other day. He wanted to know if he should put off buying his software until an OS/2 version came out. I advised him not to wait.

As you may remember from my August column, my investigations at COMDEX showed me that there was virtually no software available for use with OS/2, and much of what was could also be found for MS-DOS. Since then, I've gone to PC Expo. The picture hasn't gotten much better. The advice remains the same. If you need software, and there's a DOS version available now, don't wait.

Coming up in future issues—to LAN or not to LAN? Also, does productivity software really help productivity? ■

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

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MS-DOS, MINIFANS, MATH, AND MICE

Hardware, software, and peripherals make the Mac a multifaceted machine

Back in November 1987, I was looking for some way to reduce the number of computers that inhabit my office and my home. If I could semi-retire a couple of them, I could reclaim some valuable table space. It was about that time that I remembered the AST Mac286 coprocessor board I had seen at the Boston MacWorld in August 1987. In demos held for the press, this board (which is really two boards cabled together that occupy two NuBus slots in a Mac II) seemed to do the job of an 8-MHz IBM PC AT.

Well, I thought, here's a chance to retire a couple of old ATs and still keep basic AT/MS-DOS functionality. So I bought a couple of these beasts, along with a couple of Apple's 5¼-inch PC-compatible floppy disk drives. Installation was fairly painless.

In less than an hour per Mac II, I had a dual-operating-system computer that ran both the Mac operating system and MS-DOS. The Mac286 even shared my existing Mac hard disks by setting up separate DOS partitions on them. Goodbye, ATs. Hello, table space!

Alas, my compact-computing joy was short-lived. I issued a `DIR` command in the Mac286 window, and something weird happened. The video scrolling became slow and jerky—practically unreadable. And that happened with the standard monochrome-emulation mode in the Mac286 window, on an Apple color monitor.

Okay, I can fix that, I thought; I'll try the Hercules-emulation mode. Same problem. Must be the monochrome emulation on a color monitor, I thought. So I tried the CGA emulation. That was even worse. I tried running Microsoft Windows 2.03 under the Hercules emulation. It was so slow, I gave up. In fact, after less than a week, I gave up on the Mac286 altogether. I couldn't get any DOS work done with them because of the severe video problems.

Out came the old ATs. Goodbye, table space.

AST acknowledged the video problems with the driver software and promised fixes. In early June, I received its first update, version 1.01.

What a difference a version number makes! The video performance of the Mac286 is dramatically improved with the 1.01 software. It's so much improved that I can now use my Mac IIs for *all* my DOS work.

Besides improving the display speed, AST polished and cleaned up other parts of the interface. MultiFinder support, which was not quite there in version 1.0, has been upgraded. You can now copy DOS screens to the Mac Clipboard by columns as well as by lines. This makes it a snap to transfer stuff from a DOS database, spreadsheet, or statistics file to a Mac application.

AST will send you the 1.01 software upgrade for free if you are a registered Mac286 owner. If you buy the Mac286 coprocessor boards now, you'll get the 1.01 software. In either case, the software update turns a clever but virtually useless Mac II hardware accessory into a useful, workable solution to running DOS on a Mac.

Skeletons in 4th Dimension

Even though the promised update to 4th Dimension (dubbed version 1.1) has been delayed, Acius has not been sitting back twiddling its corporate thumbs waiting for Laurent Ribardiere to finish it. Over the last several months, Acius has released two inexpensive, but impressive, applications written in 4D: MiniFans and TopGuys.

MiniFans is a compact version of the internal corporate correspondence, customer-tracking, and distributed-information productivity system that Acius uses every day. TopGuys is a special database that contains information on about 400 influential Macintosh specialists, such as journalists, vendors, developers, and so on. In short, it's Acius president Guy Kawasaki's personal Rolodex of MacFolk. It's a very useful tool, as well as fun to rummage through.

MiniFans and (in particular) TopGuys are excellent examples of well-behaved and well-designed 4D applications. Acius wants developers and users to see how the internals work with both; that's part of the reason they have distributed them. Kudos to Acius for a nice job.

Another Acius 4D application that should be coming out soon is called Skeleton, written by technical-support wizard Dave del'Aquila (the same guy who wrote MiniFans). I got a chance to put it through its paces when I visited the Acius headquarters in Cupertino in June.

Skeleton is a good name for this developer's tool, since it provides the framework of a typical 4D application and provides the lowest common denominator of functions that these applications require. It is also fully customizable and extensible. This "skeleton" allows a design to be undertaken in the 4D custom environment, which helps speed application prototyping. Skeleton should be a help to both experienced 4D developers and novices who need some firmer ground to stand on while learning 4D.

Mathematica on the Mac

I've been using the 1.0 release of Mathematica for the Mac II for several weeks now. Even though this release is not bug-free and the documentation is not complete (two problems that Mathematica's publisher, Wolfram Research, expects to fix before this column hits the newsstands), Mathematica is certainly an im-

continued

pressive piece of software.

Mathematica is a general software system for doing math computations. The application will eventually run on a number of computers, including large systems and shared workstations (e.g., Sun, NeXT, and IBM), but its Mac implementation is the first and perhaps the most interesting, because it works fully with the Mac's user interface.

Mathematica works like a real-time electronic whiteboard (formerly blackboards—how times change) that can solve equations. You can type in your equations using numeric forms, but you can also use more advanced symbolic forms. Mathematica's symbolic processing accounts for a good measure of its power.

You can enter simple numerical calculations in Mathematica as you would with an electronic calculator, using Mathematica's syntax. For example, In[1] := N[log [4π]] finds the value of log (4π). But you can also enter symbolic calculations directly, which is something no calculator permits. For example, the entry In[3] := $x^4/(x^{2-1})$ finds the formula for the integral

$$\int x^4/(x^2 - 1)\,dx.$$

Further, you can have Mathematica integrate this expression with the command In[4] := Integrate [%, x]. Mathematica then finds the explicit formula for the integral:

$$\mathrm{Out}[4] = x + \frac{x^3}{3} + \frac{\mathrm{Log}[-1 + x]}{2} \quad \frac{-\mathrm{Log}[1 + x]}{2}.$$

Symbolic algebra and calculus could not be done previously on computers of the Mac II's size; programs of this sort were typically found only on minicomputers or supercomputers. Overall, Mathematica does many different kinds of algebraic computations, including expansion, factoring, and polynomial and rational expression simplification. Algebraic results for some kinds of matrix operations are also possible. In addition, as my example above shows, Mathematica can do calculus, evaluating derivatives and integrals and deriving power series approximations.

Mathematica on the Mac II with an RGB monitor provides a dynamite full-color display that's especially impressive when results are graphed in two and three dimensions. The jazzy display is backed by a function library of more than 400 math functions.

Items Discussed

AST Mac286 1.01............. $1599
(Software upgrade free to registered Mac286 1.0 owners)
AST Research, Inc.
2121 Alton Ave.
Irvine, CA 92714
(714) 863-1333
Inquiry 800.

4th Dimension 1.06.............$695
MiniFans 1.0..................... $20
Skeleton .999..................... $20
TopGuys 1.0...................... $20
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Mathematica 1.02 Enhanced
Macintosh II Edition........$795
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Music Mouse 1.00 for the
Macintosh...................... $60
Opcode Systems
1024 Hamilton Court
Menlo Park, CA 94025
(415) 321-8977
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Mathematica is something of a breakthrough product: It will give educators an entirely new and powerful tool in teaching mathematics. Confirmed math-phobic students may very well be drawn into Mathematica's impressive displays and its ability to solve equations quickly and display graphical results; this could enable them to absorb the algebra and calculus that seemed impossible to comprehend from a textbook.

Of Mice and Music

As good as Mathematica is, there is more to life than plotting functions or deriving a Taylor series. The publisher of Music Mouse, Opcode Systems, knows this. Music Mouse takes an approach to making music that is similar to Mathematica's approach to manipulating mathematics: Neither requires you to be an expert in the field to make good use of it.

Music Mouse is a control application that lets your Macintosh make music all by itself, or with the aid of an external speaker or stereo system, or through an external MIDI (musical instrument digital interface) synthesizer. Music Mouse also works as a stand-alone controller for MIDI synthesizers that do not have a keyboard.

It's difficult for me to explain how Music Mouse works since it's such a visceral experience. But here goes, anyway.

Once you start the application, you can control the music you're creating by moving the mouse and pressing keys on the keyboard. The Mac screen gives you an *x,y* grid display with two different melodic lines that are "wired" to the *x*-axis and *y*-axis movements of the mouse. The application sticks in two additional melodic lines, so you have four voices all told.

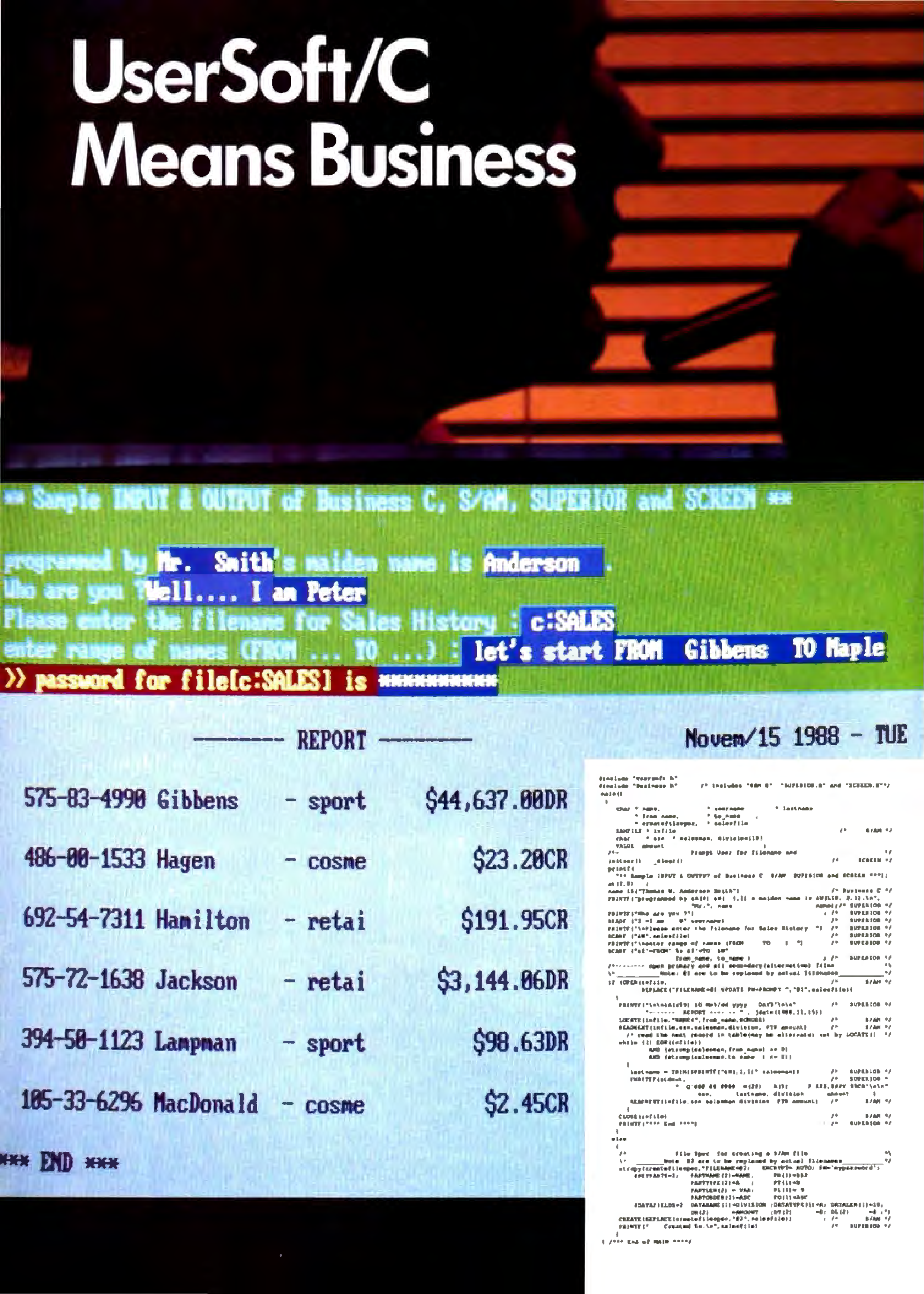
These two application-supplied lines track the ones you are creating with the mouse, and they can be varied with keyboard control (as can pitch, tempo, and so forth). The screen display gives you some visual feedback for the music created, using what Opcode calls a polyphonic cursor to show the "motion" of the music, as well as the pitch. While the effect and action are hard to describe, the results are stunning, even without hooking up a MIDI synthesizer.

The one big omission with Music Mouse is recording: As yet, it doesn't have a direct recording mode. However, you could use a macro recorder like Tempo II, AutoMac III, or the MacroMaker CDEV (supplied with System 6.0) to record a Music Mouse session. Just make sure that you use the real-time recording modes for these utilities; otherwise, your music will sound strange, indeed.

The Music Mouse can be used by first-time and professional musicians. If you're a novice, it's fun to explore some basics of music composition using this application. One caveat: It won't run properly under MultiFinder. ■

Don Crabb is the director of laboratories and a senior lecturer for the University of Chicago department of computer science. He is also a consulting editor for BYTE. He can be reached on BIX as "decrabb."

Your questions and comments are welcome. Write to: Editor, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.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enter range of names (FROM ... TO ...) : let's start FROM Gibbens TO Maple
>> password for file[c:SALES] is ***********
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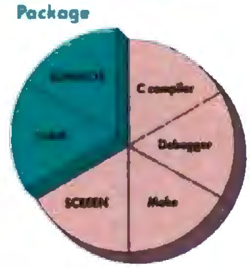

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THE GOOD NEWS AND THE BAD NEWS

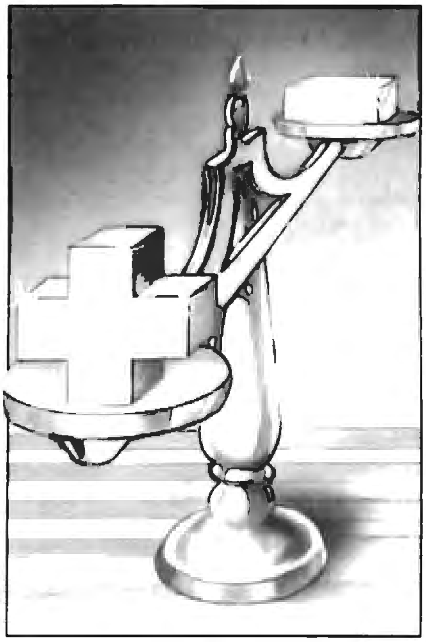
When it comes to performance, there's a price to pay for all those nifty OS/2 features

OS/2 is more important to an OS/2 application than DOS is to a DOS application. Given that, how does OS/2 perform relative to DOS? Rarely better, often only a wee bit worse, and sometimes a lot worse. As a multitasking platform, it performs better than expected.

How do I know? Simple—I ran some benchmarks. Benchmarks are one of life's sordid pleasures. Artists often say, "Everyone's a critic." Hardware and software designers could say, "Everyone's a benchmarker." Another reason to do benchmarks is the interesting mail you get after writing articles.

OS/2 is more important to an OS/2 application than DOS is to a DOS application because, as I said last month, OS/2 is a true operating system and DOS is not. If a DOS application needs to write to the screen, it can allow DOS services to do it, or it can write directly to the video buffer itself. Allowing DOS to put the characters on the screen ensures compatibility across machines and versions of DOS, but it sacrifices speed. A DOS application requiring snappy screens can always opt to bypass DOS. Under OS/2, an application's I/O must go through the operating system—hence the interest in OS/2's performance.

An associate and I have benchmarked OS/2 services, using a combination of simple programs and more complex systems to answer a number of questions. The questions and answers, summarized, follow. (Note: Whenever I say "OS/2," I mean "protected-mode OS/2," unless I specifically mention OS/2's DOS-compatibility box.)



Does a program run faster under DOS or under OS/2?

OS/2 is, in general, up to 20 percent slower than DOS, except for disk I/O. Unbuffered disk I/O is about 50 percent slower under OS/2.

Does a program run faster under DOS or under the OS/2 DOS-compatibility box?

The compatibility box runs programs up to 4 percent slower than DOS, except for disk I/O. Disk I/O can be 50 percent (or more) slower under the compatibility box.

Microsoft claims improved video I/O with OS/2. Are OS/2 video writes faster?

In some cases, yes: TYPE writes to the screen over twice as quickly under OS/2. In other cases, the result is a toss-up.

If you run multiple programs under OS/2, how great is the multitasking overhead?

Fairly low. It appears that you pay for multitasking up front, with the 10 to 20 percent system overhead. Extra per-task overhead is fairly small, no larger than 2 percent.

How does the compatibility box affect OS/2 multitasking overhead?

Radically. By design, the compatibility box does not run at all when in the background. When the compatibility box is running a DOS program in the foreground, the background OS/2 processes slow down by a factor of 100 to 500 times.

How does the choice of processor chip affect DOS versus OS/2 comparisons?

Surprisingly, the ratios of DOS times to OS/2 times do not vary much from the 80286 chip to the 80386 chip.

How much slower or faster does a program run in OS/2 background, compared to foreground?

That depends on the `PRIORITY=` parameter. With `PRIORITY=ABSOLUTE`, there is no difference for CPU-intensive tasks. Screen writes are actually slower in the foreground than in the background, because background screen writes are made to regular memory, while foreground screen writes are made to slower video memory.

With `PRIORITY=DYNAMIC`, the background process seems to wait for the foreground process to complete before it starts. (Yes, it's strange, and I'll explain further next month.)

Now let's look in detail at the benchmarks.

To the Bench

What would a benchmark suite be without the venerable Sieve of Eratosthenes? We ran the Sieve (a general compute-bound integer program), the Savage test (a floating-point test), and three tests designed to isolate video response and disk speed.

To ensure consistency, we used Mi-

continued

Table 1: *Differences in the architectures of Intel's 80x86 microprocessors have led to the development of different memory models.*

Memory model	Number of code segments	Number of data segments
Tiny	One single segment shared for code and data	
Small	1	1
Medium	1	Multiple
Compact	Multiple	1
Large	Multiple	Multiple
Huge	Multiple; data structures can be > 64K bytes	

crosoft's dual-mode C and BASIC compilers to generate both real-mode (DOS) and protected-mode (OS/2) code from the same source. Whenever possible, we just compiled and linked one program, then bound it. ("Bind" is Microsoft's term for subjecting a program to a converter that renders it able to run under DOS or OS/2.)

Absurdities in the architectures of the Intel line of processors have led to a number of "memory models" for 80x86 programs, as shown in table 1. Examples of programs in the small and medium categories include many small utility programs and, of course, benchmarking programs, but few of the large popular business applications.

The Sieve benchmark ran 1 or 2 percent slower in the compatibility box and 4 or 5 percent slower under OS/2 (see figure 1). However, with larger memory models, OS/2 was up to 44% slower on a 386 machine and 18% slower on an IBM PC AT (due, no doubt, to their different memory architectures.)

Results of the Savage test (see figure 2) were consistent; the compatibility box slowed the programs by a few percent, and OS/2 slowed them by about ten percent on the 386 and 5 percent on the AT.

We tested video I/O with a simple test designed to `TYPE` a file to the screen 100 times—first under DOS, then under OS/2. The tests were done on a 16-MHz 80386 with a Compaq VGA board.

Under DOS, the task took 60.4 seconds, while OS/2 took 27.1 seconds. Impressive. But then we created a simple program that writes lines to the screen until it runs out of time (15 seconds). The results contradicted those of the first test. In this case, DOS was able to write 2171 lines, while OS/2 wrote only 1820 lines. We wrote the program in Microsoft BASIC and compiled it for both DOS and OS/2, using the BASIC 6.0 dual-mode compiler. Obviously, OS/2 screen handling can be faster than DOS, but not always, depending on how you do it.

Disk Access

Our preliminary tests showed that OS/2 was a bit slower at disk access than DOS. The Norton Utilities provided a simple test: We ran `DISKTEST` under DOS, and then in the compatibility box. With disk caching enabled, OS/2 operated nearly as fast as DOS without a cache enabled. Without the cache, OS/2's performance was miserable: 1369.8 seconds, compared to 90.3 seconds for DOS.

OS/2's performance (relative to DOS) suffers significantly in programs that do a lot of disk input and output and for programs that use more than 64K bytes of data. While the first category may not apply to many programs, recall that large memory access was one of the principal reasons for developing OS/2 in the first place. Good disk performance is, of course, important for many applications.

As a final DOS versus OS/2 comparison, we used C code from an August 1984 BYTE article, "Benchmarking UNIX Systems" by David F. Hinnant. The results are shown in table 2. One interesting number comes up: Notice that, despite the fact that all the C programs run faster under DOS than under OS/2, the Dhrystone runs faster under OS/2! Bear in mind that there is nothing in the Dhrystone that isn't in the other tests. Could there be a "benchmark detector" in the Microsoft C 5.1 compiler?

OS/2 Tip of the Month: Making DOS and OS/2 Coexist

If you use the Microsoft Developer's Toolkit, you know that Microsoft included a neat feature whereby your program will prompt you at boot time with

```
Boot: Enter for OS/2, ESC for DOS
```

By pressing the Escape key or the Enter key, you can boot either operating system. It's called the "dual boot" feature. For some unknown reason, IBM left it out of its OS/2.

continued

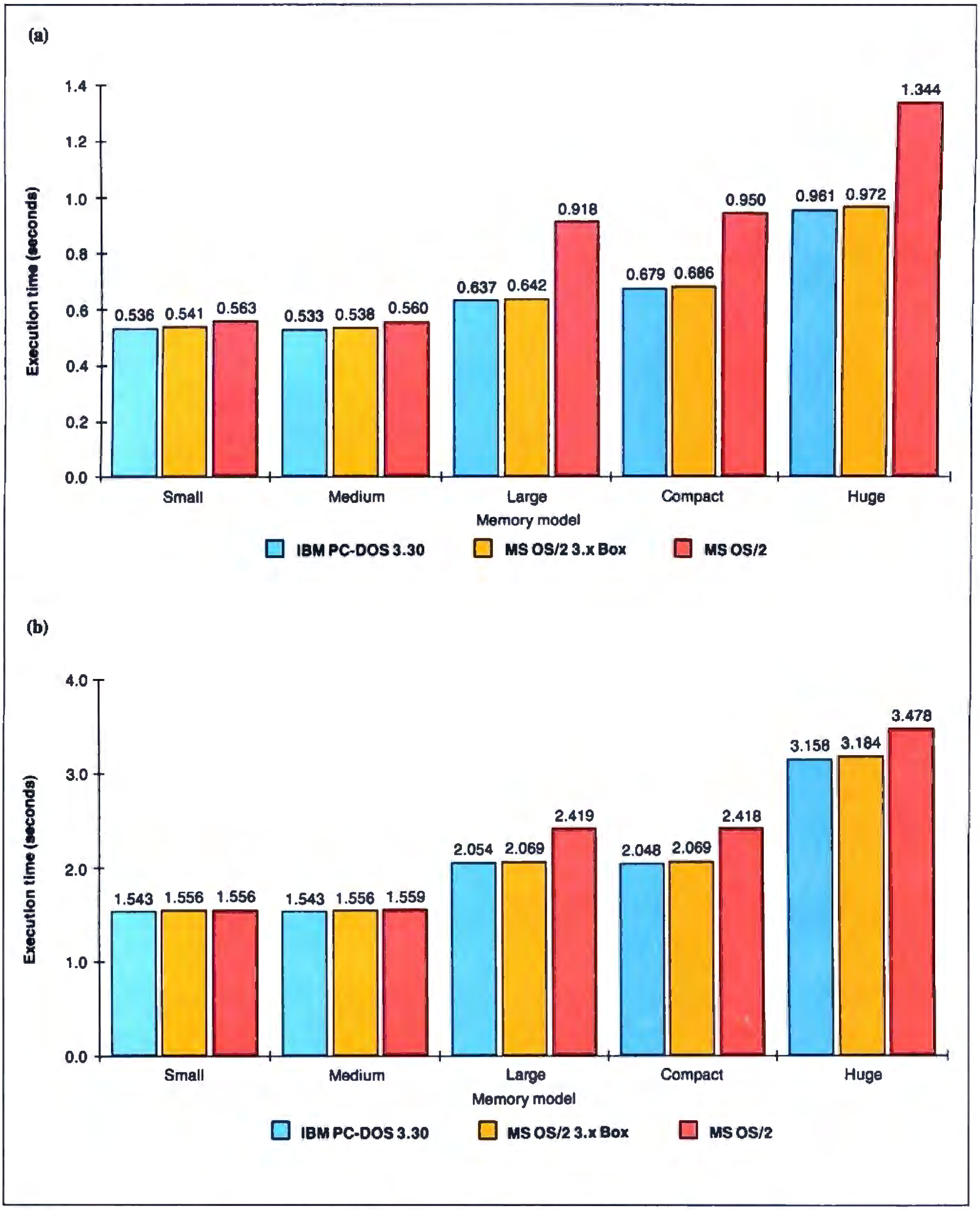


Figure 1: *According to my tests with small memory models, the Sieve of Eratosthenes took somewhat longer to run in the compatibility box and in OS/2 protected mode than in DOS. Using larger memory models, however, OS/2 took as much as 44 percent longer on a 16-MHz Trillian Power Systems 386* **(a)**, *and 18 percent longer on an 8-MHz IBM PC AT* **(b)**.

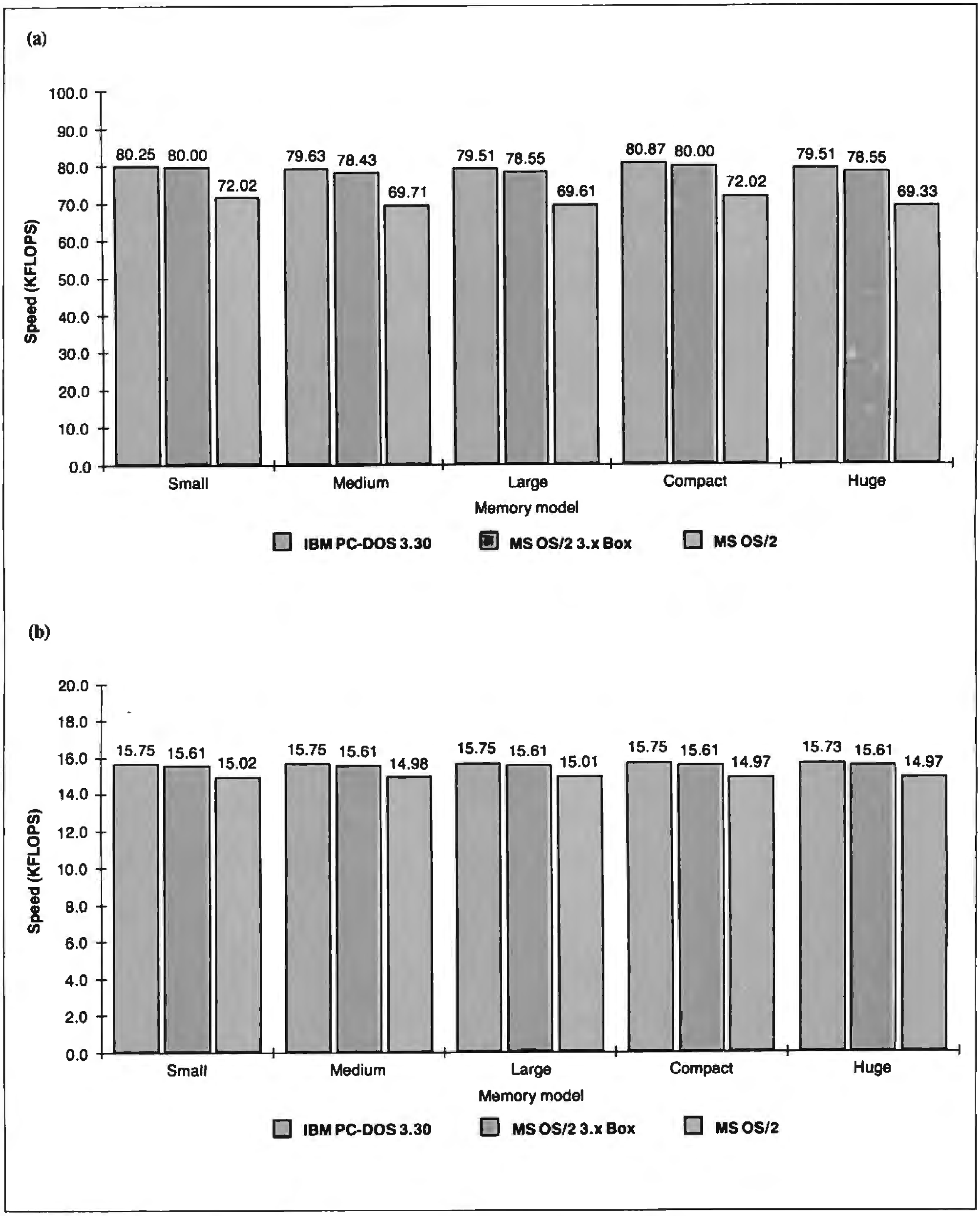


Figure 2: *Floating point rate (in kiloflops) of the Savage floating point benchmark run under DOS, the OS/2 compatibility box, and OS/2 protected mode. Note that the compatibility box slowed the programs by a few percent, while OS/2 slowed them by about 10 percent on the Trillian Power Systems 386* **(a)**, *and 5 percent on the IBM PC AT* **(b)**.

Table 2: *Results of UNIX benchmarks run under DOS, the OS/2 compatibility box, OS/2 protected mode, and OS/2 with an editor running in the compatibility box in the foreground. (Times normalized to 1.00 for DOS 3.3.)*

Test name	DOS 3.3	Compat. box	Pure OS/2	OS/2 w/editor in compat. box
Copy char array	1.00	1.02	1.06	N/A
Copy char array using pointers	1.00	1.01	1.05	111.11
Loop using auto int indexes	1.00	1.01	1.05	111.11
Loop using static int indexes	1.00	1.01	1.05	111.11
Loop using 2 register variables	1.00	1.01	1.06	104.17
Loop using 5 register variables	1.00	1.01	1.05	108.87
Int arithmetic	1.00	1.01	1.05	100.00
Long int arithmetic	1.00	1.00	1.05	90.91
Float arithmetic	1.00	1.03	1.16	100.00
Double arithmetic	1.00	1.06	1.14	142.86
Address arithmetic w/char ptr	1.00	1.01	1.05	111.11
Address arithmetic w/struct ptr	1.00	1.01	1.05	90.91
User C function call overhead	1.00	1.00	1.04	90.91
System call overhead (getpid)	1.00	1.01	24.39	N/A
Library string length function	1.00	1.01	1.09	90.91
Library string copy function	1.00	1.01	1 08	100.00
Library string compare function	1.00	1.01	1.06	100.00
Savage floating-point test	1.00	1.01	1.10	111.11
Dhrystone general benchmark	1.00	1.01	0.88	90.91
Copy file, buffered stream I/O	1.00	1.22	1.10	111.11
Copy file, unbuff low-level I/O	1.00	1.88	1.34	N/A
Copy file, buff stream blocks	1.00	1.01	1.05	142.86
Copy file, unbuff low-lvl blocks	1.00	1.01	1.14	111.11
Seek/read in file, buf stream	1.00	1.33	1.11	200.00
Seek/read in file, unbuf low-lvl	1.00	1.54	1.23	500.00
Dummy report with qsort	1.00	1.37	1.37	22.73
Dummy report with shellshort	1.00	2.07	1.95	N/A

N/A refers to timer overflow or lack of comparability

Why return to DOS, when we have the compatibility box? Well, I'll take the matter up entirely in a later column, but basically because the compatibility box is only about 80 percent compatible with DOS, and because it severely restricts your working space (maximum available memory is not 640K bytes, but about 530K bytes). Take my advice: Don't burn the DOS manual yet.

The answer: Partition your hard disk drive into C and D drives, using the DOS `FDISK` command. Format the separate drives. Put your DOS data on drive D, and set up OS/2 to boot from drive C. There is no way to `FORMAT D:/S` under DOS, but the next best thing is to create a separate boot floppy disk. Just put your usual `AUTOEXEC.BAT` file on it, then add the lines

```
set comspec=d:\command.com
```

and you're all set. Then write IBM a letter demanding the dual boot feature in the next release of OS/2.

Next month, I'll take a look at multitasking benchmarks: benchmarking OS/2 against *itself.* ■

Mark Minasi is a managing partner at Moulton, Minasi & Company, a Columbia, Maryland, firm specializing in technical seminars. He can be reached on BIX as "mjminasi."

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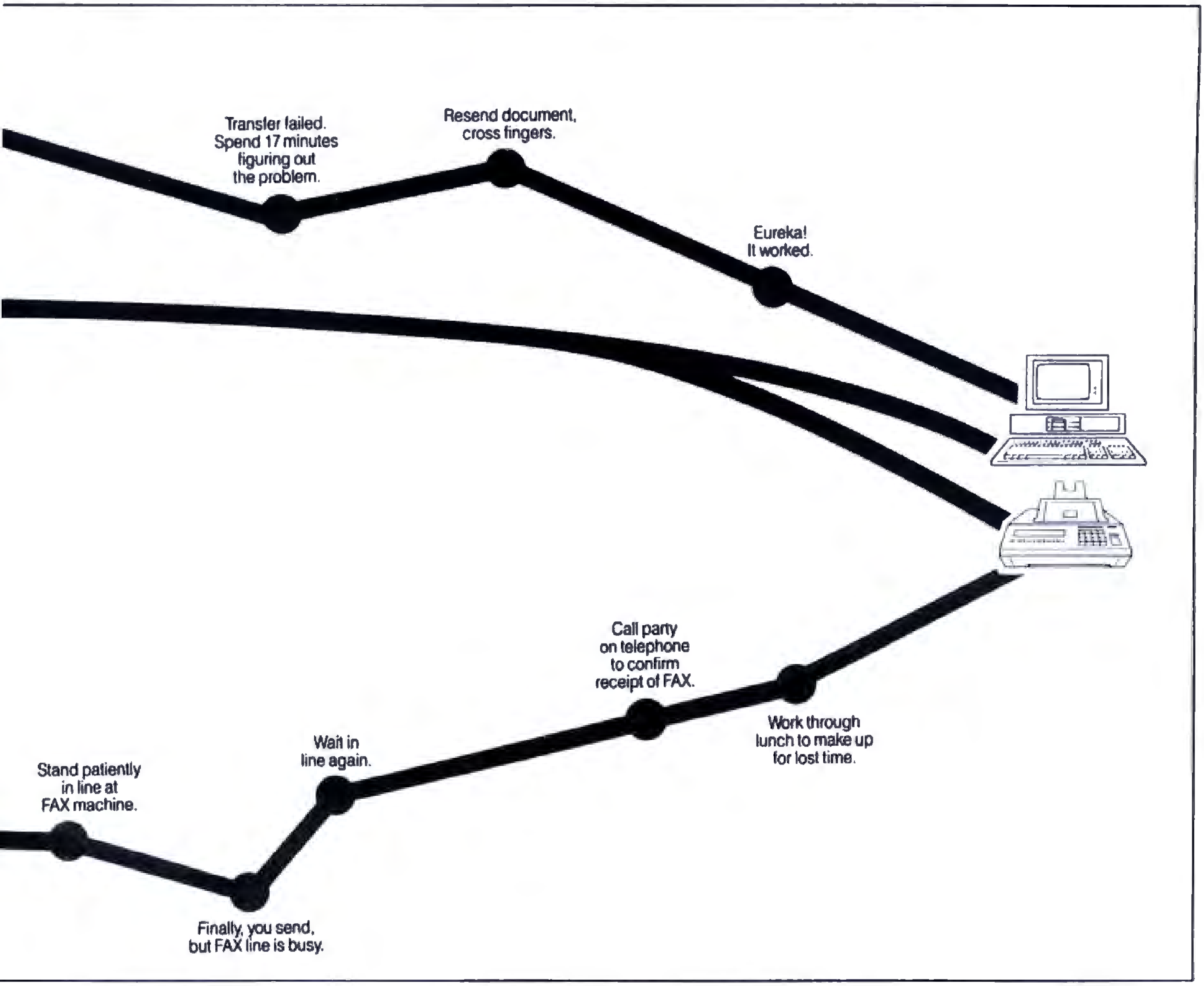

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BACK TO THE FUTURE AGAIN

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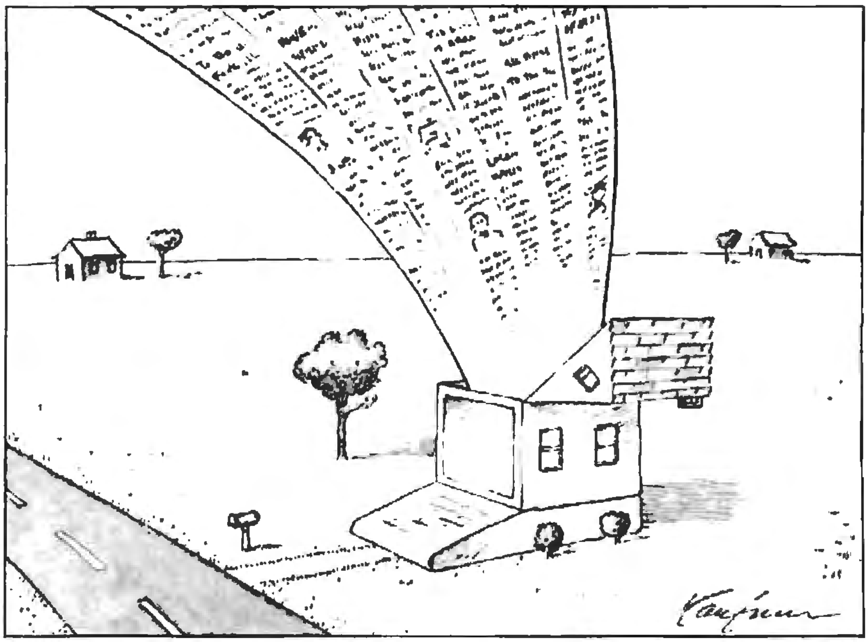

In the 1950s, futurists claimed that people in the 1980s would be commuting from their rooftops via personal helicopters, filing flight plans instead of fighting freeways. In 1959, U.S. Postmaster General Arthur E. Summerfield predicted, "Before man reaches the moon, your mail will be delivered from New York to California, to India, or to Australia by guided missiles. We stand on the verge of rocket mail."

History ultimately betrayed these predictions. Certainly in today's high-tech, ultrahip global village, such outlandish predictions would not be foisted on the public, would they? Don't believe it at all. Let's go back to the future for a minute.

It's early in the 1980s, and the burgeoning information age is being hyped by two videotex systems: Times Mirror's Gateway and Knight-Ridder's Viewtron. A perfect marriage, or so it seemed. The parent companies dealt in delivering information. They thrived on it. So now they sought to launch the next wave in information delivery: news and assorted esoteric services delivered via your TV.

However, both services flamed out. They were victims of high operating costs, perplexing user interfaces, and—most of all—flaccid consumer response. These companies should have known better than to make the American family choose between reading the day's headlines and watching *M*A*S*H* (reruns notwithstanding). *M*A*S*H* won hands down.

Back to the Drawing Board

Still, the idea of electronically delivered services, accessible from the comfort of your home, is a good idea. And a good idea has a way of hanging around until the time is right. Say hello to a good idea: Prodigy, the information-age equivalent of personal helicopters (easing daily tasks) and rocket mail (offering effective and inexpensive communications).

"We see our major competition being the traditional way people go about doing their everyday tasks," says Robert Caviglia, Prodigy's branch sales manager in the San Francisco area. There is a small catch. Prodigy's success is directly linked to the infiltration of microcomputers into the American home. By industry estimates, there are roughly 13 million of them in homes today, with slightly over 1 million of those hooked to a modem. Prodigy believes the American home is just now beginning to realize that having a microcomputer is more than a novelty.

"People aren't afraid of the PC anymore," says Dave Waks, Prodigy's director of technology and a charter member of its development team. "We are a service for people who want to use the PC to accomplish things, to make their lives easier, use their time better, gratify themselves, educate themselves."

Making the Future Work

With a work force of some 750 people, the Prodigy team has cleared extensive technical hurdles (like building its own network to carry Prodigy services) and is now working on attracting the paying customer. Three initial markets were chosen in June: San Francisco, Atlanta, and Hartford, Connecticut.

There are two prime factors in Prodigy's success equation: price and performance. Pricewise, a flat fee of $9.95 per month allows you unlimited access to the service. This "all you can eat" fee may be Prodigy's savior. Other on-line ser-

continued

ILLUSTRATION: ROBERT KAUFMAN © 1988

vices charge on a per hour basis. If you use Prodigy just for its electronic mail, you'll more than make up the $9.95.

And for that flat fee, you get up to six accounts. That means six different people can use the system for the same price. Each account has a different ID number.

Prodigy's ability to offer a low rate stems from two factors. First, its low rate is largely subsidized by more than 80 national companies, each paying upward of $20,000 for the privilege of advertising to Prodigy users. It's a captive market: When you shift to a different screen, a new inescapable ad pops up along the bottom six lines of your screen.

Some critics decry these ads as a violation of personal screen space, as if screen space were sacrosanct. Prodigy executives offer no apology. Part of their role, they say, in helping to make people's lives easier and more efficient is the offering of services or products tailored to an individual's interests. The extent of this ad tailoring depends on the user.

When first using Prodigy, you are given the option of filling in a detailed interest summary. The more specific you get, the better Prodigy is able to tailor what kind of ads show up on your screen. This tailoring raises the specter of privacy violations. Will Prodigy be able to track my individual purchasing habits? Will my interest survey be sold to hundreds of commercial companies trolling for new customers? "No," says Brian Ek. "The surveys are completely confidential and will not be used for anything beyond gathering statistics to show to potential advertisers. No names are used, no personal information released."

Should an ad pique your interest, you can instantly get more information simply by pressing the *L* key and diving into a window that further explains the product. This is a handier way of gaining more information on a product than filling out one of those ad cards found in magazines. Besides, filling out those cards usually lands your name on *someone's* mailing list, and who needs their name on another mailing list? And if you find you really like the product you're looking at, you can order it right on the spot.

The second factor in Prodigy's low price is how it approaches performance. Rather than depending on a dumb terminal, where the user is a slave to the remote system, Prodigy makes the PC the master; the system is the slave.

Prodigy's design takes full advantage of the intelligence built into the PC. (Currently, Prodigy is available only for the IBM PC and compatibles. Apple II owners will have access later this year, and Mac owners early in 1989.) All the information needed to navigate and retrieve information from Prodigy is stored in the PC.

If you're doing something on Prodigy and the information to perform that task isn't stored on your PC, only then does it query a remote computer, usually the local Prodigy site. "Your computer grabs the information it needs and stores it for future use," says Waks. In this sense, the system actually *gains* performance the more you use it. If the local site doesn't have the information you need, it then queries the main database in White Plains, New York.

"But the nice thing about the local host accessing the White Plains computer is that it stores the information you've asked for and can deliver it on demand to

continued

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another user," Waks adds.

The demonstration I was given performed flawlessly, and the full-color graphics screens were quick, even at 1200 bits per second.

What's Here

Prodigy has been branded with the title "Stodigy," apparently because it offers no innovation and less in the way of useful services. Nothing could be further from the truth.

True, I found the user interface too splashy for my tastes and, yes, a bit simplistic. But the system was designed to attract a mass market—to augment people's lives, not turn them into computer experts.

Will on-line veterans find any use for Prodigy? Of course. Its E-mail feature alone is worth the monthly price. And when Prodigy brings its conferencing capability on-line, in the form of specialized bulletin board–type services, the system just might attract more than a few power users.

Prodigy's mnemonic menu system (M for menu, H for help) is a welcome sight. If you don't want to deal with a menu, you can use a jump command and bypass a lot of on-screen real estate. In addition, you can set up a self-directed personal path that leads you sequentially through the system, visiting only areas of interest to you. Navigating your personal path entails only hitting the Enter key.

The system contains all the information that you'd expect on such a service: news, weather, and special information, like material from *Consumer Reports*. (An interesting side note: No advertising screens are visible while accessing *Consumer Reports*. As in the hard-copy publication, it is devoid of all ads. This tells me that Prodigy is likely to deal with future information providers concerned about what types of ads people are subjected to while accessing their particular database. Nice touch.)

Travel information is available. And soon you'll be able to order airline tickets, too.

There's a panel of 40 experts writing daily columns, from Howard Cosell on anything to Jane Fonda on fitness to Robert Novak on politics. And you can send E-mail to any of these experts, with a promised personal reply within 72 hours.

I was all set to really slam these columns as superficial until I read Novak's column. Novak wrote about the selection of a keynote speaker for the Democratic national convention. He outlined a fiery controversy over the choice. Good stuff. Tightly written in just over 80 words. But the biggest surprise: I read the same information, almost verbatim, in his syndicated newspaper column 3 days later. By using Prodigy, I had, in fact, scooped millions of newspaper readers.

You can access stock quotes on a 15-minute delay, as per SEC requirements. You can also buy and sell stocks via Prodigy and track your portfolio by using a type of personal path system for setting up a series of stock symbols.

And there's much more coming down the pike—grocery delivery, for one thing. You can imagine how welcome it will be for a San Francisco couple to simply type in a shopping list and have the order delivered at a predetermined time. No hassling with lines; no scheduling one's time around the supermarket.

There's also a wide variety of entertainment and educational services. One particularly intriguing game called GEO puts you in charge of a fictitious corporation. Over the course of a few weeks, you drive the company, making decisions about mergers, product development, and capital investment. You play against several other Prodigy users, and at the end of the game, your position is ranked with the others. It's a cutthroat game that any corporate barracuda will love.

Will It Work?

Prodigy does have its problems. The most perplexing one is that distribution of software and documentation has been terribly inadequate. People have waited months to receive their materials. Prodigy officials say this is "demand outstripping supply," but insiders cop to the real reasons: poor planning and poor choice of distributor. As of this writing the problems still exist, but word has it that Prodigy is aware of the hassle and is doing what it can to fix the mess.

Success is often a matter of definition. If Prodigy succeeds only in educating the American market to the fact that on-line electronic services are available and easy to use, it will be a success.

As for its fate vis-à-vis personal helicopters and rocket mail? Well, I suppose that's left for a columnist to write about sometime well into the twenty-first century. ■

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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Borland Beefs Up Its Languages

Turbo C and Turbo Pascal get upgrades, but the big news is an assembler and a debugger

Borland International is well known for its low-cost line of development languages: Pascal, Basic, Prolog, and C. But up to now, if you really needed to get down close to the silicon by using assembly language or debugging your wayward masterpiece of code when it sporadically crashed, you had to look elsewhere. No longer: Borland has closed this breach by introducing a high-speed assembler and a powerful stand-alone debugger. If that isn't enough, the company has upgraded its premier development languages—Turbo Pascal and Turbo C—with built-in source-level debuggers.

The Turbo Assembler and Turbo Debugger are entirely new. Being a lowly assembler, TASM operates more or less in a line-oriented environment; happily, it operates noticeably faster than other assemblers. The Turbo Debugger is possibly Borland's best release of this group. Like TASM, the debugger boasts support for the complete line of 80x86 processors and 80x87 coprocessors.

Turbo C 2.0 and Turbo Pascal 5.0 feature their usual integrated development environment, which consists of the compiler itself, a WordStar-style program editor, and source code debugging capabilities. Both compilers make use of expanded memory, provide faster floating-point emulation, have in-line assembly language support, and support the new stand-alone debugger. If you shun this integrated environment in favor of a program editor that you're comfortable with, each Turbo language also provides a command-line-interface version. Sound familiar? Yes, Microsoft's Quick languages give you the same option.

Turbo C 2.0

Turbo C 2.0, like its predecessor, supports every conceivable memory model: tiny, small, medium, compact, large, and huge. It now supports the `long double` data type and adds new `raise` and `signal` functions. The `raise` function signals a hardware exception, and the `signal` function lets you respond to the exception, either by two predefined handlers or by your own handler. The edit buffer makes use of the Expanded Memory Specification (EMS), freeing an additional 64K bytes of RAM to compile and debug a program. An `asm` keyword lets you add assembly language statements directly into your C code. To use this feature, though, you'll need TASM, since Turbo C generates an assembly language file rather than a linkable object code file when you use this option.

Turbo C 2.0 comes on six 360K-byte 5¼-inch floppy disks and requires 448K bytes of RAM and MS-DOS 2.0 or higher. It sells for $149.95. (Contact Borland International, 1800 Green Hills Rd., P.O. Box 660001, Scotts Valley, CA 95066, (800) 543-7543 or (408) 438-8400.) We installed a beta version of the 2.0 compiler on an Epson Equity II+ with a 10-MHz 80286 processor, 640K bytes of RAM, and a 30-megabyte hard disk drive. Turbo C has no installation program: You copy the contents of the floppies to your hard disk, or just the libraries you need. Borland also sells Turbo C Professional, a $250 package with Turbo C 2.0 and the new assembler and debugger.

When you start Turbo C, it looks a lot like Microsoft's QuickC: It has a menu bar, and you can access the menus and menu items with one or two keystrokes. The most immediate difference between version 2.0 and version 1.0 is the new Break/Watch menu, which is quite similar to QuickC's Debug menu. It lets you set and clear breakpoints as well as set "watches." A watch is a display of a variable's contents, and the display is dynamically updated as the program runs.

The built-in debugging facilities, which operate identically for both Turbo C and Turbo Pascal, are easy to use and powerful (see photo 1). Pressing F7 single-steps you through the program source code, line by line. On a color monitor, a bright bar of color highlights the statement being executed. You can set a breakpoint by stepping the program to the statement of interest and selecting Toggle Breakpoint from the Break/Watch menu. The source code statement thus selected is highlighted in a color different from that of the other statements, a nice touch if you're plodding through a lengthy trace. Or, you can move the editor cursor to the target statement and select Go to Cursor from the Run menu.

With the Break/Watch menu, you can also examine the contents of arrays and structures by means of a watch. The contents of the target variable are displayed and are updated as their contents change. You can have the watch variables displayed in a particular format, such as hexadecimal, decimal integer, real, character, Boolean, and pointer.

We used BYTE's C compiler benchmark to compare the performances of Turbo C 1.0 and 2.0. This benchmark is the source code to XLisp and consists of 24 files. It's compiled with the large model option. Turbo C lets you define and build "projects" that reference multiple source code files, so we set up an `XLISP.PRJ` file. Turbo C 2.0 compiled the project in 2 minutes, 5 seconds, versus the 2 minutes, 40 seconds required by Turbo C 1.0. The preliminary documents for version 2.0 claim that it's about 10 percent to 30 percent faster than its predecessor. The BYTE benchmark pegs it at 21 percent. We also compiled the source code for the Sieve, Sort, and Fibonacci benchmarks that were used to

continued

evaluate Microsoft C 5.1 (see "Microsoft Languages Update," April BYTE). We were pleased to see that Turbo C accepted the processor-specific `int86x()` function, used to extract elapsed machine time, as coded for Microsoft C. The version 2.0 benchmarks ran as fast as those for 1.0, except for the Fibonacci, which ran 2 seconds slower.

Turbo Pascal 5.0

Like Turbo C 2.0, the Turbo Pascal 5.0 editor can make use of EMS memory. It features the ability to generate programs larger than 64K bytes; has new built-in procedures such as `Inc()` and `Dec`; and supports several new data types, including `longint`, `shortint`, `word`, and the IEEE floating-point formats. It also offers compatibility with Turbo Pascal 3.0 and 4.0. An `inline` statement has been expanded: Formerly you could insert inline assembly language statements within Pascal source code using this keyword, but now you can declare entire procedures or functions to be of type `inline`. These functions then act like macro expansions: Every time the procedure/function name is encountered, all the assembly code within it will be directly inserted into the Pascal program.

Priced at $149.95, Turbo Pascal 5.0 comes on either three 360K-byte 5¼-inch disks or two 720K-byte 3½-inch disks. The package requires MS-DOS 2.0 or higher, one floppy disk drive, and 448K bytes of RAM for the integrated environment or 256K bytes for the command-line interface. We installed a beta version of Turbo Pascal 5.0 on the same Epson Equity II+ that we used to test Turbo C. Turbo Pascal does come with an installation program that asks you several questions and then prompts you for the disks. The compiler's source-level debugger is the same as Turbo C's. The $150 Turbo Pascal Professional version, with the assembler and debugger, is also available.

For performance measurements, we compiled the source code for the Pascal/S compiler. For comparison, we did the same using Turbo Pascal 4.0. This also tested the claimed compatibility to older versions of Turbo Pascal, since the MS-DOS implementation of Pascal/S includes a `Turbo3` unit. Both 5.0 and 4.0 compiled the 2074-line program without errors in about the same time: 4.8 seconds. Next we compiled the p-code interpreter for the Pascal/S program and used the newly created Pascal/S compiler to compile two example programs. We then ran the resulting p-code with the interpreter program. Both the interpreter and the programs ran without problems.

TASM 1.0

One of TASM's high points is support for the 80x86 processor family, namely the 8088/8086, 80186, 80286, and 80386. (For the 80386, though, it has no protected-mode environment similar to the one that's provided by Phar Lap's RUN386.) TASM also recognizes coprocessor op codes for the 8087, 80287, and 80387. TASM runs on IBM PC compatibles with MS-DOS 2.0 or higher and 256K bytes of RAM. The assembler is sold in a single package with the new debugger for $149.95.

If you activate the `/JJUMPS` command-line option (or use the `JUMPS` directive), TASM performs automatic jump sizing. This means that when the assembler encounters a conditional jump whose target is out of range, the assembler will recode the jump as a conditional branch around a nonconditional full-segment jump. So, if you have automatic jump sizing activated and TASM encounters `JNZ TARG` and determines that `TARG` is out of the jump range, it will emit

```
JZ $+5
JMP TARG
```

since the destination of an unconditional `JMP` instruction can be anywhere within a 64K-byte segment.

TASM is equipped with the `STRUCT` and `RECORD` directives, mechanisms for defining complex data structures. These directives are available in the Microsoft Macro Assembler (MASM) as well, but TASM adds the `UNION` directive for defining a single location as having multi-typed access (this is similar to C's `union`). For example, the definition

```
WORDORBYTE UNION
BYBYTE      DB          ?
BYWORD      DW          ?
WORDORBYTE ENDS

LOCATION    WORDORBYTE  <?,?>
```

lets you reference `LOCATION` as either a word or a byte. So, you could use `MOV [LOCATION.BYBYTE],255` as well as `MOV [LOCATION.BYWORD],30000` to store a value into `LOCATION`.

Perhaps TASM's biggest feature is the information contained in its 580-page user's manual. In these pages you'll find—among other things—a helpful tutorial on the pitfalls of programming in assembly language. The tips range from the absurdly simple (e.g., forgetting to return to DOS), to the mistakes we all make when we've worked late into the night (e.g., reversing operands, such as entering `MOV DX,AX` when you *really* meant `MOV AX,DX`), and on up to the fiendishly subtle (e.g., forgetting that,

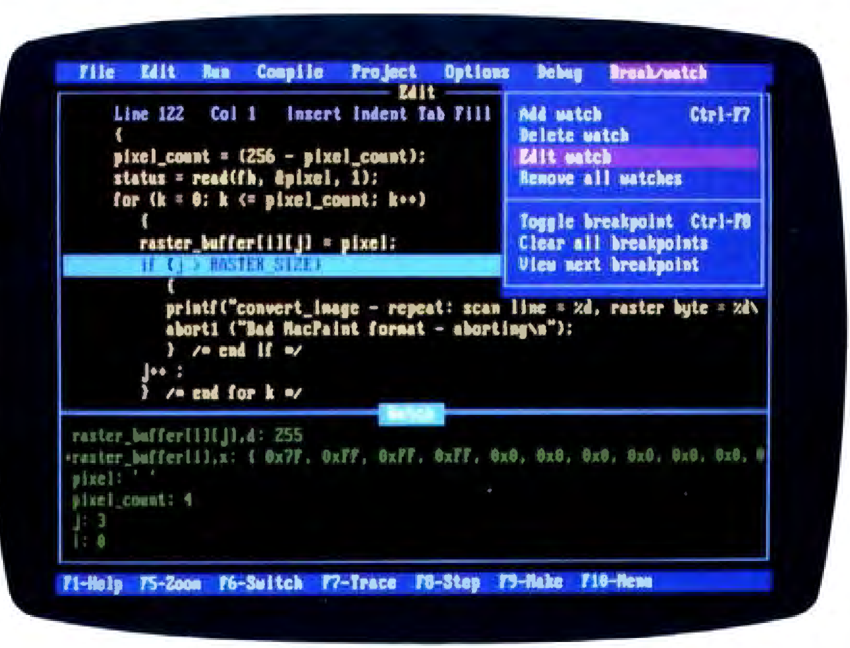

Photo 1: *Turbo C's built-in debugging facilities highlight the statement being executed. At the bottom, you can see variables that are being "watched" and their contents. You can examine the contents of an array row, or an individual cell in the array. Also note that you can specify the output format of the displayed data.*

after a string-manipulation instruction using a REP prefix, the SI and DI registers are left pointing one element away from the last address processed).

We were also impressed by the chapters on interfacing assembly language to Borland's Turbo C, Turbo Pascal, Turbo Basic, and Turbo Prolog. Each section covers parameter-passing conventions, register-passing conventions, and coping with processor segmentation.

We tested a beta version of TASM using the source code for the 8088 version of BYTE Small-C, which consists of four files ranging in size from 28K bytes to 65K bytes. Table 1 shows how TASM fared against MASM 5.0. As you can see, TASM is an average of 2.5 times faster than MASM.

We also used the Turbo Linker, TLINK, to create the executable code for the Small-C compiler. This required that we link the TASM-generated object files together with the run-time library file, which we had created some time ago with Microsoft's library manager. TLINK readily accepted the run-time file, and we had a running version of BYTE Small-C in much less time than it had taken before.

Turbo Debugger

Now that you have all these languages so you can grind out code to your heart's content, the next requirement is obvious: a debugger to fix all the mistakes you're sure you won't make.

The Turbo Debugger proudly continues the tradition of Borland windows that we've seen in the company's other language products. The debugger defines two kinds of menus: pull-down menus for activating major functions whose contents are typically static, and pop-up menus for entering information. (Macintosh programmers will see the similarity with the Mac's pull-down menus and dialog boxes.) Although the Turbo Debugger does not have a built-in editor, you can configure it to fire up your favorite editor from a pop-up menu when you're in the midst of a debugging frenzy.

Another powerful feature of the debugger is that it's polyglot; it lets you perform source-level debugging on Turbo C, Turbo Pascal, and TASM programs. Borland says that support for Turbo Basic will be added in a future release. The capabilities of the debugger in source mode are quite extensive, particularly in that you can perform expression evaluation operations in the high-level languages from within the debugger. If you're working on a Turbo C program, you can enter complete C expressions (including functions), even while debugging within an assembly language routine that your C program has called. This is powerful stuff, since you can view the contents of a memory location cast as you might use it in a C expression. For example, `(long far *) 0x4000::14` lets you view the contents of memory location 14 in segment 4000 hexadecimal as though it were a far pointer.

For Turbo Pascal, the debugger can evaluate the language's full syntax with the exception of string concatenation and set operators. Finally, Turbo Debugger can evaluate the complete assembler syntax when you're debugging TASM programs. You can even modify executables created by Microsoft LINK to work with Turbo Debugger.

To run Turbo Debugger, you need DOS 2.0 or higher, 384K bytes of RAM, and an 80-character screen. Borland recommends that you have a hard disk drive, though the company says that a dual-floppy system works fine. If you want to use Turbo Debugger on one of Borland's other language products, you'll need the following versions: Turbo Pascal 5.0, Turbo C 2.0, or TASM 1.0.

When you activate Turbo Debugger, it loads the program to be debugged, opens the module window, and positions a pointer to the start of the file. From here you can move around in the source code, set breakpoints and watchpoints, and do much of what you can in the integrated source-level debuggers described already. What's new is that you can open Turbo Debugger's CPU window and step down a level into the real insides of the system.

The CPU window is made up of five components, called "panes." The code pane shows assembly language instructions intermixed with their generating high-level expressions (if you're debugging the output of a high-level language).

continued

Table 1: *Test results show that TASM easily outperforms Microsoft's MASM on the benchmarks. All times are in seconds.*

Filename	TASM 1.0	Microsoft MASM 5.0	Source file (bytes)
CC1.ASM	7.24	18.53	65,128
CC2.ASM	5.34	13.17	44,318
CC3.ASM	7.03	18.93	65,323
CC4.ASM	4.33	9.42	28,043

Photo 2: *Turbo Debugger's numeric coprocessor window lets you dive into your system's floating-point unit (in this case, an 80387). Notice that you can enter numbers directly into the coprocessor's registers.*

Inside the stack pane you can see the contents of the word at the current stack pointer, as well as one word above and below.

The data pane displays a hexadecimal dump of a selected region of memory. Typically, you use the data pane to watch blocks of memory in your data segment for activity, but you can set this pane to view anywhere in system memory. You can also alter the data pane's display format to be hexadecimal bytes, hexadecimal words, long hexadecimal integers (the C `long` data type and the Pascal `longint` type), 8-byte decimal integers (the Pascal `comp` type), short floating-point numbers (scientific notation), 6-byte `real` numbers, 8-byte `double` numbers, or 10-byte extended floating-point numbers.

The registers pane provides a continuously updated display of the CPU registers, while the flags pane shows the state of each of the CPU's flags. And yes, if you select either the registers or flags pane, you can muck around with the processor's internals all you want.

Each pane has its own pop-up local menu. For example, in the code pane's local menu, you can select the `FOLLOW` command to see where a jump instruction will go if the jump is taken. You might also be debugging inside a subroutine and want to know what function called that subroutine; use the `CALLER` command.

If you've got a math coprocessor installed in your system, Turbo Debugger will sense its presence and let you activate a numeric coprocessor window (see photo 2). This window is similar to the CPU window in that it lets you probe the internals of the floating-point unit; you can examine and interactively modify the floating-point registers, as well as the coprocessor's status and control flags. This feature is unique among debuggers.

For anyone with an 80386 system with at least 700K bytes of extended memory, Turbo Debugger can operate in "virtual debugging mode." In this arrangement, the debugger loads itself into extended memory and operates your program from protected mode—which means that whatever you're debugging has free run of the lower 640K bytes. It also means that you can't run a virtual debugging session with software that uses the 80386's virtual or protected modes (such as DESQview, Windows/386, and Compaq's EMS simulator).

The Turbo Debugger's main attraction is its remote debugging (see photo 3). Anyone who has used CodeView to debug a graphics program and gone dazzle-happy while it flipped the screen from mode to mode will appreciate remote debugging. Simply put, you hook two machines together via serial ports. One is the debugging station, from which you execute Turbo Debugger as you normally would. The other is the remote target, on which the program under question executes, shepherded by a small program (about 20K bytes long) named `TDREMOTE` that communicates with the debugging station. In this way, the program's keyboard input and display output take place on the target, circumventing the annoying interleave of debugger I/O with the debuggee I/O. This is also handy if you're developing a software monster that's too big to crowd into memory with Turbo Debugger running stand-alone.

The remote link can operate at three data transfer rates: 9600 bits per second, 40,000 bps, and 115,000 bps. With a beta version of the debugger, we ran a quick remote session between a 4.77-MHz IBM PC XT clone and a 10-MHz PC AT clone and were surprised to see that they operated flawlessly at the highest data transfer rate. Borland also provides a remote file-manipulation program, `TDRF`, that you can operate from the debugging station to copy files between the machines, delete files on the target, create subdirectories on the target, and more.

Faster Development through Better Debugging

A lot of program development is not so much how fast you can write code, but how fast you can get it converted into machine code. To that end, compiler writers have boosted the throughput of their compilers wherever possible. However, what's overlooked at times is that a significant part of developing a program is making sure the code you wrote works. It's no good having a fast compiler if you spend most of your time tracking down a bug rather than writing useful code.

The Turbo C and Turbo Pascal upgrades are significant as good debugging tools. As far as compilation speed goes, the improvements are minor. However, now you can single-step through source code statements with a keystroke and display a variable's contents in any format. With that type of debugging ability, the performance of these development languages has improved indeed.

The only surprise to TASM is that it took Borland this long to create it. It has everything you'd expect in an assembler, and it's faster than MASM. The documentation is loaded with interfacing details and probably makes the purchase price worth it.

On the other hand, the Turbo Debugger is a pleasure to use. Its ability to connect seamlessly with other Borland languages, along with its chameleon-like countenance—the capability to operate stand-alone, in virtual 80386 mode, or remotely—should put it high on any programmer's shopping list. ■

Rick Grehan and Tom Thompson are BYTE senior technical editors at large. You can reach them on BIX as "rick_g" and "tom_thompson."

Photo 3: *Remote debugging with Turbo Debugger. The machine on the left is executing the BYTE low-level graphics benchmark program, controlled via a serial connection with the machine on the right running the debugger.*

QNX vs. OS/2 UNIX

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ARCHITECTURE If the micro world were not so varied, QNX would not be so successful. After all, it is the operating system which enhances or limits the potential capabilities of applications. QNX owes its success (over 60,000 systems sold since 1982) to the tremendous power and flexibility provided by its modular architecture.

Based on message-passing, QNX is radically more innovative than UNIX or OS/2. Written by a small team of dedicated designers, it provides a fully integrated multi-user, multi-tasking, networked operating system in a lean 148K. By comparison, both OS/2 and UNIX, written by many hands, are huge and cumbersome. Both are examples of a monolithic operating system design fashionable over 20 years ago.

MULTI-USER OS/2 is multi-tasking but NOT multi-user. For OS/2, this inherent deficiency is a serious handicap for terminal and remote access. QNX is both multi-tasking AND multi-user, allowing up to 32 terminals and modems to connect to any computer.

INTEGRATED NETWORKING Neither UNIX nor OS/2 can provide integrated networking. With truly distributed processing and resource sharing, QNX makes all resources (processors, disks, printers and modems anywhere on the network) available to any user. Systems may be single computers, or, by simply adding micros without changes to user software, they can grow to large transparent multiprocessor environments. QNX is the mainframe you build micro by micro.

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QNX

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Circle 218 on Reader Service Card

Presentation Manager and LAN Manager

A graphical interface and network support carry OS/2 well beyond the traditional DOS environment

All the pieces are starting to fall into place for OS/2, and the nearly completed system is beginning to look pretty impressive. In addition to the primary benefits of multitasking and seemingly limitless program memory, the Standard and Extended Edition 1.1 versions of OS/2 offer features that enhance usability, add functionality, and even point to a new standard for both user and programmer interfaces.

One of the most eagerly awaited features of DOS's heir apparent is the Presentation Manager, a graphical user interface scheduled to be included with Standard Edition 1.1 and released this month.

The LAN Manager, slated for release with Extended Edition 1.1, adds network support to the communications and database management capability of the current Extended Edition.

Together, the two programs represent a new direction in operating-system design: tight integration of a consistent user interface with functions currently found only in applications packages.

Presentation Manager

The phrase most often used to describe the Presentation Manager is "Windows-like," but the comparison is understated. From the user's point of view, the Presentation Manager *is* Windows, except now you're working on the system level and can access both applications programs and the operating system itself. Users familiar with either Windows or the Macintosh should have no trouble getting up to speed with the Presentation Manager's point-and-click interface.

The Presentation Manager is actually a shell program that can be enabled or disabled using the PROTSHELL command in the OS/2 CONFIG.SYS file. With Standard Edition 1.1, you have the option of using either the standard OS/2 interface or the Presentation Manager.

At boot-up, you're presented with two windows: the Task Manager and the Start Programs window. These are special operating-system windows that control the session and cannot be removed. Together, these windows replace the Session Manager found in the original incarnation of OS/2, although that is something of an oversimplification—the Start Programs window allows you to begin new tasks, and the Task Manager allows you to switch between them.

Within the Start Programs window is a list of tasks that can be started by pointing and double-clicking with the mouse or by choosing Start from the Program submenu on the menu bar. Two task choices are always in the main list: OS/2 Command Prompt and OS/2 Windowed Command Prompt. Selecting these lets you enter commands at the DOS-like [C:] prompt, either in full-screen mode or within a window.

You can also select DOS Command Prompt to work in the DOS compatibility mode, but, as always, you are limited to one real-mode session. Adding programs to the list in the window is as easy as bringing up a dialog box and specifying a name and a path to an OS/2 executable file. Tasks can be grouped in the Start Programs window, and you can switch easily from group to group.

The task list also contains two system control programs: The PM Control Panel and the PM Filing System. The Control Panel gives the user control over system parameters, such as port configurations, screen colors, fonts, and country information (such as currency, date formatting, and numbering conventions). Choosing the Filing System brings up a powerful file-management facility: It allows you to navigate through a directory tree, moving, copying, and deleting files—and subdirectories—using just the mouse. You can group files by association, change file attributes (read-only protection, archive status), and sort files using the Filing System.

The Task Manager contains only tasks that are currently running. Switching between active tasks can be done through this window or by selecting the task window with the mouse. You can also close or terminate active-task windows. The menu bar for the Task Manager offers other commands that can be used to shut down the system or to arrange windows on the screen. The shut-down choice can be used to save currently active tasks so that they will restart on boot-up. The file information is simply saved in STARTUP.CMD.

The Role of the API

Using applications in the Presentation Manager may be simple and intuitive, but writing them is a very different story. Programmers with Windows experience, like users, will feel much more at home than those used to the plain vanilla DOS environment. Even application developers just getting comfortable with OS/2 kernel programming will have to throw out much of what they know to work within the Presentation Manager shell. Of course, programs using the OS/2 kernel functions for I/O (functions beginning with the VIO, KBD, and MOU prefixes) should run from a windowed command prompt with no adjustments, but they will not take advantage of the Presentation Manager's consistent graphical interface.

Application programs are insulated from direct contact with users by the Presentation Manager's Application Pro-

continued

Presentation Manager's graphical interface provides user-friendly multitasking.

gram Interface. The API is the underside of the Presentation Manager, providing all applications with a consistent interface in the same way that the topside provides a consistent interface to the user. From the program's point of view, there are only three kinds of output and one kind of input. The application can write either text, graphics, or dialogue information to a presentation space. The presentation space can be associated with devices (screen, printers, etc.) by the application. Input to the program comes from one source only: a message queue where the API posts messages to the program about user actions.

Four different types of devices can be associated with a presentation space. There are screen, memory, metafile, and device contexts, which allow you to access output hardware without resorting to application-specific device drivers. Of course, the screen is used for almost all program output, but sending data to a printer can be done using the same screen-display code; the application merely needs to associate the presentation space with a different device context. While graphics and text can be written to any device, dialogue information (which creates an interactive dialog box) can be written only to the screen display.

All program input comes through the message queue. Each window on the screen has its own queue, which contains information specific to that window. For example, when the user resizes a window using the mouse, the Presentation Manager posts a message in the window's queue letting it know that its frame has been resized and it must update its display. Similar messages are posted when the window is moved, minimized (reduced to a bit-map icon), or terminated. Messages are processed by the application in sequential order. Windows can also send messages to each other; a good example is a scroll-bar window relaying user-selection information to the window containing the text to be scrolled.

The message-based software architecture makes writing Presentation Manager applications very much like writing applications for Windows. A Presentation Manager application must begin by registering a window class and drawing a window. Next, it must create a message queue for itself. Most of the application's time is spent in a simple message-processing loop like the following:

```
while (WinGetMsg(hab,msg,
  filter,first,last))
WinDispatchMsg (hab,msg);
```

A quit message in the queue causes `WinGetMsg` to return a value of 0, dropping the program out of the loop. Any other message is processed by a window procedure, the real meat of the application. The window procedure is generally built around a structure like the C `switch` statement, where each message is handled by its own section of code.

What allows these programs to be written in a high-level language at all is a huge assortment of standard functions and definitions, provided only (for now) by Microsoft's Software Development Kit. The functions, though readily identified (`WinEnableWindowUpdate`) will take any non-Windows programmer a while to become comfortable with. The header files and the window-handling routines also add a high overhead to any program; the source code for a Presentation Manager "Hello World" program can be 3.2K bytes long, and even a carefully linked "Hello" executable can be over 11K bytes.

LAN Manager: The Missing Link

Certainly, the release of the Presentation Manager is a major step in the development of IBM's Systems Application Architecture (SAA). The ultimate goal is a standardized interface for both user and programmer, from application to application and from machine to machine. Helping to reach that goal are powerful operating-system utilities that behave toward the user like any other application. The latest of these is the LAN Manager, another key piece to the OS/2 puzzle.

While the Presentation Manager links OS/2 to the user, the LAN Manager aspires to a loftier goal: to link users to each other. Touting the promise of multitasking and transparent resource sharing, OS/2 stalks a domain once considered the exclusive province of powerful mainframe computers. Personal computers already pack the hardware punch necessary to meet the challenge; only the software gap holds them back. For the most part, the computer community shares the OS/2 vision. We only disagree on which standard will emerge. Now, finally, Microsoft lays its cards on the table.

The LAN Manager offers an interface much like the Presentation Manager's, with a system of hierarchical menus forming the user interface and the underlying API interfacing with OS/2. The user interface breaks down into four parts: the View menu, the Message menu, the Config menu, and the Status menu. The administrator can also access a fifth menu for system maintenance. A separate interface for console servers uses the same menu structure with options limited to sending messages and monitoring activity.

The user can also drive the LAN Manager directly from the command line. This not only allows batch files to automate command sequences, but it also ensures compatibility with other PC networking products such as PC-NET and

MS-NET. Microsoft, again, tries not to leave DOS behind in its grand scheme of connectivity. The LAN Manager runs in protected mode when linking to shared resources. But once connected, it can switch to the DOS environment to run MS-DOS applications.

While the user clicks through the friendly menus, the API churns away beneath the surface. In fact, many times the user won't even realize just how hard the API works. The API persistently strives for the dual goal of smooth operation and total transparency. If the user tries to send a message before loading the messenger module, the API loads it. Or suppose the user tries to access a remote disk without first connecting to the server. The LAN Manager will automatically start a session to the server, issue a `Net Use` command to access the shared disk, validate user-access level by submitting the user name and password specified at network start time, and then proceed with the user's original request. The user, meanwhile, sees only the response to the original request, completely oblivious to the API's work. The API will even try to reestablish a disconnected session if the user issues a command after losing the link.

DOS workstations also benefit from this intuitive interface. Workstations running Microsoft Networks version 1 or 2 cannot specify a user name or a group name—a necessary input to the LAN Manager servers running in user-level security mode. However, when the server receives the request from a DOS workstation, it automatically issues a *guest* user account, complete with permissions and passwords. If this account conforms to the access level requested, the LAN Manager makes the connection.

LAN Manager's menu structure makes it easy to set system parameters.

Share and Share Alike

Whether it be messages or files or physical devices, a LAN's principle purpose is to let users share common resources. As a LAN Manager administrator, you decide who shares which resources, as well as when and how they are shared. Using the `Add Share` command button from within the View menu, the administrator can select the resource to be shared, assign a share name, designate a drive and path if necessary, limit the amount of users who can access the resource, issue a password, and determine how the resource can be used.

In the case of shared printers or communications devices, the LAN Manager establishes a queue to route requests through the network. The administrator can add, delete, and reconfigure the queue, thereby retaining complete control over system requests and device access. The administrator can also establish pools of devices and route jobs to the first available device in the pool. The LAN Manager further enhances device access and priority routing by permitting more than one queue to send requests to a particular device or device pool. A series of queues, each assigned a different priority level, waits for an available device. Priority levels allow time-critical jobs to take precedence over those jobs assigned to a lower priority. Jobs with identical priority levels are processed FIFO (first in, first out). Requests within a queue can be scheduled for a specified time or date.

The network also shares disk space. The administrator can designate entire directories (to include subdirectories) for sharing or limit access to specific files. For added security, the administrator can determine which functions each user can perform. Even though a number of users may be able to access a directory on the shared disk, some of them may only be able to write files to the directory while others can delete files or change file attributes.

In addition to reading and writing files, the user, with proper permission from the administrator, can execute remote programs in server memory. In one swoop, the user shares a disk, a program, and even memory from the server. Updated files are left in the shared directory for other users in a group to access or modify.

The LAN Manager also includes a messenger service so users can send and receive messages across the network. The administrator can send messages to a group of users or to every user on the network. Each workstation is assigned a message name, and messages are usually routed via the message name, although you may also tag a message for a specific workstation or server by designating its computer name. A `Pop Up` option enables immediate display of a received message. The message will flash in the message box at the receiving workstation. Although the LAN Manager does not currently include a text editor for message composition, the message service will transmit files as well as short notes, so the user can compose a message on any word processor and relay the file across the network. If you wish, you can have your messages automatically stored in your message log.

Although further enhancements to the LAN Manager and the Presentation Manager will surely follow, the basic pieces of OS/2 are in place. The concept is grand, the structure inclusive, but the verdict is in the hands of the users, who must see if these final pieces of OS/2 fit into the real world. ■

Steve Apiki and Stanford Diehl are BYTE Lab testing editors. They can be reached on BIX as "apiki" and "sdiehl," respectively.

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80386s for the Masses

Twenty 80386-based clones that offer a revolutionary new feature—affordability

Steve Apiki and Stanford Diehl

Intel's introduction of the 80386 chip in 1986 set the DOS world on its ear. It ushered in a new age, where multitasking, greater memory access, and ever-increasing processing speed blurred the distinction between mainframes and microcomputers. This chip put dazzling power at the fingertips of every user willing to shell out $5000 to $15,000 for a Compaq Deskpro 386 or an IBM PS/2 Model 80.

Over the last year, however, the 80386 system market has grown from these elite few to look much more like the market for IBM PC AT clones, with offshore vendors assembling systems and sparing every expense. Most of these new entrants are the same ones who have been selling AT clones for years, and many of them offer fantastic savings.

Don't let these unfamiliar names and logos fool you: These are real 80386s, capable (with enough memory) of running OS/2 or Windows/386, and of reaching more memory than an AT ever dreamed of. They can be hooked up to networks and configured as multiuser systems or used as Unix workstations. Bargain systems they may be, but even at these bare-bones prices, an 80386 machine is hardly a commodity item. Every system deserves close inspection, something not easy to do when dealing with a mail-order house.

For this month's Product Focus, we chose a group of systems selling in usable configurations for under $3000 (see table 1). Our minimum requirement was that they include a clock speed of at least 16 MHz, 1 megabyte of memory, a 40-megabyte hard disk drive, a 1.2-megabyte floppy disk drive, a hard disk drive and floppy disk drive controller, a monochrome graphics card and monitor, a 101-key keyboard, a power supply, and both serial and parallel ports. In other words, the systems we tested had to be fully equipped.

What surprised us was not only the sheer number of systems meeting this requirement, but also the many optional features available. Some companies were able to throw in an extra megabyte of memory, for example, or upgrade from the usual 16-MHz system to 20 MHz. Of course, almost all the manufacturers offer upgrades of these base systems, if high performance is a must (see the text box "Upgrading from Entry Level" on page 168).

None of these machines are built around Intel's 80386SX, which is expected to unleash a flood of low-cost systems later this year. The 80386SX is a midrange processor, offering 32-bit capability, but with a slower 16-bit data bus. These review systems are true 32-bit systems, inside and out, and they rely on mass production and low-cost compo-

Photo 1: *Two affordable 80386 machines that perform remarkably well—the Micro Express ME 386 (left) and the Gateway 386 (right).*

nents to cut costs. All were evaluated using the new 80386 versions of our standard system benchmarks (see the text box "80386 Benchmarks" on page 172).

Heart and Soul

When we sat down and started using these systems, we got used to seeing many of the same things: the same beige AT case, the same amber monochrome display, the same keyboard, and even the same motherboard. Most of these machines are assembled by resellers who simply take the components and put them in a box. The result is a hodgepodge of drives, power supplies, and system boards, where the only way to differentiate the systems is to take note of their choice of subsystems.

In such an environment, the best barometer of performance is the motherboard itself—the heart and soul of the machine—which simply becomes another component. Manufacturers can and do, however, make modifications to the same motherboard that can result in dramatic performance differences. They can adjust the memory speed and amount or change the clock frequency. What's more, some of these resold motherboard designs are clearly superior to others.

Unlocking the power of the 80386 requires complex memory interfacing. Its 32 data lines require 32-bit memory and a 32-bit path to reach it; its 32 address lines can theoretically access 4 gigabytes, but DOS limits program space to 640K bytes. Taken together, these factors impose restrictions on both the system designer and the user.

All these systems have 32-bit data paths on the system board, but you can fit only so much memory in the limited physical space. The only place to add more memory becomes the expansion slot, where you don't always get the full data path. Three of the systems—the Pacesetter 386, the Uniq 386, and the GCH EasyData 386—rely on stuffing the board with single in-line memory modules (SIMMs) to conserve real estate. Others—like the six units that share the Micronics 08-002-201 motherboard—do away with on-board memory entirely and simply have expansion cards on 32-bit slots.

The rest feature conventional memory on-board and an option for expansion using memory cards. Only 13 of the 20 systems tested, however, feature 32-bit expansion slots (see table 2); for the rest, you must fall back on 16-bit memory.

Going to a 16-bit slot halves the performance of the 80386, because it is forced to get the first word and then the second rather than making the 32-bit fetch it's capable of. At that point, your high-priced 80386 is acting like an 8086. Other memory performance hits occur when a CPU makes sequential access to the same memory bank. While the Micronics-based systems and a few others employ static RAM (SRAM), most systems make use of bank-switched dynamic RAM, where the CPU accesses one bank while the other bank of DRAM is refreshed. If a read or write operation

continued

Table 1: *For less than $3000, all these systems offer at least a 16-MHz CPU and 1 megabyte of RAM, with a variety of memory configurations and expansion options (● = yes; ○ = no).*

Computer	Price	CPU										Motherboard
		Speed	Waits	Speed select (MHz)							FPU slot	
				4.77	6	8	10	12	16	20		
Blackship 386	$2813	16 MHz	0	●	●	●	○	○	●	○	287	Micronics 08-002-201/B
Bus 386	$2800	16 MHz	0	●	●	●	○	○	●	○	287	Micronics 08-002-201/B
Club 386	$2724	16 MHz	0/1	○	○	●	○	○	●	○	287	Everex EV-3000A
CompuAdd Standard-386	$2705	16 MHz	0	●	●	●	○	○	●	○	287	FS-101
DataWorld 386	$2744	16 MHz	0	●	●	●	○	○	●	○	287	Micronics 08-002-201/B
Fortron 386	$3000	20 MHz	0	○	○	○	●	○	○	●	287	Cache Comp 386-1001-002
Gateway 386	$2995	20 MHz	0	○	●	●	●	●	○	●	287/387	Gene 386
GCH EasyData 386	$2994	16 MHz	0/1	○	○	●	○	○	●	○	287/387	GCH PCB-386-AT-16
Hertz 386	$2995	16 MHz	1	○	○	●	○	○	●	○	387	Intel iSBC 386-AT
Micro Express ME 386	$2954	20 MHz	0/1	○	○	●	○	○	○	●	287	AMI-386
Micro 1 Power 386/20	$2995	20 MHz	0	●	●	●	○	○	○	●	387	Micronics 08-011-201
PC Network THE PC 386	$2854	16 MHz	0	●	●	●	○	○	●	○	287	Micronics 08-002-201/A
Pacesetter 386	$2995	20 MHz	0/1	○	○	●	●	○	○	●	287/387	CompuSystems ver 1.0
Spear Mono-386A	$2500	16 MHz	0/1	○	○	●	○	○	●	○	287	Everex EV-3000A
Suntronics-386	$2785	16 MHz	0	●	●	●	○	○	●	○	287	Micronics 08-002-201/A
Uniq 386	$2675	16 MHz	0	○	○	●	○	○	●	○	287	2M 810-04
Value 386	$2831	16 MHz	0	●	●	●	○	○	●	○	287	Micronics 08-002-201/B
VIPC Micro 386	$2999	20 MHz	0/1	○	○	●	○	○	○	●	287/387	AMR Micro 386
Whole Earth 386	$2995	16 MHz	0/1	○	●	○	○	○	●	○	287	AMI/Mylex 386
Zeos 386 Tower	$2995	16 MHz	0/1	○	●	○	○	○	●	○	287	AMI-386

[1] Memory-access times may vary with machine purchase.
[2] Requires motherboard modification; otherwise, 1 megabyte.
[3] S = static; D = dynamic.

is attempted twice consecutively on the same bank, a delay is imposed on these systems. This performance problem lies in wait for any DRAM-based system; only faster RAM can help.

One system feature that can do wonders for processing speed is a memory cache. Six of these systems use a RAM cache to boost their processing power: the Micro Express ME 386, the Zeos 386 Tower, and the Whole Earth 386, with the AMI motherboard; Spear's Mono-386-A and the Club 386, with motherboards much like the AMI; and the Micro 1 Power 386/20. The cache is, in all but one case, 64K bytes of 32-bit SRAM, with short access times (40 to 45 nanoseconds). The Micro 1 features a 32K-byte RAM cache. The power of this feature was demonstrated in our benchmarks (see the graphs on page 173), where the top finisher overall and the top finisher in the 16-MHz group both had memory caches.

Most of these systems use the 384K bytes of RAM between 640K bytes and 1 megabyte—which DOS can't directly address—to relocate BIOS or video BIOS from slow ROM (sometimes referred to as shadow RAM). This feature did not make a significant difference on our benchmarks, but software that makes frequent BIOS calls should see significant improvement.

Raw CPU and memory speed are, of course, important factors that can't be overlooked. All these systems use the 80386 double sigma, the standard chip with 32-bit address and data lines. While six systems run a 20-MHz clock, only four actually use the 80386-20. The other two, the Gateway 386 and the VIPC Micro 386, use the same 80386-16 as every other system and simply run it at higher than its rated speed. Both machines turned in good benchmark performances, but constantly running any piece of equipment out of spec is a risky proposition at best.

Gateway added to the performance of its machine by including 60-ns RAM, which placed it well within the true 20-

Photo 2: *Inside the Gateway 386: a 20-MHz clock, dual 80287/80387 support, and a 32-bit expansion slot provide power and room for growth.*

RAM						ROM BIOS	Runs OS/2 as configured	Power supply
On-board memory	Type[3]	Access time	Extended memory	Max. 32-bit memory	Cache			
1 M	S	80 ns	0	10 M	None	Phoenix 386 BIOS 1.10.B2	○	220 W
1 M	S	80 ns	0	10 M	None	Phoenix 3.07	○	200 W
1 M	D	120 ns[1]	0	4 M[2]	64K	AMI 386 BIOS	○	192 W
1 M	S	100 ns	0	10 M	None	Phoenix 386 BIOS 1.10.B1	○	200 W
1 M	S	80 ns[1]	0	10 M	None	Phoenix 386 BIOS 1.10.B2	○	230 W
1 M	S	80 ns	0	10 M	None	Award 386 BIOS c3.03	○	200 W
1 M	D	60 ns	0	12 M	None	Award 386 BIOS c3.03	○	200 W
2 M	D	100 ns	1 M	16 M	None	Phoenix 1.00 03	●	200 W
2.5 M	D	120 ns	2 M	16 M	None	Phoenix 386 BIOS 1.00.00	●	220 W
1 M	D	100 ns	0	4 M[2]	64K	AMI 386 BIOS	○	220 W
1 M	S	80 ns	0	10 M	32K	Phoenix 386 BIOS 1.10.B2	○	200 W
1 M	S	80 ns	0	16 M	None	Phoenix 386 BIOS 1.10.B2	○	200 W
1 M	D	100 ns	0	8 M	None	Phoenix 386 BIOS 1.01.02	○	200 W
1 M	D	80 ns	0	4 M[2]	64K	AMI 386 BIOS	○	200 W
1 M	S	80 ns	0	10 M	None	Award 386 BIOS c3.03	○	200 W
1 M	D	120 ns	0	8 M	None	AMI 386 BIOS	○	200 W
1 M	S	80 ns	0	10 M	None	Phoenix 386 BIOS 1.10.B2	○	220 W
2 M	D	100 ns	1 M	10 M	None	Quadtel BIOS	●	200 W
1 M	D	120 ns	0	4 M[2]	64K	AMI 386 BIOS	○	200 W
1 M	D	120 ns	0	4 M[2]	64K	AMI 386 BIOS	○	200 W

MHz category on our index. While memory speed played a role in all machines' success on our tests, the effect was outweighed by caching and clock speed more often than not.

Each reviewed machine has provisions for changing the CPU clock speed. Most are constantly running at a bus speed of 8 MHz to maintain compatibility with other devices. Several have multiple crystals on-board and are able to switch to four different speeds.

You should consider more than speed when evaluating a motherboard. A key point is expandability—though 32-bit slots are important for memory expansion, 8-bit and 16-bit slots are just as vital for everyday cards like disk drive controllers and graphics adapters. The systems all have between four and six 16-bit expansion slots. On-board memory capacity must also be considered, because the price of a chip set is far less than the price of an expansion card. All machines also include battery-backed clock chips.

Photo 3: *The popular Micronics 08-002-201 motherboard found in 6 of the 20 review machines (the Blackship 386 is shown here).*

While the AMI motherboard mentioned earlier may well be the fastest, the most unusual is easily the AMR Micro 386 on the VIPC Micro 386. The VIPC, a proprietary design, includes everything but the disk drive controller on the motherboard, leaving all but one 16-bit slot available for future expansion. A serial port, a parallel port, and EGA circuitry are built in. This saves a considerable amount of money when configuring an EGA system, but you wind up paying for EGA even if you don't need it. The VIPC suffered on our benchmarks because monochrome EGA is several times slower than Hercules graphics.

The Difference a Drive Makes

As July's roundup of hard disk drives pointed out, only system clock speed affects your computer's performance more than drive access times. A slow disk drive can seriously thwart the impressive processing speed of the 80386 chip. You cannot simply drop the chip into a system and expect breathtaking performance.

continued

Upgrading from Entry Level

Just because you've decided on an entry-level 80386 system doesn't mean you have to live with it forever. Choosing a versatile system initially can lead to a wealth of performance-enhancing options down the road. As with any computer purchase, the number one criterion in selecting an upgrade path must be its utility in performing your primary application.

The best upgrade for calculation-intensive applications is a floating-point unit. An 80287 or 80387 can, in some cases, double your processing speed. We ran the 16-MHz Compaq Deskpro 386 through our benchmarks—with and without an 80287—and the difference was striking: a score of 10.38 on our application index versus 8.81, and that's taking into account applications that don't access the FPU at all.

There is also a marked difference between running an 80287 and running an 80387. Not only does the 80387 allow for direct 32-bit communication with the 80386, but its special hardware-implemented transcendental functions let it calculate sines and exponentials with ease.

To test the effect of a fast 80387 on overall system speed, we ran the benchmark suite on a 20-MHz Deskpro 386/20. The results: 17.93 when including the coprocessor, and 14.25 when leaving it out. Again, the numbers factor in applications like word processing and databases, which perform the same with or without the FPU.

Coprocessors let you compile and run programs specifically made to take advantage of 8087 code. Most FORTRAN and C compilers include library routines for this purpose; the alternative, using emulator code, is not nearly as good as the real thing. As an example, consider the numbers earned by these machines on our Livermore Loops and LINPACK tests. All of them, using the test compiled with emulation routines, scored significantly lower than the 80287-equipped IBM PC AT. The AT scores 0.0237 million floating-point operations per second on the Livermore Loops and takes 1010.22 seconds to execute the LINPACK; compare these with the benchmark results on page 172.

Adding memory is another way to increase performance without wasting any of your initial investment. The real multitasking power of an 80386 can be put to use only if you have enough space to use it in. Adding memory above the 1-megabyte level will let you use OS/2, which requires 1.5 megabytes. Memory must be at the same speed throughout the system, and it must be added in full-bank increments.

Unlike the standard 8-bit PC slot and the standard 16-bit AT slot, there is no standard for 32-bit expansion boards. You will often need to purchase memory boards from the same source as your system board, and your ability to upgrade memory may be only as good as the longevity of your system's manufacturer. Dynamic RAMs are not cheap, and more and more memory is not always the answer. If you plan to use your 80386 more as a fast AT than as a multitasking system, better upgrade choices are available.

One of the best choices is adding a faster hard disk drive. Drive-access time contributes to delays no matter what applications you run. There is a difference, however, between adding memory or a coprocessor and upgrading your drive: The upgrade makes your current hard disk drive obsolete. If you have additional drive bays, you can continue to use your old drive, of course, but chances are you won't use it often enough to justify its original cost.

Nevertheless, the drive will probably be the slowest subsystem on your 80386, and a natural target for replacement. When you choose to do so, you can choose those with new high-speed small-computer-system-interface or enhanced-small-device-interface controllers that can cut average seek times from 28 milliseconds to 10 ms. These will really accelerate the performance of your system, but be prepared to pay dearly for them.

Other upgrade options will, like additional memory, affect your capability more dramatically than they will affect your performance. Color graphics, for example, will let you use the speed and power of the 80386 for CAD applications. With a sufficiently versatile system, the possibilities for improvement are almost endless.

Vendors, in an effort to stake a claim in the inexpensive 80386 market, must cut corners wherever possible by weighing the trade-off between low price and lost performance. Nowhere is that delicate balance more critical than in the choosing of a hard disk drive. That's because vendors can save considerable money by installing a bargain drive, and they can fatally hobble their system in the process.

Four of the systems employ the Seagate ST251-1 40-megabyte hard disk drive (see table 2), and for good reason: The company and the drive enjoy an excellent reputation. The drive's price is one of the lowest on the market, and it's a solid, dependable product. Six others opted for the original ST251, a slower drive, and the move turned out to be particularly bad for the PC Network THE PC 386, which finished last on our disk benchmarks.

Zeos, on the other hand, opted for the Seagate ST277R, and our benchmarks reveal that the choice was a good one. In addition to excellent performance, the ST277R delivers over 50 percent more storage space, packing in 64 megabytes of data. Despite a slow access time of 40 milliseconds, the ST277R achieves its performance boost by employing run-length-limited (RLL) encoding at 7.5 megabits per second. The ST251-1 uses the same ST412 interface as the ST277R, but it uses modified-frequency-modulation (MFM) encoding at 5.0 megabits per second. The original ST251 uses the old ST506 interface.

While Zeos made a good choice, other vendors did not. Uniq Technology should have heeded our July warning. That month's Product Focus placed the Microscience HH-1050 at the bottom of the benchmark results. Unfortunately, Uniq placed that same drive into its system and paid the price of poor performance. Those vendors selecting the Seagate ST4053 (VIPC, Blackship, and Value) also suffered the consequences, as all three systems placed in the bottom half of our drive benchmarks and our overall rating. Micro Express went with the Priam V150, and that drive certainly did not hamper the system's top-of-the-heap performance.

Disk drive controllers also play an important role. Since these systems are best thought of as entry machines on which to build, the controller should conform to that philosophy by offering ready expansion. All the systems tested support two

continued

Table 2: *The systems use a wide variety of disk drives, which differ substantially in performance.*

Computer	Controller	Floppy	Hard disk		
			Type	Access	Capacity
Blackship 386	WDC WD1003-WA2	1.2 M	ST4053	28 ms	44 M
Bus 386	LCS-6620TX	1.2 M	ST251	40 ms	42 M
Club 386	Everex EV-332	1 2 M	Micropolis 1333A	28 ms	44 M
CompuAdd Standard-386	WDC WD1003-WA2	1.2 M	MiniScribe 6053-II	25 ms	44 M
DataWorld 386	WD-1006-WAH/WD-1002 FDC	1.2 M	ST251	40 ms	42 M
Fortron 386	Ntl. Computer Ltd. NDC5425	1.2 M	ST251-1	28 ms	42 M
Gateway 386	WD-1006-WAH/WD-1002 FDC	1.2/1.44 M	ST251-1	28 ms	42 M
GCH EasyData 386	Data Technology 5280CRA	1.2 M	ST251	40 ms	42 M
Hertz 386	WDC WD1003-WA2	1.2 M	Micropolis 1323A	28 ms	44 M
Micro Express ME 386	Ntl. Computer Ltd. NDC5425	1.2 M	Priam V150	28 ms	44 M
Micro 1 Power 386/20	WDC WD1003-WA2	1.2 M	Toshiba MK-134FA	25 ms	44 M
PC Network THE PC 386	WDC WD1003-WA2	1.2 M	ST251	40 ms	42 M
Pacesetter 386	WDC WD1003-WA2	1.2 M	ST251-1	28 ms	42 M
Spear Mono-386A	Everex EV-332	1.2 M	ST251	40 ms	42 M
Suntronics-386	WDC WA2-16	1.2 M	ST251	40 ms	42 M
Uniq 386	WDC WD1003-WA2	1.2 M	Microscience HH-1050	28 ms	44 M
Value 386	WDC WD1003-WA2	1.2 M	ST4053	28 ms	44 M
VIPC Micro 386	WDC WD1003-WA2	1.2 M	ST4053	28 ms	44 M
Whole Earth 386	WDC WD1003-WA2	1.2 M	ST251-1	28 ms	42 M
Zeos 386 Tower	Adaptec 2372	1.2 M	ST277R	40 ms	64 M

Software key: a) Setup/diagnostics
b) Disk utilities/disk management
c) Video utilities
d) I/O utilities
e) 386 utilities
f) Memory management
g) MS-DOS 3.30 w/GWBASIC

hard disk drives and two floppy disk drives. Most vendors selected the Western Digital controller (WD1003-WA2) for the same reason that many selected the ST251-1 hard disk drive.

The Adaptec 2372 controller boosts the performance of RLL-encoded drives, but using MFM encoding lets you upgrade without buying a new controller.

National Computer Limited's NDC5425, the controller of choice in two of the three top performers, also proved a worthy product, delivering functionality, expandability, and 2-to-1 interleave.

DataWorld and Gateway reverted to a dedicated hard disk drive controller paired with a separate floppy disk drive controller. The 1-to-1 interleave of this combination enabled these two machines to finish second and third on our drive benchmarks, just behind the Adaptec 2372/ST277R-equipped Zeos.

The Flesh and Bones

With so much emphasis being placed on the nitty-gritty system components—CPU, memory, and hard disk drive—the nuts-and-bolts features that bring it all together are often overlooked. Most users don't put much thought into the selection of things like monitors, keyboards, and cables. Sure, they are necessary, but as long as they perform the basic functions, you're covered.

But think about that. The keyboard and the monitor are your direct interface with the computer. That's where the rubber hits the road. Though a blurry monitor or a defective keyboard might not affect basic system performance, it most certainly will affect your productivity, your enjoyment while working on the computer, and, in the long run, your overall evaluation of the product.

All the systems include monochrome graphics cards, except for the VIPC, which comes with an EGA on the motherboard. With the exception of the Bus 386's monochrome card, all the graphics cards also include an additional printer port. Each card supports 720- by 348-pixel resolution and packs a 64K-byte video buffer. The graphics cards in the Fortron 386 and the Gateway 386 performed the best in our video benchmarks.

The monitors also share the same basic specifications, although several vendors offer a 14-inch display rather than the standard 12-inch model. However, it was the shape of the screen, rather than the size, that made the biggest difference. The new flat display screens with square corners definitely presented a crisper image with less glare. While GCH, Hertz, CompuAdd, and Suntronics ship flat screens, we especially liked the EverVision 14-inch flat display atop the Club and Spear machines.

Like art and pizza combinations, the satisfactory feel of a computer keyboard is a matter of personal taste. In general, though, most people prefer a keyboard with positive tactile response and firm recoil. All these systems include either a 101-key or 102-key layout in the Enhanced IBM AT style.

The feel of the keyboards covered a wide range, from very subtle differences to basic design differences. The Blackship, Suntronics, and PC Network keyboards all lacked that comforting feel of positive tactile response: It's hard to tell when you've made true contact with the keys. Fortron's keyboard had miniature Control and Alt keys, and it also suffered from excessive recoil. On the other hand, the DataWorld, Hertz, Pacesetter, Value, Whole Earth, and Zeos key-

Video			Expansion slots			Ports			Software Included
Board	Monitor	Size	8-bit	16-bit	32-bit	Printer	Serial	Game	
DTK	Quimax	14"	2	5	1	2	2	1	a,f
MGC	Panasonic	12"	2	5	1	1	1	1	a,d
Everex	EverVision	14"	2	6	0	1	1	0	b,c,d
MG-150	Samsung	12"	2	5	1	1	0	0	a,c
Graphicsmith MGP	Samsung	12"	2	5	1	2	1	1	a,f
MGP Monochrome	Samsung	12"	2	5	1	2	2	0	a,b,f
TOP MGP	Samsung	12"	2	5	1	2	2	1	a,f,g
MGP Adaptor	X-TRON	14"	2	5	1	2	1	0	a,b
Everex	Hertz	14"	2	4	2	2	1	0	a
Turbo MGP	VM-1400	14"	2	6	0	2	1	0	a
MG-132	Samsung	12"	2	5	1	2	1	1	a,b,c,d,f
6046 MGP	Samsung	12"	2	5	1	2	2	1	a,b,f
Twinhead	Packard Bell	12"	2	6	0	2	1	0	a,e
Everex	EverVision	14"	2	6	0	2	1	0	a,b,c,d,g
MGP	Mitsuba	14"	2	5	1	2	1	1	a
MG-150	Samsung	12"	4	4	0	2	1	1	a,c
Hercules	Samsung	12"	2	5	1	2	1	1	b,e,f
Motherboard	Quimax	14"	1	6	1	2	2	0	a,c
C&F Herc Comp	Packard Bell	12"	2	6	0	1	1	0	b,c
CT-6040T	Packard Bell	12"	2	6	0	2	1	1	b,c

boards all had the IBM-like true-click feel.

Almost all these systems use cables with a basic design flaw: They're just too darn short. This problem rears up most flagrantly with the Zeos system because of its "tower" configuration. This setup lets you free desk space by placing the unit on the floor beneath you, but the cables were so short that we still had to put the Zeos on the table with its monitor and keyboard. Kind of defeats the purpose of the "tower" design, doesn't it? CompuAdd's Standard-386 commits a worse oversight by omitting a COM1 port. You can expect an immediate upgrade if you go with this unit.

Another oft-overlooked item is documentation, and with these systems, clear documentation is not a given. Most of the vendors simply ship the manuals provided by the component manufacturers. This includes the woefully inadequate hard disk drive installation manual for those systems packing Seagate drives. We found confusing jumper settings on the Gateway machine, and the motherboard documentation did little to help. The motherboard manual shipped with the Uniq system was so poorly written that it was often incoherent.

In fact, a lack of clear and useful documentation plagued all these systems, although the Spear Operations Manual and the Club User's Manual were more comprehensive than most, and the Pacesetter's Technical Reference Guide displayed impressive depth.

The Price of Paying Less

While these systems offer attractive price breaks, most of the companies are unknown quantities in the 80386 market. Most haven't yet built a strong track record. If you end up spending saved money on repair bills, enhancements, or perhaps even another computer before the expected life has expired, you end up losing in the long run.

Major vendors, on the other hand, usually have a proven track record. Good or bad, that track record is something to go on. It's often a key to such factors as durability, reliability, and customer satisfaction. These vendors usually have established a network of customer support that few minor vendors can match. Though the minor vendors often have a technical-support department, staffing is usually inadequate.

Remember, also, that these vendors had to cut costs somewhere. Just make sure you know where the cuts were made and what the trade-offs are. For example, a couple of the vendors, Gateway and VIPC, shipped 20-MHz crystals with 16-MHz chips. The chips will run at 20 MHz, but the manufacturer will not guarantee performance at that rate. So it's a gamble. You have to decide if that kind of risk is worth taking.

Given the piecemeal structure of these systems and their low price, you'd expect to run into a few problems now and again. We expected to run into a few during this review, but it went far beyond our expectations. Fully 6 of these 20 machines had problems when we first received them, problems that ranged from nuisances to complete system failures. And these are demonstration units, which should be the cream of the crop.

Problems included BIOS fatal errors, erratic disk failures, a nonfunctioning serial card, and the especially annoying keyboard with the *T* key not working. Some systems were shipped with mechanical problems, like a full-height disk drive jammed into a drive bay at a 45 de-

continued

Computer	Conventional benchmark results			BYTE Benchmark Indexes: Low-level			BYTE Benchmark Indexes: Application-level					
	LINPACK	Lvrmore	Dhry	CPU	Disk	Video	Wp	Sprd	Db	Sci/ eng	Complr	Cum. appl*
Micro Express ME 386	1698.51	0.0125	5952	3.30	1.47	2.58	3.46	2.73	1.73	1.31	2.32	11.54
Gateway 386	2000.61	0.0107	5149	2.77	1.55	2.80	3.16	2.25	2.39	1.14	2.27	11.21
Fortron 386	2001.60	0.0102	5086	2.77	1.33	2.84	3.15	2.78	1.54	1.12	2.15	10.74
Zeos 386 Tower	2140.23	0.0094	4098	2.61	1.97	2.25	3.08	2.67	1.54	1.05	2.30	10.64
DataWorld 386	2513.00	0.0081	4061	2.20	1.52	1.64	2.76	2.34	2.15	0.90	2.14	10.29
Spear Mono-386A	2141.21	0.0095	4724	2.61	1.38	2.28	3.01	2.66	1.45	1.05	1.92	10.09
Micro 1 Power 386/20	2366.35	0.0087	4336	2.54	1.44	1.86	2.90	2.39	1.69	0.98	2.07	10.03
Club 386	2141.21	0.0099	4716	2.62	1.39	2.28	2.91	2.17	1.56	1.05	2.06	9.76
Whole Earth 386	2140.17	0.0099	4743	2.75	1.30	2.25	2.92	2.16	1.50	1.05	2.05	9.68
VIPC Micro 386	2118.10	0.0100	4766	2.91	1.33	1.90	2.72	2.46	1.54	1.07	1.90	9.68
CompuAdd Standard-386	2513.00	0.0081	4065	2.20	1.43	1.66	2.64	2.34	1.50	0.88	1.91	9.27
Pacesetter 386	2211.96	0.0097	4081	2.36	1.43	2.06	2.60	2.15	1.48	0.97	1.88	9.08
Suntronics-386	2514.00	0.0081	4065	2.20	1.23	2.33	2.62	2.15	1.44	0.90	1.83	8.93
Blackship 386	2519.38	0.0085	4045	2.43	1.33	1.48	2.74	2.01	1.43	0.89	1.81	8.88
Bus 386	2513.33	0.0081	4065	2.20	1.04	1.63	2.57	2.14	1.51	0.89	1.70	8.81
Value 386	2513.34	0.0085	4065	2.20	1.22	1.65	2.66	2.00	1.32	0.90	1.85	8.74
GCH EasyData 386	2569.08	0.0083	4065	2.42	1.34	1.84	2.45	2.00	1.50	0.90	1.90	8.74
PC Network THE PC 386	2513.00	0.0085	4065	2.20	0.93	1.63	2.54	1.97	1.43	0.91	1.83	8.67
Uniq 386	2544.00	0.0074	4115	1.87	1.26	1.50	2.47	1.91	1.45	0.82	1.78	8.44
Hertz 386	2898.97	0.0075	3396	2.03	1.32	1.57	2.09	1.61	1.32	0.82	1.75	7.59

*Cumulative application index. Graphs at right are based on indexes and show relative performance.
Indexes show relative performance; for all indexes, an 8-MHz IBM PC AT = 1.
All low-level benchmarks were generated using the 80386 version (1.1) of Small-C (32-bit integers).
For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance.
For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE.

80386 Benchmarks

Rick Grehan

BYTE is taking this opportunity—the first roundup of affordable 80386 systems—to introduce our 80386-specific low-level benchmarks. I've modified the code-generation portion of BYTE Small-C for MS-DOS to emit 80386 code compatible with Phar Lap's 386|ASM, 386|LINK, and RUN386 combo package. The most important addition? It's 32-bit integers, of course. As you peruse the benchmark results, be aware that the Sieve, Sort, and Matrix programs, calculated into the CPU indexes, are now manipulating 32-bit integers, pointers, adds, subtracts, multiplies, and divides, and an addressing capability that cracks the 64K-byte barrier.

We're also generating two additional figures with the String Move benchmark: doubleword-odd and doubleword-even. Recall that String Move clocks the time required to move blocks of data from one memory location to another, and that it moves the bytes one at a time (byte-wide) and two at a time (word-wide). The new version reports the additional figure for 4 bytes at a time (doubleword-wide). Also, depending on the processor's data bus width and the system's memory hardware, moving a word from odd address to odd address can turn in a significantly different time (usually a worse result) than moving a word from even address to even address. The same holds true for doubleword moves.

Though none of these systems include a floating-point unit, I've modified the floating-point coprocessor library—which originally assumed only an 8087 coprocessor—to take advantage of new instructions within the 80387. (We've also developed an 80287 library that we'll bring on-line soon.) You'll see the most noteworthy performance boosts in the benchmarks involving transcendental functions. Specifically, the 80387 has a single instruction for calculating the sine (on the 8087, you had to derive the sine from the tangent), and calculating the exponent requires fewer instructions than for the 8087 and the 80287.

We'll be using the 80386 version of the benchmarks for all upcoming 80386 machines. As usual, we'll be making the source code for the 80386 version of Small-C and the updated benchmark programs available in the public domain (see page 3 for details). If you have any suggestions or comments, we'd like to hear them.

Rick Grehan is a BYTE senior technical editor at large. He can be reached on BIX as "rick_g."

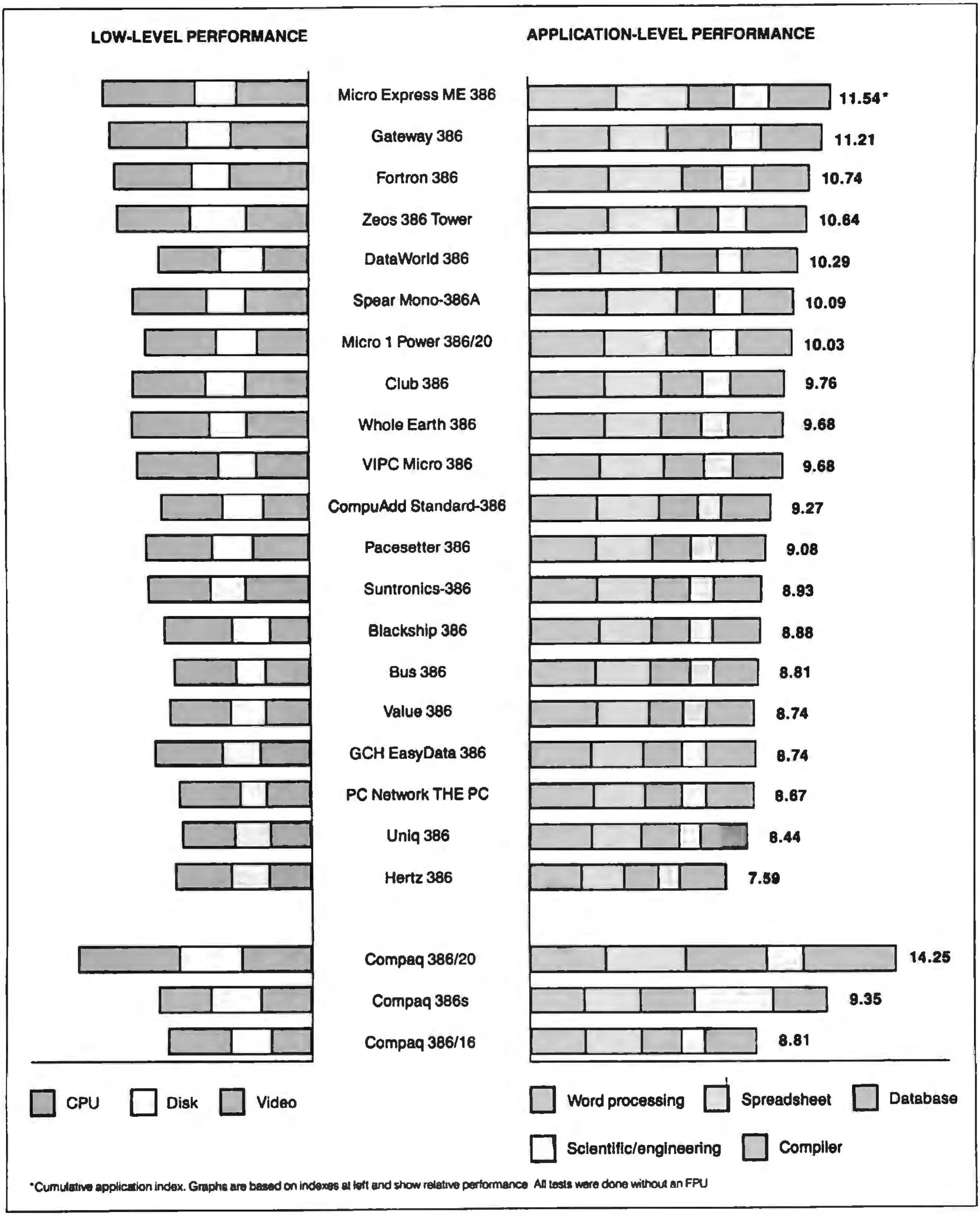

Figure 1: *The Micro Express ME 386 and the Gateway 386, with 20-MHz 80386s, finished tops. Of systems with 16-MHz 80386s, the Zeos 386 Tower and the DataWorld 386 are on top. Fourteen systems finished higher on the benchmarks than a 16-MHz Compaq Deskpro. Compared to the Compaq 386s, all had a higher CPU index, and half had a higher application index.*

Company Information

Blackship Trading Co.
385 Oyster Point Blvd., Suite #10
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Inquiry 898.

Bus Computer Systems
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New York, NY 10001
(212) 627-4485
Inquiry 899.

Club AT, Inc.
3401 West Warren Ave.
Fremont, CA 94589
(415) 683-6600
Inquiry 900.

CompuAdd Corp.
12303-G Technology Blvd.
Austin, TX 78727
(800) 627-1967
Inquiry 901.

DataWorld, Inc.
3733 San Gabriel River Pkwy.
Pico Rivera, CA 90660
(213) 695-3777
Inquiry 902.

Fortron Corp.
2380 Qume Dr., Suite F
San Jose, CA 95131
(408) 432-1191
Inquiry 903.

Gateway 2000
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Sioux City, IA 51107
(800) 233-8472
Inquiry 904.

GCH Systems, Inc.
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Sunnyvale, CA 94086
(408) 733-2131
Inquiry 905.

Hertz Computer Corp.
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New York, NY 10016
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Micro Express
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Santa Ana, CA 92705
(714) 662-1973
Inquiry 907.

Micro 1
557 Howard St.
San Francisco, CA 94105
(415) 974-5439
Inquiry 908.

New PC Network
625 Academy Dr.
Northbrook, IL 60062
(312) 205-1300
Inquiry 909.

Pacesetter Systems
7130 Fire Lane Rd.
Columbia, SC 29233
(803) 736-0673
Inquiry 910.

Spear Technology, Inc.
710A Landwehr Rd.
Northbrook, IL 60062
(312) 480-7300
Inquiry 911.

Suntronics Co., Inc.
12603 Crenshaw Blvd.
Hawthorne, CA 90250
(213) 644-1140
Inquiry 912.

Uniq Technology, Inc.
1120 Stewart Ct., Suite G
Sunnyvale, CA 94086
(408) 736-7440
Inquiry 913.

Value Plus Distributing
900 Larkspur Landing Cir., #165
Larkspur, CA 94939
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Inquiry 914.

VIPC Computers
384 Jackson St., Suite #1
Hayward, CA 94544
(415) 881-1772
Inquiry 915.

Whole Earth Electronics
2990 Seventh St.
Berkeley, CA 94608
(415) 653-7758
Inquiry 916.

Zeos International
530 Fifth Ave. NW, Suite 1000
St. Paul, MN 55112
(612) 633-4591
Inquiry 917.

gree angle, or motherboards installed so close to the edge of the case that the flange on the expansion cards wouldn't fit in the slot. Not all terribly serious problems, but they do indicate a general lack of quality control in some of these systems.

The Best for Less

Looking at these systems made us remember the true meaning of the word "clone." At first look, none of them stood out from the rest. With so many common components and identical features, we thought picking the best would be impossible. Luckily, a few of the systems shucked the "cheap" label and displayed an admirable mix of performance and quality. A couple of the systems went a step further, emerging as truly exceptional buys.

It's one thing to compare these systems to one another and find outstanding performance; it's quite another to look at them in reference to the rest of the 80386 arena and find the same thing. The systems we've rated highly here give good account of themselves, even against Compaq's big guns. In fact, all but six of these machines finished higher on our benchmarks than a similarly equipped 16-MHz Deskpro.

While none were able to touch the overall performance of the Deskpro 386/20—with its high-speed enhanced-small-device-interface disk drive controller and dedicated cache controller—the top finishers were able to come much closer than their prices would indicate. And what of the 386s, Compaq's 80386SX-based machine? Every last one of these review machines earned a better CPU index than the 1.86 assigned to the 386s.

Superior subsystems also became apparent. Our benchmarks demonstrate the superiority of the AMI-type motherboard: The three AMI systems and the two very similar EV-3000A-equipped systems made up half of the top 10, regardless of the other system parameters. The AMI does, however, have significant drawbacks: A low memory ceiling and a lack of 80387 support will hamper future upgrades. On the other side of the coin, the common Micronics 08-002-201 motherboard was installed in systems accounting for 6 of the bottom 10. For a full accounting of the performance indexes, see page 173.

Often, the choice in memories comes down to a trade-off between size and speed. The Hertz 386, though very slow, does come with 2.5 megabytes of mem-

continued

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ory. The Hertz was able to run memory-hungry OS/2 as configured, a trait shared only by the EasyData 386 and the VIPC Micro 386. Our test for OS/2 compatibility was a simple one, running three simultaneous processes from Microsoft's OS/2 demonstration disk. No times were recorded. We did have some video problems when running OS/2 on the VIPC, and we could not get it to run successfully using the on-board EGA. The company assured us that it had no problems running OS/2 on similar units, and we did get it to work using an external Hercules card.

All manufacturers claim Windows/386 compatibility. We were unable to test this, though, because Windows/386 version 2.0 does not include a Hercules driver, and version 2.1 was not shipping as of press time.

Beyond the raw benchmark results, we looked at many factors when evaluating these systems. We considered the apparent quality of the overall product, the performance of the subsystems, the general look and feel, and the reliability of operations. Even so, it is hard to ignore the impressive performance of the Micro Express ME 386 on our benchmarks. It not only excelled on our low-level tests, especially the CPU index, but it also blazed by the other machines when converting that low-level capability to practical applications. Churning along at 20 MHz, it posted an application index of 11.54, good enough for top honors.

However, when evaluating the whole package, the Gateway 386 surpasses all the others. Coming in a close second on our application index, the Gateway delivers speed without sacrificing features: a 16-MHz chip running at 20 MHz, 60-ns RAM, a 1.44-megabyte 3½-inch floppy disk drive to accompany the standard 1.2-megabyte 5¼-inch floppy disk drive, an extra serial port and a game port, DOS 3.30 with GWBASIC, and sockets for both the 80287 and the 80387 coprocessors. The system ran without a glitch, although we would prefer to see a true 20-MHz chip under the hood. We were truly surprised to see a system of this caliber selling for less than $3000.

It's a testament to the state of the 80386 market. You don't have to wait for the unveiling of the 80486 or for prices to drop on the hybrid 80386SX to get an 80386 at a reasonable price. The shakeout has arrived. The clones are here. And they can get the job done. ■

Steve Apiki and Stanford Diehl are testing editors for the BYTE Lab. They can be reached on BIX as "apiki" and "sdiehl."

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Bucking the System

Dell's System 310 proves that top-notch performance doesn't have to come at top-shelf prices

John Unger

Making a 20-MHz 80386-based microcomputer run at its maximum potential requires more than a 20-MHz CPU: The entire suite of hardware components has to interact efficiently. Such optimized performance was obviously a prime consideration when Dell's engineers designed the System 310.

The System 310 is a solid, high-performance 80386 computer that's a prime contender for the title of fastest 20-MHz 80386 machine. But that's not all; the machine's excellent performance comes at a price that's well below that of comparable systems.

The System 310 is available in a variety of models that share the same basic hardware. Each has a 20-MHz CPU, 1 megabyte of RAM, a 1.2-megabyte 5¼-inch floppy disk drive, and a VGA card. The entry-level model also includes a VGA monochrome monitor and a 28-millisecond 40-megabyte hard disk drive for $4099. My review unit included 2 megabytes of RAM, a 20-MHz 80387 coprocessor, a 1.44-megabyte 3½-inch floppy disk drive, a 90-megabyte enhanced-small-device-interface (ESDI) hard disk drive, and a high-resolution VGA color monitor. This brought the grand total for my system to $7000.

Performance Credentials

A Chips & Technologies 20-MHz 80386 chip set underlies the System 310's basic design. These components, integrated with a concurrent bus architecture and high-speed cache and main memory, form the framework of the Dell System 310. You can set the 20-MHz 80386 CPU to switch to 8 or 4.77 MHz when you press the Control, Alt, and backslash keys. The system's expansion bus runs independently of the CPU's clock speed at a consistent 8 MHz. The motherboard also has one 32-bit memory slot, six 16-bit AT slots, two 8-bit PC slots, and a socket for a 20-MHz 80387 math coprocessor.

Memory access has been optimized in two ways. The system's concurrent bus architecture allows the system bus to be effectively decoupled from the processor bus. The CPU can then execute instructions while the system bus is running direct memory access (DMA) cycles, thereby speeding up operations such as disk and memory data transfers. The System 310 also incorporates an Intel 82385 cache memory controller and 32K bytes of high-speed, 35-nanosecond static RAM (SRAM), like the Compaq Deskpro 386/20, the ALR FlexCache 20386, and other high-performance 80386 machines.

The main purpose of the cache is to provide a fast access buffer of SRAM between the processor and the slower, normal dynamic RAM that makes up the computer's main memory. The cache

continued

Dell System 310

Company
Dell Computer Corp.
9505 Arboretum Blvd.
Austin, TX 78759
(800) 426-5150

Components
Processor: 20-MHz 32-bit Intel 80386 with zero wait states, switchable to 8 or 4.77 MHz; socket for 20-MHz 80387 coprocessor
Memory: 1 megabyte of 80-ns RAM, expandable to 2 megabytes on system board (maximum system memory is 16 megabytes); Intel 82385 cache controller with 32K bytes of 35-ns SRAM; Phoenix 80386 ROM BIOS Plus, version 1.10 09
Mass storage: One 1.2-megabyte 5¼-inch floppy disk drive; 40-megabyte AT-type or 90-, 150-, or 322-megabyte ESDI hard disk drive
Display: Monochrome, EGA, VGA color, VGA Plus color, or VGA monochrome monitor
Keyboard: 101-key IBM Enhanced-style keyboard
I/O interfaces: Two RS-232C serial ports with DB-9 connectors; DB-25 parallel port; one 32-bit memory-expansion slot, six 16-bit slots, and two 8-bit slots

Size
6¼ x 21⅛ x 17½ inches; 45 pounds

Software
Microsoft MS-DOS 3.30 and custom utilities; Microsoft GWBASIC 3.22; Microsoft Windows/386

Options
1-megabyte SIMM upgrade: $899.95
Dell memory-expansion board with 2 megabytes: $1799.99
20-MHz 80387 math coprocessor: $799.95
40-megabyte internal tape backup unit: $399.95
1.44-megabyte 3½-inch floppy disk drive: $199.95

Documentation
167-page System 310 Owner's Manual; 77-page MS-DOS 3.30 Enhancement Guide; 475-page MS-DOS 3.30 User's Reference; 425-page Microsoft GWBASIC Interpreter User's Reference

Price
Base system (with one 1.2-megabyte 5¼-inch floppy disk drive, 40-megabyte hard disk drive, and VGA monochrome display): $4099
System with 322-megabyte ESDI hard disk drive and VGA Plus color display: $7699
System as reviewed: $7000

Inquiry 883.

controller holds what it thinks are the next 32K bytes of instructions and/or data the CPU needs and lets the CPU run with no wait states. The chip does more than simply control the high-speed SRAM cache, though. It also figures out when to load new data into the cache, and it determines which parts of RAM are mapped directly to the video display and shouldn't be put into the cache.

I don't want to give the impression that the System 310's main memory is slow; it's not. Dell uses 80-ns RAM chips on the motherboard, which has eight connectors for special single in-line memory modules (SIMMs) that each hold 256K bytes of RAM. (The system comes with 1 megabyte of RAM that takes up four of these slots.) You can also add memory to the system by mounting a Dell memory card fitted with 80-ns memory chips into a proprietary 32-bit expansion bus. Finally, you can use standard AT-type memory cards in the 16-bit expansion slots. If you decide to add RAM to the system by using the Dell bus, however, you won't have enough room to add a full-length expansion card in the 8-bit slot at the left-hand edge of the computer. The maximum configuration for system memory is 16 megabytes.

To make the most of the increased memory-access performance that the system's interleaved memory provides, you have to install an additional 1 megabyte of RAM on the system board. Also, if you install a proprietary 32-bit memory-expansion card, you must add another megabyte to the standard 1 megabyte to achieve the full benefits of interleaved memory. After adding 4 megabytes of RAM to the motherboard and the 32-bit bus, you can install an additional 12 megabytes of RAM by using Lotus/Intel/Microsoft Expanded Memory Specification memory cards in the 16-bit AT-compatible expansion slots.

You also have the option of copying the system BIOS from ROM to a special write-protected area of RAM located above the 640K-byte partition. The BIOS ROM and RAM have identical memory addresses. A similar option for the BIOS of an EGA or VGA speeds system and video display performance. You can make these options part of the system's setup program so that they take effect when you boot the system. This feature may be incompatible with future releases of DOS or OS/2, however, so Dell made it an option in the setup program.

Speaking of Speed

There's only one way to describe the performance of a microcomputer like the System 310: It flies. The machine has all the hardware and design potential to make it as fast as or faster than any other 20-MHz 80386 system that BYTE has tested. The Dell machine has a slight edge over the Compaq 386/20 in that it uses 80-ns RAM for its interleaved memory while the Compaq uses 100-ns chips, and the Dell can store the instructions from its operating-system BIOS and video ROM chips in RAM for faster access.

The System 310 outperforms the IBM PS/2 Model 80 in all BYTE's benchmarks. It enjoys a slight advantage over the Compaq 386/20 in most of the tests and is in a dead heat with the ALR FlexCache 20386. The comparative benchmark tests show little difference between these three computers in terms of overall performance, so other factors such as price, service, or expandability may be the distinguishing factors.

Sometimes increased performance comes at the expense of software incompatibility. However, I had no trouble running WordPerfect 4.2 and 5.0; BRIEF 2.1; Turbo C 1.5; Quattro 1.0; Dan BricKLin's Demo II 1.0; and Microsoft C 5.1. The system also ran through the application benchmark suite without a hitch.

While my review machine had an 8-bit VGA board, Dell says that the System 310 will be shipping with 16-bit boards by the time you read this. This is likely to change the video- and graphics-oriented benchmarks.

Expansion Options

Physically, the System 310 closely resembles other large MS-DOS microcomputers. It has a 200-watt power supply, and the front right corner has room for three half-height drives. Only the top two spaces are suitable for floppy disk drives or a tape backup unit, though; the bottom space is suitable only for a hard disk drive because the front case covers most of it. My system's Mitsubishi 1.2-megabyte 5¼-inch floppy disk drive and Sony 1.44-megabyte 3½-inch floppy disk drive fit into the top two slots.

To the left of these slots is another storage bay that can accommodate either two half-height hard disk drives or a single full-height hard disk drive. The front case completely covers these slots. The review system's Control Data Corp. half-height 90-megabyte ESDI hard disk drive was mounted in the bottom of this storage bay.

The system includes eight expansion slots. Six of them use the 16-bit IBM PC

continued

Dell System 310

APPLICATION-LEVEL PERFORMANCE

Dell System 310 **18.2***

WORD PROCESSING

XyWrite III + 3.52	Medium	Large
Load (large)	N/A	10
Word count	02	16
Search/replace	04	.18
End of document	01	10
Block moves	.08	.08
Spelling check	:07	47

Microsoft Word 4.0	
Forward delete	:10
Aldus PageMaker 1.0a	
Load document	:07
Change/Bold	19
Align right	15
Cut 10 pages	13
Place graphic	.04
Print to file	1.31
Index:	**3.45**

SPREADSHEET

Lotus 1-2-3 2.01	
Block copy	:02
Recalc	01
Load Monte Carlo	·09
Recalc Monte Carlo	:04
Load rlarge3	:02
Recalc rlarge3	·01
Recalc Goal-seek	.02
Microsoft Excel 2.0	
Fill right	·04
Undo fill	1·28
Recalc	·02
Load rlarge3	:17
Recalc rlarge3	:01
Index:	**3.56**

DATABASE

dBASE III + 1.1	
Copy	:49
Index	.05
List	1:03
Append	1:32
Delete	·01
Pack	1 18
Count	:03
Sort	51
Index:	**2.84**

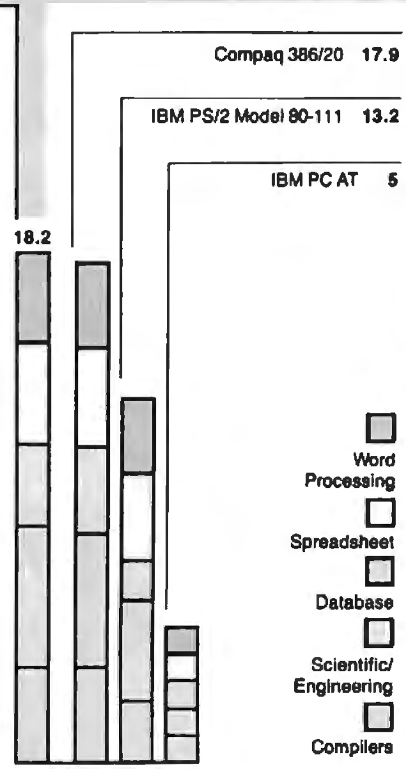
SCIENTIFIC/ENGINEERING

AutoCAD 2.52	
Load SoftWest	34
Regen SoftWest	.27
Load StPauls	:07
Regen StPauls	:05
Hide/redraw	8.37
STATA 1.5	
Graphics	16
ANOVA	·10
MathCAD 2.0	
IFS 800 pts.	11
FFT/IFFT 1024 pts	:11
Index:	**4.98**

COMPILERS

Microsoft C 5.0	
XLisp compile	3·04
Turbo Pascal 4.0	
Pascal S compile	:03
Index:	**3.41**

All times are in minutes seconds. Indexes show relative performance, for all indexes, an 8-MHz IBM PC AT=1



*Cumulative applications index. Graphs are based on indexes at left and show relative performance.

LOW-LEVEL PERFORMANCE[1]

Dell System 310

CPU

Matrix	3.30
String Move	
Byte-wide	21.48
Word-wide	
Odd-bnd.	29.10
Even-bnd.	10.75
Doubleword-wide	
Odd-bnd	21 03
Even-bnd	5.38
Sieve	17 78
Sort	13.34
Index:	**3.91**

FLOATING POINT

Math	6.08
Error[2]	0.00E+00
Sine(x)	2.01
Error	2.00E–09
e^x	2 23
Error	1.00E–09
Index:	**8.38**

DISK I/O

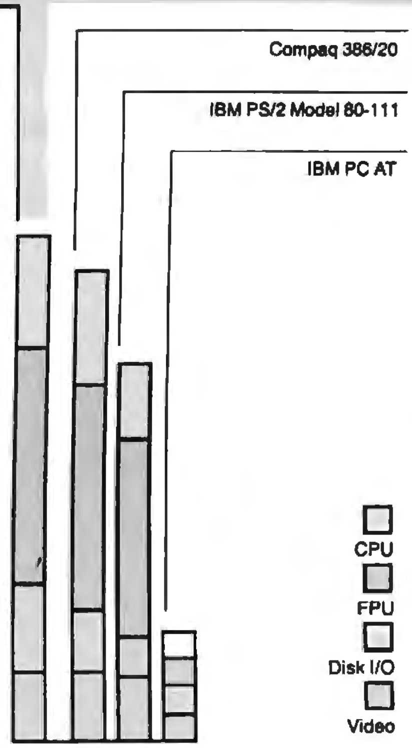
Hard Seek[3]	
Outer track	3 33
Inner track	3.33
Half platter	6 67
Full platter	9 96
Average	5.82
DOS Seek	
1-sector	7 42
32-sector	19 25
File I/O[4]	
Seek	0.09
Read	0 05
Write	0.80
1-megabyte	
Write	3.09
Read	2 94
Index:	**3.21**

VIDEO

Text	
Mode 0	3.92
Mode 1	3.90
Mode 2	3 77
Mode 3	3.75
Mode 7	N/A
Graphics	
CGA.	
Mode 4	1 46
Mode 5	1 49
Mode 6	1.54
EGA.	
Mode 13	3.42
Mode 14	3 68
Mode 15	N/A
Mode 16	3 68
VGA·	
Mode 18	3.81
Mode 19	1.50
Hercules	N/A
Index:	**2.45**

CONVENTIONAL BENCHMARKS

LINPACK	170.27
Livermore Loops[5] (MFLOPS)	0 16
Dhrystone (MS C 5 0) (Dhry/sec)	6596 00



N/A=Not supported by graphics adapter
[1] All times are in seconds. Figures were generated using the 8088/8086 and 80386 version (1.1) of Small-C
[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
[3] Times reported by the Hard Seek and DOS Seek are for multiple seek operations (number of seeks performed currently set to 100)
[4] Read and write times for the File I/O benchmarks are in seconds per 64K bytes
[5] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance

For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE

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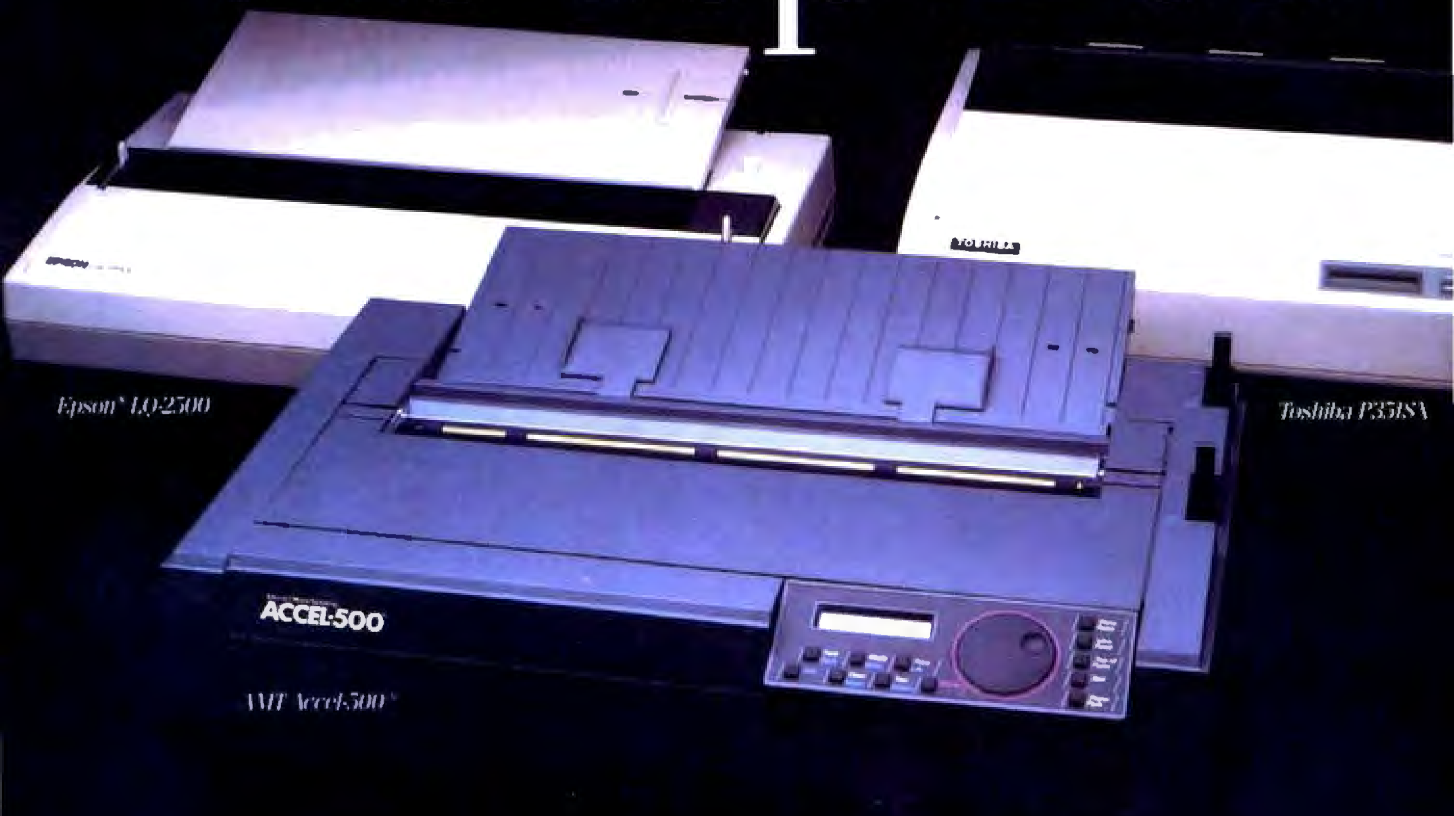

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AT-type bus, and the other two use the 8-bit IBM PC bus. The half-length VGA card on my machine occupied one 8-bit slot, and a Western Digital 1007 ESDI controller disk resided in one 16-bit slot. The latter uses a 1-to-1 interleave and has a data transfer rate of 651K bytes per second. It includes cabling for two floppy disk drives and two hard disk drives and has power supply connectors for four disk drives.

The System 310 has three standard display options: VGA monochrome, standard VGA, and VGA Plus. All use the same VGA card and differ only in the type of monitor included. Monochrome and EGA displays are also available.

Paradise makes the principal very-large-scale-integration chip on the VGA display adapter. My review unit came with a 14-inch Mitsubishi VGA Plus monitor, which has a 0.31-millimeter dot pitch. This adapter/monitor combination gives crisp color graphics at up to 640 by 480 pixels in 16 colors and provides high-quality text. By contrast, the standard VGA color monitor offers similar resolution, but at a dot pitch of 0.42 mm. The monochrome monitor displays 16 shades of gray at 640 by 480 pixels. Unlike IBM's PS/2 computers, the System 310's display chips are on expansion boards, not on the motherboard.

My one complaint about the Dell System 310's hardware is that it's noisy. The cooling fan was louder than that in any other system I've seen, and a high-pitched tone emanated from somewhere within the depths of the hardware.

My machine worked fine during my evaluation, but it failed to boot during testing in the BYTE Lab. Calls to Dell revealed that the machine had a defective ROM BIOS (version 1.10 08). Two new ROM chips (version 1.10 09) failed to solve the problem, however. Dell then sent a new motherboard with the new BIOS installed, and the System 310 worked fine. The company says that all machines it has shipped to customers have the newer BIOS chips.

Finishing Touches

In addition to MS-DOS 3.30, Dell includes 15 enhanced utility programs that make the operating system easier to manage.

The utilities are more useful and easier to use than a handful of similar public domain or even commercial software programs because of the uniformity in command-line argument syntax and the similarity of their help screens.

The System 310 includes Microsoft MS-DOS and GWBASIC manuals and an owner's manual that gives clear, liberally illustrated instructions on setting up the system. Dell also bundles Microsoft's Windows/386 software with the System 310.

Dell sells its computers by mail order only and has a toll-free number for technical assistance. The support technicians I spoke with were knowledgeable and responded to my questions quickly. As part of Dell's 1-year warranty, Honeywell Bull provides on-site service for customers who live within 100 miles of one of Honeywell's 180 customer-service dispatch offices, and you can extend the service contract for up to 4 years.

A Dollar Saved

Compared to the Compaq Deskpro 386/20 and the ALR FlexCache 20386, the System 310 is a better value. My review unit, at $7000, is about $6000 less than a comparably configured 386/20. Substitute a 150-megabyte ESDI hard disk drive and, at $7598, the System 310 is some $2000 less than a similarly equipped FlexCache.

The only drawbacks to the System 310 were its noisy fan and the limitations on its expansion bay configuration. You can access only two of the five expansion bays from the front of the case, so you can't install two floppy drives and an internal tape backup unit, for example.

Do you need the kind of performance this computer delivers? For many users, the answer will be no. A zero-wait-state 80286 machine with a 12- or 16-MHz CPU will give you most of the qualitative "feel" of speed and instant response that the System 310 gives when running applications such as a word processor or spreadsheet.

But others need to stay at the leading edge of hardware and software development. A high-performance 80386 is a necessity if you want to be able to move quickly into all the generations of OS/2 as they develop or to run Unix on a microcomputer that's powerful enough to let this operating system work as it should.

For such users, the System 310 has much to recommend it. It exhibits flawless high performance, its hardware design and components are among the best available, and it's priced right. For my money, the System 310 is the system to beat. ■

John Unger is a geophysicist for the U.S. government and lives in Hamilton, Virginia. He writes graphics software and uses computers to study the earth's crust. He can be reached on BIX as "junger."

The Odd Couple

The Amstrad PPC640 (left) and Epson Equity LT (right).

The Amstrad PPC640 and Epson Equity LT portables have little in common

Wayne Rash Jr.

There could hardly be a greater contrast between the Amstrad PPC640 and the Epson Equity LT. The PPC640 is so large that it will fit on no lap of which I'm aware, and it has dual floppy disk drives. The Equity LT, which will fit on a lap, has a floppy disk drive and a 20-megabyte hard disk drive.

The Equity LT is by far the more traditional of the two machines. It closely resembles other laptops, such as the NEC MultiSpeed HD (June BYTE). The Equity LT features a V30 CMOS processor running at 10 MHz and 640K bytes of RAM. My review unit of the Epson Equity LT had a 9⅝- by 4½-inch backlit, supertwist, liquid crystal display (LCD) screen with blue characters on a silver background. It also had an internal 20-megabyte hard disk drive and a 720K-byte 3½-inch floppy disk drive. The review unit also came with an internal 1200-bit-per-second modem. As outfitted, this machine costs $3767.

The Amstrad PPC640, designed in the U.K., is hardly traditional. It features an unusual case design. It has a full-width, IBM PC AT Enhanced-style keyboard and a 6⅝- by 4¾-inch supertwist LCD screen, and it runs on 10 C-cell batteries. The system has an 8086 CPU running at 8 MHz, 640K bytes of RAM, dual 720K-byte 3½-inch floppy disk drives, and an internal 2400-bps modem. This is a large machine, too wide and too long to fit on a lap—and even if it would fit, the keyboard is hinged in such a way as to make laptop use impossible. It is primarily designed as a portable for desktop use. This computer will run you $1199.

There are some similarities between the two machines, though. Both are compatible with the IBM PC XT. They both use 3½-inch floppy disk drives. Finally, they both let you use an external monitor so that you can avoid eyestrain in the office.

The Epson Equity LT

If you're planning to use a computer while traveling, the Equity LT's design makes it a good choice. With the backlit LCD screen and the hard disk drive, it's convenient to use on an airplane or in an office. The relatively light weight and slim profile make it easy to carry.

The Equity LT's screen swings up to reveal a modified version of the AT's Enhanced keyboard. The Caps Lock key is located next to the *A*, and the Control keys are on the lower corners of the keyboard. Across the top of the keyboard is a string of 10 function keys, rather than the 12 found on other versions of the Enhanced keyboard.

A full numeric keypad is just to the right of the alphabetic keys. Above that are a bank of LEDs and a tiny door that covers a group of switches. The LEDs monitor such things as battery condition

continued

Amstrad PPC640

Company
Amstrad, Inc.
1915 Westridge Dr.
Irving, TX 75038
(800) 237-3116
(214) 518-0668

Components
Processor: 8086 running at 8 MHz; socket for optional 8087-2 math coprocessor
Memory: 640K bytes of RAM
Mass storage: Two 720K-byte 3½-inch floppy disk drives
Display: CGA or monochrome on internal LCD or external monitor
Keyboard: 101-key full-size Enhanced-style layout
I/O interfaces: One parallel port; one serial port; RGB video connector
Other: 2400-bps Hayes-compatible modem

Size
19½ × 16½ × 4 inches (open); 12 pounds

Software
MS-DOS 3.3; SoftKlone Mirror II; PPC Organizer

Options
None

Documentation
354-page Amstrad Portable PPC; 29-page PPC Organizer Software

Price
PPC512 (with 512K bytes of RAM and one floppy disk drive): $899
PPC512 (with 512K bytes of RAM and two floppy disk drives): $999
PPC640 (with 640K bytes of RAM, two floppy disk drives, and a 2400-bps modem): $1199

Inquiry 884.

Epson Equity LT

Company
Epson America, Inc.
2780 Lomita Blvd.
Torrance, CA 90505
(800) 922-8911

Components
Processor: NEC V30 running at 4.77 or 10 MHz
Memory: 640K bytes of RAM
Mass storage: 720K-byte 3½-inch floppy disk drive; 20-megabyte 3½-inch hard disk drive
Display: CGA on internal backlit LCD or external monitor
Keyboard: 85-key modified Enhanced-style layout
I/O interfaces: One serial port; one parallel port (configurable as external floppy disk drive port); RGB video connector; proprietary expansion bus for modem card or memory expansion

Size
13½ × 12¼ × 3¼ inches; 14⅕ pounds

Software
MS-DOS 3.2; GWBASIC 3.2; Xtree disk management utility

Options
Supertwist LCD screen: $299
Backlit LCD screen: $499
1200-bps modem: $299
Carrying case: $49
Cigarette lighter adapter: $29

Documentation
140-page Equity LT User's Guide; 376-page Equity LT MS-DOS 3.20; 404-page Equity LT GWBASIC 3.20

Price
Equity LT with dual floppy disk drives: $1899
Equity LT with 20-megabyte hard disk drive and 720K-byte floppy disk drive: $2999
System as reviewed: $3767

Inquiry 885.

and the disk drive activity, as well as the current condition of Num Lock, Caps Lock, and Scroll Lock. The switches beneath the door control the appearance of the screen, the CPU clock speed, and whether the machine uses the built-in screen or an external monitor.

On the right side of the machine is the 720K-byte 3½-inch floppy disk drive. On the dual-floppy disk version, there is a companion drive on the left side; in my review unit, the hard disk drive resided on the left side. In the rear are connectors for a serial port and a parallel port, a CGA monitor, and a power connector. There are also a power switch and a series of DIP switches that select the assignment of the parallel and serial ports. One switch allows the parallel port to double as a connector for an external floppy disk drive. If you choose that option, however, you lose the ability to use a parallel printer.

The carrying handle slides out from beneath the front edge of the keyboard. This is a handy location for carrying the computer, but it results in a ridge directly in front of the space bar on the keyboard. This ridge interfered with my typing.

The Equity LT can use a reflective or backlit LCD screen. You can remove the LCD screen and set it aside, which makes using an external monitor easier. If you have an external monitor, you could use this machine as your only computer.

Epson includes a reference disk that makes the Equity LT more convenient to set up and also provides sophisticated diagnostics should something go wrong. For daily use, Epson has provided the convenient Xtree disk management utility. Xtree supports several of the more common MS-DOS functions through a menu system. The Equity user's guide is well organized and illustrated.

Power User

The Equity LT can run on AC or internal battery power. The AC adapter recharges the batteries when the computer is off. A complete recharge of the batteries, which are composed of eight nickel-cadmium cells, takes 12 hours.

Epson designed the screen so that the backlighting will turn off after a user-selected period of minutes to help save battery power. In addition, you can turn the internal modem and hard disk drive on and off as required. Since modems and hard disk drives are heavy users of power, keeping them turned off can do a lot to extend battery life.

In spite of all this, the batteries, when fully charged, can run the machine only for slightly less than 2 hours, and the low-battery light begins flashing after 1½ hours. These times are based on my use of the computer with very little hard disk activity and with the screen backlighting turned off about 80 percent of the time.

Amstrad's PPC640

The PPC640 seems an eccentric machine in some ways. Its most noticeable characteristic is its layout. It does not look like any other computer in the marketplace. In large part, this is due to the full-size Enhanced keyboard that graces the machine. It is also partly due to the small screen located on the left side of the machine's top surface.

The PPC640 makes a strong impression from the first time you open the case and look at it. It's wide. Counting the comfortable plastic handle on the right side, it's 19½ inches wide, as compared to the Equity LT's 13½-inch width.

The keyboard folds out from the top toward you. This is a full-size 101-key, AT Enhanced-style keyboard, with

continued

Amstrad PPC640, Epson Equity LT

APPLICATION-LEVEL PERFORMANCE

WORD PROCESSING	Amstrad	Epson
XyWrite III + 3.52	**Med./Lrg.**	**Med./Lrg.**
Load (large)	.27	24
Word count	:10/:74	:08/.57
Search/replace	:18/:58	.14/:45
End of document	:05/:33	:04/:24
Block moves	:31/:30	:20/:19
Spelling check	:43/4:39	:26/3:12
Microsoft Word 4.0		
Forward delete	1:23	.56
Aldus PageMaker 1.0a*		
Load document	N/A	25
Change/Bold	N/A	.76
Align right	N/A	59
Cut 10 pages	N/A	·50
Place graphic	N/A	.13
Print to file	N/A	5:35
Index:	**N/A**	**1.02**

SPREADSHEET	Amstrad	Epson
Lotus 1-2-3 2.01		
Block copy	:23	10
Recalc	·06	:04
Load Monte Carlo	2·55	:51
Recalc Monte Carlo	26	20
Load rlarge3	·42	12
Recalc rlarge3	·04	:03
Recalc Goal-seek	·12	10
Microsoft Excel 2.0*		
Fill right	N/A	14
Undo fill	N/A	6:28
Recalc	N/A	.05
Load rlarge3	N/A	1 12
Recalc rlarge3	N/A	.05
Index:	**N/A**	**0.86**

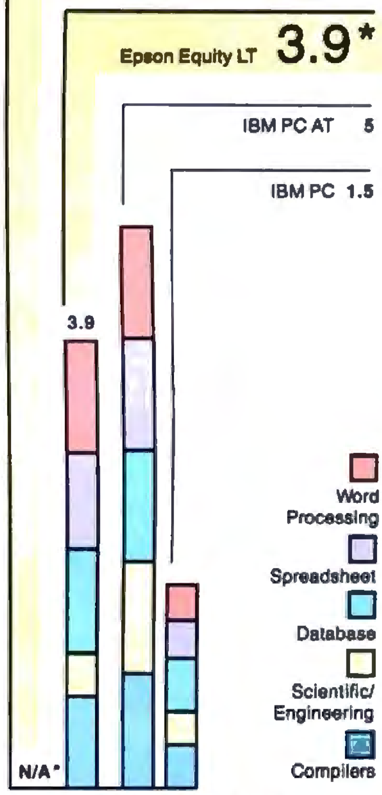
DATABASE	Amstrad	Epson
dBASE III + 1.1*		
Copy	N/A	2:49
Index	N/A	.29
List	N/A	:28
Append	N/A	5:02
Delete	N/A	·05
Pack	N/A	3:12
Count	N/A	.24
Sort	N/A	2:31
Index:	**N/A**	**0.92**

SCIENTIFIC/ENGINEERING	Amstrad	Epson
AutoCAD 2.52*		
Load SoftWest	N/A	6.56
Regen SoftWest	N/A	6:40
Load StPauls	N/A	1:55
Regen StPauls	N/A	1·47
Hide/redraw	N/A	1.26:25
STATA 1.5		
Graphics	3·31	2 41
ANOVA	2.23	1.53
MathCAD 2.0		
IFS 800 pts.	4:32	3·34
FFT/IFFT 1024 pts.	5.31	4 13
Index:	**N/A**	**0.34**

COMPILERS	Amstrad	Epson
Microsoft C 5.0*		
XLisp compile	N/A	12:5
Turbo Pascal 4.0		
Pascal S compile	·43	:14
Index:	**N/A**	**0.81**

All times are in hours:minutes seconds Indexes show relative performance, for all indexes, an 8-MHz IBM PC AT = 1

*Not run on the Amstrad PPC640 The PPC640 is limited to 720K-byte floppy disks and could not run tests where the program and files exceeded 720K bytes We were unable to compute an application index for the Amstrad PPC640



*Cumulative applications index. Graphs are based on indexes at left and show relative performance

LOW-LEVEL PERFORMANCE[1]

CPU	Amstrad	Epson
Matrix	20.16	15.76
String Move		
Byte-wide	113.37	87 17
Word-wide:		
Odd-bnd	113 37	87 16
Even-bnd.	56.74	43.61
Sieve	109.41	84.25
Sort	86.61	67 23
Index:	**0.72**	**0.93**

FLOATING-POINT[2]	Amstrad	Epson
Math	N/A	N/A
Error	N/A	N/A
Sine(x)	N/A	N/A
Error	N/A	N/A
e^x	N/A	N/A
Error	N/A	N/A
Index:	**N/A**	**N/A**

DISK I/O	Amstrad	Epson
Hard Seek		
Outer track	N/A	9.20
Inner track	N/A	9.24
Half platter	N/A	23.05
Full platter	N/A	27.65
Average	N/A	17.28
DOS Seek[3,4]		
1-sector	77.55	39.18
32-sector	432.14	107.46
File I/O[5]		
Seek	0.59	0.41
Read	13.22	2.12
Write	12.92	2.08
1-megabyte		
Write	N/A	N/A
Read	N/A	N/A
Index:	**N/A**	**0.57**

VIDEO	Amstrad	Epson
Text		
Mode 0	18.18	13.79
Mode 1	18.18	13.81
Mode 2	15 71	14.96
Mode 3	15.71	14.96
Mode 7	N/A	N/A
Graphics		
CGA.		
Mode 4	7.76	6.08
Mode 5	7 80	6 08
Mode 6	8.13	6.36
EGA.		
Mode 13	N/A	N/A
Mode 14	N/A	N/A
Mode 16	N/A	N/A
Index:	**0.66**	**0.62**

CONVENTIONAL BENCHMARKS	Amstrad	Epson
LINPACK	9307 62	7189 36
Livermore Loops[6] (MFLOPS)	2.30E-03	3.00E-03
Dhrystone (MS C 5.0) (Dhry/sec)	1103 00	1438.00

[1] All times are in seconds All figures were generated using the 8088/8086 version (1 1) of Small-C (16-bit integers).

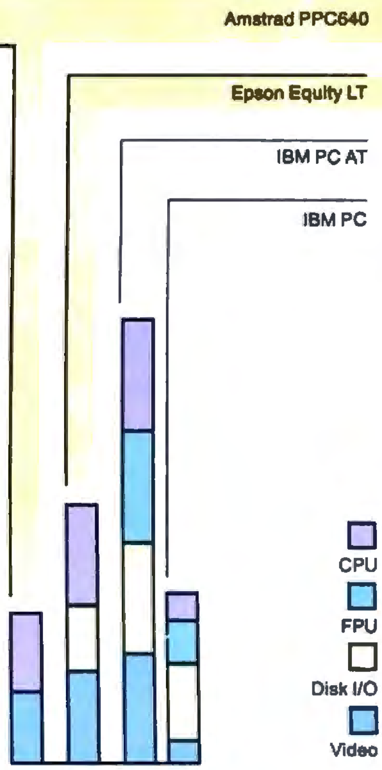
[2] Floating-Point benchmarks were not performed because the Epson Equity LT and Amstrad PPC640 did not have a math coprocessor chip.

[3] The Amstrad PPC640 did not have a hard disk drive, all times are for floppy disk drives

[4] DOS Seek times for the Epson Equity LT 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 64K bytes.

[6] For the Livermore Loops and Dhrystone tests only, higher numbers mean faster performance Tests were performed in emulation mode



For a full description of all the benchmarks, see "Introducing the New BYTE Benchmarks," June BYTE

Not Really a Laptop

In addition to the other laptops in this review, I also looked at the Laser Compact XT (available from Video Technology Computers, Inc., 550 East Main St., Lake Zurich, IL 60047, (312) 540-8086).

The Laser Compact XT is a dual-speed (4.77- and 10-MHz) IBM PC XT clone with no expansion slots and meager documentation. This minimalist computer is sold for a minimal price—$599 for the base model with 512K bytes of RAM, and $699 for the 640K-byte model.

The idea behind the Laser Compact XT appears to be to provide a full-featured clone for as small a price as possible. In this its designer seems to have succeeded.

This machine is about the size of a laptop computer that contains its single 360K-byte 5¼-inch floppy disk drive on the right side of the machine. It is equipped with 1.6 megabytes of memory, CGA and Hercules graphics, a parallel port, a serial port, a joystick or mouse port, and an external disk drive connector for the optional external 360K-byte floppy disk drive. It comes with RAM disk software, so the lack of a second floppy disk drive is not a big problem. Finally, it weighs less than 12 pounds and has a handle that folds out

from underneath so you can carry it around.

Using the Laser Compact XT

Getting the Laser Compact XT set up is a chore. The documentation is both slim and vague. When I tried to set the video board to handle a CGA monitor, I found the documentation so confusing that I had to call the manufacturer's technical hot line to get the proper instructions.

Once I got the Laser Compact XT set up, it performed adequately. It supported CGA when I had the switches set properly, although the character set was smeared and hard to read. The machine was shipped with MS-DOS 3.21 and GWBASIC. Unfortunately, the RAM disk drivers were shipped on a boot disk with MS-DOS 3.20; I had to jockey the disks around until I could get the newer version of DOS onto the memory driver boot disk. This could be a problem for a new user.

There seemed to be no problem with compatibility for the software I tried, which included WordStar 4.0, Lotus 1-2-3 version 2.01, and some games, such as Tetris. There were no problems with copy protection at high speed when I used Lotus 1-2-3.

The keyboard occasionally doubled characters, and it was hard to use unless the rear of the machine was propped up on its carrying handle. Once oriented like this, the keyboard was farther off the tabletop than is the case with a detached keyboard on an IBM clone.

The Occasional Computer

This is a machine for people who sometimes want to work at home or who sometimes need an IBM compatible. It is quite portable, although you will need a monitor where you are going—unless you plan to carry that, too.

The Laser Compact XT is not dependable enough to be a primary computer. It does what it advertises, but you can't add expansion cards. If one floppy disk drive and a RAM drive are what you need, then this might make an acceptable secondary machine.

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every key faithfully placed in its proper location.

The main section of the computer has a small screen on the left side. The screen will tilt to any position, from perfectly flat to nearly upright, so you can adjust the angle for better viewing. Adjusting the angle is important, because the Amstrad PPC640 uses a reflective LCD screen. The supertwist LCD screen is reasonably clear, but it's much harder to see than a backlit display. This machine needs either an external monitor or good room lighting.

Beneath the display are cooling vents; for them to work properly, the display needs to be tilted upward. The PPC640 stopped running twice during the course of this review, and each time it started again after I raised the screen and allowed the machine to cool. The area beneath the screen gets warm, but not hot, during long periods of operation.

Next to the screen is a small cubbyhole that can hold a telephone cord for the built-in 2400-bps modem. Below that are controls for screen contrast and speaker volume, and a series of LEDs that show disk drive activity, whether the CRT is enabled, and whether the power is on. Below the LEDs is a switch that controls the power source.

Power in the Amstrad PPC640 comes from 10 C-cell alkaline batteries or from an AC adapter. The user's manual advises against using rechargeable batteries. Amstrad also provides a 12-volt car adapter that you can plug into your cigarette lighter. The C-cell batteries lasted about 3 hours before the battery alarm sounded; during that time, the PPC640 ran the BYTE benchmarks twice.

On the right side of the PPC640 is a square plastic handle that protrudes from the carrying case so you can carry the computer securely. Next to the handle is a pair of 720K-byte 3½-inch floppy disk drives. An internal hard disk drive is not available. On the rear of the machine is a door that swings open to reveal a serial port, a parallel port, a DIN connector for power, a coaxial DC power connector, an RGB monitor connector, and a pair of RJ-11 connectors for the modem.

Hands on the PPC640

Once you get past the size, you'll find that Amstrad has added some software that makes the PPC640 easy to use. An integrated package called the PPC Organizer includes text retrieval, an appointment book, a card file, a word processor, and a calculator. It's a convenient package, and it supports a color monitor if you have one attached. Mirror II, a communications package, is also bundled with the system.

The PPC640 is extremely quiet. Since it does not have a hard disk drive, there's none of the whirring and whining that goes with one. The floppy disk drives are quiet and trouble-free.

Since the PPC640 has a full-size keyboard, it was easier to get used to than any other laptop I've reviewed. The keyboard is just like those on larger machines. If you do a lot of word process-

continued

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ing, this keyboard will fit right in.

The PPC640's documentation was adequate. The user's manual contained instructions for not only the computer but also MS-DOS and the Mirror II communications software.

Spotty Benchmarks

The BYTE Lab couldn't run the full suite of system benchmarks on these machines. The PPC640 lacked a hard disk drive, so running some software, such as Aldus PageMaker and dBASE III Plus, was impossible. Neither machine had a math coprocessor chip, thus eliminating the FPU tests.

In the tests that the BYTE Lab could run, both laptops were adequate in benchmark performance. Even though both used 8086-level technology, they performed well when compared to the IBM PC XT; in many tests, both of them ran two to three times faster than the XT. Even when compared to the 80286-based AT, they put in a respectable showing.

The Equity LT consistently performed at 80 percent to 90 percent of the speed of the AT. In one test—the word-processing application benchmark—the Equity LT actually beat the AT by a small margin. Overall, this machine shows exceptional speed. There is one area, the Scientific and Engineering tests, where the processor's limitations (and lack of a math coprocessor) show up; I think it's unlikely, however, that this machine would be purchased for a heavy user of AutoCAD.

The PPC640 was also reasonably fast, especially for an 8086-based machine costing under $1200 and running on flashlight batteries. It turned out a respectable half to two-thirds of the speed of the AT. Since this machine is designed to be a clone of the old XT, its benchmark performance was certainly adequate. The PPC640 could not run all the application benchmarks, but those it could handle indicate that it maintains its speed relative to the AT.

Interestingly, in sorting operations, the PPC640 was virtually as fast as the AT; this is probably due to the 16-bit data path the 8086 shares with the 80286.

Stick with Others

The Epson Equity LT is similar in style and price to portable computers available from other manufacturers, such as NEC or Toshiba. But the NEC MultiSpeed HD's keyboard is slightly easier to use, and the Equity LT's carrying handle causes an awkward ridge in front of the keyboard, making typing difficult. The Equity LT is basically a sound machine at a reasonable price, but in terms of overall convenience, I still prefer the NEC or Toshiba computers.

The Amstrad PPC640 is unique. It has no hard disk drive and no backlit display, but it has the best keyboard available on a portable. This makes typing easy, but it reduces the machine's portability. The PPC640 is similar in price to other machines, such as the Toshiba T1000, but it has dual floppy disk drives.

Neither machine, though, succeeds in breaking new ground. If I were buying a laptop portable, I would stick with the NEC MultiSpeed HD, Toshiba T1000, or Zenith SupersPort. ■

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Bringing the Outside World

Five low-cost scanners for capturing images or text

Laurence H. Loeb

Without a doubt, the Macintosh's built-in graphics capability gives it uses that its designers never thought of. Desktop publishing is a good example of this: It requires a machine that can freely mix graphics and text, organize them, and then display them consistently—something that the Mac does very well. This ability to freely use graphical information to illustrate or amplify text has spawned many a newsletter that might have never been produced otherwise.

However, these capabilities don't solve a fundamental problem for many people who wish to use them. Simply put, not everyone can draw the images they want.

This is where the scanner as graphics tool comes into the picture. A scanner is a piece of hardware that copies an image and converts it to an electronically usable form, either as an image in the Mac's RAM or as a file on disk. Once you get an image from, say, a book or magazine or snapshot into the Mac, you can then manipulate it with any of an army of Mac applications. You can import the image to an application either via the Clipboard or by opening the file.

Another use of scanners is in optical character recognition (OCR). With the right application, the Mac can analyze an image to recognize the presence of characters. This allows rapid data entry from paper documents and eliminates typing it in by hand, which is time-consuming and error-prone.

I took a look at five scanners designed for use with the Macintosh: ThunderWare's ThunderScan ($249), Mirror Technology's VisionScan ($695), Microtek Lab's MSF-300C scanner ($1795 with small-computer-system-interface connector and cable), Datacopy's Model 730 ($2495 with SCSI connector kit), and New Image Technology's MacScan ($1995). I chose a price ceiling of about $2500. This range by no means covers the entire Mac scanner market, but it should give a good picture of what's available at the low end and what the price/performance trade-offs are.

The least expensive scanners (ThunderScan and VisionScan) use the Mac serial port to convey data. The most costly scanners (the MSF-300C, Model 730, and MacScan) are flatbed devices that resemble small photocopiers and use the SCSI port to communicate with the Mac. The SCSI port allows faster data transfer rates between the Mac and the scanner than you get through the serial ports. All scanners except the VisionScan can save gray-scale information with an image.

To obtain some realistic, quantitative results, I scanned the same image with each scanner. The image was BYTE's standard test sheet (see figure 1). All scanned files were saved as bit maps—that is, with no gray-scale information. All that can be shown on a Mac display (except for that of the Mac II) is bit-map information, so the scans all looked the same on-screen. For consistent results when saving the image to disk, I saved all the scans as 1-bit-per-pixel Tag Image File Format (TIFF) files. I used a Mac Plus with 2.5 megabytes of RAM using MultiFinder 6.0 with System 6.0.

Using What You've Got: ThunderScan

The ThunderScan uses your Imagewriter printer as the scanning mechanism (see photo 1); it replaces the ribbon assembly on the Imagewriter with an infrared scanning device. Software on the Mac controls the Imagewriter, using its carriage to advance the paper with the image on it up past the print head and moving the print head with the attached scanning device back and forth across the image. It scans by measuring the infrared reflection point-by-point as the scanning device moves across the paper.

The ThunderScan system is an ingenious way to use all the hardware of a typical Mac system to get scanning capability, since Mac users usually have a printer. But what if you have a LaserWriter? Sorry, you're out of luck. What if you've got a book, rather than a photo or magazine page? If it can't fit into the Imagewriter carriage, again you're out of luck.

The scanning device feeds data to the control software via either serial port. ThunderScan draws 5 volts from the Mac for its power. In its original design, it obtained this power from the DB-9 serial ports on 128K-byte and 512K-byte Macs. But on the Mac Plus and SE, the DB-9 connectors have been replaced with mini DIN-8 connectors, and a 5-V source is not available. ThunderWare built a special PowerPort adapter, supplied with the scanner, that makes these machines electrically and cable-compatible to the original design.

The PowerPort adapter fits over the external floppy disk drive connector and draws the 5 V from it. A duplicate connector lets you attach an external drive to your Mac. The adapter also has a DIN-8 connector for the Mac's printer port, and these signals are provided on a DB-9 connector to the scanning device. Mac II users have to obtain a special PowerPort adapter since it doesn't have an external floppy disk drive connector.

Setup is amazingly simple. You remove the printer ribbon from your Imagewriter or Imagewriter II printer and clip the scanning device into its place. Then you attach the PowerPort adapter to the external floppy disk drive connector. Next, you attach the scanning

into a Macintosh

VisionScan

device's cable to the provided junction box, and the Imagewriter's printer cable to another connector on this box. Then you hook the junction box to the PowerPort connector. Finally, you copy the software to your start-up disk. Although this operation sounds involved, in just under 10 minutes I was ready to do my first scan.

The ThunderScan 4.0 software lets you select a specific area of the page to be scanned. You cannot directly set the dots per inch of the scan, but you can set magnifications from the standard 75-dpi scan (from 50 percent to 300 percent) to change the resolution. The software checks the amount of memory required for the scan before it takes place; if not enough memory is present, the ThunderScan application will not allow the scan to proceed. This application also includes an editor that allows a FatBits level of picture editing and the use of the MacPaint-like lasso, select, pencil, eraser, and scrolling hand tools.

The scanner can store 32 levels of gray-scale information for the image in memory. You can also edit the gray scales of the scanned image with a gray-level map editor and then save it to disk. You can save an image as a bit-mapped MacPaint document (up to a maximum of 32K bytes in size) or as a MacDraw PICT file; you can save the image's gray-scale information as a ThunderScan file, an Encapsulated PostScript File (EPSF), or a TIFF file from within the ThunderScan application. TIFF files are saved in either a 1-bit "vanilla" format or a 4-bit compressed format. Due to the wide latitude that the TIFF specification allows in its implementation, ThunderScan TIFF files might not be compatible with certain applications, such as Zedcor DeskPaint. However, PageMaker and Quark XPress accept the TIFF format.

Because of the nature of its scanning mechanism, the ThunderScan takes the longest of the devices tested to do a scan (see table 1). However, if you can spare the time, ThunderScan gets you into the game inexpensively.

No Moving Parts: VisionScan

The next step up the scanning ladder is the VisionScan from Mirror Technology. The VisionScan unit is a Chinon flatbed scanner with no moving parts except for an internal mirror in the head (see photo above). It has a maximum resolution of 200 dpi. You place the image to be scanned on a flat base underneath an arm that extends up and over the base holding the image. The bottom of this overhead arm is clear, and it contains the charge-coupled device and optics that do the scanning. The image is illuminated by room light—the scanner adjusts for ambient level when you power it on. Depending on how a room is lit, the arm may cast a shadow on the document; it will show up as a darkening of the scanned image in the shadowed area. This happened to me during testing, and I found that supplemental fill lighting from a small high-intensity lamp is necessary for best results.

Like the ThunderScan, the flatbed scanner's data goes to either of the Mac's serial ports. An adapter cable provides the connection between the VisionScan's DB-25 serial port and the Mac's DIN-8 port. A Centronics-style parallel port is present on the scanner, but, at least with the setup I had, there's no software or cabling to make use of it. An external power supply plugs into a wall outlet, similar to the power supplies found on some calculators and modems.

You can set up this scanner pretty quickly. Place the scanner on a flat surface, and connect it to the Mac using the adapter cable. Next, connect the power cord to the scanner, and then plug the power supply into a wall outlet. Check the position of several DIP switches on the scanner, then turn the scanner on. Copy and install the software onto your start-up disk, and you're done.

You control scanning with either the VisionScan 1.0 application program or a supplied VisionScan desk accessory 1.0. Scans can be made at 100-, 120-, 150-, and 200-dpi resolutions. You can't edit the image from within either of these programs. Zedcor's DeskPaint DA 1.05, supplied with the VisionScan, is a full-featured editor that provides the necessary functions.

This scanner has three methods of determining what portion of the image is to

continued

	ThunderScan	VisionScan	MSF-300C
Type	Imagewriter scanner	Flatbed scanner	SCSI flatbed scanner
Company	ThunderWare 21 Orinda Way Orinda, CA 94563 (415) 254-6581	Mirror Technology 2644 Patton Rd. Roseville, MN 55113 (612) 633-3255	Microtek Lab, Inc. 16901 South Western Ave. Gardenia, CA 90247 (800) 654-4160 (213) 321-2121
Features	300-dpi scanning cartridge with detachable adapter box; ThunderScan 4.0 software; user's guide; all necessary cabling; external drive PowerPort connector for use in connecting to Macintosh Plus or SE	200-dpi Chinon scanner; 15-V external power supply; VisionScan 1.0 software; user's guide; Zedcor's DeskPaint software; DB-25-to-Apple DIN-8 serial port connector	300-dpi MSF-300C scanner; interface box with 5-V power supply and tabletop mounting brackets; scanner-to-interface box connector; spare scanning lamp; VersaScan Plus 1.05 graphics software with user's guide; scanner-to-Apple DIN-8 connector for serial port use
Hardware Needed	Macintosh 512K, 512KE, Plus, SE, or II	Macintosh Plus, SE, or II	Macintosh 512KE, Plus, SE, or II; DB-25-to-50-pin SCSI converter cable (for Mac Plus, SE, or II)
Software Needed	System 3.2/Finder 5.3 or higher (System 4.2 or higher for Mac SE/II)	System 4.2/Finder 6.0 or higher	System 4.2/Finder 6.0 or higher
Options	Mac II power supply: $49	None	None
Price	$249	$695	$1595 Bundled with SCSI connector and cable: $1795
	Inquiry 893.	**Inquiry 894.**	**Inquiry 895.**

be scanned. As with most of the scanning software, you can specify the scan area with a click and drag of a rectangle outline over a template that represents the scanner bed. You can also scan the area of intersection determined by the position of adjustable horizontal and vertical sliders on the scanner base. This ends the need to measure an image to find where to set the scan, because you can specify it directly with the image itself. Or, you can place the provided small v-shaped markers on the image itself. These markers indicate to the scanner the top right and bottom left corners of the image area you wish scanned. This is much more intuitive than having to select an area from within a application on a Mac screen.

You can save images as MacPaint (again, only to a 32K-byte file limit), PICT, Compressed TIFF (unrecognized by DeskPaint), Uncompressed TIFF (recognized by DeskPaint), and Clipboard formats (to get around the 32K-byte MacPaint limit but not the Clipboard's 1024-pixel width limit).

Scans at all dpi ranges from 100 to 200 dpi took about the same time, and the scanner was easy to use. The scanner-control DA was a convenient and useful tool, and I could do most necessary touch-ups with the DeskPaint DA. The scanner was light enough to transport

◀ **Photo 1:** *The ThunderScan (left) uses an Imagewriter or Imagewriter II print head.*
Photo 2: *The Datacopy Model 730 and SCSI adapter unit.*

Model 730	MacScan
SCSI flatbed scanner	SCSI flatbed scanner
Datacopy Corp. 1215 Terra Bella Ave. Mountain View, CA 94043 (415) 965-7900	New Image Technology, Inc. 9701 Philadelphia Court Lanham, MD 20706 (301) 731-2000
300-dpi Model 730 flatbed scanner with AC power cord; installation and maintenance guide; SCSI unit needing no external power supply; scanner-to-SCSI unit connectors; MacImage 2.01 graphics software with user's guide	300-dpi Canon IX-12 scanner; AC power cord; SCSI unit with external 5-V power supply; scanner-to-interface unit cable; Mac SCSI port-to-interface unit cable; MacScan 1.38 software; instruction manual
Macintosh Plus, SE, or II; DB-25-to-50-pin SCSI converter cable	Macintosh Plus, SE, or II
System 4.2/Finder 6.0 or higher	System 4.2/Finder 6.0 or higher
MacImage Kit with SCSI connector: $695	Textscan OCR software: $395
$1800 Bundled with MacImage Kit: $2495	$1995
Inquiry 896.	**Inquiry 897.**

easily and was compact enough to fit well on my cluttered desk. The only potentially serious flaw I found was the need to provide supplemental lighting so the overhead arm would not cast a shadow.

It is harder to scan a book on this scanner than on the flatbed ones because there's no easy way to hold the book flat. The scan output may be distorted over the bowed surface. However, single flat sheets scan rather nicely.

Short a Cable: The MSF-300C

The first SCSI flatbed scanner I evaluated was the Microtek MSF-300C. It consists of the flatbed scanning unit itself, an interface unit, an adapter cable to connect the scanner to the interface unit, a brick-size power supply for the interface unit, and the VersaScan Plus 1.05 software for the Mac. [Editor's note: *As we went to press, Microtek introduced its MSF-300Q scanner, which can record 64 gray levels. It costs $2495.*]

The Microtek interface unit is a wide metal box that comes with support brackets used to mount it vertically on the desk next to the scanner. This unit sits electrically between the scanner and the Mac's SCSI port. The unit has a single DB-25 connector for the scanner cable, and two 50-pin SCSI connectors. The two SCSI connectors let you daisy chain other SCSI devices or use a SCSI terminator block to terminate the bus. A relatively thick DB-25-to-DB-25 cable connects the unit to the scanner. The scanner itself is a flat, bulky metal box with its own power cord and switch.

Right away, while hooking up the scanner, I ran into a problem: A needed cable was not supplied with the unit. This cable, made by Apple, converts a 50-pin standard SCSI socket to Apple's DB-25 SCSI connector. Unfortunately, the cable is not standard issue from Apple. You must order it, and Microtek assumes you already own one. You'll save yourself some embarrassment if you have this cable handy when the box comes.

The VersaScan Plus 1.05 application that comes with the scanner will be familiar to anyone who has used similar software with AST Research scanners. It combines paint-like tools for editing a scanned image and the control functions necessary to operate the scanner. A dialog box lets you set the scan's resolution (75, 100, 150, 180, 200, or 300 dpi) and the area of the image to be digitized. The dialog box also displays the amount of memory available for a scan. You can even bypass the SCSI port and communicate with the scanner at 9600, 19,200, or 57,600 bits per second through the Mac's serial port. This feature should be of use to 512KE Mac users whose machine lacks a SCSI port.

The time to scan an image was the same (14 seconds) regardless of the format I saved it in. (Available formats include the VersaScan native format,

Table 1: *The scanners compared. I scanned an 8- by 6-inch image at 150 dpi and noted the elapsed time. The image was saved as a 1-bit-per-pixel TIFF file. Times are in minutes:seconds.*

	Time	File size (K bytes)
ThunderScan	25:37	117
VisionScan	1:14	192
MSF-300C	0:14	501
Model 730	0:15	249
MacScan	0:12	122

MacPaint, TIFF, gray TIFF, PostScript, and gray PostScript). As long as you have sufficient RAM to store the image, you can edit it right away. I ran VersaScan under MultiFinder with other applications taking up available RAM to simulate out-of-memory conditions, and the error handling was graceful, without loss of work. The TIFF files the MSF-300C saved, though, were huge compared to those saved at the same dpi by the other scanners. I can find no reason for these excessive file sizes.

Slick Hardware, Mediocre Software: Datacopy Model 730

The Datacopy scanner package consists of a flatbed scanner (I looked at the Model 730), a small SCSI unit, an adapter cable to connect the interface unit to the scanner, and the MacImage 2.01 software. The Datacopy is the only SCSI scanner whose interface box did not require an external 5-V power supply; its installation was much neater, without excess cabling. The front panel of the scanner, with its scanner status lights, has a slick "instrument" look to it.

Setup is fairly quick and simple. However, I ran into the same problem I had with the Microtek scanner: a missing SCSI adapter cable. To be fair, Datacopy's SCSI adapter kit does include a DB-50-to-DB-50 SCSI cable that you can hook to an external SCSI hard disk with a second SCSI connector. However, if you own a Mac SE or Mac II with an internal hard disk, you need that Apple adapter cable.

The supplied MacImage 2.01 application, like the scanner, had some nice touches. The image setup dialog box uses pop-up menus for selecting scanning parameters. You can scan images at resolutions of 75, 100, 120, 150, 180, 200, 240, and 300 dpi and with 16 gray levels. The application has excellent control

continued

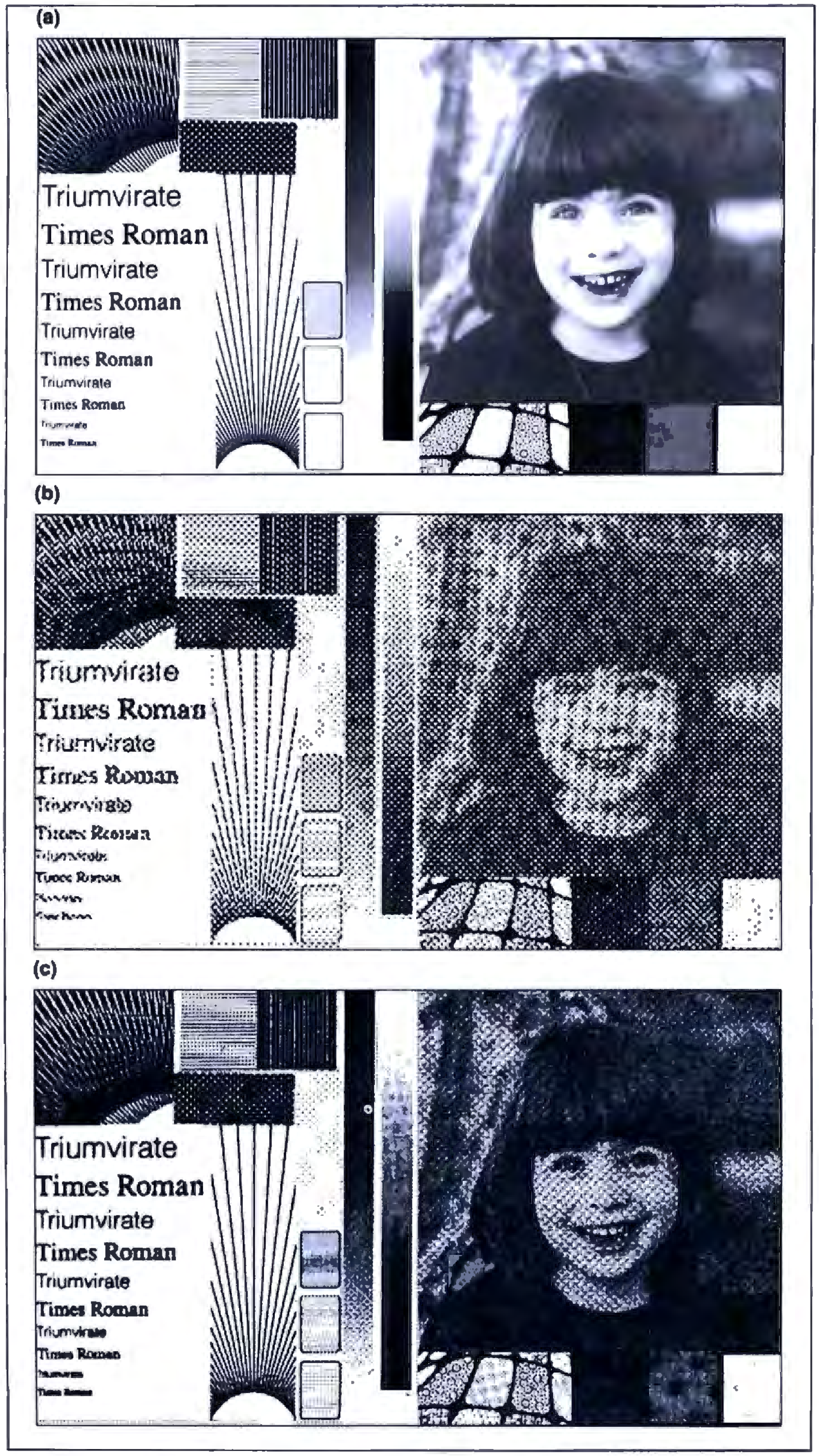

Figure 1: (a) *BYTE's test pattern for scanner quality.* **(b)** *The test pattern scanned at 150 dpi. The Microtek scanner was adjusted for halftone scanning to accommodate the halftone image. When the scanner was adjusted for line art, the lines and patterns looked considerably better, but the halftone's quality suffered.* **(c)** *The test pattern scanned at 300 dpi, halftone setting. Notice the improvement in the lines and patterns as well as in the halftone image. All images are actual size.*

functions, such as a halftone data editor that allows use of custom halftone patterns, and a gamma value editor that lets you use custom gray levels. A rich variety of useful formats is available for storing images, including scaled and clipped MacPaint, a proprietary Datacopy format (compressed and uncompressed), compressed and uncompressed TIFF, PICT, PostScript, EPSF, Raster Image File Format (used by Image Studio), and SuperPaint.

Another useful and unique feature of the software is the Auto-Configure command. This allows the system to find the correct SCSI address of the scanner, as well as confirm the hardware model used, since the MacImage application is designed to run with several models of Datacopy scanners. Highly useful for the novice, it eliminates the possibility of setting the SCSI address to the wrong value.

Still, the software needs to be revised. After completing a 300-dpi scan in 15 seconds, the MacImage program took almost 5 minutes to spool the 994K-byte uncompressed TIFF file to disk and return control to the user. Once the image was available on-screen, the only editing tool available was a FatBits pencil. Loading and converting files not saved in the Datacopy format also takes too long, compared to other programs doing the same thing. These waits, and the lack of a suitable image editor, mar an otherwise nicely done product.

No Complaint: MacScan

New Image Technology's MacScan uses the Canon IX-12 flatbed scanner, which is also sold as the Princeton Graphic Systems' LS-300F. The MacScan did not need any additional SCSI cables. The supplied ribbon cable connects the Mac's DB-25 SCSI port to the DB-25 SCSI connector on the scanner's interface unit. The cable also has an extra connector so that it can be connected as male-to-female or male-to-male. It is so handy for connecting Mac SCSI devices in general that I may forget to pack it back into the box when I return the unit. The interface unit requires an external power supply.

The supplied MacScan 1.21 software (the company says the version now being shipped is 1.38) did a good job of controlling and editing scans. You set the scan region by clicking and dragging on a template on the Mac's screen. Many MacPaint-like tools are available for editing, and the image is loaded into memory rather than spooled to disk. You can select, manipulate, print, and save subareas of the image separately from the main image. A full-page scan took 12 seconds regardless of the resolution (75, 150, 200, or 300 dpi) of the scan. You can save files as TIFF (uncompressed, compressed, and gray-scale), EPSF (standard or Macintosh format), MacPaint, SuperPaint, PICT, and PageMaker 1.2 formats. Gray-scale information is limited to 4 bits (16 levels) and can only be saved in the TIFF format.

I liked this unit best of all the SCSI scanners because the hardware occupied the smallest volume and because the software is loaded with features. It also gave the best results at 300 dpi.

Reading What's Scanned: OCR

I used Read-It! 1.06 by Olduvai Software to do some OCR tests. This application can drive the Microtek scanners or MacScan and can even read a bit-mapped image to extract character information as ASCII text. It costs $395 for any scanner but ThunderScan (this version costs $149). Olduvai also supplies type tables containing 200-dpi information that allows the application to make character decisions with the data. I tried Read-It! with two of the five scanners: the Mirror Technology VisionScan, because of its aggressive price/performance ratio, and the New Image MacScan, because Read-It! can control the MacScan unit.

I had Read-It! load a type table very similar to the type of the document I was using. Since the application learns from its mistakes, I went through one recognize/learn cycle with it to make sure that my type choice was reasonable.

The VisionScan produced good results on the first pass: Only 3 out of 880 characters were not recognized. The MacScan worked well at 200 dpi, but the performance with the program's supplied 200-dpi type tables degraded significantly when I did a 300-dpi scan. The increased sensitivity of the 300-dpi scan introduced errors in recognition.

What Scanning Is Worth

All the scanners produced good results. Scanning at a higher resolution improves the overall image, but since the Mac display is limited to 75 dpi, the images look the same on the screen. Where the higher resolution pays off is when you print the image to a device that can support it (see figures 1b and 1c). Of course, higher-resolution scans require more memory and more disk space.

If it were my money, I'd buy the Mirror Technology VisionScan. Its price/performance ratio is unequaled. Performance was fine for my personal use. It's smaller than the other units, and setup is fast. Since it uses the serial port, turning the Mac off is not necessary, as it is when connecting a device to the Mac SCSI port. I also liked the flexibility of having the scanner software as a DA. It made the scanner available whenever I wanted it, without the need to launch a separate control program.

But if you need 300-dpi resolution for LaserWriter output, I recommend the New Image MacScan. The hardware and software are complete, the $1995 price is reasonable for a SCSI flatbed scanner, and the company promises a gray-level upgrade for those who need it by the time this article sees print. Your scanner will not be obsolete should you wish to upgrade. ■

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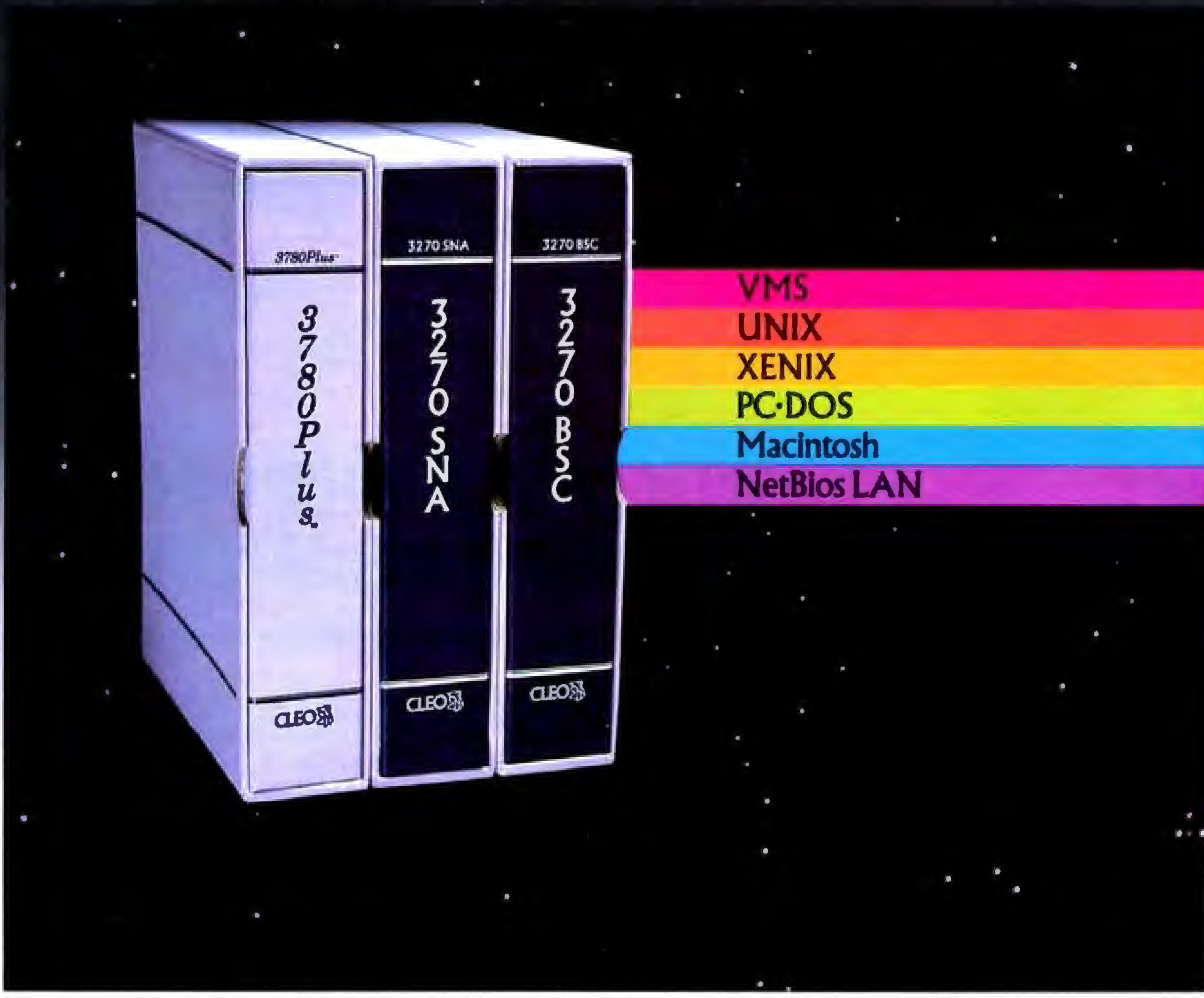

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Smalltalk à la C

C_talk provides object extensions to C in a Smalltalk-like environment

Namir Clement Shammas

Developers who program in C are always in need of a better way to handle objects. C_talk 1.0, an object-oriented language from CNS, may be the answer. It gives the C programmer object-oriented programming and a Smalltalk-like environment. C_talk extends the C language with elements of an object-oriented language, such as classes, objects, methods, messages, inheritance, and dynamic bonding. And, in certain respects, C_talk rivals C++.

For data, C_talk implements classes and methods. The identifier `id` is used to define any object class. The C declaration of `id` is

```
typedef long id;
```

The `id` type is used to store the memory address for the definition of an object class.

Also available are both class and instance variables. *Class* variables are shared by all the instances of that class. *Instance* variables are the private variables (or record fields, if you like) associated with each instance of the object class. Every time an instance (equivalent to a variable in structured languages) is created, a new set of instance variables are also allocated. By contrast, only one set of class variables exists at any time.

C_talk comes with a set of defined "foundation classes," with the "object" class as the parent of all classes. The foundation classes include the popular data structures, such as `Buffer`, `Stream`, `ByteArray`, `Collection`, and so forth. You can inspect and even alter the C_talk code for any of these methods.

The second object-oriented aspect that C_talk supports is inheritance. Inheritance is a powerful aspect of object-oriented programming that lets you bypass having to rewrite similar code for every new subclass. This means that both the class and instance methods of a class object are automatically inherited by all subclasses. C_talk supports linear inheritance, where a subclass can inherit from only one parent class (also called a superclass). You can override inherited methods by simply defining new ones with the same name for a subclass.

The third object-oriented component of C_talk is messaging that activates various objects and lets them interact with other objects. Here C_talk introduces its own new syntax. A C_talk message, like that of Smalltalk, is made up of a receiver (i.e., the object receiving the message), the selector (which is very similar to a function or procedure in structured languages), and optional arguments. The general syntax for a C_talk message is

```
@receiver selector <list of
  optional arguments>@;
```

Receivers can be either classes or instances. The most frequently used messages associated with classes are those that create new instances, such as

```
id CalculatorStack; /* assign id
to instance */
.....
@Stack new_ &CalculatorStack@;
```

This example informs the stack object class to invoke the `new_` selector and create a new stack. `CalculatorStack` points to the dynamically allocated in-

continued

C_talk 1.0

Type
Object-oriented language

Company
CNS, Inc.
Software Products Dept.
7090 Shady Oak Rd.
Eden Prairie, MN 55344
(612) 944-0170

Format
Two 5¼-inch floppy disks

Hardware Needed
IBM PC or compatible with 512K bytes of RAM and a hard disk drive; a mouse is recommended

Software Needed
Microsoft C, Turbo C, Lattice C, or C86

Language
C

Documentation
152-page user's manual

Price
$149.95

Inquiry 892.

stance of Stack. All instances of object classes are declared dynamically. Once created, the instances of the classes can receive their own messages to store, recall, and manipulate data. For example, the following message clears the contents of the stack CalculatorStack:

```
@CalculatorStack clear@;
```

Or a message could push a new value in the stack:

```
@CalculatorStack push_
  newValue@;
```

Messages in C_talk have optional arguments. C_talk employs a scheme where each argument is preceded by a keyword. A keyword is an identifier ending with an underscore. The complete name of the selector is the concatenation of all the keywords involved. For example,

```
@room putLen_ len width_ wide
  height_ high@;
```

assigns the three dimensions of a room object. The selector is putLen_width_height_, and the arguments are len, wide, and high.

And like C functions, C_talk permits messages to return data:

```
getVolume
/* get the volume of a room
  assuming that room has the
  following instance variables:
  double length, width, height;
*/
{
return (self->length * self->width
* self->height);
}
```

C_talk does not require you to define a data type for the message. You must, however, type message arguments. The manual suggests the Kernighan and Ritchie convention of listing the arguments' data type on separate lines.

Also, notice in the above example that C_talk supports the identifier self, which enables you to make references to the variables of an object. In addition, C_talk also implements the identifier super so that you can refer to the superclass. You can use the above message as a function to assign a value to a variable:

```
volume = @room getVolume@;
```

C_talk also supports an interesting feature that adds a lot of flexibility in messaging: the ability to use variables to represent selectors. You place the actual selector name in backward single quotes and assign it to a variable. Then the variable is used in the message:

```
int selector;
...
selector = 'getVolume';
....
volume = @room selector@;
```

Generally, I found the object-oriented syntax and constructs of C_talk easy to learn. However, I recommend that most C programmers become familiar with the rules of object-oriented languages first and then begin using C_talk. The learning effort for C_talk is far less than that for, say, Smalltalk. Getting into the world of object-oriented programming is made even easier with the C_talk environment (see the text box "Object-Oriented Programming Basics" on page 203).

The C_talk Environment

There are three main components that make up C_talk's package: the browser, the preprocessor, and the make utility. The C_talk browser manages the window-based environment that you use to enter, view, and edit C_talk applications. The C_talk preprocessor converts C_talk files, which contain hybrid C and C_talk code, into pure C source code. You use the C_talk make utility to intelligently preprocess and compile updated files and then relink the application's object code files. It yields applications compiled with either Microsoft C, Turbo C, Lattice C, or C86.

The C_talk browser brings a slick Smalltalk-like environment to C programmers. Using a mouse is highly recommended, but it is not mandatory. The browser contains five windows, of which three can display scrollable information. The windows consist of the following: title, classes, method type, methods, and contents (a text editor window).

I used the two-button Microsoft Mouse to work with the system. Pressing the right button while the rectangular cursor is in a window causes an associated menu to pop up. In general, you can select any option by positioning the mouse and clicking on its left button. If you move the mouse away from the pop-up menu, the menu simply disappears. I found this to be a graceful way of removing the menu. In the absence of a mouse, you can use the cursor-control keys to select options and move around in the browser.

The title window in the browser displays the environment filename. Its accompanying pop-up menu lets you perform basic management of the environment: exiting, invoking the DOS shell, invoking a DOS command, editing a file, setting up the Make specification, and saving the entire contents of the environment.

The Make setup option leads to another pop-up window. The latter window permits you to specify the C compiler's command line, a list of auxiliary files in use, the linker's command line, and the list of .OBJ and .LIB files to be included in the linking process. You can easily examine and alter these specifications outside the C_talk browser by using a text editor to edit the environment file.

The classes window displays the various class identifiers that are associated with the environment examined by the browser. To illustrate how classes inherit properties from their superclasses, the browser displays classes indented according to the inheritance level. Beyond a certain level, classes are not initially displayed. You can use an option in the associated pop-up menu to display the invisible classes. This is helpful when concentrating on a particular subtree of classes. Other options in the class menu let you load, save, delete, swap, and add

Object-Oriented Programming Basics

Object-oriented languages work by issuing commands to data objects, telling them to perform certain procedures or functions. For example, to calculate the square root of a number in an object-oriented language (OOL), you must send a message to the object (in this case, the number) telling it to return its square root. The general syntax is

```
object selector [arguments]
```

The selector is the method invoked and is equivalent to a procedure or function in structured languages. An OOL has a set of methods (i.e., routines) that are declared to work with it. Thus, an OOL combines the what (the object) with the how (the method).

An important departure from traditional structured programming in an OOL is the way the data types are handled. In object-oriented milieus, data types are called classes and are also considered to be objects. While this may seem very odd for veterans of structured languages, classes have their own methods that, for example, empower the creation of dynamically allocated variables, called instances. Instances are also objects with their own set of methods and hidden data structures. Accessing the data structure of an instance requires methods that authorize you to do so. Also, methods can permit access to specific parts of an instance. Thus, object-oriented programming fosters data hiding to implement robust software applications.

Inheritance is a powerful concept used by OOLs based on the ability to define subclasses derived from parent classes. Subclasses are able to automatically inherit the data structures and methods of the parent classes. Consequently, less coding is needed if the inherited method is valid for a subclass. But a subclass can also define its own data structure (i.e., add to the inherited structure) or its own methods. Linear inheritance is the typical scheme of inheritance where a subclass inherits from a single-parent class. Some OOLs implement nonlinear inheritance, which allows a subclass to inherit from two or more parent classes.

The hierarchy of classes has an interesting impact on message handling. When an object receives a message, the message is first searched in the catalog of methods directly associated with that object. If none matches the incoming message, the methods of the parent class are searched, and so on. The search either finds a matching method along the path of ancestor classes or fails.

classes. Since C_talk maintains the exact hierarchy of classes, loading a deeply nested class causes the program to load all its superclasses not already in the browser. When you select a class, the contents window displays the substance of the header file (in C) associated with the class.

The appealing part of the C_talk environment is that it lets you access the information related to a class. The method types window permits you to select properties that are related to either a class or an instance. When either is selected, the C_talk environment automatically updates the methods and contents windows. Initially, these windows reveal variables and methods related to the selected class or its instance. When a method is selected, the contents window then displays the detailed listing of that method.

Since the contents window is a text editor, you can modify the method of a class, the method of an instance, the variables of a class, or the variables of an instance. The contents window's pop-up menu supports copying, cutting, and pasting text; saving the substance of the contents window; and performing text search or translation. When using a mouse, the contents window displays both an underscore text cursor and a mouse block-type cursor. I found that editing text was confusing when the system shifted from the text cursor to the mouse cursor. Backspacing and moving the cursor often required me to click on the mouse or press the Insert key to reposition the text cursor.

Processing Files

The C_talk application environment is stored into an ASCII text file with an

continued

.ENV extension name. The default environment filename is APP.ENV, and it contains a list of the object classes, followed by a list of auxiliary C files. Any related .OBJ or .LIB files are listed next, followed by the sequence of commands to invoke the C compiler and the linker. Thus, you can edit .ENV files with text editors to alter the compiler and linker sequences. Originally, APP.ENV contained commands to invoke the Microsoft C 4.0 compiler. I edited the .ENV file to invoke the Microsoft C 5.1 compiler installed on my hard disk drive.

Each application should reside in a separate DOS directory. Each object class in an application is stored in a separate text file with the .PRE extension name. These .PRE files contain all the information relevant to a class. The C_talk browser uses an exclamation character as a special delimiter, allowing it to parse the various declarations when reading a .PRE file. You can alter a .PRE file with your favorite text editor provided that you do not tamper with exclamation characters.

The C_talk preprocessor is a utility that you invoke separately from the DOS command line. You can invoke the preprocessor for any object class without going through an entire sequence of checking related superclasses. The C_talk preprocessor reads a .PRE file and yields a .C file containing C code. The preprocessor is able to detect inconsistencies and flags them for additional editing.

You also invoke the C_talk make utility as a separate program from DOS. The make utility's role is to invoke the C_talk preprocessor, C compiler, and linker. Only the .PRE files that belong to updated object classes are run through the preprocessor. The corresponding C files and all altered auxiliary C files are recompiled, and the linker is invoked to relink the entire set of object files.

Writing a C_talk application is relatively easy, though there are a few rules to watch out for. The first is that the main() function should be placed after a dummy method, using the following general method:

```
main /* dummy C_talk method */
{
}
main() /* the actual main function */
{
<declarations>
_init_classes();
<other code lines, I/O, etc.>
}
```

In addition, the main() function must include a call to the _init_classes() function, found in the file CLASSES.C. The C_talk browser updates CLASSES.C to include the declaration of new object classes and calls to initialize them. If CLASSES.C is not properly updated, you may get a linker-error message, putting a halt to the production of the application's executable file.

Overall, C_talk provides a very practical and smart route to object-oriented programming. Its Smalltalk-like environment is easy to use, and its object-oriented extensions to C are powerful. Clearly, C_talk is a worthwhile product for any programmer interested in getting into object-oriented programming. ■

Namir Clement Shammas is a columnist for several computer magazines and a freelance writer living in Glen Allen, Virginia. He can be reached on BIX as "nshammas."

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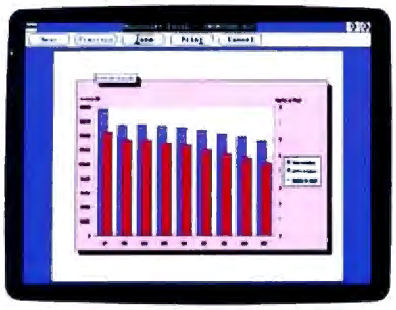

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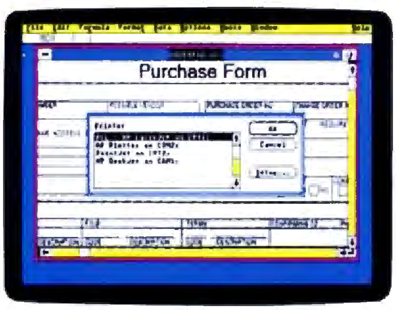

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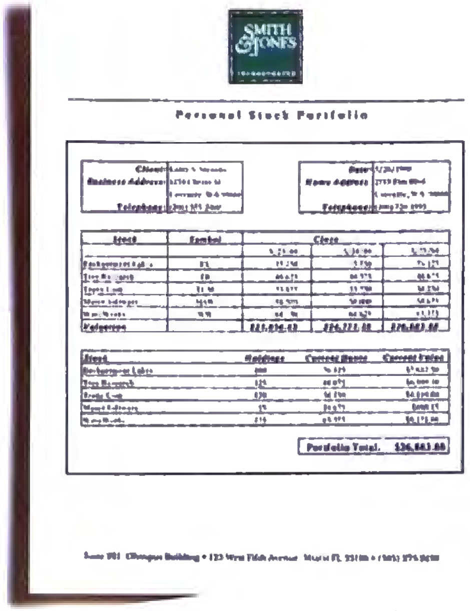

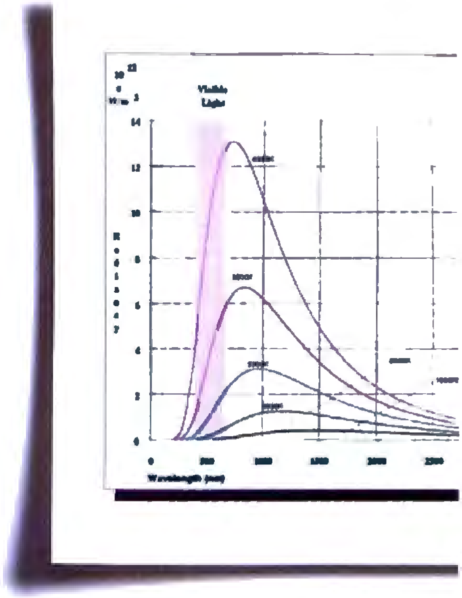

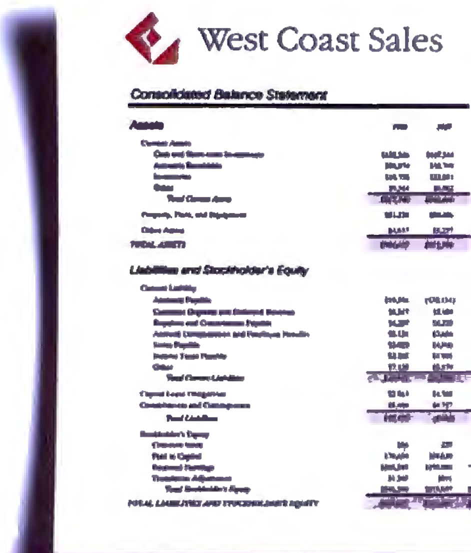

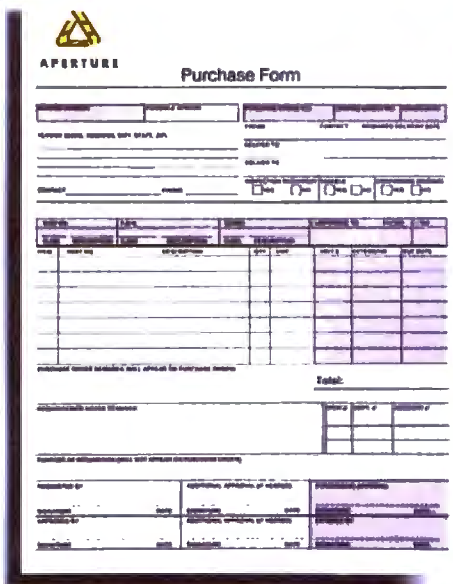

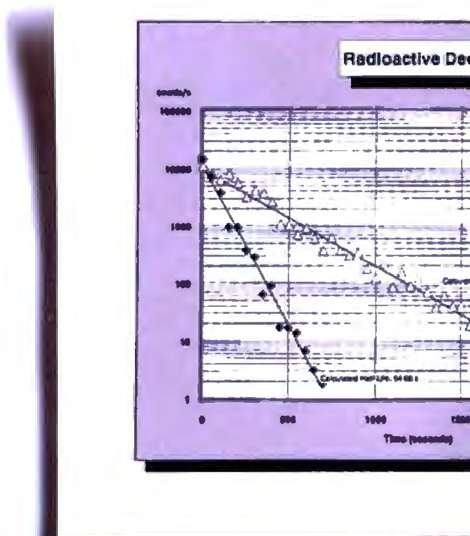

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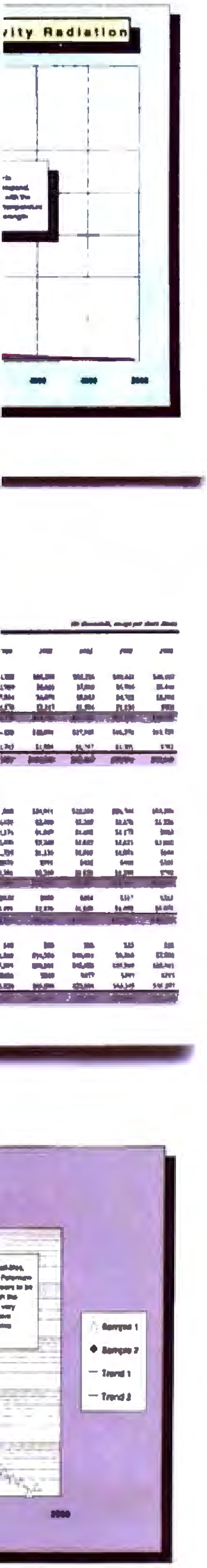

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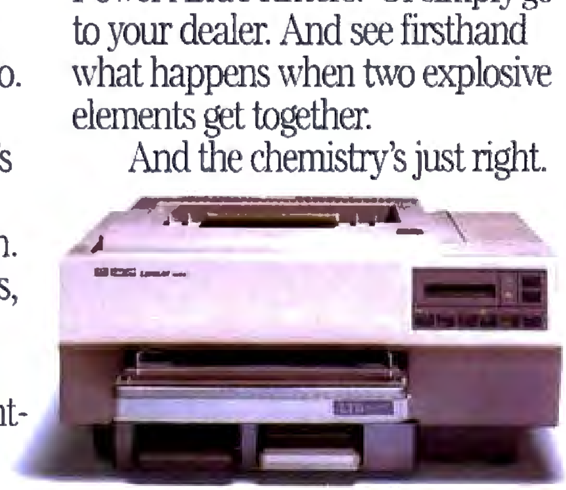

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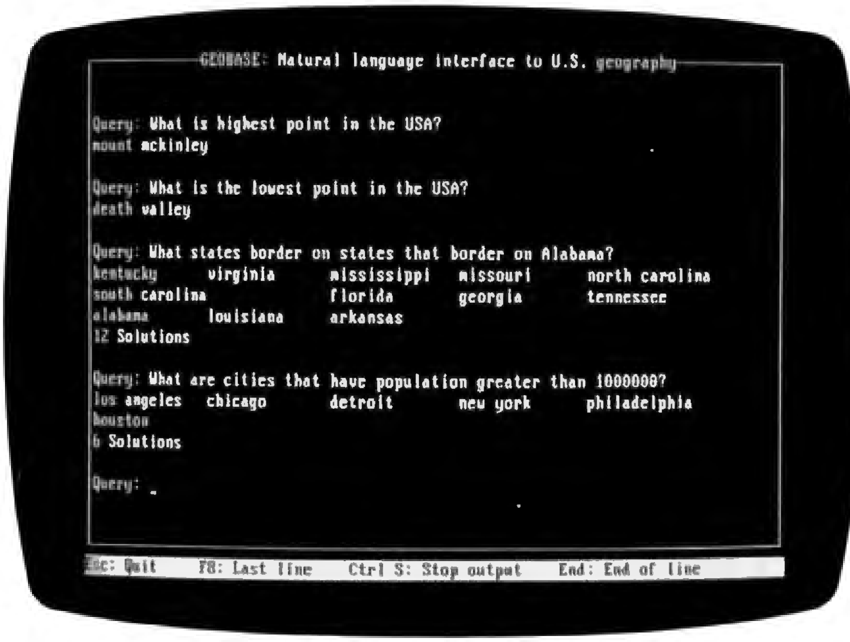

Version 2.0 offers enhanced database and graphics features

Alex Lane

Programming languages and their implementations fuel endless debates within the microcomputing community. Should an implementation provide precisely those features set forth in the language's definition, or should it alter that definition for the convenience of the implementer and the user? Borland International's language products—mentioned often in such debates—fall into the latter camp, and its Prologs are no exception to the rule. Turbo Prolog 2.0 stretches the language even more than did the original Turbo Prolog 1.0 (September 1986 BYTE).

Borland's Prologs enforce strong typing of objects and relations (Edinburgh Prolog, the de facto standard, doesn't) and limit the assert and retract mechanism to facts alone (Edinburgh supports dynamic modification of facts, predicates that define relations, and rules involving those predicates).

Despite these impurities, Turbo Prolog has found a following. Users appreciate features like fast compilation, linkage to stand-alone .EXE, foreign-language compatibility, integrated edit and debug facilities, and the rich assortment of built-in predicates that work with numbers, strings, files, windows, the Prolog database, and the DOS environment. Turbo Prolog 2.0 upgrades these capabilities and breaks significant new ground in two areas—graphics and the database system.

Though straightforward, the installation process isn't completely intuitive. For example, to install it on a hard disk you must make the hard disk drive, not the floppy disk drive, your default drive; in my opinion, that detail should be transparent to the installation routine. Once begun, installation of Turbo Prolog is a mindless, disk-swapping affair. Many of the files are bundled into archives; the installation program spends most of its time unarchiving them. At the end, it reminds you to insert the commands `FILES=20` and `BUFFERS=40` into the `CONFIG.SYS` file.

You'll need just under 1.5 megabytes of free space on your hard disk to install all the files that come with Turbo Prolog 2.0. A root directory contains the compiler, the core library `PROLOG.LIB`, the librarian, and the linker. Five subdirectories contain Borland Graphics Interface (BGI) drivers and font files; all the sample code shown in the documentation; answers to tutorial problems; model Prolog applications like Geobase (a geographical database that supports natural-language queries) and the Prolog Inference Engine (PIE), an Edinburgh-style Prolog interpreter written in Turbo Prolog; and reference examples comparing the use of the old and new standard predicates.

To use Turbo Prolog 2.0, you'll need an IBM PC, XT, AT, PS/2, or true compatible, PC-DOS or MS-DOS 2.0 or higher, and a minimum of two floppy disk drives and 384K bytes of memory. Such a system would be barely usable (the installed Turbo Prolog would be spread out over five disks), so I wholeheartedly agree with Borland's minimum recommended system—a hard disk drive and 640K bytes of RAM. I evaluated the package on a 16-MHz ARC 386i equipped with a multiscan monitor, a hard disk drive, and 512K bytes of RAM, and also on a 4.77-MHz IBM XT equipped with a CGA, a hard disk drive,

continued

Turbo Prolog 2.0

Type
Prolog programming language

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Borland International
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(800) 543-7543
(408) 438-8400

Format
Four 5¼-inch floppy disks

Language
C

Hardware Needed
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Documentation
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462-page reference guide

Price
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an 8087 math coprocessor, and 640K bytes of RAM.

General Improvements

Most Turbo Prolog 1.x programs will compile unchanged. Those that won't are ones that refer across module boundaries to domains, databases, or predicates; you must now explicitly declare these elements to be global. Also, version 2.0 assumes that global predicates are deterministic (i.e., not expected to generate multiple solutions). That assumption enables the compiler to emit more efficient nonbacktracking code in situations that don't require backtracking. You must qualify a global predicate with the keyword `nondeterm` to make it nondeterministic.

The files domain now supports `stdin`, `stdout`, and `stderr`. These names, familiar to C programmers, enable Turbo Prolog programs to communicate with other programs by means of DOS pipes. C programmers will also appreciate new directives for conditional compilation (`ifdef`, `ifndef`) and the capability to define constant expressions.

You can log the debugger's output directly to a file or printer; this feature really helps when you're trying to track down strange program behavior in the middle of a trace. You can enable or disable run-time checks for integer and stack overflow, and you can control the size of the heap available to a compiled Prolog program.

TLIB, the librarian, stores predicate object modules in library files. I use it to reduce disk clutter; by archiving source code on floppy disks and storing the corresponding object code in a library, I minimize the number of .PRO files in my Prolog environment.

Several command-line parameters are now available with Turbo Prolog. The -e flag loads a specified file into the editor; by default, it loads WORK.PRO. The -s flag loads a setup (.SYS) file. You can enable or disable snow-checking with -c. And the -x flag enables Turbo Prolog's high-resolution text modes (43 or 50 rows by 90, 120, or 132 columns).

The syntax of the language has been changed in ways that move it closer to traditional Prologs. Comments, which in version 1.x programs required the C idiom `/* . . . */`, can appear as the remainder of any line that begins with a percent sign. Predicates can now have multiple arities. For example, a predicate called `sales_contact` might have two forms, one describing a name and address relation and another describing a name, address, and phone-number relation. In documentation, you'd write `sales_contact/2` and `sales_contact/3`; in code, you'd write `sales_contact` and let the compiler choose, based on the number of arguments supplied.

Many of the standard predicates now have multiple arities. The `makewindow` predicate, for example, has two forms; `makewindow/8` does the basic job, and `makewindow/11` adds control over the style of the frame and position of the title. Some new standard predicates are `bios/4`, which returns the status of flags; `edit/13`, an upgraded version of the original `edit/2` facility that gives Prolog programs access to the Turbo Prolog editor for complex I/O; and `exit/1`, which sets the DOS `errorlevel`.

Database Support

The database portion of Turbo Prolog has been almost completely redesigned. In the old scheme, a single internal database served as the repository for facts. You filled it from three sources: database predicates in source code; database predicates stored in a separate file and accessed by means of `consult`; or `assert` predicates contained in clauses or a goal. The `retract` predicate deleted a fact, and `save` wrote the contents of the database to an external file. Available RAM limited the size of the run-time database. Although the 1.x documentation hinted at a way to virtualize the database, it was disk-intensive and involved a laborious indexing scheme.

Version 2.0 preserves and extends the internal database facility. Now you can name multiple internal databases, and you can `consult` or `save` each separately. New versions of `consult`, `save`, `assert`, and `retract` work with these named internal databases. To use a database across module boundaries, you must declare it in the global database section and declare its predicates in the global predicates section. As before, the amount of RAM limits the size of internal databases.

The new external database implements a virtual store of facts. You can put an external database in RAM or expanded memory, if there's room, or you can put it on a disk file. An external database is made up of one or more chains (linked lists) of terms and, for each chain, an associated B+ tree is used to index it. New predicates analogous to `save`, `consult`, `assert`, and `retract` work with external databases. The specialized accessors `db_chains` and `chain_terms` bind entire chains or individual terms to Prolog variables during backtracking. You can use the `bt_` (B+ tree) predicates to sort chains and gain fast keyed access to terms.

The internal and external databases aren't compatible with one another. You can't use `assert` or `retract` with an external database, nor can you chain internal predicates. But that's logical, since terms belonging to an internal database are actually part of a Prolog program, while terms belonging to an external database are data manipulated by that program. This arrangement isn't unique to Turbo Prolog 2.0. Arity/Prolog 4.0 implements something quite similar. The Turbo Prolog 2.0 documentation devotes a full chapter to external databases. Sample programs clearly illustrate how to scan, update, restructure, protect, and display them.

Borland Graphics Interface

If you've had a chance to play with Turbo Pascal 4.0, you're probably familiar with the BGI. The BGI comes with Turbo Prolog 2.0 as well. It supports CGA, MCGA, EGA, VGA, Hercules, AT&T 400-line, 3270 PC, and IBM 8514 graphics adapters. Turbo Prolog 2.0 offers more than 70 new standard predicates; they create and manage viewports (graphics windows), draw shapes such as circles and rectangles, and define patterns used to fill shapes. All these new features get a workout in the sample program `GRDEMO.PRO`. Though at first graphics and Prolog might seem an odd mixture, I can think of some interesting applications combining the two. A system of artificial intelligence-based controls for a water treatment plant could graphically represent water levels and flow patterns. A circuit-board troubleshooter could illustrate where to put logic probes, or could display waveforms.

There are two ways to package code that uses the BGI. The easiest way is to compile and link the Prolog program, then run the resulting `.EXE` file in the presence of the drivers (`.BGI` files) and fonts (`.CHR` files). The disadvantage here is that the program has to be able to locate these files. Alternatively, you can use the new `bgidriver` and `bgifont` compiler directives, which specify the drivers and fonts you want to attach to your program. This approach consolidates your application into a single file. But that file is substantially bigger—a program that incorporates all the drivers supplied with the package grows by almost 30K bytes.

Table 1: *Turbo Prolog 2.0 lags behind version 1.1 on number-crunching tasks but betters its predecessor in symbolic computation.*

	Source file	.EXE file		Memory compile		Compile/ link		Run time	
	(bytes)	(bytes)		(seconds)		(minutes:seconds)			
Test		1.1	2.0	1.1	2.0	1.1	2.0	1.1	2.0
Floating point	635	35,503	32,436	2	2	0:15	0:18	0:30	0:36
List reversal	908	35,854	29,923	2	2	0:15	0:18	0:23	0:11
Sieve	973	35,790	26,323	2	2	0:15	0:18	0:03	0:03
Math	1456	38,526	33,251	5	4	0:17	0:21		
sqrt								0:05	0:06
ln								0:14	0:14
exp								0:24	0:24
atan								0:15	0:16
sine								0:16	0:16
Factorial	656	35,546	37,055	2	2	0:14	0:17	0:21	0:31
Towers of Hanoi	677	35,478	29,067	2	2	0:14	0:17		
10 rings								0:85	0:16*/0:34**
7 rings								0:11	0:02*/0:04**
5 rings								0:03	0:01*/0:01**
Disk write	605	36,425	27,854	2	2	0:14	0:17	0:29	0:29
Disk read	470	36,444	30,625	2	2	0:14	0:17	0:16	0:16

* Snow-checking off
** Snow-checking on

Foreign Languages

Though version 1.x could link Prolog programs with external routines written in foreign languages, the feature never worked to my satisfaction. Happily, version 2.0 is fully compatible with Borland's Turbo C. You can write C routines that support Prolog predicates, as before. You can even call Prolog predicates from C; the catch here is that the main program must be implemented in Prolog, so Prolog can control the stack and heap.

Not having a current version of Turbo C close at hand, I linked a simple C routine compiled under Microsoft C (version 5.0) with a program written in Turbo Prolog 2.0. Despite a few complaints from the linker about undefined symbols, I could call the routine successfully from Prolog. Despite all this, I remain skeptical about the usefulness of the language interface. In theory, it's a great way to subcontract computing tasks that Prolog doesn't handle well, like numerical analysis and sophisticated string handling. In practice, you have to own another Borland language product, and you need more than a passing acquaintance with concepts like memory models.

Sample Programs

Turbo Prolog 2.0 comes with a wealth of sample programs. These serve two purposes: They teach Turbo Prolog by example, and more generally, they motivate the study of some classic problems that Prolog helps to solve. Borland, as always, provides source code for these applications so you can study and try to modify them. In a welcome change from version 1.x, the documentation describes these applications.

Geobase is a database that contains information about the geography of the United States and a natural-language query facility that lets you ask questions like "What is the largest city in Mississippi?" The documentation tells how to compile and link the program, outlines its architecture, and suggests how to extend it to other domains. `SEN_AN`, a sentence analyzer, uses a context-free grammar to parse simple English sentences. GENI, an expert-system shell, comes with a small knowledge base containing definitions of various kinds of animals. In consultation with GENI, you specify an animal's attributes (e.g., "has feathers," "doesn't have long legs"), and the program seeks to identify the animal in question. GENI has an update mode, too. When it can't identify the animal you have in mind, the program can help you add it to the knowledge base. The documentation, again, suggests ways for you to extend the application into other domains.

The PIE impressed me most of all. PIE is a small but powerful Prolog interpreter that, unlike Turbo Prolog itself, permits the user to assert and retract both facts and rules. The appendix that describes PIE is dense and, at times, patronizing of traditional Prolog implementations, but nonetheless it's an education in the esoteric art of Prolog interpretation. The program does have its bugs. I noticed that when goals are resatisfied during backtracking, the trace window displays the old instantiated variables rather than anonymous variables. In addition, I had to reboot my XT with a DOS-only disk in order to compile PIE with the trace mode enabled. Nevertheless, I was able to load and run an unmodified copy of the Prolog chestnut `QUEENS4.PRO`.

Nearly 1000 pages of high-quality documentation accompany the software. That's a great improvement over the version 1.x manual in terms of both quantity and quality. The new documentation set divides into two hefty tomes: a 480-page user's guide and a 462-page reference guide. The user's guide explains how to install the package on your computer, how to set up the environment, and how to get started with the editor. Then it dives into Prolog. Topics include backtracking, unification, lists, recursion, strings, windows, files, graphics, databases, and debugging.

Most of the reference guide is devoted to the description of version 2.0's stan-

continued

dard predicates. The rest of the book features a programmer's guide, a list of error messages, and a series of appendixes describing the applications that come with Turbo Prolog 2.0.

Better Performance?

For testing purposes, I used a 4.77-MHz IBM PC XT with a hard disk drive, an 8087 coprocessor, and 640K bytes of memory. I tested versions 1.1 and 2.0 using the same benchmarks that were used for the BYTE review of version 1.0. There's one minor change—I modified the floating-point test so that it passes intermediate results on recursive calls.

The floating-point tests measure the time required for 5000 iterations of a set of floating-point multiply and divide operations. The list-reversal test, adapted from a Lisp benchmark, clocks 30 reversals of a list of 50 integers. The Sieve of Eratosthenes finds all the prime numbers between 1 and 100, 10 times. The math benchmark performs 1000 calculations each of square root, natural logarithm, exponential, arctangent, and sine functions. The factorial test computes 10! 1000 times. The Towers of Hanoi benchmark writes a narrative description of the solution to that puzzle for 5, 7, and 10 rings. Finally, the disk read and write benchmarks write a 64K-byte file to a floppy disk drive and read it back.

Version 2.0 produced code that was 20 percent to 30 percent smaller than that produced by version 1.1 (see table 1). Somewhat surprisingly, 1.1 outperformed 2.0 on the math-intensive benchmarks. That result doesn't particularly concern me, however; Prolog isn't a number-crunching language. If you need those capabilities in a Prolog context, consider linking appropriate routines written in assembly language or C. Prolog's strength is symbolic computation, and on those benchmarks—the list-reversal test and the Towers of Hanoi—2.0 significantly outperformed 1.1. The results for the Towers of Hanoi with and without snow-checking, by the way, show the rate of text output to the screen to be an important limiting factor.

A Mature Environment

Like its predecessor, Turbo Prolog 2.0 isn't a traditional Prolog; the language is strongly typed and doesn't let you dynamically assert and retract rules. But logic programmers aren't necessarily complaining. Many, for example, support Turbo Prolog's strong typing. In any case, as Prolog implementations proliferate, it's getting harder to point to a definitive standard.

Turbo Prolog 1.0 was a useful and popular implementation of Prolog. Borland International has raised Turbo Prolog 2.0 a cut above that. The external database puts serious knowledge-crunching capability into the hands of Turbo Prolog programmers, and the BGI features should yield some interesting graphical applications. Traditional it may not be, but Turbo Prolog has certainly become a mature environment for logic programming.

Editor's note: *The Prolog source code for the benchmarks is available in a variety of formats. See page 3 for details.* ■

Alex Lane is a knowledge engineer for Technology Applications, Inc., and lives in Jacksonville, Florida. He can be reached on BIX as "a.lane," where he is the moderator of the prolog conference.

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A powerful tool for storing and manipulating data

Pam Oppenheim

The manual to D the Data Language advises that "D is a very different animal in many respects. Not difficult, just different." And it's right—D is very different from the majority of PC database packages. It is a DBMS that, for example, lets you create custom applications for every user who accesses the database. A number of people can, therefore, get only the information they need without seeing confidential or extraneous data.

Indeed, D is a powerful, flexible tool for manipulating data. First, it provides a mechanism for getting information into a database, and then it supports development of integrated menus, procedures, reports, and screens. But this flexibility is not always immediately apparent.

D ($395) comes with two spiral-bound manuals, a small addendum for the latest version, and four 360K-byte 5¼-inch floppy disks. The addendum, included with version 2.7, which I reviewed, covers new features, such as pop-up menus, color monitor support, the ability to recover deleted records, new options for many commands, pie charts, bar graphs, histograms, and a facility for building context-sensitive help for your applications.

A batch file handles the installation and lets you put D in the subdirectory of your choice. The batch file prompts you for the three program disks and checks that you've inserted the correct one. The program is not copy-protected. The fourth disk contains an example database, which you copy into the subdirectory with D. The program requires 512K bytes of RAM and a hard disk drive (it uses about 1 megabyte). I ran D on a Compaq Deskpro that uses an 8086 processor at 7.14 MHz with a 20-megabyte hard disk drive.

D in Action

Within D, information is organized as database definitions (DBDs) that contain data groups, which are analogous to files, procedures for menus, automated processing, and reports. Data groups are defined as fields, supporting alphanumeric or numeric character and binary field types. Subfields are supported and add to your ability to control and access information. For example, a master field-name job number can consist of a customer number, a sequence number, and the year. You can reference the single entity or any of the components.

The lack of a date type is inconvenient. However, using the JDATE and EDATE functions, which convert character data from a specified format to the equivalent Julian date or calendar date, procedures can be developed to process dates as needed. The starting date for Julian calculations is user-definable as part of the database definition. If you set up a dates field with subfields, it's easy to pull reports for specific periods without any date conversion required at all.

You must compile the DBDs and pro-

continued

D the Data Language 2.7

Type
DBMS

Company
Caltex Software, Inc.
3131 Turtle Creek Blvd., Suite 1101
Dallas, TX 75219
(214) 522-9840

Format
Four 360K-byte 5¼-inch floppy disks

Language
C

Hardware Needed
IBM PC, XT, AT, or compatible with 512K bytes of memory, one floppy disk drive, and one hard disk drive

Software Needed
DOS 2.0 or higher

Documentation
136-page Introduction Manual
367-page User's Guide

Price
$395
$75 for the run-time module

Inquiry 889.

cedures before you use them. Part of the data group definition is the number of records it contains. When the file is full, you can't add more information without updating the DBD. Changing a database is a multistep process that, at the very least, requires you to unload data from the DBD into a temporary file, make the modification, recompile the DBD, modify and recompile procedures if you've changed any DBD names, open the DBD, and reload it. After verifying the data, you must edit procedures to reflect the new field types and sizes and recompile them again. Finally, you must rebuild the keyed field references. Sometimes, flexibility has a high price.

An INFO command lets you know all about your database, from the basic structure to the number of loaded and active records. A uniqueness column shows you the number of unique values that exist for a particular field. An associated command, REDUCE, lets you compress a set of isolated records to reflect only the unique values. This is similar to dBASE's UNIQUE qualifier on indexes, but it's more flexible since it does not limit access.

To Caltex's credit, it advises users of the importance of establishing backup and reload procedures for all DBDs. In fact, the company goes so far as to include a chapter in the documentation on database maintenance and recovery. STRUCTURE, CONSTRUCT, DESTRUCT, and KEY help you rebuild keyed fields should they become damaged. Yet, in working with D, I experienced no data losses, even when I purposely turned off the power while updating a file.

To DOS, a database definition represents only four open files, regardless of how many data groups and procedures exist. D supports an unlimited number of data groups, keyed fields, and related files within a DBD.

Confusion arises when you first try to use these keyed fields, because the data is displayed in the order in which it was entered. The terms *key* and *keyed index files* imply that the data is ordered on the value. I determined that, unlike dBASE's index files or indexed sequential-access method file structures, keyed fields do not generate index files or, in any other way, impose a visible structure on the data. The keyed field provides an internal structure used by the FIND command to isolate records within the data group.

There are trade-offs to either approach. Imposing the structure takes time during all data-entry and update activity and makes the system more vulnerable to corruption during power failures. Without that structure, you must organize your data via sorts every time the order is important.

Sorting It Out

Fortunately, D's sorts are fast and powerful. A sort lets you specify multiple fields, ascending and descending orders, and case insensitivity. An option enables you to specify the use of high instead of low values for missing data. You can apply sorts to a collection (isolated portions of files) or to an entire data group. The sorted order remains in effect until you sort on another field, add records to the working set, clear the collection, or close the database. A single-field sort of 1586 records took less than 2 seconds, while the comparable dBASE sort (I used dBASE III Plus 1.1) took 4 minutes and 27 seconds and also took up valuable disk space.

D's PICK, FILL, and FIND commands are the mechanisms for isolating data. They more closely resemble dBASE's FOR and WHERE clauses than its SEEK command. dBASE's SEEK command located a record and advised me that a record did not exist in less than 1 second using my

continued

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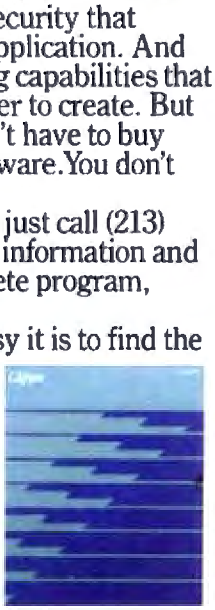

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1586-record file. The FIND command isolated matching records in just over 2 seconds. But FIND allowed me to look at these matching records nearly instantaneously, while dBASE's BROWSE FOR and DISPLAY FOR were slow in writing just the first 16 entries to the screen. FIND is the means for loading data records into memory from a data group. A WHERE clause that supports greater than, equal to, less than, starting value, and an "any value" expression provides control over which records are retrieved. The any value operator is extremely powerful, locating records if the contents of the field contain the value. This capability does not exist in dBASE. PICK supports locating information by record numbers rather than by values. You can specify single records or ranges of records to be retrieved.

Command and Control

You can edit any command that is still on the screen; simply move the cursor to the command and press Enter. The line is now redisplayed as the next line to execute, and you can edit the line before execution.

Context-sensitive help is always available by pressing F1. The use of a split screen when displaying help lets you complete a command easily by following the displayed syntax. You can look up field names in the same fashion. I found this process far superior to that of manually writing down the syntax while in help so that I could enter the command correctly when I exited help.

Creating moving light-bar menus was a delight. From the procedure menu, I selected MENU, and, using the text editor, I listed the procedure names and descriptions. To mark the options for the menu, I placed the cursor to the left of the procedure name and pressed F5, for each allowable menu selection. D automatically handles all the cursor control and highlighting, then invokes the selected procedure.

On the down side, there is no type-ahead buffer and no indication that what you've typed has gone to never-never land. Most commands, except for compiles, execute fast enough so that this is not a major problem. Still, I would have preferred to receive a warning from the program, rather than having to type the commands all over again.

A text editor lets you create reports, procedures, screens, and even the database definition. The editor supplied with D is adequate, providing insert and overstrike modes, full-screen and line-edit modes, and block moves and copies. You can use any text editor that creates pure ASCII files; however, you can't invoke the editor from D, resulting in a loss of productivity.

Within the screen definitions, you have access to a wide range of field edits, including required, unique, fill, uppercase conversion, and auto-increment. Templates, ranges, and lists are fully supported. As it does with moving light bars, D handles all the specified edits from the menu to enter or edit data without any user-generated code. When specified conditions have not been met, a terse prompt like ALPHA or REQUIRED appears on the screen and a beep sounds. Unless the override option is invoked, you must correct the response before D proceeds to the next prompt.

UPDATE and APPEND commands let you enter and edit information in the data file. When using screens, you must be on the last transfer field to write the data to the file. Because you have total control over the prompt order, this field may be anywhere on the screen. To avoid problems, the manual advises you to press End to get to the last transfer field, then press Enter to write the data to disk.

You can generate output via print commands or a comprehensive report procedure. `PRINT` does a reasonable job of providing columnar information with titles, column headings, subtotals, and grand totals, but there is little format control. `PON` and `POFF` commands control output that is sent to the printer.

`REPORT` provides more control over content and appearance via detail, breakpoint, and final (ATEND) sections. Within these sections, conditional processing is supported with `IF` statements. Data can be calculated, printed, or written to data groups.

From the title and declaratives sections, you can control titles, subheadings, and footers. As with most databases, you can place date, time, and page-number displays within the report. `BTITLE` enables you to put titles in the body of a report, greatly adding to the flexibility of the report generator.

From a report, you can isolate records to another collection using the `SELECT` command. This feature can help you reduce the number of times you must process a file to get information. For example, while printing customer statements you can collect all the customers whose balances are over 30 days outstanding. From this collection, you can also print an overdue account list without processing the file a second time.

Via a `WRITE` statement, you can use a report to update any data group within the database. As with `SELECT`, this lets you accomplish complex processing with a minimum of overhead.

File Importation

DBF, ASCII, data-interchange format, and blocked files can be loaded into D, but there is no automated import. After correctly defining a data group to store the information and a record definition, which defines the file structure to be read, you must `LOAD` the information. This area in particular is not well documented. It took me four tries and about 30 minutes to transfer my file. Caltex says it is currently rewriting the documentation for the new version. The company specifically acknowledged the problem with the import/export explanations and advised me that additional material would be available in the new release.

An intuitive relationship exists between data groups whenever they share a common field. Consider a DBD consisting of customers and sales. Viewing the related data is as simple as `FIND`ing the records you want from the sales files and `MATCH`ing the information with customers using the customer number field. The `MATCH` command locates all records in the sales data group that have customer numbers equal to those in the customer file. There is no limit to the number of data groups that can be matched. And since D does not structure the data files, you need not worry about the related files being indexed on the relate field, as is required in dBASE. D's strength becomes apparent when you use `RELATE` in conjunction with `MATCH`. `RELATE` lets you create one ordered, logical file of the merged data for reports and fully sup-

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ports one-to-one, one-to-many, many-to-one, and many-to-many relationships, all with remarkable ease. By comparison, to process these complex relations in dBASE correctly, you must write code that explicitly tests the conditions.

Options with RELATE let you translate information via an intermediate data group and control the primary sort order for reports. The translation feature lets you use codes as input for speed and reliability, while reports show the appropriate meaning instead of the code.

Variables are defined by the SET command and are accessible everywhere within D. Arithmetic calculations and string concatenation are supported.

Final Input

Where does D fit in the PC database picture? If you're looking to manage a few files, such as a mailing list or parts inventory, the more traditional tools, such as dBASE, are better choices. If the order of your data is always important, the required sorting in D makes it an unacceptable alternative.

D is a viable applications development tool and is especially useful for situations where many people use the database for separate functions. By defining personal interfaces, which are yet another kind of procedure, the developer can show the users only the information they need to know and provide access to only those functions they need to perform. Data security is easier to enforce, because users see only what you want them to see—without ever knowing that more data exists.

Applications that require multiple file updates, as a result of processing, are also a good fit, as are large applications with highly normalized files that exceed the maximum number of open files allowed by DOS.

The flexibility of the data structures, and the ability to order the data when you need it, as you need it, are perhaps most useful for those situations where it is difficult to initially determine all the required operations and reports.

D is different and takes some getting used to. But it allows a high degree of customization and is a good alternative to dBASE for developing custom applications. ■

Pam Oppenheim is president of Rational Solutions, Inc. (Fort Lauderdale, Florida), an independent software consulting firm involved in the planning, design, and implementation of mini- and microcomputer systems. You can reach her on BIX as "editors."

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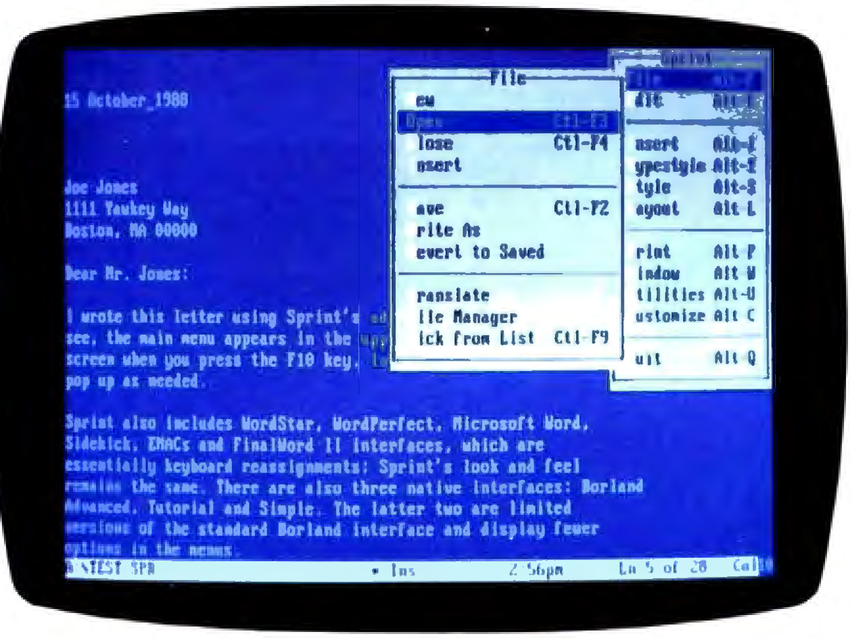

A high-end word processor that you can customize

Lamont Wood

Borland International, the firm that originated the pop-up software genre with SideKick, has come up with another new genre—soft software.

Softness is the whole idea behind Borland's new Sprint word processor, a full-featured, top-of-the-line word processing package that you can customize beyond recognition, since the necessary source code and programming language are included with it. It also does a perfectly good job when it comes to producing a document, although it lacks many of the desktop publishing functions offered in other packages. For this review, I ran Sprint 1.0 on a 4.77-MHz Eagle PC with 640K bytes of RAM and a 20-megabyte hard disk drive.

Different by Design

Borland touts Sprint as a word processor with multiple interfaces. This multiple interface capability is actually a product of Borland's design philosophy—Sprint isn't just a word processing program; it's also a macro-based programming language designed for writing word processing programs. Its verbs and syntax are reminiscent of C. When you run Sprint, you're actually running a program in what Borland calls the "Sprint macro language." Unlike the macro capabilities of other word processors, Sprint goes beyond printer file and keyboard interface modification to let you alter or rewrite any part of the program.

Sprint includes the source code for its macros. Once you find and unpack them from an archive file on one of the distribution disks, you can load them into Sprint as word processing documents and then study, modify, compile, and use them. Complete documentation for the macro language is included.

The language is specially designed for writing word processing applications; its verbs deal mostly with text and menu manipulation. It also has global and local variables and conditional statements, and there's an interesting `menu` verb that handles displaying a pop-up menu and executing whatever command the user picks from the menu list.

It's fairly simple to load the source code for the user interface and change key assignments: You simply load and edit the source code as you would any other word processing document. For instance, if your sloppy typing makes it advisable to eliminate the command assignment for Control-A, you can load the source file (`SP.SPM`) and find the list of keyboard assignments using the `Find` command; you'll see `^A : WordBack`. You replace `WordBack` with `Null`, save the file, and then load it as a macro definition, so that when your left hand slips, nothing happens.

You could also use the Sprint macro language to write your own word processor from scratch. But budding word processor programmers had best take note—the source code for the main Bor-

continued

Sprint 1.0

Type
Word processor

Company
Borland International
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95066
(800) 543-7543
(408) 438-8400

Format
Eleven 5¼-inch floppy disks; 3½-inch floppy disks available

Language
C

Hardware Needed
IBM PC or compatible with 384K bytes of RAM and two floppy disk drives or a hard disk drive

Software Needed
DOS 2.0 or higher

Documentation
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388-page Advanced Reference Guide
504-page Advanced User's Guide
32-page Alternative User Interfaces

Price
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Inquiry 891.

land interface macro is 73K bytes long. Word processor programming is not a trivial task.

Sprint also comes with some interesting canned macros (invoked through the Potpourri menu) for things like "transpose letters" and "delete next paragraph." You can either call them up from a menu or assign a keystroke to each one and invoke them automatically.

Presumably, you could keep adding macros and eventually rewrite Sprint to something that exactly suits your tastes. You could have Sprint automatically do a lot of little chores, like stripping out the `Return for next line` prompts that always sprinkle everything you download from certain electronic mail services—or you can create entire programs, such as a text database for handling filing tasks (see listing 1). But Borland is selling Sprint as a word processor, not a programming language, so the package should stand on the merits of its word processing features.

Abundant Interfaces

As shipped, Sprint 1.0 is bundled with nine interfaces: Microsoft Word, WordPerfect, WordStar, SideKick, Final Word II, EMACS, Borland Tutorial, Borland Simple, and Borland Advanced.

The first three interfaces offer compatibility with the leaders in the word processing market, so their inclusion is to be expected. SideKick is a Borland product. Borland produced Sprint by acquiring, rewriting, and enhancing Mark of the Unicorn's Final Word II, so Final Word's interface was included. EMACS, a mainframe editor, was included because it was the precursor to the Final Word interface. The Tutorial and Simple interfaces are subsets of the Borland Advanced interface, which is the native Sprint interface. Borland is also working on other interfaces, including MultiMate Advantage and DisplayWrite. You can also create your own interface using Sprint's macro language.

The idea of having multiple interfaces seems to be simply to ease the user into using Sprint. Having a Microsoft Word or WordStar interface doesn't mean that when you call up Sprint you'll be tricked into thinking you're using those programs. The interface basically covers keyboard reassignments and custom pop-up menus that are overlaid on Sprint's main structure.

Borland makes no attempt to clone the "look and feel" of the target software. It simply attempts to help users, habituated to one of these word processing programs, to get up to speed with Sprint by emulating the function keys and key combinations these programs use.

For instance, when using the Microsoft Word interface, that program's command menu doesn't suddenly appear along the bottom of the screen. Instead, Sprint's one-line shaded status line appears there. But when you press Escape, a pop-up menu appears that lists the commands you would normally see on the bottom of the Word screen, and the function keys have the same effects they would have if you were using Word. If you choose to load more than one interface during the installation procedure, you can switch between them while editing a document.

For the perplexed, there's a command that gets you an on-screen diagram of the assignment of the function keys, and a macro prints a quick reference card for whatever interface you're using. The Alternative User Interfaces booklet that comes with the documentation covers the basics for each.

Sprint stores files in its own format, which is ASCII with embedded control characters, no matter which interface you use. But it does include translation facilities to convert to and from ASCII, DisplayWrite 4.0 (and other IBM Document Content Architecture–formatted files), Microsoft Word, MultiMate 3.3, MultiMate Advantage, WordPerfect 4.0, and WordStar. You can also import SideKick Plus Outlook outline files, but you can't export them back to SideKick.

The Native Interface

The Borland Advanced interface has several ways of doing almost anything. To save a file, for instance, you invoke the Save command by pressing F10 to bring up the main menu, and then you scroll to the menu's File item (via the cursor keys or by pressing *F*) to call up the submenu dealing with file commands. (Or you could just press Alt-F.) You press *S* to scroll to the Save entry on the submenu. Or you can skip the whole process and just press Control-F2. Alternately, you could edit the interface macro as described earlier so you can invoke it with any key combination you select.

Meanwhile, on the screen, what you see is *not* what you get, and it may not even be approximately what you get when you're doing fancy formatting, such as columns or footnotes. Sprint has no graphics mode, and the screen displays straight text with embedded commands. Changing to multiple columns or changing font sizes has no apparent effect. You simply see a highlighted `BEGIN COLUMNS2`, for instance, if you go to a two-column page.

You can change fonts through the Typestyle selection on the main menu. Since the process of installing Sprint involves specifying which printer (and font cartridge, if applicable) you're using, Sprint knows what typefaces are available and presents you with a list. To change to, say, 14-point Helvetica Bold (having installed the B cartridge on a LaserJet Plus or equivalent), you'd invoke the Font command under the Typestyle command and pick HelvBold from the list. The boldfaced command `FONT HELVBOLDENDF` appears with the cursor under the `E` in `ENDF`. All text positioned between `HELVBOLD` and `ENDF` appears in Helvetica Bold.

The Customize Screen option replaces the highlighted screen commands with the actual control characters Sprint uses. This helps to diagnose formatting prob-

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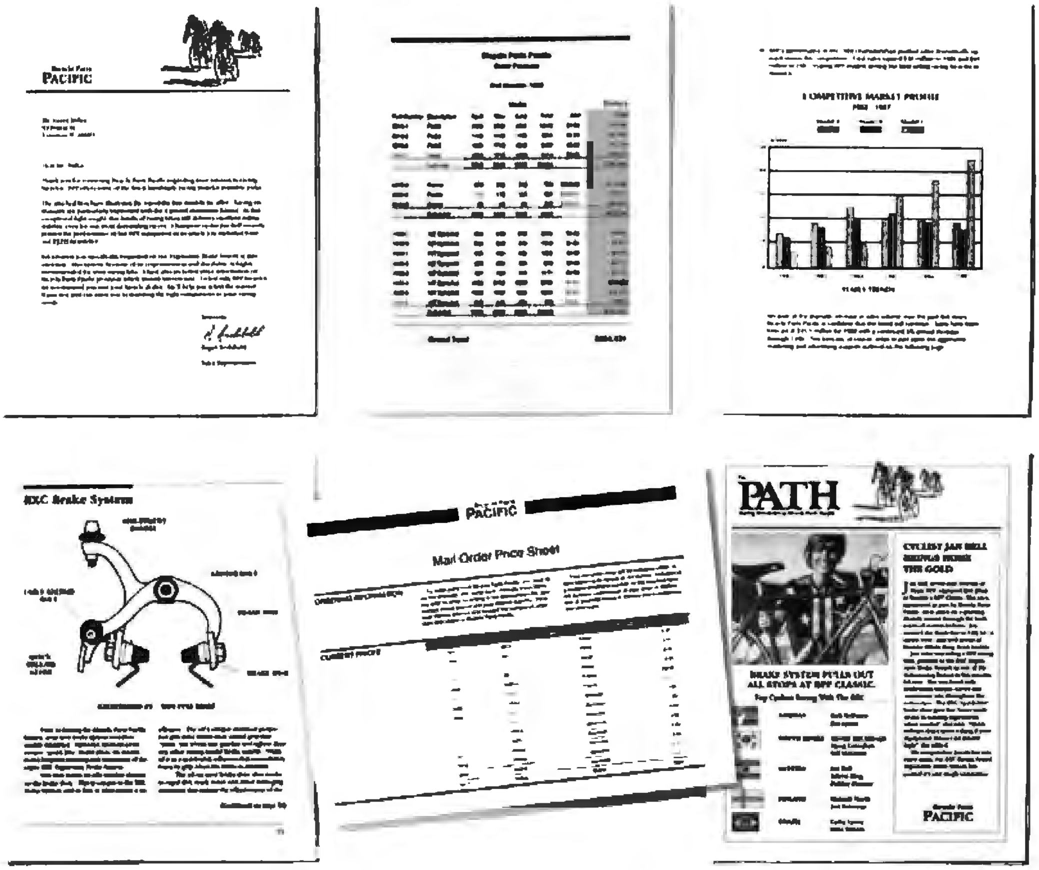

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Print samples were created using Microsoft Word, Microsoft Excel, and Aldus PageMaker

Listing 1: *This simple macro provides a look at Sprint's macro language. The routine formats a Sprint text file for use with Ventura Publisher by replacing quotation mark characters (ASCII 34) with printers' open or closed quotation marks (indicated in Ventura Publisher as* <169> *and* <170>, *respectively).*

```
Ventura :                        ; Name of macro.
 while (34 csearch) {            ; Search for ASCII
                                 ; 34 (") occurrences and
   c                             ; when found move forward
                                 ; one character.
   if istoken                    ; If the new position is
                                 ; part of a word,
      (r c del insert "<169>")   ; back up, delete the ", and
                                 ; insert <169>.
  else                           ; Or, if the position is not
                                 ; part of a word,
      (r c del insert "<170>")   ; back up, delete the ", and
                                 ; insert <170>.
  }                              ; This } ends the "if true"
                                 ; condition for the search.
  r toend                        ; Means "reverse to end"
                                 ; (i.e., go to top of file).
```

Table 1: *Benchmark results for Sprint versus Microsoft Word and WordPerfect. The use of a mouse with Microsoft Word and Sprint gives both programs an advantage on the keystroke count test. All times are in seconds.*

	Sprint 1.0	Microsoft Word 4.0	WordPerfect 4.2
Keystroke count	160	158	246
Search and replace	46	24	8
Reformat 4K-byte file	1	<1	<1
Convert ASCII to word processing	11	1	7
Convert word processing to ASCII	17	5	12
Print in columns	101	160	90
Scroll text	32	35	89
Load word processing file	1	3	2
Save word processing file	3	6	4

lems. For example, in one document I created, I found that strange blank spaces and randomly positioned capital letters showed up in my printouts. Using the Customize Screen option, I discovered stray control characters in the file left over from my previous editing sessions. I deleted these, and the problem went away. Switching to control-character mode makes the text hard to read, however; tabs, for example, show up as ^I, and the actual tab spacing disappears.

To get an idea of what your text looks like without actually printing it, you can use the Preview command. This formats the text as if Sprint were printing it, with headers, footers, and margins displayed on the screen. But the text has the same fixed size and spacing that the raw text on the word processing screen has. So if you change to an 8-point proportional font, for example (so that a lot more text can fit on a line), the text on the preview screen doesn't change size. Since the character size remains the same on the screen, and the margins stay the same, where does all the extra text go?

The preview screen formats the text so that it shows the material that is flush against either margin, and the extra text drops from the middle of the line. Except for the first and last words of each line, the material is gibberish. There's no harm in this, since the point is to see how the page is laid out, but it's a bit disconcerting the first time you see it.

According to Borland, a version that supports graphics mode is in the works and will run under OS/2's Presentation Manager. Borland says that it avoided graphics for version 1.0 in order to make the software useful on a broader range of hardware and to enhance performance. Sprint does, indeed, respond well, and its benchmark results were respectable, if not blazing, compared to Microsoft Word and WordPerfect (see table 1).

I/O Issues

As for printed graphics, Sprint lets you use embedded commands to print Encapsulated PostScript Format (EPSF) graphics as part of a document, but it doesn't handle any other kinds of graphics files. There are also commands to draw lines and bars, but these, likewise, work only if you are using a PostScript printer. Sprint also makes provisions for using a Microsoft Mouse.

Sprint includes a 100,000-word spelling dictionary and a 25,000-root-word thesaurus. The dictionary has an autospell feature that you can set to beep when you misspell a word. The autospeller actually kept up with my typing (about 80 words per minute), and I found the instant feedback valuable.

Also included is a mail-merge facility for generating form letters, an outliner, style sheets, and a glossary facility for capturing and replaying keystroke sequences. There are commands for creating indexes, which are dynamic (i.e., they follow page-numbering changes).

You can configure Sprint to save text automatically—it updates your changes to a separate "swap" file every time you stop typing for at least 3 seconds, so that a power outage or forgetting to save the file won't cost you a day's work. Sprint automatically retrieves unsaved changes from the swap file each time you call up the document. You can also set the interval between disk updates to any number from 0 (no update) to 60 seconds. This process is transparent; it doesn't snag the keyboard or the display, and the only evidence that shows it occurring is the disk indicator light.

You can have up to six windows open on the screen at one time, each containing either different documents or different parts of the same document, and you can shift text between windows. Each window stretches all the way across the screen, but the vertical size is adjustable and can be as shallow as one line.

The documentation—a softbound user's guide, an advanced user's guide, a reference guide, and an alternative user interfaces booklet—is thorough. However, Sprint's help screens are all that most users will need to get up and running. Also, while each book has an in-

continued

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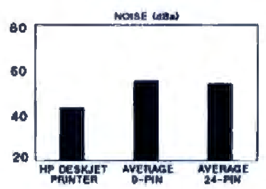

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HEWLETT PACKARD

dex, the documentation could use a central index. There's no hint in the user's guide of advanced features, such as column formatting, which are discussed in the reference guide.

Run for the Money

Seen from a programmer's viewpoint, Sprint is a delight. Seen from a typist's viewpoint, however, it offers nothing new. Sprint's most unique feature is its programmability. But how many typists want to write their own user interfaces? And even experienced users are more likely to cringe than salivate when presented with yet another programming language.

Putting programmability aside, Sprint offers most of the features of its competitors and is adequate. However, it doesn't share the aspiration of the current generation of word processing programs: adding desktop publishing functions (see "Word Processors for Desktop Publishing" in the May BYTE). For example, Total Word can capture screen graphics from other programs, and MASS-11 supports Lotus PIC, Hewlett-Packard Graphics Language, and EPSF files. By contrast, Sprint has no graphics mode, supports only PostScript graphics files, and you can create only lines and boxes with it. It also has no redlining, scientific equations, on-screen math, or other recent offshoots of the word processing features checklist wars.

On the other hand, at $199.95, Sprint is far less expensive than its rivals. It's a no-risk word processor that's so easy to use that anyone brought in from a temporary office help agency could pick it up immediately. Sprint's multiple interfaces could also help users that are familiar with different word processors to standardize on one word processing file format without having to learn a new keyboard interface.

If your word processing needs are more sophisticated and you're willing to do some programming, Sprint is a word processor you can ultimately adapt to any project. If you want a word processor with capabilities that push the limits of technology, Sprint won't fit the bill. But if desktop publishing functionality isn't essential, or if you want a word processor you can alter to match your needs, then Borland has something for you. ■

Lamont Wood is a freelance writer in the computer and electronics fields and lives in San Antonio, Texas. He has been using word processors professionally for more than 10 years. He can be reached on BIX as "lwood."

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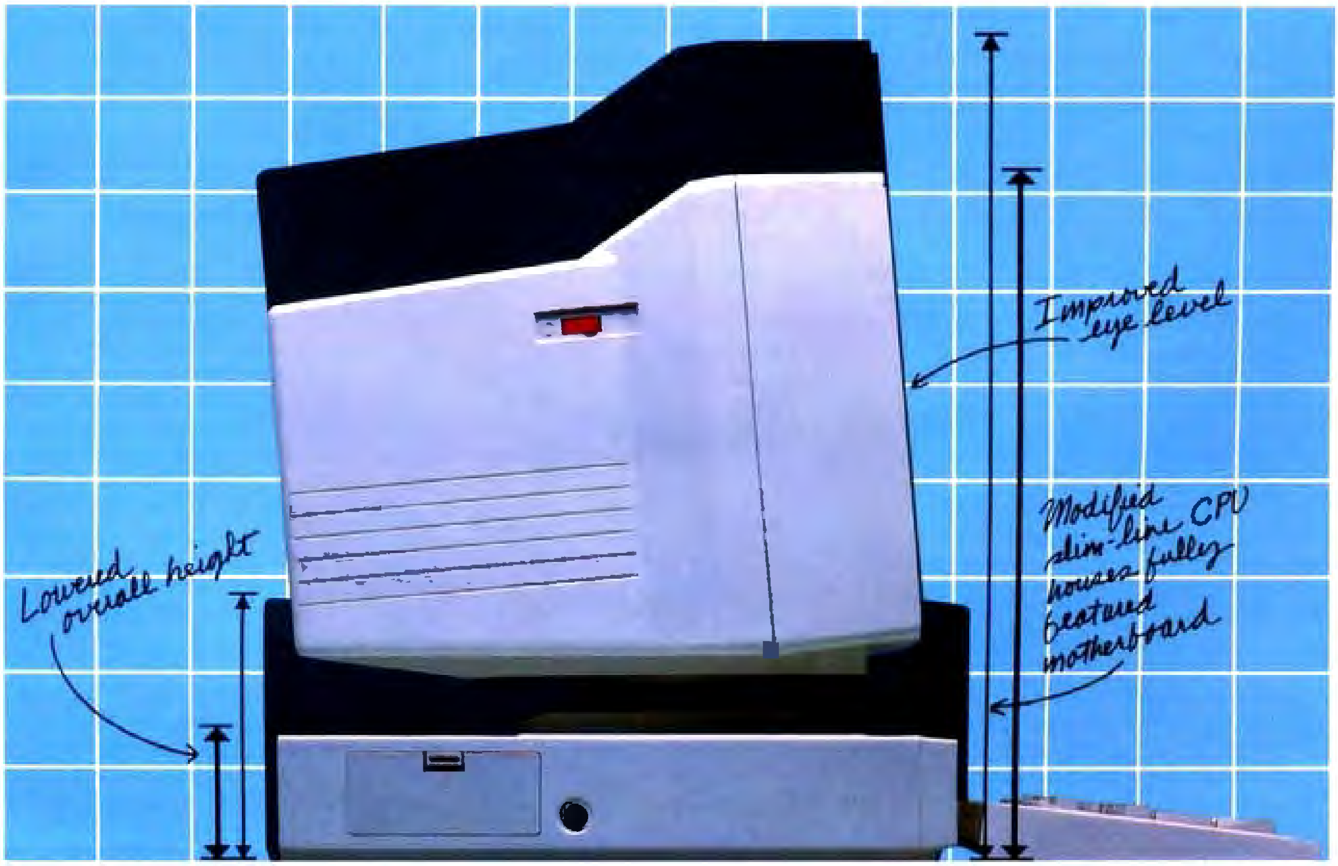

Thanks to an advanced design, and the advanced manufacturing techniques needed to turn design into hardworking reality, the TCS-4000 is an ideal computer for even the most demanding corporate system requirements. Yet, its price is such that it can easily and effectively serve as a workstation.

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Review Update

Poor Man's PostScript

No longer must you invest a minimum of $4000 for a laser printer or $1800 for an upgrade card to take advantage of PostScript, Adobe's standard page-description language (PDL). GoScript, a $195 printing utility from LaserGo (9235 Trade Place, Suite A, San Diego, CA 92126, (619) 530-2400), generates output on a Hewlett-Packard LaserJet Series II printer from most PostScript files. And you don't even need a fancy laser printer. GoScript can produce PostScript documents on your lowly dot-matrix. A poor man's dream!

Unfortunately, the dream withers under the harsh glare of reality. Because GoScript requires no intelligent laser printer controller board, you'd expect a trade-off in processing speed. This trade-off, though, is hard to swallow. As a reference, I ran GoScript through the same benchmarks used for our PostScript laser printer review (September BYTE). I also used the same IBM PC AT with PageMaker and Adobe Illustrator to create and print Encapsulated PostScript files. In the review, the QMS ColorScript 100, a thermal printer with beautiful output in four colors, posted the slowest time by far on all three speed tests. The large (30-page) text file printed in 26:22 (minutes:seconds); the small (6-page) text file printed in 6:02; and the 1-page graphics file printed in 4:57.

I started the tests by booting GoScript and sending the large text file to a dot-matrix printer. Four pages and 90 minutes later, I aborted. The small text file poked through in 22:15, and the 1-page graphics file took 15:40. I thought the throughput times might improve when printing to the LaserJet, but they actually got worse. The graphics file, for instance, took 35:05.

For $195, you may be willing to live with slow-motion throughput, but it'll be even harder living with the output. The dot-matrix printout approached illegibility, and the laser output, though much better, did not support special-effects features (e.g., rotation and shadowing). GoScript uses Bitstream outline fonts rather than true Adobe fonts, but that's not the problem. PostScript was not made for dot-matrix printers, and it shows.

When I ran GoScript on a 20-MHz 80386 system, the times edged up to tolerable limits. The graphics file came through at 3:03, and the small text file took 13:38. Unfortunately, us poor folk can't afford 20-MHz 80386s. And so it seems PostScript must remain a luxury of the privileged elite.

Adobe's Destiny: More Clones Ahead

As hard as Adobe tried to stave off imitators by employing proprietary scaling algorithms and hiding embedded font commands, any industry standard-bearer must one day face the inevitable. Destiny Technologies (930 Thompson Place, Sunnyvale, CA 94086, (800) 874-5553; in California, (408) 733-3171) has joined the first wave of PostScript clonemakers with the release of PageStyler PDL.

PageStyler has a 12-MHz 68000 CPU and 2.5 megabytes of RAM (upgradable to 4.5 megabytes). The PC-resident board costs $1195, but you'll also need the $495 software and at least one of the $100 printer interface cards (for the HP LaserJet Series II, Destiny LaserAct II, Acer LP-76, or Canon LBP-8 II). That still adds up to a significant savings over true PostScript boards. The software includes 13 base fonts. Options include an additional 22 downloadable fonts and a memory upgrade.

The PageStyler software took a while to load (4:26), but you can set up your autoexec file to do that. The large text file printed in 8:27, at the bottom of the heap compared to other PostScript printers or even true PostScript boards such as the JetScript ($2495). However, PageStyler handily beat out PC Publisher's Kit, a PostScript clone we tested in September. The small text file printed in 1:59. Only the ColorScript was slower than that. PageStyler also came up slow on graphics throughput, posting a time of 4:12.

PageStyler, despite its slowness, did produce high-quality output. Destiny selected Bitstream fonts over the Adobe versions, but the differences between the two, though noticeable, are not flagrant. PageStyler performs all the slick PostScript effects: shading, rotation, curves, character manipulation, and shadowing. If you have a laser printer without PostScript capability, you should take the upgrade plunge. The improvement in output will startle you. Which upgrade path to take will be a harder choice to make. You can go with true Adobe PostScript or you can opt for a less expensive—and slower—clone.

PostScript Printing from NEC

NEC (NEC Information Systems, 1414 Massachusetts Ave., Boxborough, MA 01719, (508) 264-8000) throws its hat into the PostScript ring with the Silentwriter LC-890. The $4795 unit is actually an LED printer, not a laser. It comes with a 10-MHz 68000 processor, 3 megabytes of RAM, 35 resident fonts, and two 250-sheet hoppers. The rated speed is 8 pages per minute at 300 dots per inch. Interfaces include parallel, serial, and AppleTalk connections.

The Silentwriter is one of the easiest page printers to set up and use. The toner cartridge snaps over the toner hopper for quick and clean loading. All functions and interfaces are configurable from a menu on the control panel, and a print-density dial controls the print darkness.

In addition to handling all of PostScript's special features, the Silentwriter produces exceptional print with particularly smooth gradations. NEC has gone with the real thing: true PostScript (version 47) and licensed fonts from Adobe.

The printer is slow, though. It came out near the bottom on all three of the AT speed benchmarks when compared to the printers reviewed in September. The large text file printed in 5:59, the small text file in 1:37, and the graphics file in 3:03. The Silentwriter did much better on the Macintosh side, placing among the upper half of those printers tested. Interfacing through AppleTalk, the Silentwriter registered times of 7:40 on the large text file, 1:30 on the small text file, and 1:57 on the graphics file. Despite slow times, this is a solid product and a good buy.

—Stanford Diehl
Testing Editor, BYTE Lab

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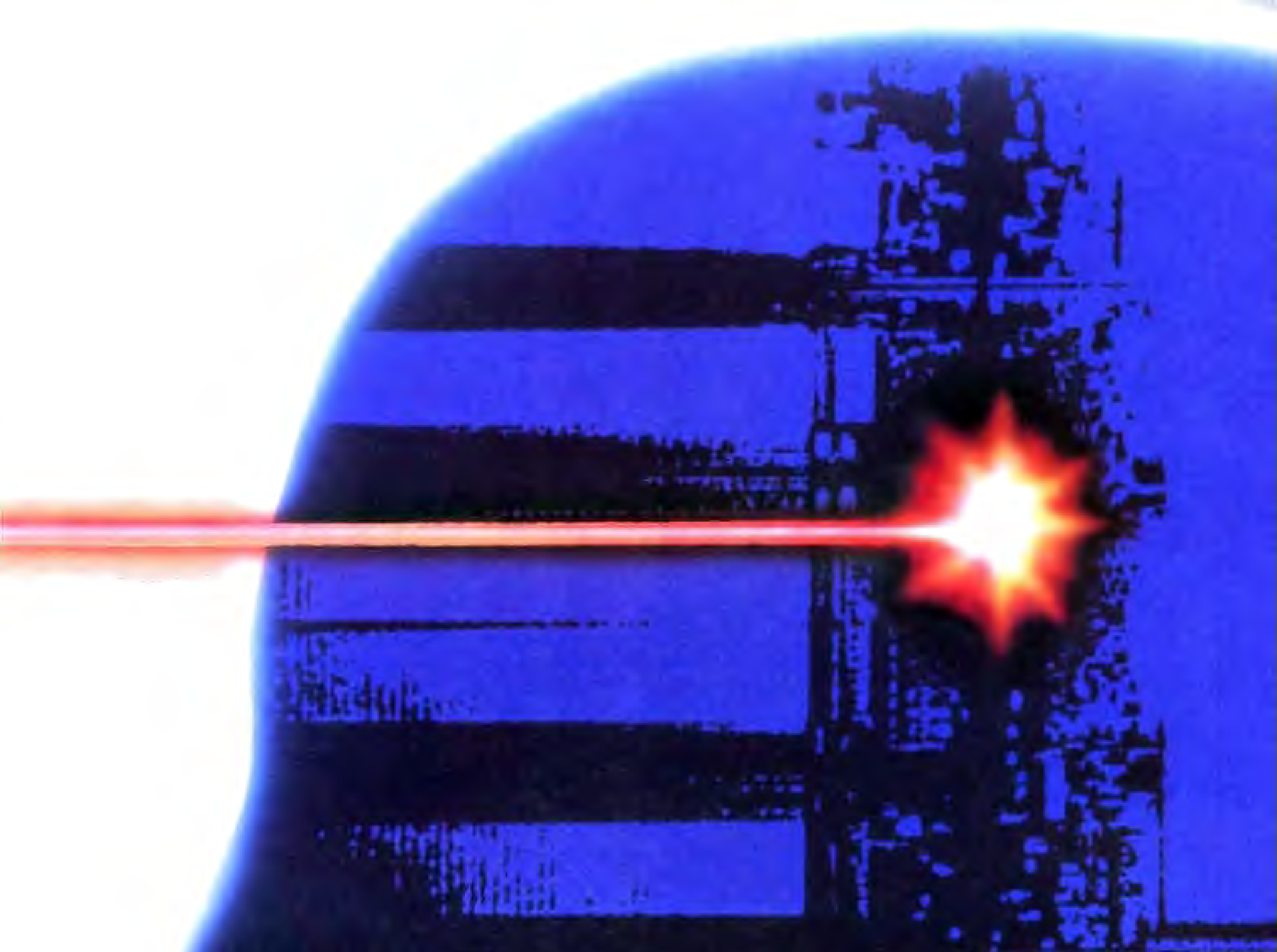


Hypertext

Imagine, if you will, walking into the New York Public Library and picking up a book on Mozart. You begin to read and learn that Mozart was an Austrian composer in the late 1700s. You wonder what else was happening in Austria then, so you go to the card catalog, find a book on Austrian history, go to the stacks, locate the volume (if it's not checked out), and read it before you continue.

In this book, you find a reference to old Salzburg, and you wonder what it looked like. Back to the card catalog, and the stacks, to find a book with images from that time. Finally, you get back to Mozart and read of a piano concerto you've never heard. This time you head for the library's record collection and listening room.

This process continues until you have either satisfied your desire for knowledge on the subject or worn yourself out searching for it, whichever comes first.

Now imagine sitting at your computer and bringing up a hypertext system on music. You begin to read about Mozart. When you wonder about Austrian history, you simply highlight the text and request more information with a mouse click or a few keystrokes. To find images of old Salzburg, you use the same process. And to hear the piano concerto? The same.

Sounds a lot simpler, doesn't it? The only restriction to this seemingly endless fountain of knowledge is that the author of the hypertext system had to establish the connections for you to follow and provide the additional knowledge for you to retrieve.

In the article "A Grand Vision," Janet Fiderio delves into the mysteries of hypertext: where it came from (Ted Nelson's Xanadu and Douglas Engelbart's NLS), where it is now (Guide and HyperCard for microcomputers), and where it's going (CD-ROM). Janet describes its form and various functions, such as browsing, nodes, and links—aspects that separate hypertext systems from normal databases—as well as the two main directions of recent hypertext research.

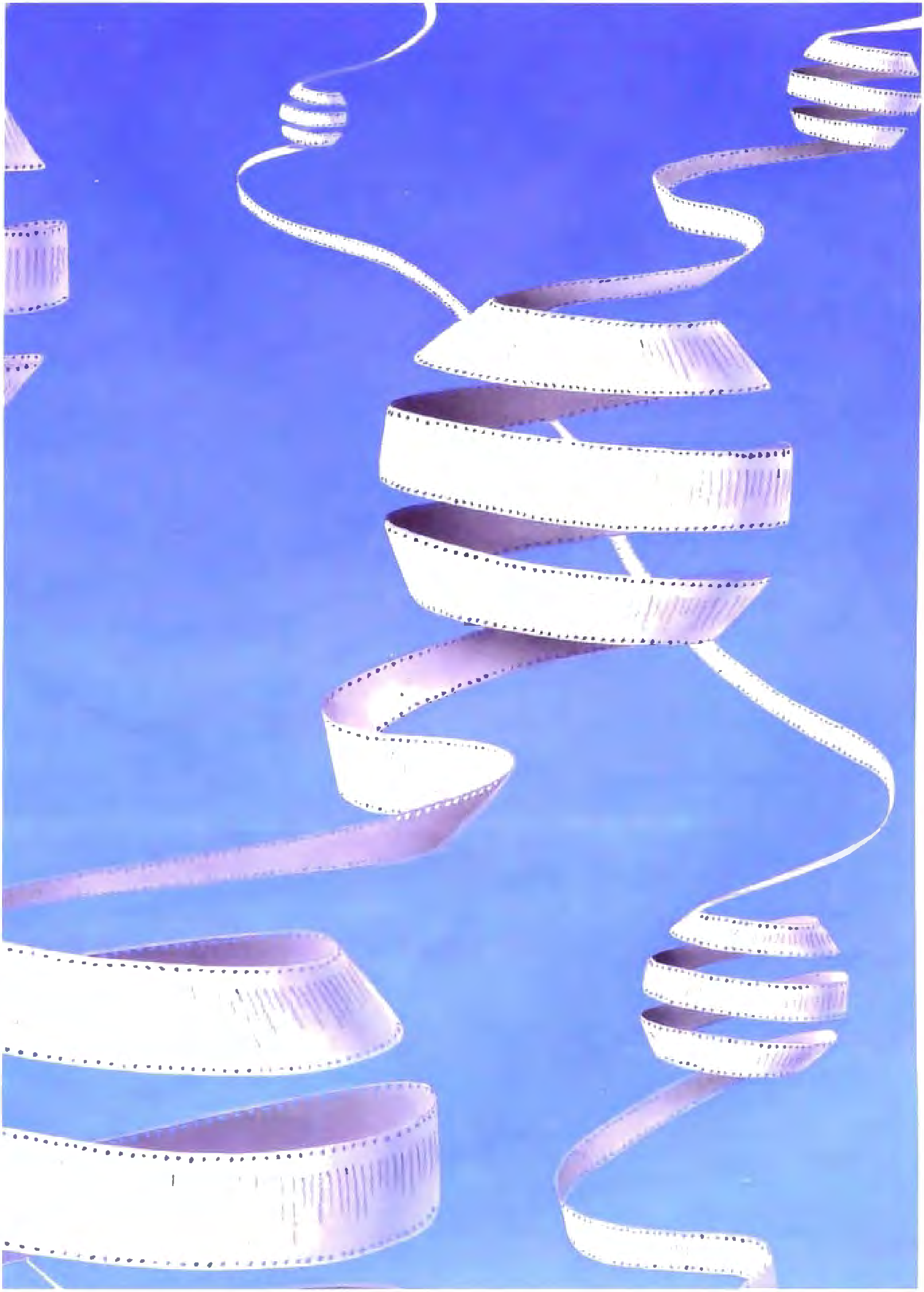
One of these directions, using hypertext for great libraries of information, is the thrust of the article "From Text to Hypertext" by Mark Frisse. To organize large volumes of textual material, you must convert and structure quantities of (hopefully) on-line text into hypertext format. Mark deals with this process and its attendant problems.

The other research direction is using hypertext as an aid to problem resolution. In their article "The Right Tool for the Job," Michael L. Begeman and Jeff Conklin describe the gIBIS system's approach to system analysis. This system provides a framework within which to present issues, take positions on those issues, and argue with those positions—a framework for constructive discussion.

Finally, in "Hyper Activity," we provide a variety of resources, including some current hypertext products, various educational institutions involved in hypertext research, and a short, noninclusive reading list.

As the mass of knowledge we all must assimilate in this multifaceted world of ours continues to grow, from Mozart to microcomputers, the future of hypertext systems looks bright indeed.

—Jane Morrill Tazelaar
Senior Technical Editor, In Depth



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A Grand Vision

Hypertext mimics the brain's ability to access information quickly and intuitively by reference

Janet Fiderio

For 1945, the vision was a grand one: an on-line text and retrieval system that contained not only post-war scientific literature but also sketches, photographs, and personal notes. The machine, called a memex, would let you browse and make associative links between any two points in the library. You could then record and traverse them at will.

Vannevar Bush, President Roosevelt's science advisor and overseer of all wartime research, including the Manhattan Project, envisioned, yet never created, the mechanism. It became the foundation for all hypertext systems. (See the text box "The Pioneer Spirit" on page 238.) Now, 43 years later, hypertext applications are finding their way out of the research laboratories and into the market.

What Is Hypertext?

Hypertext, at its most basic level, is a DBMS that lets you connect screens of information using associative links. At its most sophisticated level, hypertext is a software environment for collaborative work, communication, and knowledge acquisition. Hypertext products mimic the brain's ability to store and retrieve information by referential links for quick and intuitive access.

Current hypertext programs don't use typical database record and file structures; their databases usually consist of screen-size workspaces called *nodes*. You can fill these computer index cards with text, graphics, images, and audio and video data. Most hypertext implementations link nodes in either a hierarchical or nonhierarchical fashion; some support both structures.

Early designers envisioned hypertext either as an environment for interconnected writing and literature storage or as a sophisticated, multipurpose research environment that encouraged cooperative thinking on shared projects. Product development now proceeds on several fronts. Universities, including Brown, Carnegie-Mellon, and the University of North Carolina at Chapel Hill, are experimenting with hypertext systems as multiuser teaching, library-reference, and writing environments. Commercial hypertext applications—like on-line reference manuals and documentation, public information systems, authoring systems, cooperative work systems, and personal organization tools—are either available or in development.

Hypertext programs, and the free-flowing databases that are their trademark, have been adapted for electronic publishing, project management, systems analysis, software development, and CAD. You can also find software

continued

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(e.g., outline processors, teleconferencing systems, and windowing products) that borrow some, but not all, hypertext techniques.

In Many Flavors

Hypertext systems come in many flavors and support varying tasks. Typical hypertext software consists of a text editor, graphics editor, database, and browsing tool for three-dimensional viewing. (The *browser* is usually a graphic that you use to become oriented within a database filled with many nodes.) Bit-mapped displays, a mouse, windows, icons, and pull-down menus are all standard hypertext tools.

The various systems have one underlying database, and so far there's no DBMS standard. Current products use everything from home-grown to relational databases. Some products let you distribute the database across a number of networked file servers to create a collaborative hypertext environment.

When you use a hypertext application that you didn't help to author, you really see only the front-end of the program—the user interface. The machinations of the back-end, the database, are hidden. Depending on the application, some systems feature highly developed front-ends, like those in CAI systems, or complex back-ends, like those in research and cooperative work environments.

As a system user, you have access to a number of indexing capabilities. You can create inverted files of words, phrases, or keywords in context and perform word or Boolean searches. Some programs let you create hierarchical indexes, like tables of contents, while others let you create content-based indexes, like thesauri. Some systems let you create both.

If you write applications or use a system that doesn't delineate between author and user, you have access to hypertext's editing, linking, and development tools. You can author both simple and complex applications, depending on the hypertext system you use. In addition, many products let you invoke programs from your application at the touch of a mouse. These programs can be short and macro-like or large conventional programs that you would normally run from the operating system.

Not surprisingly, the only thing standard about hypertext systems is that there are no standards. It's a new technology with creative new implementations. One emerging standard, the Standard General Markup Language (SGML), lets hypertext authors create links across various applications. Although you usually hear SGML described as an electronic-publishing standard indicating type sizes and formats, it also features useful document-structure cross-referencing and indexing commands. Most text editors can read links created with SGML.

A Discrete Affair

To use a hypertext system, you must get used to parsing your information into small discrete units, or nodes, which consist of a single concept or idea. In theory, nodes are both semantically and syntactically discrete. The information contained in a node can usually be displayed on one computer screen. In situations where you need more space, some programs let you create longer nodes that scroll up from the bottom of the screen.

Nodes can come in two varieties:

The Pioneer Spirit

Vannevar Bush designed a simple machine by today's standards. It used microfilm and photocells to store its data. But Bush, who was President Roosevelt's science advisor, dreamed up an information organization and retrieval scheme bold enough to influence two hypertext pioneers 20 years after the fact.

The first researcher influenced by Bush's concepts of associative links and browsing was Douglas Engelbart. His research at the Stanford Research Institute in the early 1960s centered around using computers to augment human intellect. At that time, he began developing the On-Line System, or NLS, now called Augment and used internally for several projects at McDonnell-Douglas.

Augment is an on-line work environment. In its original form, it served as a storage receptacle for memos, research notes, and documentation; as a communication network, since on-line conferencing was possible; and as a shared work space where researchers could plan and design projects.

Still running on a DEC 20, Augment stores information in a sophisticated hierarchical structure allowing nonhierarchical branching. Since speed was important, Engelbart invented the mouse as an input device. He also came up with the concept of viewing filters. Via filters, you can view a shortened version of the statement or file, which lets you move quickly through a hypertext database, scanning for only pertinent data. In fact, Engelbart was the first to use an F10 context-dependent Help system, an integrated mail system, multiple windows, and a shared screen.

While these developments helped researchers deal with complex multidimensional problems, Ted Nelson took Bush's concept a step further. Nelson envisions hypertext as an on-line network holding the world's literary treasures under one roof. Xanadu is his version of the publishing utility of the future. It is, perhaps, the most well-known hypertext system. It was Ted Nelson, in fact, who originally coined the word *hypertext* over 23 years ago to mean nonsequential writing.

As designed, Xanadu will be an ever-expanding publishing environment that millions of people could use to create, interact, and interconnect with linked electronic documents and other forms of hypermedia, such as movies, audio, and graphics. It's designed to run in parallel on many networks of servers. On a basic level, a storage manager lets you create links between like topics and then keeps track of the origins, variations, and interconnections of the text.

Xanadu documents consist of native bytes, the original document and inclusions, information originally found in other documents, and hidden pointers. Links are attached to bytes. You can ask the system to tell you where bytes came from, and you can ask to see them in their original form.

Since the number of documents created via Xanadu's system can be immense, the system tracks documents using a four-part designator that can locate the server, user, document, and contents. (For a detailed explanation of the tracking scheme, see "Managing Immense Storage" in the January BYTE.) Xanadu is more than just an on-line reference system, however. It's also an interactive writing and conferencing environment.

One of the most radical points about Xanadu is that existing programs won't operate under it. New applications will need to be developed for it to gain widespread acceptance.

A Xanadu prototype is now up and running on a Unix-based Sun workstation. Nelson claims that products based on the Xanadu hypertext concept will ship sometime in 1989 (see the item in Microbytes in the July BYTE).

typed and untyped. An untyped node is a box for information. It has no label or descriptor, so you can fill it with anything. A typed node is labeled, and the descriptor helps you determine the style of information contained in the node. Types help you to classify nodes or define specialized operations. They are also helpful when you're browsing through a database looking for a particular area of interest.

One system that uses typed nodes is gIBIS, the Graphical Issue-Based Information System from MCC (Microelectronics and Computer Technology Corp.). It's a prototype designed for systems analysis of complex problems. It lets you create three basic types of nodes: *issue* nodes, describing an issue you wish to discuss with your work group; *position* nodes, describing an assertion that resolves an issue; and *argument* nodes, containing your objection or support for a position node. Organizing nodes in this manner helps gIBIS users navigate easily through a complex hypertext network. (For more details, see the article "The Right Tool for the Job" on page 255.)

You can also combine nodes to form *composite* nodes. These are composed of related subnodes that can be handled as a single object or broken out into individual elements. You can create icons to reflect the contents of a composite node for easy access. You can also rearrange subnodes if needed.

Depending on the hypertext product you use, nodes can be displayed on the screen one at a time, as in Apple's HyperCard, or in groups, as in NoteCards from Xerox Palo Alto Research Center (PARC), a system designed for idea processing (see figure 1).

The Missing Link

In general, links are used to connect the nodes. A hypertext link is like an electronic footnote, an endnote, or a parenthetical phrase. That is, just as footnotes and parenthetical phrases direct readers of printed material to related points or further topics for research, hypertext links connect you to associated text or ancillary information.

Links, therefore, are the mode of transportation in a hypertext network. You follow them to move about between various nodes. You can usually embed them in text and then edit and review them to ensure that they are valid. You can also create, delete, or change link attributes.

Links must have two qualities: Your computer must be able to trace or follow them, and they must be able to transport you quickly from one node to another. Usually one or two keystrokes or the tap of a mouse button is all you need to transport you from one node to the next. The total time required to traverse a link is small, usually only a second or less.

While it's normally up to you to create links between nodes, some products can create links automatically; this ability may be useful for systems that need to cross-reference large text databases. Systems such as NoteCards also let you "type" links. A typed link specifies a particular relationship between two nodes, one that you define.

Links can do more than just connect two nodes, however. Depending on the hypertext system, links can connect annotations to a document (including notes and comments, like electronic Post-its) and provide organizational information, such as where the text fits in a table of contents or where it originated. Therefore, links can help define the node's relationship to other nodes within the database. Links may also clarify the contents of charts and graphics by connecting the graphics to explanatory information like longer descriptions.

Links usually originate at a single point, like a sentence, called a link *reference*. Their destination, called a link *referent*, is usually a node, a chunk or region of text.

Points and Buttons

A *point* is a single character, token, or icon that "points out" a link in a document. It's usually identified by either the name of the destination node, the link, or an arbitrary string, and by whether it's a source or destination point.

HyperCard and Guide (from OWL International) refer to points as *buttons*. Buttons can trigger the display of additional information, traverse a link, or activate a program. They can be represented by text or icons, or, as in HyperCard's case, they can even be invisible. (For more information on these two popular microcomputer hypertext systems, see the text box "What about Micros?" on page 242.)

A Bird's-Eye View

Hypertext systems are designed to let you browse through or quickly peruse associated nodes. While this feature is important, it can also be a problem, because in large hypertext databases, you can forget how or why you got to where you are. To alleviate this problem of disorientation,

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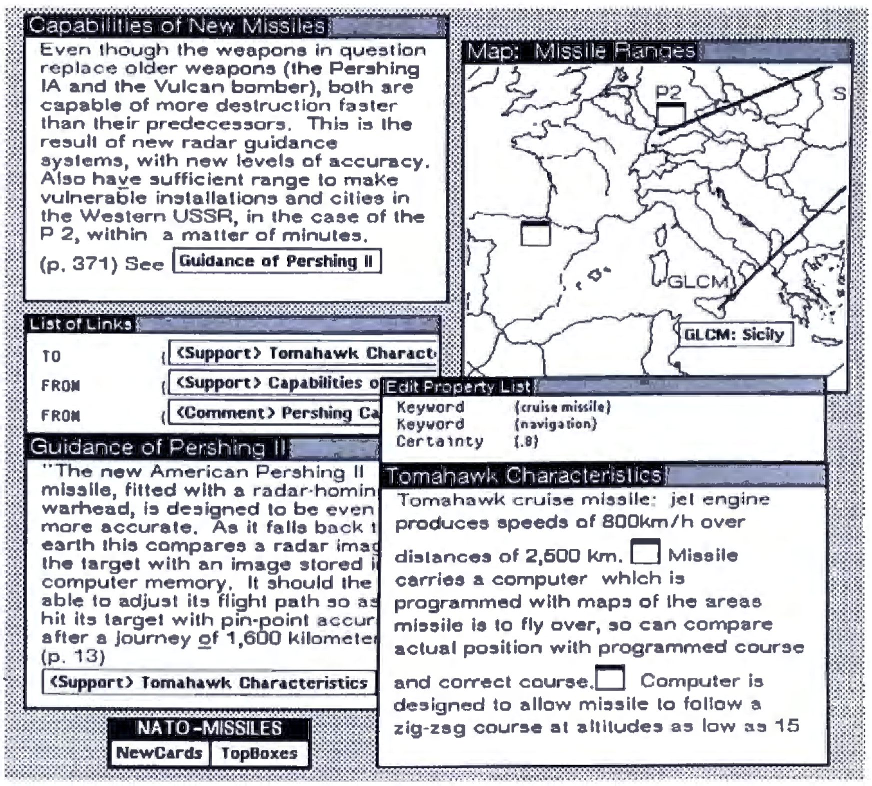

Figure 1: *NoteCards' display of multiple nodes. Note that the lower two nodes further clarify the topic introduced in the upper left node. (Graphics courtesy of Frank Halasz from MCC.)*

many systems provide a tool called a *graphical browser*.

The graphical browser is a node that contains a structural diagram of a network of nodes. Browsers usually supply a global or "zoom lens" map of the network. You can use the browser to orient yourself or to move directly to an area you're interested in by selecting that point on the screen with a mouse (see figure 2). While not all systems provide a graphical browser, most attempt to provide some type of overview system that helps you stay oriented in the network and visualize how information is linked. In large hypertext environments consisting of hundreds of nodes, browsing tools are especially important because it's so easy to get lost.

A browser can also help you decide on your next action. For example, Symbolics' Document Examiner, an on-line hypertext documentation system for Symbolics' Lisp machines, uses its browser, the Show Overview command, to help you quickly locate information. The command displays a tree-structured view of related nodes called *records*. By repeatedly using this command, you can get a feel for the context of the surrounding subject area and familiarize yourself with an area of interest.

A Variety of Tools

Depending on the particular product you use, commands and features may vary. Some hypertext products use a *path* to help you find your way through a network. Paths are default routes through a database; they guide or direct you through an ordered list of nodes.

When you follow a path, you are really letting the original author guide you to the next logical node, which relieves you of navigational duties. An example of a system that used paths is Textnet, created by Xerox PARC researcher Randall Trigg. It was designed as a multiuser literary-exchange system for the scientific community.

A viewing filter is another interesting hypertext tool. Basically, a filter does exactly what you'd think it would—it suppresses detail. By filtering the lower level of a node's contents, you can scan quickly through a network for the information you need.

Where the Products Are

The availability of windowing products and low-cost workstations with high-resolution graphics and storage options like CD-ROM have made the development of hypertext products more attractive. Fifteen or more systems are now used in universities and in research centers such as MCC and Xerox PARC, and commercial products are in development.

Hypertext systems vary significantly, depending on the applications and users they address. They are designed for either single-user or multiuser applications and are most commonly run on workstations, although more and more microcomputer applications are becoming available. HyperCard and Guide are perhaps the best known of the microcomputer products.

Typically, you'll find four types of hypertext systems: problem-resolution systems, on-line browsing systems, library or literary-exchange systems, and multipurpose systems. Depending on the type of system, the tools available may differ.

Systems designed primarily for problem resolution and network creation feature tools that help you define and analyze data through structured types of links and nodes. These systems help you organize elements in unstructured problems and feature commands that let you create and modify internal links between concepts quickly.

Most importantly, the tools can usually suppress details through viewing filters similar to those in Douglas Engelbart's On-Line System (NLS). (NLS is now used as a prototype for several collaborative-work projects at McDonnell-Douglas under the name Augment.) Such products might be used for systems analysis, idea processing, or authoring new applications. Augment and gIBIS are examples of systems designed to be problem-resolution work environments.

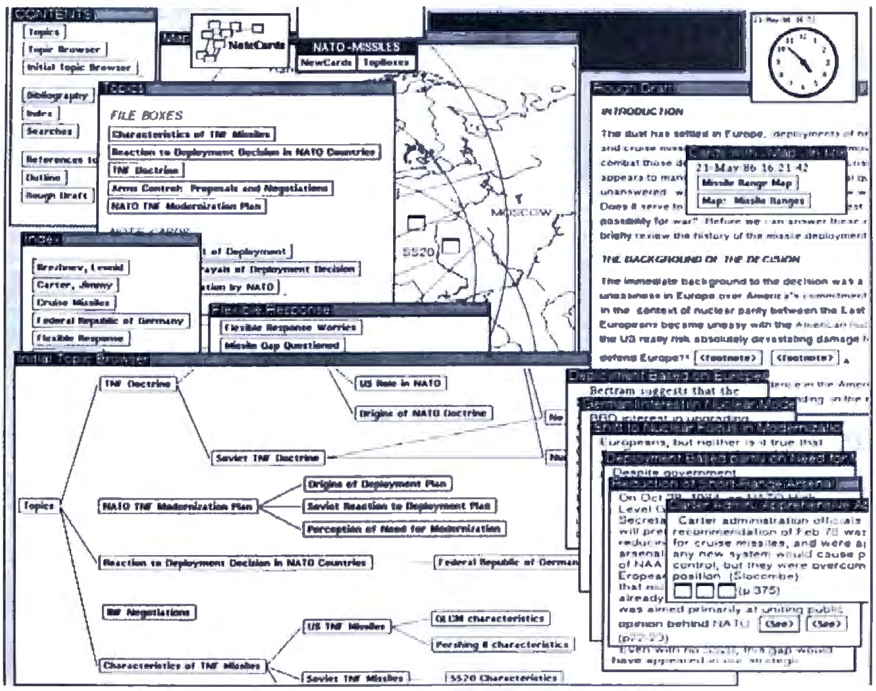

Figure 2: *NoteCards' displays can hold a significant amount of information. In this screen shot, a graphical browser (lower left) takes up much of the display space; a contents node, a topics node, and an index node are also displayed; and pages of relevant information are shown at the lower right. (Graphics courtesy of Frank Halasz from MCC.)*

Just Browsing

Hypertext systems created primarily for browsing, such as CAI programs or on-line reference manuals, have fewer user tools for editing or link creation. These systems feature clear, understandable screen displays for presenting information and easy-to-operate browsing commands for perusing it. For example, the Document Examiner features a clean, book-like user interface and heuristic on-line string and keyword searches. You use these features to browse through the documentation, sometimes viewing information in several levels of detail.

Like many other browsing systems, the Document Examiner won't let you modify a reference manual, but you can keep a chronological record of recent searches or information of interest using the Bookmarks Pane. You can save personalized bookmarks and use a mouse to call bookmarks for fast retrieval. And

continued

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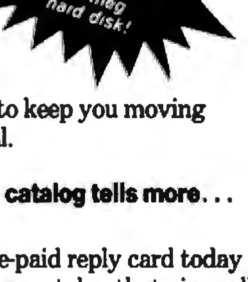

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What about Micros?

Want to test the hypertext waters and see what all the hoopla is about? Well, if you don't have a workstation handy, two of your primary options for microcomputer hypertext environments are OWL International's Guide and Apple's HyperCard.

Guide

Guide, which runs on both the Macintosh systems and the IBM PC AT and compatibles running Microsoft Windows, is a general-purpose hypertext tool (see "Guide" by William Hershey in the October 1987 BYTE). A few of the applications you can develop with it include on-line documentation, storyboards, E-mail, and CAI courseware.

Guide lets you create dynamic layered documents. The "guideline" network is organized in both a hierarchical and a nonhierarchical manner. To move about hierarchically, you use replacement buttons, which follow embedded menus. You can also use note buttons to bring up complementary information, such as a definition of a word or phrase. An inquiry button, which reveals the other buttons at your disposal, is also available.

To follow nonhierarchical links, you use the reference button, which will jump you to a new document or a different section of the document you're in.

Guide 2.0 uses an internal script language to let you execute external programs from your Guide document. You can also access and control videodisk players and modems via the serial port.

Last, but not least, a version called CD-Guide lets you create CD-ROM applications. OWL also markets a developer's toolkit so software developers can use Guide as a frame for an on-line help system.

HyperCard

HyperCard, available for the Mac II, the Mac Plus, and the Mac SE, is a personal organization tool and a simple database manager (see "HyperCard" by Gregg Williams in the December 1987 BYTE). It is also a commercial software developer's tool and is in use in some corporations as a front-end to the mainframe database.

This system uses screen-size cards (or window-size cards on the Mac II) organized into topic-related stacks to create simple databases. One card is displayed at a time. Touching your mouse cursor to a button on a card executes a script written in HyperTalk, HyperCard's programming language.

You can browse through already-created stacks (stackware), paint and type, author new cards and stacks, and write and edit HyperTalk scripts. (It's fairly easy to write scripts with HyperTalk because of its English-like syntax.)

HyperCard applications have been developed in many areas. Much stackware is available in the public domain.

Editor's note: *An assortment of public domain stacks can be found on BIX in the "stackware" area of the listings conference. See page 3 for more details.*

you can display a piece of documentation in an editor window while you write program code in another part of the screen.

The Document Examiner is particularly interesting because it's integrated into the software-development environment that it supports. It lets you scroll through the entire Symbolics software-development product documentation. The hypertext implementation of this documentation has an estimated 11,000 nodes and 23,000 links.

Another system designed for structured browsing by a large user base is ZOG, developed in 1972 at Carnegie-Mellon University and installed in 1982 as a computer-assisted information-management system on the USS *Carl Vinson*, a nuclear-powered aircraft carrier. Its applications included an on-line policy manual and an on-line maintenance manual with a videodisk attachment.

The commercial version of ZOG is KMS (Knowledge Management System) from Knowledge Systems. ZOG/KMS uses *frames* instead of nodes; frames are connected by two kinds of links, hierarchical and cross-referential. To help you navigate through a network, frames are formatted with a name, a title, a body, tree items linked to lower-level links, and special and command items. For simplicity and speed, ZOG and KMS use neither overlapping windows nor a graphical browser. The developers focused, instead, on fast text-search capabilities, multiuser support, and a minimal system-response time.

CD-ROM is particularly well suited as a database for hypertext browsing systems. One such system, being beta tested by Boeing for Knowledgeset Corp., is an on-line maintenance manual for the Boeing 757.

On-Line Libraries

Systems envisioned to support mammoth on-line libraries, documents, and document creation and critiquing, such as Ted Nelson's Xanadu, are the third major application group of current hypertext systems. These systems will probably feature complex, multiple structured back-ends, or databases, that can store everything from collaborative notes and research to E-mail, documents, and whole libraries.

Unfortunately, these systems will be difficult to implement because of the complexity and size of the task. Before such systems can become a reality, we must develop a standard user interface and a central storage system. In addition, we must be able to maintain the network such that all links are legitimate, copyrights and royalty issues are addressed, and the systems are fast enough to meet the needs of the general public.

Significant research in this area has been completed. Ted Nelson and his colleagues have worked on Xanadu for years. Randall Trigg's system, Textnet, let users store archival documents, making time-consuming research unnecessary. The system allowed collaborative writing and the critiquing of new documents. It featured two types of nodes—those containing text and those containing tables of contents of other nodes. The system defines over 80 types of links.

While many of the designs for the original on-line library systems had to be implemented from scratch, researchers at Bellcore are working on a hypertext-like front-end to connect existing on-line encyclopedias, libraries, and wire services. When completed, Telesophy, as the design is called, will let you access CD-ROM, recorded speech, and image archives. (Putting existing text onto a hypertext system is a challenge in itself. See the article "From Text to Hypertext" on page 247.)

Several well-known hypertext products function as general-purpose systems. You can customize these products to fit your application or simply to experiment with hypertext itself. NoteCards, HyperCard, and Guide are three such systems.

In the Driver's Seat

Regardless of the application, to use a hypertext system correctly, you must real-

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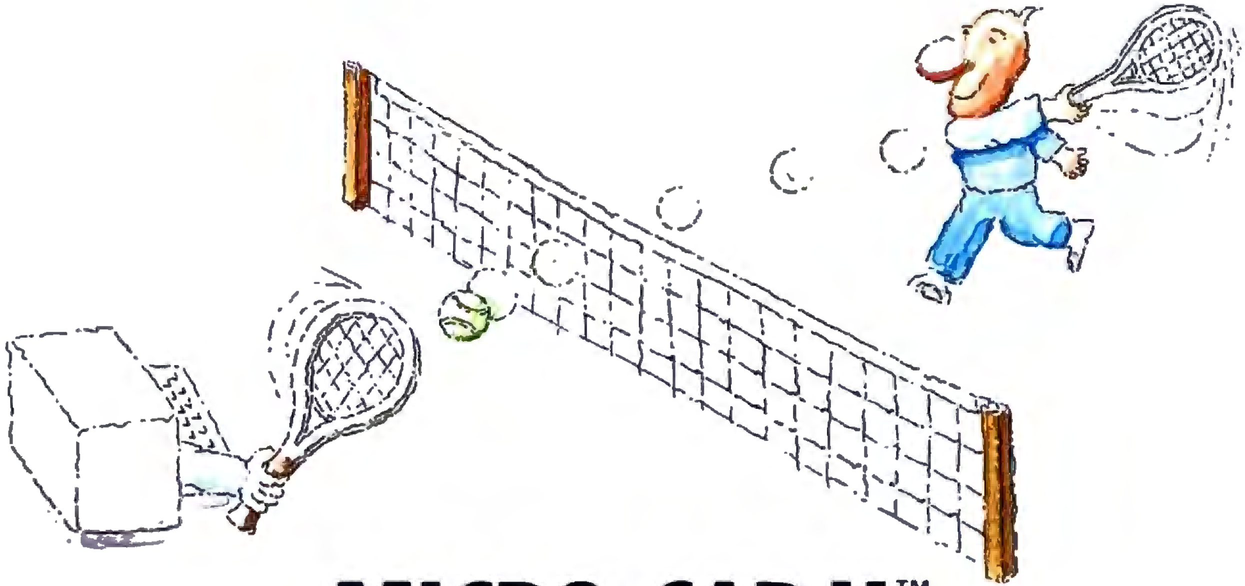

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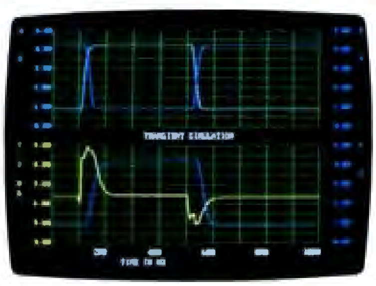

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Circle 288 on Reader Service Card

Some hypertext systems give you control when you may need guidance.

ize that you are in the driver's seat. Hypertext products won't think for you. They have no artificial intelligence. They might help you clarify and manage your thoughts or speed you through your research, but you are in control. Your value judgments determine what to include in the database, what type of links to create, and how to organize topics.

If you use an on-line hypertext documentation system, you decide which nodes to access and which links to follow. If you follow obscure paths, you may find it hard to locate information. Likewise, if your associative powers are weak and you create meaningless links, you may well end up with a worthless database. To put it simply, branching documents, like hypertext, require greater attention from both the system's users and its authors.

The Problem with Hypertext

Hypertext is an immature technology with many problems yet to resolve. Perhaps the most difficult part of creating a hypertext system is not building the user interface but creating sound underlying data models that can be maintained.

Since hypertext systems need to be maintained, systems designers should watch for uncontrolled linkages, which will become maintenance problems. Just as large software programs with many patches can turn into "spaghetti" code, so a hypertext system can turn into a morass of meaningless, obscure connections and references. Hypertext systems, therefore, must let you edit and delete links and nodes easily.

Another problem for some users is that some hypertext systems give you control when, in fact, you may need guidance. You may, for example, get lost following obscure links before you have a firm grip on the basics of the subject area you're trying to research.

When you're reading printed text, a good author will guide you through a network of interrelated, relevant points. With hypertext, you guide yourself and make your own associations—at the risk of taking the wrong turn and getting lost. Even experienced hypertext users can get lost in large hypertext networks. While graphical browsers may help, the lack of visual and spacial cues can still be disorienting. One of the valuable attributes of printed copy is that it has such cues.

Another issue is the difficulty of breaking a thought or a segment of information into a node. Themes in a document or thought can be very tightly interwoven, so much so that breaking the information into discrete nodes would be detrimental. Therefore, not all literature is suited for a hypertext literary system.

On a similar note, even though information may have discrete components, you may not be at the level where you perceive these units when you are constructing a hypertext application. In such cases, you might break information into nodes prematurely and at a later time realize that your logic was skewed. Then you would need to edit, rearrange, or retitle the information.

Unfortunately, such changes are not well-supported by all hypertext systems at this time. Virtual structures—nodes, links, or composites—would be useful in this situation. They would change dynamically when you add or delete nodes and links, depending on their descriptions. Virtual structures are similar to relational database views.

One last concern is that many hypertext systems are really only suited for new application development. Converting existing applications to hypertext is a difficult task because the file structures are so different.

Tremendous Potential

Augmenting human intellect with the help of hypertext is a grand vision indeed, one worth exploring. Hypertext applications, including interconnected writing, on-line libraries, and collaborative work environments, have tremendous potential. Current products are just the forerunners of more sophisticated applications, and we will probably see many hypertext features in mainstream software packages.

But hypertext is still in its infancy; implementation and design problems and standards issues must be resolved. Just as it takes a writer time to shape and mold a good short story, it takes time for the structure of new concepts to gel and for practical applications to emerge. But the concepts that underlie hypertext, whether they go by that name or another, will be with us for a long time to come. ■

Janet Fiderio is a BYTE technical editor. She can be reached on BIX as "jfiderio."

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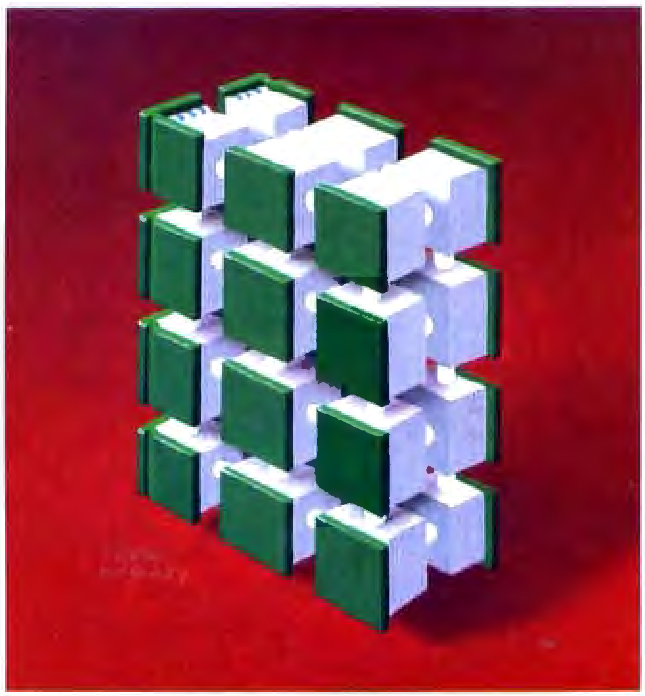
From Text to Hypertext

Traditional tools like outline processors already incorporate many of hypertext's lessons

Mark Frisse



One reason hypertext is attracting so much attention these days is that more and more people are communicating via electronic media. Equipped with a modem and a microcomputer, you can spend a good bit of time reading electronic bulletin boards, composing electronic mail messages, contributing to group databases, and preparing large documents for printing and distribution.

However, communicating through these channels means that you often have to integrate fragments of text into your personal computer archives. You can do this by placing text items as separate entries into a file system, which works as long as you don't have too many interdependent files to manage. Hypertext programs provide another alternative for information storage.

But hypertext can be used for more than creating simple databases of 3 by 5 cards. You can also use these programs to convert on-line versions of a printed document, such as a book, into hierarchical hypertext skeletons amenable to complex user-specified interactions. The examples included in this article come from converting part of a manuscript for a medical textbook into an experimental hypertext handbook using Xerox's NoteCards. You can follow them to learn some of the tips you'll need to turn text into hypertext.

Setting Up the Cards

Hypertext lets you rearrange text. In the early systems described by Theodor Nelson and Douglas Engelbart, the basic unit of text is a single character. New documents are created by linking characters from different documents. For instance, character strings from *Romeo and Juliet* could be merged with those from *Julius Caesar* to create a new play entitled *Caesar and Juliet*.

While this approach is exciting, it isn't widely adopted in hypertext design. A second approach, which is advocated by developers of systems such as Xerox's NoteCards and Apple's HyperCard, specifies a nondecomposable data structure, often called a card. You define cards both in terms of the types of data structures they support (e.g., text, bit-mapped graphics, and video) and the operations that can be performed on the data structures (e.g., text insertion and deletion).

To map a flat-text file onto a set of hypertext cards, you first decide how much text you want to place in each card and then create a program that will perform this transfer with minimal intervention. If your text file consists of a series of E-mail items, addresses, or telephone conversation summaries, you can easily fit

continued

each item from the text file into a separate card. If an essay or other lengthy text file is not divided into logical sections, you usually must place an arbitrary number of paragraphs onto a card. You can write sentences into scrolling text fields, but this approach can detract from the power of the card metaphor.

But the organization of some flat-text files can't be characterized as either a series of discrete, unrelated paragraphs or a single lengthy text file. The medical-handbook text files used in these examples are hierarchically structured documents. A specific set of identifiers—either Roman numerals, uppercase letters, integers, or lowercase letters—pinpoints each level of the hierarchy (see figure 1). Because the text between the identifiers consists of only a few sentences or paragraphs each, it's appropriate to use these identifiers as card delimiters (see figure 2). In text files with many sentences between delimiters, you might have to obtain a line or paragraph count to decide when to start a new card.

Making the Connections

Hypertext's power resides in the links that weave isolated cards into a unique graph-structured fabric. When you transform a flat-text file into hypertext, you must recognize two distinct classes of links. The first, structural links, enforces the mapping between the conventional document and the hypertext skeleton. These links must be generated by programs, text parsers, that convert conventional text into hypertext. The second class, user-defined links, lets you create new, nonsequential paths through text.

Each collection of cards in a hypertext document has some underlying order maintained by structural links (see figure 3). The order of cards in a random-file hypertext database (e.g., recipes, phone numbers, and so on) can be arbitrary and quickly modified through standard sorting techniques. The order of cards representing a lengthy essay is sequential and usually static. E-mail stacks can be ordered by topic, and, within a topic, by date of receipt. In a hierarchically structured document like the medical handbook, card order resembles a tree. In this case, the limbs of the tree declare the structural relationships between cards.

A text-parsing program converts flat-text files into hypertext documents. The underlying structure of the flat-text file determines the text parser's complexity and function.

For example, database parsers can look for new record identifiers. These identifiers signal the system to create a new card and to copy the new record's contents to the new card. Parsers for essays can simply allocate to each card in turn as many paragraphs of text as will conveniently fit on each card. Parsers for mail systems, on the other hand, might require a list of acceptable identifiers and, for each topic, a pointer to the last card filed under the identifier. Parsers for hierarchical documents can use an ordered list of identifiers to create a hierarchical hypertext consisting only of cards and structural links.

For each possible set of identifiers, there exists only a limited number of "acceptable" tokens that lead to creation of a new card and appropriate links. For example, if you were placing text from a section labeled "V.C.2.a." into a card,

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II. Pathophysiologic mechanisms. Respiratory failure can be separated into oxygenation failure and ventilation failure. While the two may occur together, it is useful to separate them to understand their pathophysiology and management. In addition, critical tissue hypoxia may result from nonpulmonary factors that influence oxygen delivery, and these must also be considered in comprehensive treatment.

A. Oxygenation failure. The transfer of oxygen from alveolar air to pulmonary capillary blood is affected by the partial pressure of oxygen in the alveolus (PAO2), the diffusion of oxygen across the alveolar-capillary membrane, and the matching of alveolar ventilation to capillary perfusion. The five mechanisms that may lead to a low arterial oxygen tension (PaO2) are low inspired oxygen tension, alveolar hypoventilation, diffusion impairment, mismatch of ventilation to perfusion, and right-to-left shunt. The goal of oxygen therapy is to relieve critical hypoxemia. Although clinical criteria are important, serial ABGs are crucial to plan and evaluate treatment.

1. Response to oxygen administration depends on the underlying pathophysiology (see sec. II.A). Three patterns are common.

a. Hypoxemia caused by mild to moderate lung disorders. This pattern is typical of flu and asthma.

b. Hypoxemia caused by severe lung disorders is more refractory to supplemental oxygen, and potentially toxic concentrations are often typical of severe disorders.

Figure 1: *A representative section of a medical handbook. The identifiers are (in order) Roman numerals, uppercase letters, integers, and lowercase letters.*

S1.II. PHYSIOLOGIC MECHANISMS

II. Physiologic mechanisms. Respiratory failure can be separated into oxygenation failure and ventilation failure. While the two may occur together, it is useful to separate them to understand their pathophysiology and management. In addition, critical tissue hypoxia may result from nonpulmonary factors that influence oxygen delivery, and these must also be considered in comprehensive treatment.

S1.II.A. OXYGENATION FAILURE. THE TRANSFER OF OXYGEN

S1.II.B. VENTILATION FAILURE IS PRESENT WHEN THE

S1.II.C. OXYGEN DELIVERY AND TISSUE OXYGENATION

S1.II.D. INSPIRATORY MUSCLE FATIGUE OCCURS WHEN THE

Figure 2: *A hypertext card from the same section of the medical handbook. The card contains only the text delimited by the identifier II and the identifier* A. *The titles of other child cards denoted by uppercase* B, C, *and* D *are visible on the hypertext card but not on the page displayed in figure 1.*

the acceptable identifiers would be any member of the set VI, D, 3, b (see figure 4). If the identifier read was D, the current subtree "C.2.a." would be popped, a new card of level "VI.D." would be instantiated, and a structural link between card "VI." and card "VI.D." would be created. Defining card identifiers appropriately is critical for simple, rapid parsing of hierarchical documents.

Although most flat-text file parsers employ ad hoc grammars, the parsing process will be simplified if document-definition language standards become more widespread. One of these, the Standard Generalized Markup Language (SGML), appears particularly promising. SGML emphasizes document structure over document appearance. For example, the standard might identify a string as a "section heading," but it would not make any statements about the section heading's font or size.

SGML also lets individuals or groups define logical structures for new document types. This flexibility increases the likelihood for standards in specialized and highly technical publishing niches. Finally, the interest shown in SGML by the federal government has encouraged the development of a number of tools for authoring, revision, and document parsing. Conceivably, these tools can be used to simplify the conversion of text already in electronic form into personal or community hypertext.

Finding the Right Card

Creating a hypertext from a flat-text file is rather simple. You exploit document identifiers to parse the file and create the new data structure. Developing the software that lets you access appropriate portions of a hypertext document is much more difficult. Most hypertexts let you access cards through several methods.

First, the initial cards in many hypertext documents contain a brief table of contents. This method provides you with an overview of the overall organization of the hypertext document. Browsers are another way you can find a card. They are useful when you want to peruse small lists or card networks. String pattern-matching is the third card-access method. It's useful when you think that the search will retrieve a small number of useful cards and very few, if any, useless cards.

Unfortunately, there are many situations where these methods are inadequate. The table of contents method fails when a card can be filed under any one of several categories, which requires you to

continued

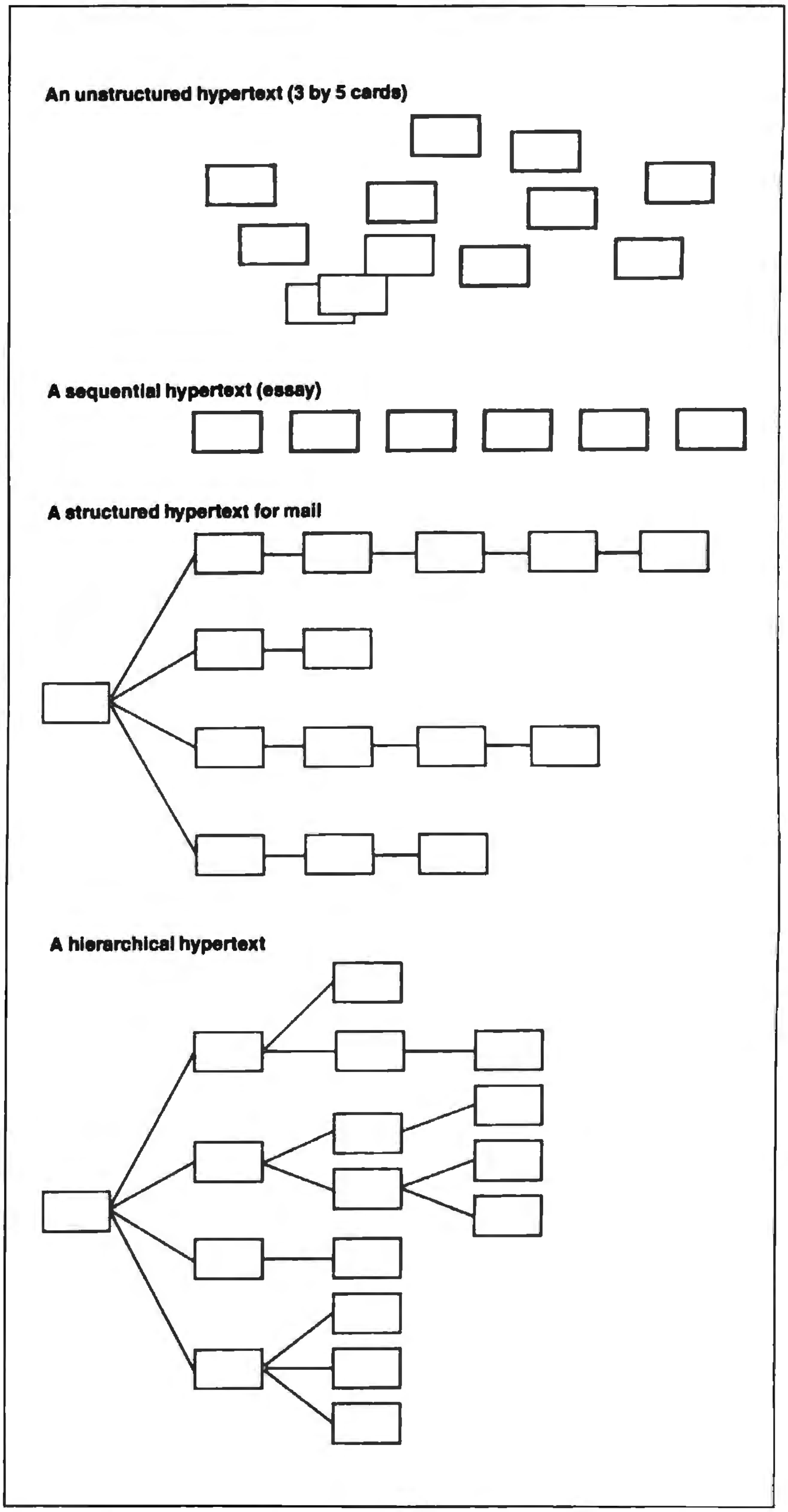

Figure 3: *Hypertext file-card arrangements. Some applications, like unsorted recipes or telephone logs, require only a random ordering. Long essays generally require a sequential ordering. Mail files resemble trees with a strong sequential component. Complex documents in outline format require hierarchical data structures.*

search many categories to find desired information. Browsing can be laborious if there are many cards to peruse, and pattern matching fails if the desired card uses a synonym (poor recall) or if there are many unwanted cards containing the same search string (poor precision). Therefore, you need alternative methods for both card indexing and card retrieval.

Hypertext Indexing

You can, however, exploit two powerful document-indexing techniques in hypertext. The first, indexing using a controlled vocabulary, classifies each document by one or more members of a finite set of descriptor terms. The National Library of Medicine's Medical Subject Headings (MeSH) system is one of the best examples of this approach.

This 15,000-term hierarchical vocabulary is used to classify most of the world's medical literature. Its principal advantage is that it is a widely agreed-upon vocabulary implemented by experts in the field of medical classification. This ensures that properly trained users, and effective programs, retrieve equivalent queries.

Unfortunately, there are two major shortcomings to indexing small hypertext documents with controlled-vocabulary terms that are developed for larger documents. First, you must create the vocabulary so that each card is classified by at least one term, and you must have a relatively uniform distribution of classification terms among all hypertext cards. Both criteria are difficult to achieve. Second, the contents of the cards using the index terms must be classified manually, a prohibitive expense for most hypertext authors.

You can use a second powerful document-indexing technique, classification with an uncontrolled vocabulary, when a structured body of index terms is not available or when cost factors prohibit the controlled-vocabulary method. The uncontrolled-vocabulary method creates inverted indexes by eliminating stop words (e.g., *the*, *are*, *a*), removing suffixes (e.g., -s, -ing, -ed), and retaining word roots as indexes into the text file.

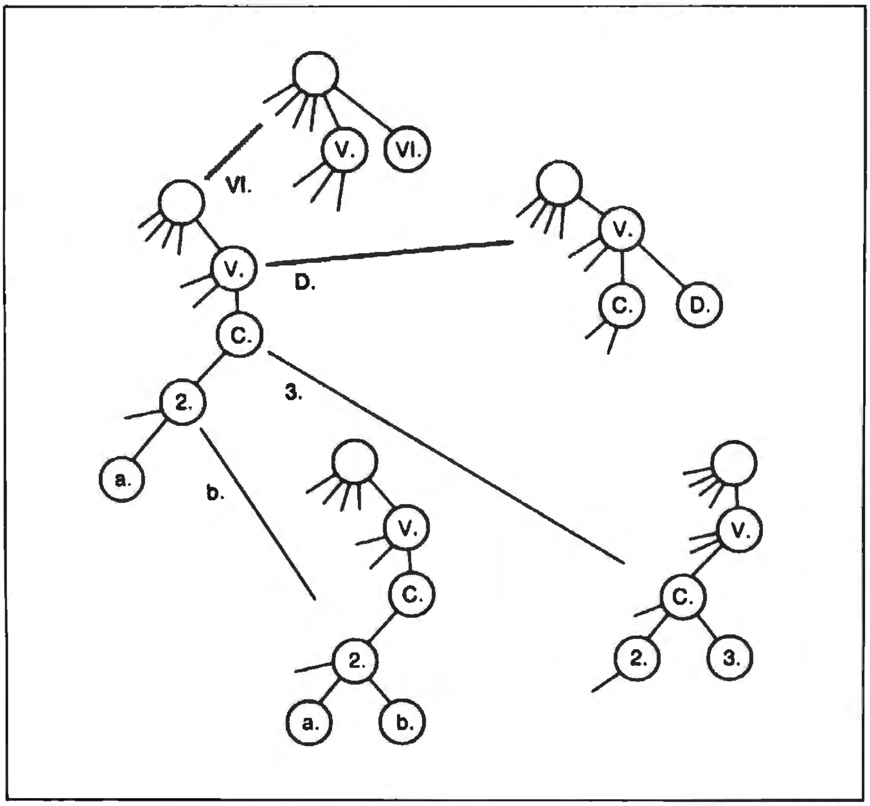

Figure 4: *The characters preceding each section of the handbook serve both as delimiters to assigning text to a card and as identifiers to control the parsing and creation of links between cards. The leftmost tree is a part of the subtree present when the active card is V.C.2.a. The arrows depict each possible new card identifier. The rightmost trees depict the trees that would result from the detection of each legal identifier.*

For example, the sentence "The lungs are inflated" creates the index terms "lung" and "inflate." In general, the index file will be about one half the size of the text file. Proponents of this approach argue that, for most domains, it is as effective to retrieve information this way as it is via controlled vocabularies. Moreover, the software needed to create these indexes is readily available. But for many applications, the space required by the indexes and the problems that occur because of misspellings and synonyms offset the benefits of indexing with an uncontrolled vocabulary.

Making the Best Match

Adding information-retrieval approaches commonly used for larger documents could make hypertext systems more powerful and responsive. How you implement these approaches depends on the structure of the underlying hypertext. In unstructured, highly modular hypertext (e.g., unrelated cards with significant amounts of free text on each card), the hypertext is really just a "folder" containing many tiny documents. In these settings, you don't need to enhance traditional free-text document-retrieval techniques. If, on the other hand, you have created a highly structured hypertext, you must exploit retrieval techniques.

In the hypertext medical handbook prototype, the power of uncontrolled-vocabulary indexing techniques that measure card content was combined with heuristic card-weight propagation functions that reflect card context. This was done so that the user could identify the "best" set of cards for browsing about a requested topic. The system doesn't try to identify a card with "the answer" to the query.

For example, if a hierarchically structured hypertext contains several potentially useful sibling cards whose parent doesn't contain text relevant to the query, you could design the system so it presents you with a sequential list of the sibling cards (see figure 5). As an alternative, it could just show you the parent card and provide a note on the card saying several of the children appear to contain useful information (see figure 6).

The good point about the second option—seeing the parent card—is that it conveys additional information concerning the context in which the various child cards are stored. This means you can better judge their relevance.

There are three basic steps to implementing this approach. First, define a utility function that calculates a card's intrinsic "utility" based on the query

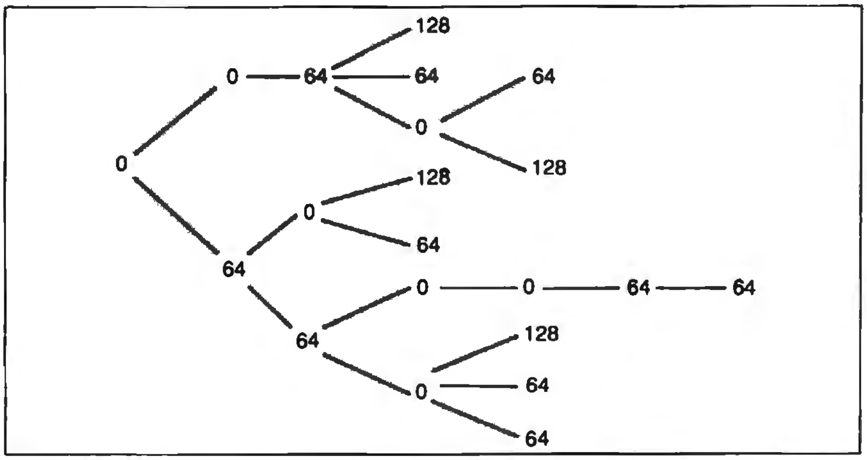

Figure 5: *This graph displays only the intrinsic card utilities resulting from a query. Cards with positive values contain one or more terms in common with the query terms. Cards with a value of 0 do not contain any of the query terms. The graph displays only structural links between cards.*

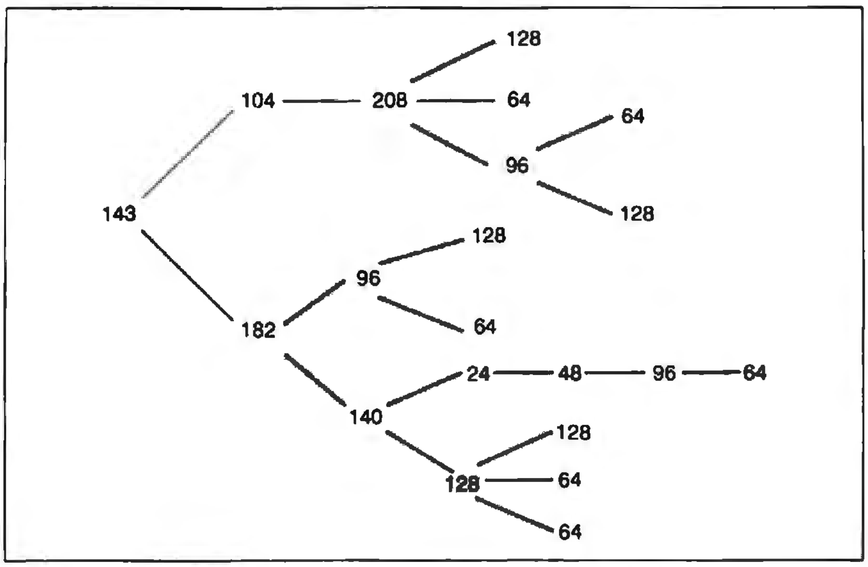

Figure 6: *Here, a graph displays the total card weights, which are the sum of the intrinsic card utilities based on card content and the propagated weights based on card context. Even in this simulation, the propagation of weights has a marked impact on the ranking of cards and suggests that the lower subtree might prove to be a good candidate for browsing.*

terms and card contents. Then, identify a method that propagates these weights to neighboring cards so that cards with contextual information are recognized. Finally, use both the intrinsic utility and the propagated weights to identify which cards should be considered candidates for graphical browsing. Let's analyze each of these steps in greater detail.

Weights and Measures

A card's utility is due in part to the correspondence between terms within the card and the query terms stipulated by the user. This component of card utility is called the *intrinsic weight*, and the value can be calculated using a modification of Salton's well-known algorithm.

This algorithm assigns term weights to cards as a function both of the frequency of occurrence of the term in the entire search space and of the number of cards containing the term. The algorithm assigns a higher weight to cards containing infrequently used terms and also to cards containing several occurrences of a term that is not found in many other

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July	■	■		■	■	■	
August	■			■		■	■
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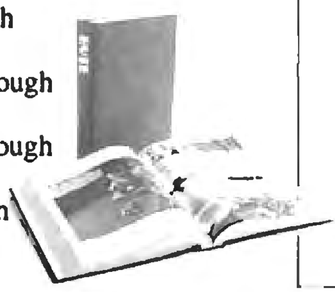

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cards. The formula is as follows:

$$weight_{ij} = k \times freq_{ij} \times (\log(n) - \log(docfreq_j) + 1)$$

where $weight_{ij}$ is the weight component of card i due to term j; k is a constant; $freq_{ij}$ is the number of occurrences of term j in card i; n is the number of cards in the collection; and $docfreq_j$ is the number of cards containing the term j.

A card's utility also depends on its relationship to other cards. The term *extrinsic weight* describes the component of a card's total weight contributed by propagation from neighboring cards. In the hypertext medical handbook, a card's extrinsic-weight component depends on the weights of its immediate descendant cards. The following formula represents this dependency:

$$totalweight_i = \sum_j weight_{ij} + \frac{1}{y} \sum_d totalweight_d$$

where y is the number of immediate descendants of card i, and d is an immediate descendant of card i.

This propagation function is called recursively from the leaf cards to the root card. A graphical display of the search subtree and card weights (see figure 6) serves as a road map for browsing.

Term-weight assignment and propagation allow for cards to be ranked on the basis of an estimate of their utility to the user. In general, you hope for a ranking that will produce a short list of cards that are distributed throughout the hypertext. In this situation, you can quickly explore various subtrees, jumping from one location to another. You can, however, retrieve more aberrant lists. Consider, for example, the common case where the second-highest-ranking card is the parent of the highest-ranking card.

Presenting both cards on the browsing candidate list may suggest that the cards represent two markedly different avenues for browsing rather than the actual state of term-weight predominance in a single subtree. As an alternative, you could remove the highest-ranking child card and display only the parent, under the assumption that the increased context provided by the latter outweighs the decrease in weight due to card content. However, if this process is applied recursively, you ultimately will arrive at a card list containing only the root of the tree. You can apply several heuristics to manage these aberrant cases. One of the most useful heuristics halts the replacement process when the replacing parent card is of some fractional weight of the original highest-ranking card.

In addition to the obvious traditional problems associated with uncontrolled indexing vocabularies and full-text document retrieval, the approach used throughout this article is limited in many other ways. First, the propagation function does not take into account graphs, cycles, and link types with different semantics. Second, the current approach can't exploit user feedback in any meaningful way.

It would be desirable to update card weights dynamically on the basis of user responses to the card's contents. Unfortunately, most alternative approaches to this problem (e.g., Bayesian updating or Connectionism) appear too impractical for routine use.

Learning Its Lessons

Many points about creating and using hypertext are already clear. First, you have to distinguish hypertext programs from hypertext documents. You can use hypertext programs for tasks ranging from replicating mundane 3-by-5 card files to creating complex hypertext documents consisting of multiple interrelated cards and links. This distinction is crucial, since only card content is important for simple 3-by-5 card files, but both content and context are important when creating true hypertext.

Second, it's easy to build hypertexts and add links incrementally, but it's difficult to use hypertext effectively. Even with extensive search capabilities and graphical browsers, it's not always possible to retrieve desired information or to avoid getting lost in a hypertext graph.

Third, the computational complexity of information-retrieval algorithms suggests that alternative computer architectures might be more useful.

Finally, it's clear that many problems in the field are unresolved. Will effective updating and revisions require that links be bidirectional? Can we arrive at a standardized set of hypertext card types (e.g., text, graphics, sound, and video)? Will hypertext systems provide a true advantage over other media?

Traditional tools like outline processors have already incorporated many of hypertext's lessons. Similar innovations will affect E-mail, collaborative work tools, and others in the future. ■

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The Right Tool for the Job

Even the systems design process falls within the realm of hypertext

Michael L. Begeman and Jeff Conklin

Hypertext is an ideal model for the systems design process. We have been working on a hypertext project, the Design Journal, to provide a systems design team with a medium in which all of their work can be computer-mediated and supported. This includes such traditional documents as requirements, specifications, high-level design, and the design document itself; it also includes scenarios, design reviews, interviews with users, designers' early notes and sketches, design decisions and rationale, internal design constraints, meeting minutes, and so on.

The Design Journal places particular emphasis on capturing the *design rationale* as the center around which to integrate all the other documentation. This rationale includes design problems, alternative resolutions (including those later rejected), trade-off analyses among these alternatives, and a record of the tentative and firm commitments made during problem resolution. We have built a running prototype of the Design Journal; it's based on the Issue-Based Information Systems (IBIS) method and is called gIBIS (graphical IBIS).

The IBIS Method

The IBIS method was developed by Horst Rittel (see reference 1) and is based on the principle that the design process for complex problems is fundamentally a conversation among the stakeholders (i.e., designers, customers, and implementers) in which they pool their respective expertise and viewpoints to resolve design *issues*. Any problem, concern, or question can be an issue and may require discussion (if not agreement) for the design to proceed. In the IBIS model, this argumentation constitutes the design process.

IBIS focuses on articulating the key *Issues* in the design problem. Each Issue can have many *Positions*. A Position is a statement or assertion that responds to the Issue. Often Positions are mutually exclusive, but they needn't be. Each Position, in turn, can have one or more *Arguments* to support or object to it. Thus, each separate Issue is the root of a (possibly empty) tree; its children are Positions, and their children are Arguments.

There are nine kinds of links in IBIS. For example, a Position *Responds-to* an Issue, and this is the only place you can use the Responds-to link. An Argument either *Supports* or *Objects-to* its Position. Issues can *Generalize* or *Specialize* other Issues, and they can also *Question* or be *Suggested-by* other Issues, Positions, and Arguments. (The remaining two links are *Replaces* and *Other*.)

A typical IBIS discussion begins when someone posts an Issue node containing

continued

a question such as "How should we do X?" That person can also post a Position node proposing one way to do X, as well as some Argument nodes to support that Position. Someone else can post a competing Position responding to the Issue and can support the Position with Arguments, and so on. New Issues that the discussion raises can also be posted and linked into the nodes that most directly suggested them.

There is no stopping rule, nor is there a particular way of registering Issue resolution by agreeing on some Position. The goal of the discussion is for each stakeholder to try to understand the elements of the others' proposals, and perhaps to change the others' minds. The method inhibits unconstructive rhetorical moves, such as argument by repetition and name calling, and supports more constructive moves, such as seeking the central issue, asking questions and giving answers, and being specific in supporting your own viewpoint.

In implementing gIBIS, some changes and extensions have been made to allow needed flexibility, but the method has been changed as little as possible. The extensions to IBIS in the current gIBIS tool are three: an additional Other type for nodes and links, as an escape mechanism when you can't find a way to express a thought within the IBIS framework; an additional External type for nodes that contain non-IBIS material, such as requirements, documents, design sketches, or code; and the ability to let Positions specialize or generalize other Positions, and to let Arguments specialize or generalize other Arguments.

The gIBIS Tool

Three technological themes guided our design of gIBIS. First, we wanted to explore the capture of the rationale behind the design. Second, we wanted to support computer-mediated teamwork, particularly the kinds of design conversations that might be held over networked computers, electronic mail, or news (see references 2 and 3). Third, we needed an application with an information base large enough to allow us to investigate the navigation (searching and browsing) of very large information spaces.

The browser lets you see the IBIS graph structure, its nodes, and their interconnecting links.

The pattern of gIBIS usage falls into two categories: Some people use the tool primarily as an isolated hypertext tool for structured thinking and design, while others use it primarily as a vehicle for structured communication.

The basic gIBIS interface is divided into four windows (see photo 1): a graphical browser on the left, a structured index into the nodes on the top right, a control panel below the index window, and an inspection window in which to view the attributes and contents of nodes and links. This interface is somewhat unusual among hypertext systems: To view the contents of a node or link, you must select it, and the contents will display in the inspection window.

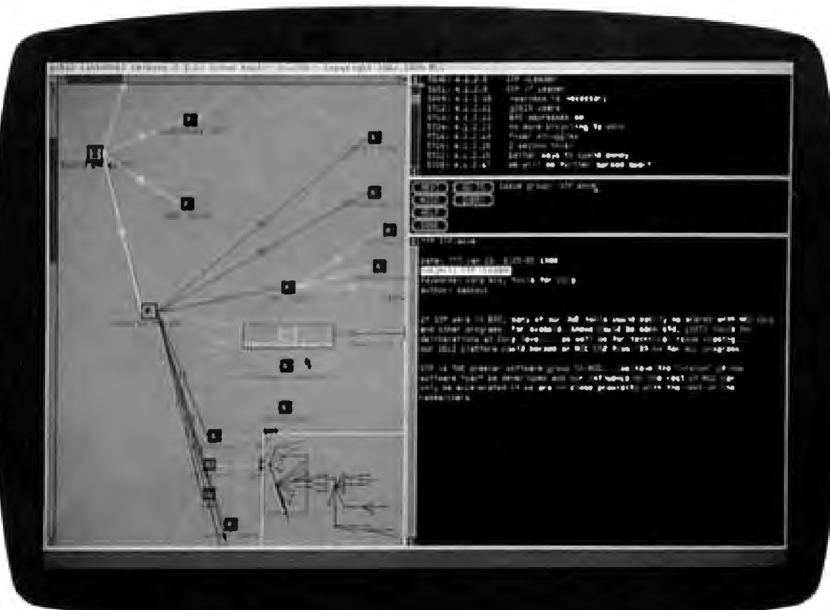

Photo 1: *The gIBIS interface. Note the graphical browser (left), the structured index (upper right), the control panel below the index window, and the inspection window (lower right).*

The Browser

The browser lets you see the IBIS graph structure, its nodes, and their interconnecting links. Most of it is dedicated to a local view of the network: a zoomed-in view of the current area of interest, with nodes and links in full detail. The lower-right portion of the browser contains a global overview: a zoomed-out view of the entire network without node labels, link-type icons, and secondary links. A rectangular overlay indicates the scope and position of the current local view.

You can scroll the browser window by using traditional scroll bars or by "snap scrolling" (clicking the mouse anywhere within the local view to center that location in the window). This method lets you fine-tune the position of the display and scroll diagonally without having to reposition two independent scroll bars. You can also scroll to an area outside the local view by repositioning the local-view indicator in the global-view window. You simply drag the rectangle to a new area within the global view to update the local view.

The browser supports a direct-manipulation-style interface (see reference 4) to the display objects (nodes and links). You select a display object by clicking on it with the left button of your three-button mouse. The browser highlights and boxes it, puts its contents in the inspection window (see photo 1), and scrolls its index line to the top of the index window. A right-button mouse click displays context-sensitive menus that let you create, edit, delete, and move objects.

For example, if you press the menu button without selecting an object, a menu appears indicating that the only legal operation you can perform is Issue creation (i.e., the beginning of a new

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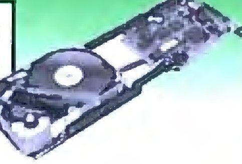

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IBIS structure). By contrast, if you select an Issue node, the menu changes to reflect the legal operations on Issues. If you create a follow-up Position node, it is placed next to the Issue and linked to it with a Responds-to link. Then, the inspection window divides in half and a Node Creation window preloaded with a structured template appears beneath it.

You fill in the template's structured fields (e.g., Subject, Keywords, and so forth) and provide an optional description of the node's topic (i.e., an unstructured node body). When the node is complete, you push the Submit button in the control panel (which appears only during Node Creation and Editing); the node is then parsed and stored, and the browser and index windows are updated to include it.

When you follow the "Link to another node" menu item, you can choose from the set of legal outgoing link types for the current node, and the new link appears stretching between the source node and the current mouse position. You move the mouse to the destination node (by "rubber banding") and then drop the end of the link there.

You can also select canonical IBIS subnets (i.e., a single Issue followed by its Positions, and their Argument nodes) as a single entity. The gIBIS tool supports the movement and automatic layout of these subnets as wholes. Further, it lets you gather a subnet into a single composite Issue-Position-Argument (IPA) node; this node provides additional structure to analyze competing Positions and commit to one of them (Issue resolution).

While it has a structure and body all its own, the IPA node by default inherits its label, subject, and keywords from the root Issue of the underlying subnet. Selecting the composite means traversing the underlying subnet and composing an "inherited" body, which is shown in the inspection window along with any composite-specific text (see figure 2). Since the inherited body can become quite long with a large subnet, a function key lets you suppress (or reveal) it in the inspection window.

The node-index window provides an ordered, hierarchical view of the nodes in the current network.

The Node-Index Window

The node-index window provides an ordered, hierarchical view of the nodes in the current network. To traverse the network, you follow Primary links in depth-first order starting from each Issue. The Issues, Positions, and Arguments are given sequence numbers like you might find in an outline editor (see reference 5). For example, the Subject line for Issue 8 is I.8; it has no children, so that's all there is. The Subject line for Issue 9 is I.9; its first Position node (P.9.1) has two Argument nodes (A.9.1.1 and A.9.1.2), and so forth. Issues are ordered by creation date. The view-configuration panel lets you tailor the index to reflect by Subject, Author, Keyword, or node Label.

You can select nodes through the index as well as the browser. Clicking on a node's index line makes that node current: Its icon is highlighted in the browser, the window is scrolled, if necessary, to bring it into the local view, and its contents appear in the inspection window. This browsing method provides a linear, compressed view of the data in the network.

The Control Panel

The control panel is composed of a set of buttons that extend gIBIS's functionality beyond simple node and link creation. Each button hides a menu that extends or tailors its basic function. The Next button, for example, normally records that you have read the current node before it displays the next one. But if you press the right-hand mouse button while over the Next button, the hidden menu will appear. This is a slight extension of basic

continued

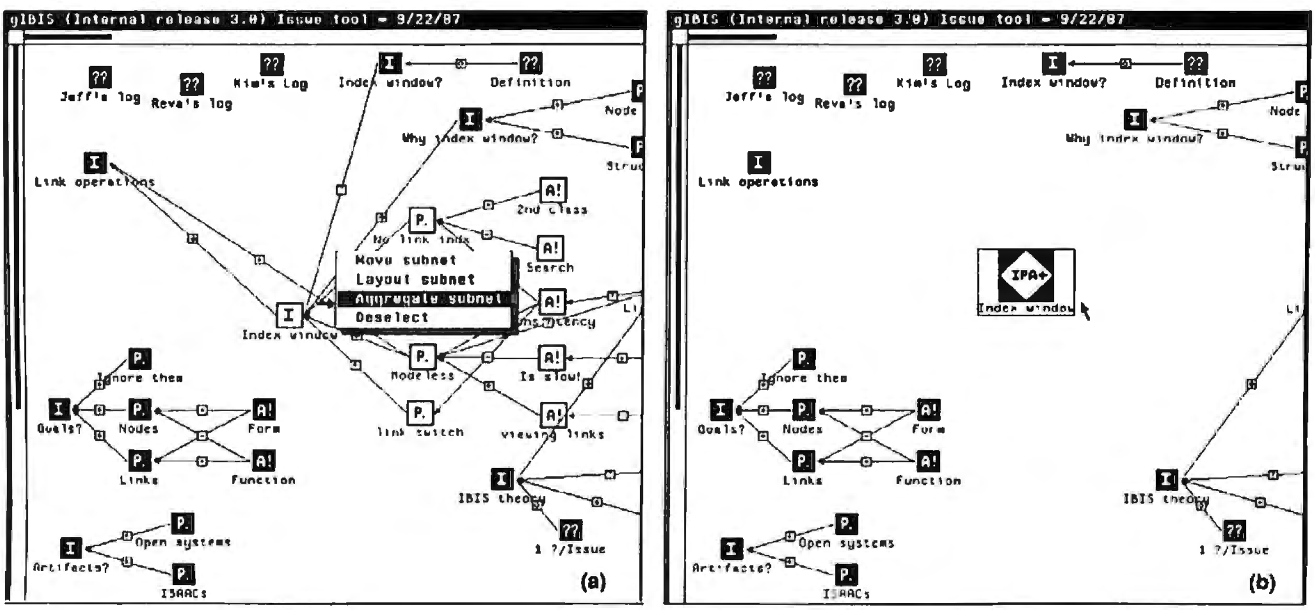

Figure 1: *A canonical IBIS subnet* **(a)** *before and* **(b)** *after aggregation. Since the "inherited" body can be quite long in a large IBIS subnet, a function key lets you suppress or reveal the inherited text body in the inspection window.*

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Problems in Paradise

One common but subtle difficulty in hypertext systems is that sometimes it's unnatural to break your thoughts into discrete units, particularly if you don't understand the problem well and those thoughts are vague, confused, and shifting. With gIBIS, this effect is pronounced, because the IBIS method imposes on you a rather austere selection of node and link types; gIBIS makes you think within a particular framework (i.e., you focus on Issues without necessarily resolving them), and this can be disruptive.

The early phase of considering a writing or design problem is critical and fragile and must be allowed to proceed in a vague, contradictory, and incomplete form for as long as necessary (see references 1 and 2). However, any insights should be captured, and gIBIS should support the emergence of a coherent structure as it develops.

Design conversations often feature commitments like "Let's try X—it has advantage Y." This is a Position and a supporting Argument, but no Issue is mentioned. Since you don't always see the Issue or Position immediately, it would be nice to have a "proto-node" in which to record ideas, snippets of text, and perhaps graphical sketches before having to structure them.

Ultimately, of course, it's valuable to have separated these elements into Issues, Positions, and Arguments. But when you're struggling to solve a problem, the mental effort required to separate it into discrete thoughts, identify their types, label them, and link them can be prohibitive.

Finding the Right Answer

In the IBIS method, you resolve an Issue by selecting one of the Positions that respond to it as being "the right answer," or at least "the Position we are committing to for now." You could mark the Position node as Selected and display it by marking such nodes distinctively in the browser, perhaps with a somewhat different color.

We have recently added an Issue resolution feature to gIBIS. It combines indicating resolution with the aggregation into Issue-Position-Argument nodes; once an Issue is part of an IPA node, you can resolve it. At the moment, you change the value of the Resolved field to True and indicate which Position holds the resolution.

The rationale for adopting a particular conclusion may require more explanation; for instance, perhaps all the argumentation didn't occur within gIBIS. Sometimes, resolving an Issue transcends the original options. Such resolutions may combine elements of the original options and abandon prior assumptions or presuppositions. Sometimes, when a breakthrough occurs, it's clearly the right solution.

The gIBIS tool needs to allow such leaps in argumentation and not force the Issue to a well-structured resolution. This may be as simple as providing the free-text annotation of an IPA tree or the marking of some discussions as "irrelevant in light of Position X."

Getting the Whole Picture

Using hypermedia for cooperative work has its problems as well. Sometimes, an unexpected problem can emerge when several users work cooperatively in a shared Issue group. Unless each author writes clearly and completely, while you might understand the individual nodes, it's hard to follow the thread of thoughts as it winds through several dozen nodes. That is, the hypertext tool forces the author to express ideas in a fined-grained, separated manner, and this obscures the larger idea being developed.

This is a familiar problem common to many hypertext systems: The freedom of choice inherent in branching documents requires greater care from both the author and the reader. The separation of Position and Argument in IBIS (i.e., an idea and its justification) could also be another factor.

However, there may be a more subtle issue here: Traditional linear text provides a continuous, unwinding context thread as ideas are proposed and discussed—a context that the writer constructs to guide you to the salient points and away from the irrelevant ones. Indeed, a good writer anticipates questions and confusions that you may encounter and carefully crafts the text to prevent them.

The hypertext (or at least the gIBIS) author, however, is encouraged to make discrete points and separate them from their context. Sometimes, the gIBIS author, in a hurry to capture a design Issue and its analysis, may write only the bare minimum necessary to record the essence of the Issue, Positions, and Arguments. Even the careful author, however, may not anticipate all the routes to a given node, and so may fail to develop the context sufficiently to clarify its contents.

Using a *path* may linearize a network's segments sufficiently to provide context (see references 3 and 4). And there are higher-level constructs that aggregate a set of nodes. The new IPA-node type combines all of an IBIS subtree's nodes (an Issue, its Positions, and their Arguments) into a single node and lets you append additional IPA-specific text as well. This linearizes the discussions of individual Issues and reduces the sense of fragmentation you sometimes have when reading a gIBIS network, but it's probably not sufficient to restore the context in which those nodes were created.

Finally, part of the context is the relative importance of the points presented, and we need to incorporate an "importance" meter into gIBIS nodes. One possibility would be to incorporate one of three keywords, HI IMPORTANCE, MED IMPORTANCE, or LO IMPORTANCE, into each node at creation. This would guide you to the most salient points first (see also reference 5); it could also be used to control the level of clutter in the browser display.

Staying on Track

It's common in conversations to "go meta" and make a comment on the *process* (as opposed to the content) of the discussion (i.e., "But that isn't the issue here"). Similarly, in IBIS discussions, sometimes you need a meta-discussion when one person in an Issue group feels that another has misused the IBIS structure to present ideas. For example, if B feels that A's Issue node is actually two Issues and a Position, B needs a way to express this and to initiate a discussion about it.

There are three levels of collaborative work: *substantive* (the content of the work), *annotative* (comments about substance), and *procedural* (comments about procedures and conventions) (see reference 4). In IBIS, you can theoretically treat all three levels as Issues. For example, B could post an Issue, connected by a Questions link to A's Issue, asking "Isn't this really two Issues and a Position?" While this is a valid move, it has drawbacks.

B's Issue is by its nature meta-substantive, although whether it's annotative or procedural is unclear. But by placing it in the network, B creates an Issue that adds complexity to the browser display without shedding any light on the problem being discussed; B also initiates a discussion that may change the network, after which this meta-discussion will have only historical interest.

This problem has several resolutions. You could have special meta-level Issue, Position, and Argument nodes to distinguish them from substantive ones. Or you could label nodes as "only of historical interest." Such nodes could be archived or have their display suppressed so they wouldn't normally be visible. You could also give each node its own meta-layer (only displayed on request) for such discussions. In a simple version of this option, you can append a meta-line at the end of any gIBIS node and then begin an annotative or procedural discussion there. The node's author might append a response or revise the network to correct the structural error.

Lost and Found

A hot issue in hypertext research is how to use a graphical browser effectively to navigate networks with more than a few dozen nodes. This is part of the more general problem of disorientation, particularly its visual and spatial aspects in a large data space. Although gIBIS has addressed this problem with its global-view and query mechanisms, many hypertext systems have not.

Keeping Current

Any database must be able to manage changes to its data. Often, a versioning scheme that allows older versions of the data to be marked and archived is used. In gIBIS, the issue of change is of unusual importance, because the very nature of an "Issue base" is its use for evolving discussions in which older material may be accurate and highly important, inaccurate and of only historical interest, or anything in between. For example, the original form in which an Issue is framed may be biased toward a particular Position, or it may contain a presupposition that is later made explicit and rejected. How can you handle this "outdated" form of the Issue?

Sometimes, the Issue and its discussion subnet may be isolated and wrong; then it's easy to decide to archive that subnet and delete it. But more often, parts of the subnet will be wrong, misleading, or irrelevant, while others are still relevant or important and part of an active region of the network. How do you prevent these partially invalid segments from poisoning the network?

Perhaps you could systematically indicate the age and relevance of network material by, say, displaying older nodes as yellowed or frayed (unless they have been recently visited and updated). Like importance, salience, and confidence, age and relevance are somewhat subjective measures and can be only partially automated. Another possibility for managing change is completely human: As Issue networks grow in size and importance, organizations should have people whose job is to maintain the currency and consistency of the Issue base.

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functionality and leaves the current node marked unread.

For those functions with no extensions, the menu provides a longer explanation of the button's functionality. For example, the Goto button loads a particular Issue group's data into the browser; it hides a Help menu that tells you to "enter an Issue group name and push this button."

The Misc button hides a grab bag of functionality. For instance, the Tool Config item lets you tailor particular aspects of the interface. If you select it, a new window appears that contains the gIBIS configuration parameters, their current settings, and any constraints on their legal settings. These parameters are divided according to whether they affect the index, the browser, or the inspection window.

Primary and Secondary Links

When a node is created, it's usually automatically linked into the existing network of nodes. This automatic first link is its *primary* link. Later, you may connect that node to others in the network, but all subsequent links are *secondary* and differ from the primary one both visually and navigationally.

Filtering out the secondary links from a canonical IBIS subnet results in a hierarchy that becomes the basis of the index window's structured listing. For example, let's say that three Positions respond to an Issue, and two of them have supporting Arguments. The Positions are mutually exclusive, so each Argument also objects to the other Positions; hence, secondary links make these connections explicit.

It's easier to understand the IBIS network if, on first pass, the browser displays only the primary links and "turns off" the secondary links. The Next button leads you through the network in the canonical IBIS order (the same sequence as the index window). The primary-link view shows clearly how the current node relates to the surrounding conversational structure. After the first pass, you can make the secondary links visible, if you wish, to see the cross-relationships encoded in the network. (In keeping with the design philosophy of tightly coupled windows, selecting a node with the Next button causes the same scrolling and highlighting as selection via the browser or index window.)

The Use of Color

We designed gIBIS for use on Sun workstations with color monitors. Thus, color

continued

is used to indicate node- and link-type information, as well as such special node states as "currently selected" and "matches the current query." You can also configure gIBIS to customize the color mapping.

This flexibility caused some trouble at first, and we quickly added a set of standardized color mappings. Having colored nodes and links turns out to be one of the most compelling aspects of gIBIS. You can quickly learn the type mappings for the most commonly used nodes and links, and type identification then becomes a rapid, reflexive activity. While you may occasionally change your mappings with the Tool Config panel for special purposes (like making some links invisible for presentations), most users commonly set up their colors and leave them alone.

If you have a monochrome monitor, the information encoded by color is duplicated with icons. While gIBIS by default presents both color and icons, both can also be suppressed. Usually, the color-monitor user suppresses the link icons to make the browser view appear less cluttered.

Using color presents its own set of problems, however. For one, you must have a color display. And you are limited to a small number of color mappings. The gIBIS tool contains nine link types and is probably near the limit of people's ability to reliably perform the mapping. By adding the link-type icons, the mapping complexity drops, and more link types could be safely added.

More surprising, however, is the large machine-to-machine variation among color monitors in overall brightness, convergence, and RGB-gun saturation. This variation has eliminated the possibility of using a single, standardized set of color mappings for all machines. The color settings that produce bright, highly defined images on one screen can be dark, muddy, and indistinct on another. To address this, the four sliders at the bottom of the Tool Config window let you fine-tune the color map to your machine.

Search and Query

Another control-panel feature is the Query button. Pressing it brings up a small query-construction window. It contains a small control panel and a specification section for "query by example," which lets you create a protonode against which the nodes in the current IBIS net will be matched. When you press the Execute button, the query is parsed and evaluated, and its results displayed in both the browser (selected nodes turn a bright yellow in both the local and global views) and the index window (the window shows only the index lines for those nodes satisfying the query).

You can then examine those nodes using standard navigation techniques. Pressing the Help button reveals another window (obscuring the browser window), which contains instructions on how to formulate queries, their appropriate grammar, and a number of examples.

This query-specification technique lets you formulate node-content searches based on the logical AND of predicates over node attributes. The grammar could be extended to allow full Boolean expressions over the predicates, but there has been little demand for it. These more sophisticated queries may be required when the networks become very large, but the simple query engine in gIBIS is

continued

sufficient for searching moderately sized networks.

A Time Saver

Choosing a relational DBMS as a storage manager for gIBIS provides concurrency control, record-level locking, reliable data storage, fast access methods, and a reasonable search engine. In addition, the one we used includes an uninterpreted data type (a field for long text passages, digitized voice, graphics bit maps, or whatever). Thus, you can store the body of a node as part of a database record. In retrospect, implementing gIBIS on top of an existing DBMS allowed us to focus on the task at hand and saved us many months.

Unfortunately, the DBMS doesn't adequately notify you when a table or set of records is modified (e.g., when a new node is added to an Issue group). To overcome this, we added a notification layer that keeps track of the status of the database for each individual user. When the database is modified so that it changes your view of the data, you are notified and your view is updated appropriately.

Using a DBMS presents one major drawback, however: It closes the system. In essence, all the objects that the Issue networks reference must reside within the database. Unfortunately, many objects that instigate Issue-based discussions, like requirements or architecture documents, as well as those objects resulting from these networks, such as code and documentation, are external to the database. A special *surrogate* type of node lets gIBIS reference external objects, such as text, graphics, or spreadsheets, in a "blind faith" sort of way.

A surrogate has two parts: a pointer to the external object (usually a fully qualified path name) and the name of an optional display program that gIBIS should invoke to display the object. If you don't specify a program name, the default display program assumes that the external object is a text file and loads it into the standard inspection window. If you specify a display program, gIBIS invokes it and passes it the external path name as an argument.

A Useful Structure

IBIS is a powerful method for research thinking and design deliberation. If you're working alone, the Issue-Position-Argument framework helps to focus your thinking on the hard, critical parts of a problem and to detect incompleteness and inconsistency in your thinking. If you're collaborating in an Issue group, the structure gIBIS imposes on discussions is useful and exposes axe grinding, hand waving, and clever rhetoric. It has a tendency to make assumptions and definitions explicit.

You can trace some of these advantages to the *semi-structured* nature of IBIS networks (see reference 6). The writer can structure a complete message without any constraints on what is said, while the reader has a recurrent structure in the text that aids search and comprehension. The explicit rhetorical structure of IBIS reveals at least the general structure of an unfolding discussion. Indeed, a distinct advantage stems from the particular structure that IBIS provides. That is, a good match exists between some of the cognitive structures and processes of design and the three node types and nine link types that compose IBIS.

However, we have found some major shortcomings in gIBIS. There is no spe-

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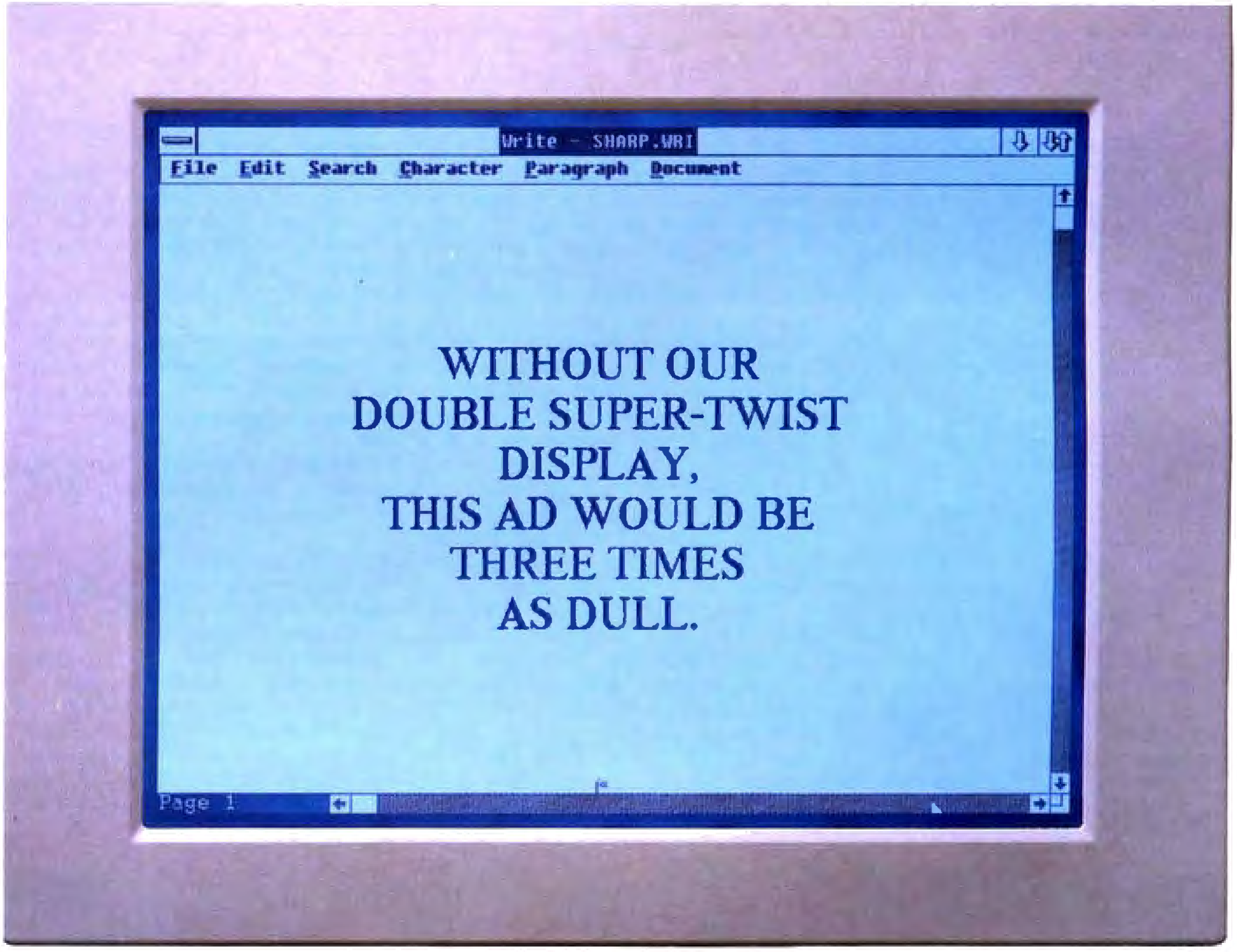

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cific node type for goals and requirements. There is no particular support for making a decision (or reaching a consensus) among the various Positions of an Issue, and no way to indicate that such a decision has been made. Design decisions usually result in adding solution elements to the design itself (e.g., code, module structure, and so on), but these elements are not supported by gIBIS and must be stored externally. (For further discussion of these and other shortcomings, see the text box "Problems in Paradise" on page 260.)

A Synergy of Tool and Method

The noncomputerized IBIS method is cumbersome and would not have reached the popularity that it has here in our lab without the gIBIS tool to support it. Although gIBIS is not the only hypertext system available in our environment, it has achieved wider and more prolonged usage in a much shorter time than has PlaneText, the other system (see reference 7). We speculate that this is due to a particularly good match between the requirements of the IBIS method and the hypertext facilities of the gIBIS tool.

For example, one clear success has been in using color to indicate the types of the IBIS nodes and links. Perhaps this is partly because there are only a few distinct node and link types in IBIS, and each has reasonably well-defined semantics, so the browser display can use bright primary colors that, after a while, become strongly associated with their meanings. Despite its narrow design and rigid functionality, gIBIS provides facilities that are easy to learn and quite helpful with ill-defined design problems. ■

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Michael L. Begeman and Jeff Conklin are members of the MCC Software Technology Program (Austin, TX) and the authors of gIBIS. They can be reached on BIX as "editors."

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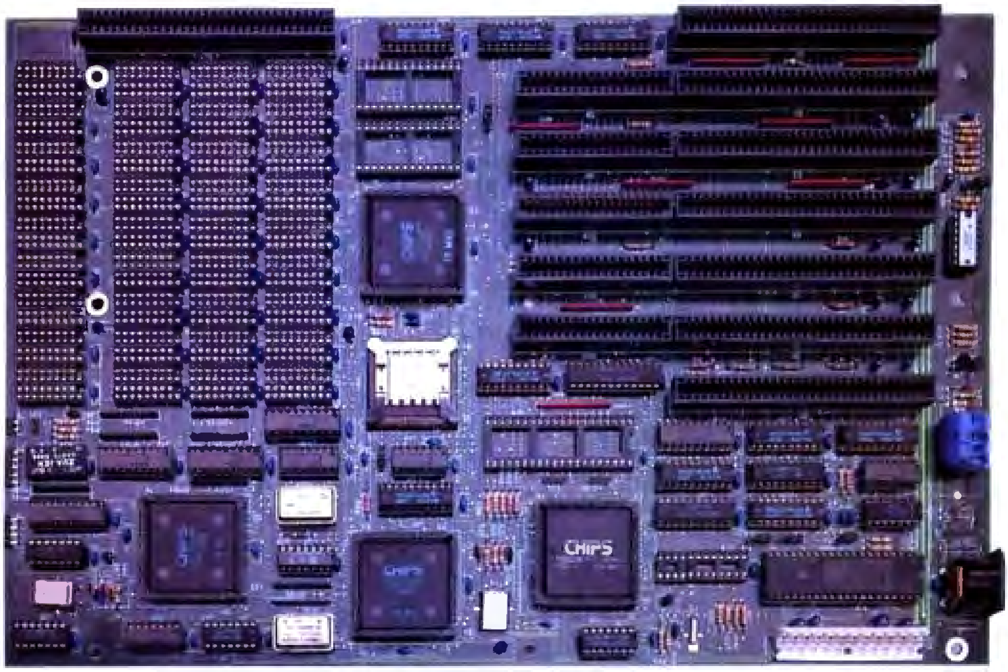

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Document Examiner
Feature of Genera software environment that comes bundled with Symbolics workstations
Symbolics, Inc.
11 Cambridge Center
Cambridge, MA 02142
(617) 621-7500
Inquiry 957.

Graphic KRS (Knowledge Retrieval System) $400
Workstations
Text KRS $300
Workstations
Hyper KRS $3000
(includes 1 Hyper Indexer and 10 Hyper KRS)
Additional workstation copies $125
Knowledgeset Corp.
60 Garden Court, Building A
Monterey, CA 93940
(415) 968-9888
Inquiry 963.

Guide
Mac $199.95
IBM PC, AT, PS/2s $275
IBM XT $300
Owl International, Inc.
14218 Northeast 21st St.
Bellevue, WA 98007
(800) 344-9737
(206) 747-3203
Inquiry 959.

HyperCard.....................$49
Mac Plus, SE, and II
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010
An assortment of public domain stacks for HyperCard is available on BIX in the "stackware" area of the "listings" conference.
Inquiry 960.

KMS (Knowledge Management System) $1995
Sun 3, 386i, and 4 workstations; Apollo DN 3000 and DN 4000 workstations
Scribe Systems, Inc.
Commerce Court, Suite 240
4 Station Square
Pittsburgh, PA 15219
(412) 281-5959
Inquiry 961.

Knowledge Pro, a knowledge processor $495
IBM PC, XT, AT, and PS/2s under MS-DOS
Knowledge Garden, Inc.
473A Malden Bridge Rd.
Nassau, NY 12123
(518) 766-3000
Inquiry 962.

MacSMARTS................ $195
Mac 512 or higher
MacSMARTS Professional.................. $495
Mac 512 or higher
Cognition Technology Corp.
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Cambridge, MA 02138
(617) 492-0246
Inquiry 964.

Marcon, a DBMS with hypertext-like indexes......... $495
IBM AT or higher
Marcon Plus $795
IBM AT or higher
AIRS (Automated Information Reference Systems), Inc.
335 Paint Branch Dr.
College Park, MD 20742
(301) 454-2022
Inquiry 965.

HYPERTEXT RESEARCH AND DEVELOPMENT

Bell Communications Research (Bellcore)
435 South St.
Morristown, NJ 07962
(201) 829-2000
Superbook, *a text browser*
Telesophy, *on-line literary system*
Thoth II, *a system that embeds semantics into hypertext*

Brown University
Institute of Research in Information and Scholarship
P.O. Box 1946
Providence, RI 02912
(401) 863-2001
Intermedia, *an interactive teaching and learning environment (in development)*

Carnegie-Mellon University
Computer Science and English Departments
Pittsburgh, PA 15213
(412) 268-2565
Notes, *a hypertext writer's tool (in development)*
ZOG, *a multiuser hypertext system (in development)*

MAD Intelligent Systems
55 Wheeler St.
Cambridge, MA 02138
(617) 492-1982
Developing hypertext through machine-generated links. Common Lisp software that runs on a Mac II and Unix machines. Prototype in use by the New York Stock Exchange.

MCC (Microelectronics and Computer Technology Corp.)
Software Technology Program
3500 West Balcones Center Dr.
Austin, TX 78759
(512) 343-0978
gIBIS, *a problem-analysis tool that runs on Sun workstations (in development)*
PlaneText, *a Unix-based, general-purpose system (in development)*

University of Maryland
Department of Computer Science
Human Computer Interaction Laboratory and Institute for Advanced Computer Studies
College Park, MD 20742
(301) 454-4255
Hyperties, *an instructional, interactive encyclopedia system (in development)*

University of North Carolina at Chapel Hill
Department of Computer Science
CB #3175
Sitterson Hall
Chapel Hill, NC 27599
(919) 962-1792
WE, *an interactive writing environment*

University of Southern California
Computer Science Department
Los Angeles, CA 90089
(213) 743-2311
DIF, *a hypertext system with software engineering tools (in development)*

The Xanadu Operating Co.
8480 Fredericksburg, Suite 138
San Antonio, TX 78229
(512) 927-6073
Xanadu, *a worldwide hypertext library (in prototype for Sun workstations)*

Xerox Palo Alto Research Center
Intelligent Systems Laboratory
3333 Coyote Hill Rd.
Palo Alto, CA 94304
(415) 494-4000
NoteCards, *an information analyst's support tool*

RECOMMENDED READING

Conklin, Jeff. "A Survey of Hypertext." *IEEE Computer*, September 1987.

Halasz, Frank. "Reflections on Notecards: Seven Issues for the Next Generation of Hypermedia Systems." *Communications of the ACM*, July 1988.

Hypermedia: The guide to interactive media production (premier issue from MIX Publications, 6400 Hollis St., #12, Emeryville, CA 94608, (415) 653-3307).

Hypertext '87 Conference Proceedings. University of North Carolina at Chapel Hill, Department of Computer Science (CB #3175, Sitterson Hall, Chapel Hill, NC 27599).

Nelson, Theodor H. "Managing Immense Storage." BYTE, January 1988.

Salton, G., and M. J. McGill. *Introduction to Modern Information Retrieval*. New York: McGraw-Hill, 1983.

CONFERENCE

HyperExpo Boston
World Trade Center
Boston, Massachusetts
October 15–16, 1988

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PC Power, Part 1:

POWER PROTECTION

Just what do those power protection devices do, and how well do they do it?

Mark Waller

Mention power protection, and the first thing many people think of is lightning. But, as someone who spends every day solving computer-related electrical-power problems, I think of money—protecting your investment in computing without wasting your money in the process.

To be sure, you must protect your computers from lightning. But you don't want to spend hundreds of dollars on a product only to find that it won't solve your problem. Neither should you deceive yourself into thinking that by spending just a few dollars on a surge suppressor, you have absolutely protected your computer from being damaged by a thunderstorm.

The Problem

Computer equipment is designed to operate with a steady stream of uninterrupted sine waves of 120 volts root means square (RMS). The nature of utility power is such that, as often as twice a day, you may experience some electrical disturbance that falls outside your computer's acceptable limits. In major data centers across the country, study after study has shown that surges, sags, brownouts, blackouts, and damaging impulses happen with dismaying frequency.

Over the last 10 years, the quality of power has steadily declined. Microcomputer users are especially vulnerable to this degradation. While mainframe computers have the advantage of employing a dedicated power source, microcomputers live off power straight from the local power company. However, there is one alleviating factor in this situation.

Since you plug your computer into a nearby outlet, your machine is normally located a good distance from the building service entrance (i.e., the meter, or the place where power enters your building). Thus, in order to reach your equipment, potentially damaging impulses generated outside your location must travel through the impedance of lots of copper wire. This barrier serves to dampen out many of those disturbances, but you can derive only small comfort from this fact.

The real problem occurs along the electrical path from where the power enters your building to your machine. Between these two points are all kinds of devices, such as elevators, air conditioners, coffee makers, and so on. The ignition of an oil furnace, for instance, produces an electrical spark that can generate an impulse that might be more than 1200 V. The starting transient of an air conditioner is strong enough to interfere with any electronic equipment that may be connected to the same power-source transformer. Copiers are notorious as a source of noise that creates soft errors in computers that share circuits with them.

Any equipment that arcs, cycles on and off, or draws excessive bursts of current is a potential hazard to your computer. There are far more pervasive culprits residing inside your building than any potential lightning strike, and they should be the prime focus of your protective strategy. Lightning-caused surges are rare events. When protective devices such as gas tubes (lightning arresters) are shorted across a power line, lightning is diverted to ground. When this happens, you and other users down the line will experience a momentary power sag. This is why you will see lights flicker during storms.

It's more important to protect your computer from the more common electrical malfunctions caused by equipment in your building than to protect it from infrequent lightning surges.

Cause and Effect

The pressure to put computers into smaller and smaller packages caused a quiet revolution in power-supply design. Until the 1980s, computers used what is called a linear power supply (see figure 1). Its most prominent feature was a 60-Hz power transformer connected across the input (between line and neutral). After the line voltage was transformed from 120 V to 5 V, or whatever level was necessary to satisfy the DC logic, the power was rectified and filtered. (A rectifier is a device that converts AC current into DC current.)

Those 60-Hz transformers made linear power supplies big and heavy. Out of the need for smaller, lighter power supplies,

continued

ILLUSTRATION: MIKE HODGES © 1988

the switching power supply was born (see figure 2). This design change eliminated the power transformer. With the new circuit, the incoming power is applied directly across the bridge rectifier. The resulting ripple DC is then pulsed at between 20 kHz and 100 kHz, depending on the specific supply design.

The action of chopping up the rectifier's output into high-frequency segments allows designers to use a high-frequency transformer, which is smaller and thereby reduces the size of the power supply.

The use of switching power supplies also dramatically affected computers' susceptibility to noise. A linear supply draws current in step with the voltage sine wave. In other words, as the line voltage rises and falls, the power supply's current demand rises and falls along with it. Linear power supplies are voltage-sensitive, however. If the supply voltage varies more than a few percent plus or minus, problems will develop.

On the other hand, a switching power supply (sometimes called a switch-mode power supply) is not voltage-sensitive. Such power supplies draw current in huge gulps once every half cycle. For this reason, the power source's internal impedance can be a problem because if the impedance is too high, the power source cannot deliver power easily. But while you must be concerned about current, you do not have to concern yourself with voltage regulation as you do with the linear power supply. Switching power supplies regulate the level of voltage by varying the amount of current that is drawn. This action is basically independent of the voltage of the power source.

Because they contain switching power supplies, microcomputers can operate over a wide voltage range. This range can be from as low as 80 V to as high as 140 V.

There are devices on the market, such as ferroresonant transformers, that regulate voltage to microcomputers. However, since your computer's power supply does not need voltage reg-

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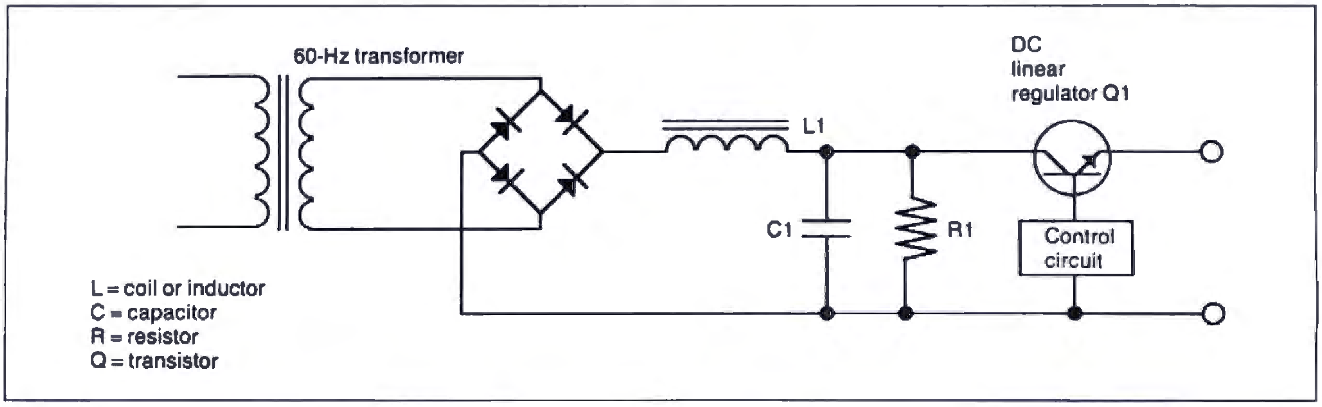

Figure 1: *Linear power supplies, used in small computers up until a few years ago, featured a large 60-Hz power transformer connected across the input. Such power supplies were sensitive to variations in voltage and made power supplies bulky.*

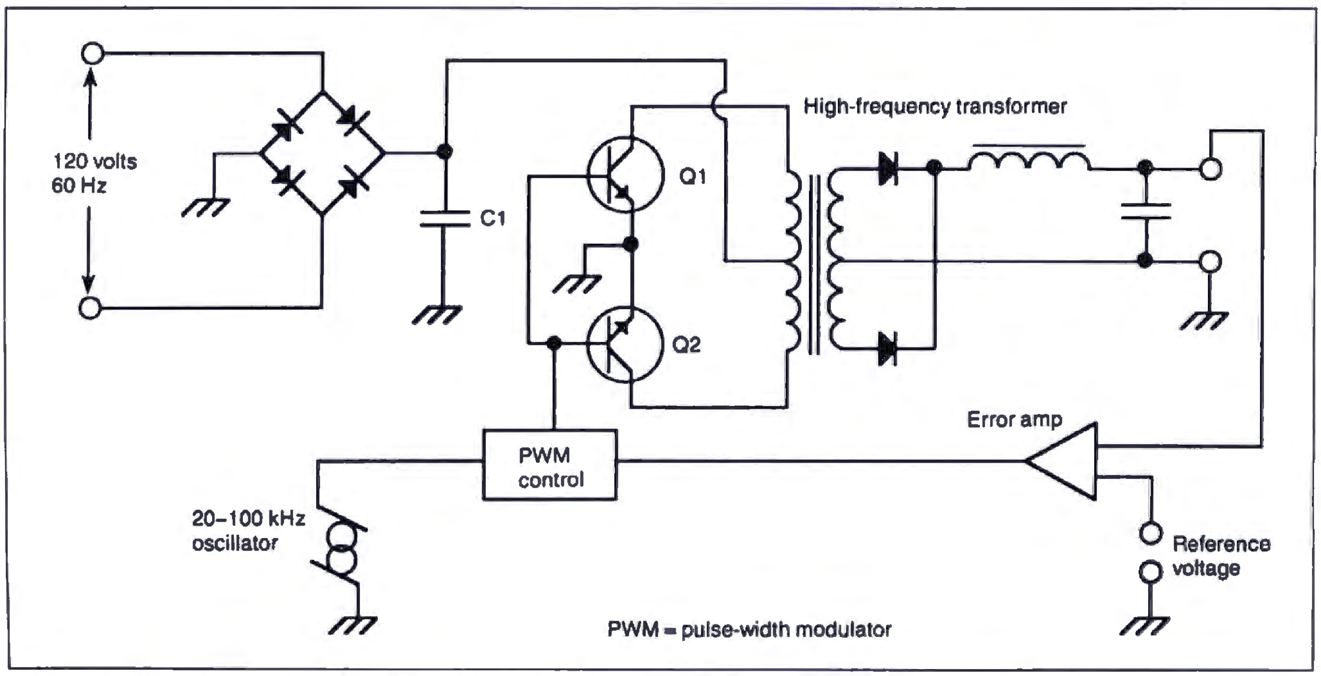

Figure 2: *The circuit of a switching power supply. The use of small, high-frequency components allows such power supplies to be smaller but makes the computer vulnerable to common-mode noise.*

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ulation, these devices are unnecessary. In addition, such devices limit the amount of instantaneous current that can be delivered to your machine's power supply—an undesirable attribute, for the reasons explained earlier.

Noise About Noise

If you look behind the faceplate of the nearest wall plug, you will see either two or three wires. The black wire is called the phase wire, sometimes termed the "line" or "hot wire." The white wire is called the neutral wire. If you see a third wire, it will be the ground wire and will be either green or bare copper. If you do not see a third wire, the installing electrician may have used the metal conduit as the ground path.

Where your service enters your building, you will find that the neutral and ground are bonded. If you measure the voltage between neutral and ground at the outlet, it will usually be zero. If you measure from line to ground, or from line to neutral, it will read 120 V. These three wires not only provide power to your computer, but are the path through which electrical noise travels.

Let's define electrical noise as any signal, other than the desired signal, that appears in a circuit. Noise, then, can be either minor or major. Noise can include large transient events or damaging impulses, or it can be continually oscillating signals from spinning motors and other kinds of interference. There are two kinds of noise: *normal mode* and *common mode* (see figure 3).

Normal-mode (or transverse-mode) noise appears as a voltage between line and neutral. The word *normal* is used because that's normally where utility power is transmitted, between line and neutral.

Common-mode noise can be measured from line to ground or neutral to ground. This type of noise appears on both the line and neutral with respect to ground; in other words, it is common to both lines.

Basically, your computer's power supply is vulnerable only to high-energy impulses that appear in the normal mode (normal-mode noise). And generally speaking, a computer's chips and logic are vulnerable only to common-mode noise.

Power-supply components are designed to take line voltage (normal mode) with peaks of up to 170 V and convert it to DC. Because power-supply components are so rugged, they have a high degree of immunity to normal-mode noise. An oncoming impulse would have to be several hundred volts before it would damage your computer's power supply.

The old linear power supply, with its big power transformer, was immune to common-mode noise. Noise appearing along the line and neutral would cancel in the primary winding, because they are 180 degrees out of phase. If the cancellation process was imperfect, the magnetic transformation would convert it to normal-mode noise. Not so with switching power supplies.

Switching power supplies have no up-front transformer. And, because their components are tightly packed, they offer many capacitive paths at various frequencies. Stray capacitive coupling inside your machine and ground loops between other devices can let common-mode noise slip into, around, and through the power supply and reach the computer's chips and logic. Also, your logic chip's ground reference is usually tied directly to power ground—a sure recipe for disaster. What this means is that at various frequencies, common-mode noise may appear across the logic circuits themselves.

Because the distance between connections on the chip is only a few microns, ICs can tolerate only a fraction of the voltage that the rectifiers inside the power supply can tolerate. Noise from a few volts to a few dozen volts will interfere with your processing. Common-mode noise exceeding a few dozen volts could destroy your computer's chips.

Ground Yourself

Ground, as it relates to computers, is probably the single most misunderstood electrical concept. As far as your computer is concerned, ground is not earth. Grounding something has nothing to do with driving a copper rod into your flower bed. The earth is not an electrical septic tank into which we flush unwanted noise to make it disappear forever.

Electricity travels in circuits, and current flowing to a point will flow away from that point. If current is directed to a ground wire, it will reemerge somewhere else along any electrical path that might be part of the ground circuit. This circuit may take different paths at different frequencies.

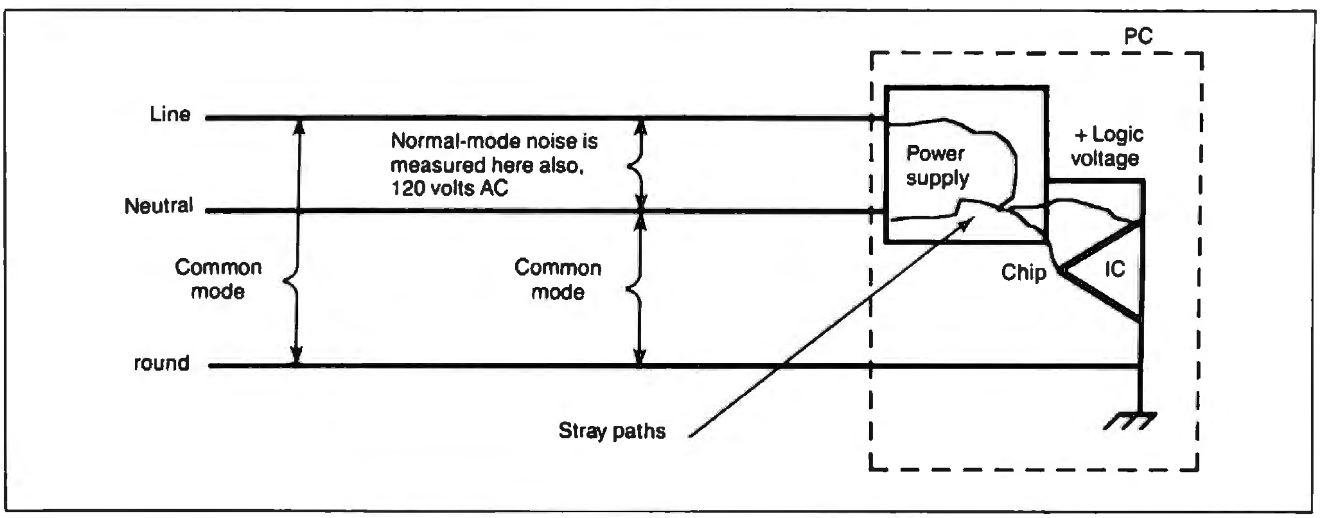

Figure 3: *Normal-mode noise appears as voltage between the line and neutral wires in a circuit. Common-mode noise appears between the neutral and ground wires. If common-mode noise can find a stray path (and it will, especially through a switching power supply), it will appear across the chip from one of its pins and the logic ground pin. Normal-mode noise appears across the power supply just like utility power.*

If a power glitch occurs in your computer at normal power frequencies, electricity directed to the ground wire should travel back to the electrical panel to trip a breaker. At higher frequencies, however, a noise signal may find stray paths through boards, cables, or between cabinets to be a far lower impedance route back to its source than the power ground wire. This is called a ground loop (see figure 4). Ground loops can be a source of processing errors as well as actual hardware damage.

Local area networks are extremely susceptible to ground loops. In such an environment, current will flow because of the electrical potential difference between the ground connections of different workstations. This undesirable current flow may induce dangerous voltage levels in nearby electronic components.

An IC is referenced to ground. It operates by detecting a logic level of so many volts with respect to ground. If the ground reference point changes in relation to the logic level, errors will result. If this voltage difference exceeds the *withstand* rating of the chip, current will bridge the substrate of your chips and destroy them.

Suppressing Those Surges

Before looking at the actual circuit elements involved in the common surge suppressor, let's look at what it is supposed to suppress. Typically, you think of a surge as a spike or an impulse. Figure 5 shows what an impulse might look like. It initially rises to a peak and then oscillates in a diminishing fashion until it dissipates.

There are two vital features to an impulse. The first is its kinetic energy (joules or watt seconds) determined by its peak voltage, current, line impedance, and time span. The second is its rise time, or the time it takes to rise from nominal voltage to its peak voltage.

It is the front slope of the impulse that causes damage to your computer. This rapid rate of change is full of energy at various frequencies. The faster the rise time, the more high-frequency components the spike contains. It is these high frequencies that find those stray paths and cause all the damage. Lightning, arcing, and sparking have extremely fast rise times. At these high frequencies, the physics of electricity and the paths it follows are very different from 60-Hz utility power. Your computer's circuitry was never designed to digest this kind of high-frequency energy.

Scientists have tried to quantify and define what the typical spike might look like. The result of their findings is a standard that has come to be known as the IEEE 587 ring wave (see figure 5). It is a waveform with strict parameters and is a test-measuring criterion for surge-suppression equipment. This is why so much good power equipment states proudly on its package that the product can withstand so many hits of the IEEE 587 test wave.

Recently, UL introduced a testing standard of its own, called UL 1499. In most respects, this waveform is similar to the ring wave. When you are in the market for surge-suppression products, look for these standards to tell you that the product actually performs as advertised.

But will surge suppressors really protect your computer?

Diversion Tactics

Actually, a surge suppressor doesn't suppress unwanted electrical energy; it diverts it. Rather than suppressing, absorbing, arresting, or otherwise making unwanted impulses disappear, these devices actually divert the energy from one path to another.

Transient suppression devices come in four different varieties: metal oxide varistors (MOV), zener diodes, filters, and gas tubes. By far the most popular device is the MOV. The term *varistor* means variable resistor and describes the MOV's basic function. As voltage builds up across this device's terminals, it reaches what's called the breakdown voltage. At this point, the varistor changes from a highly resistive device to a low-resistance device, and large amounts of current can then flow through it.

If you connect a MOV in parallel to your machine, when a spike comes along, the MOV will clip it. In other words, that portion of the impulse that rises above the MOV's breakdown voltage is clipped off and diverted through the MOV. This clipping level is usually around 140 V RMS. The peak let-through

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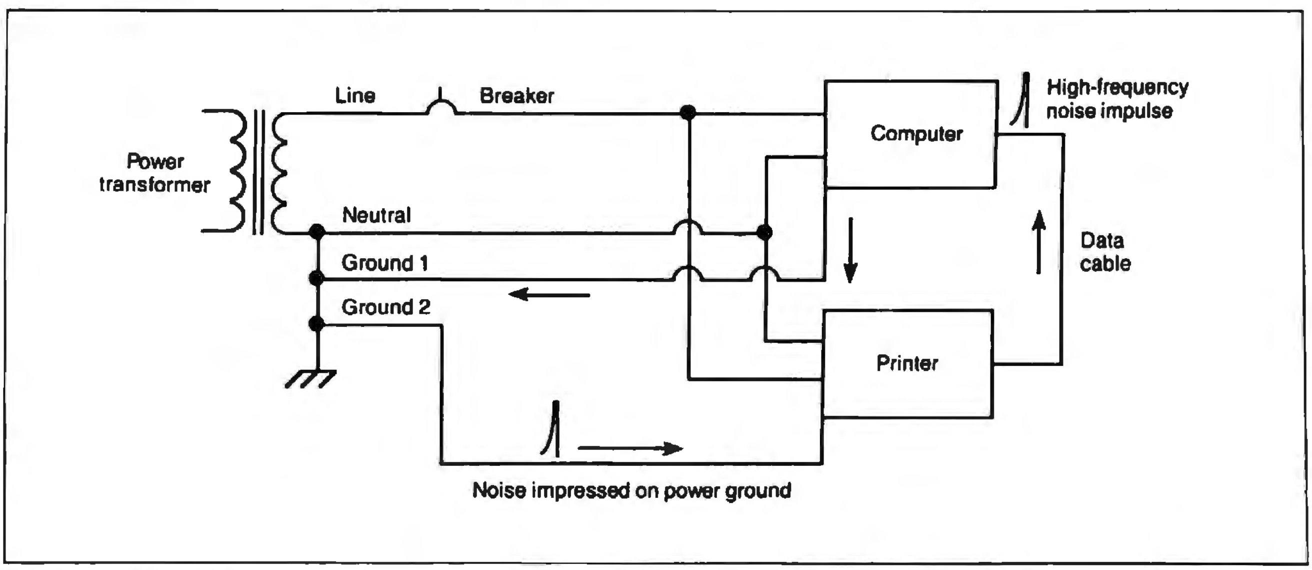

Figure 4: *Noise current will take the path of least resistance, a situation that may interfere with the transmission of data between devices or even cause damage.*

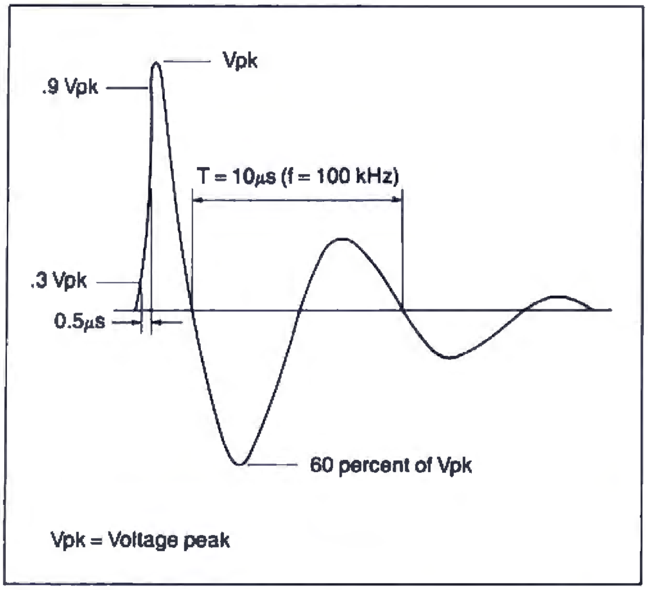

Figure 5: *The IEEE 587 ring wave is a testing standard for surge-suppression products. Engineers have found this wave shape to be typical of what might appear on 120-V circuits leading to your computer.*

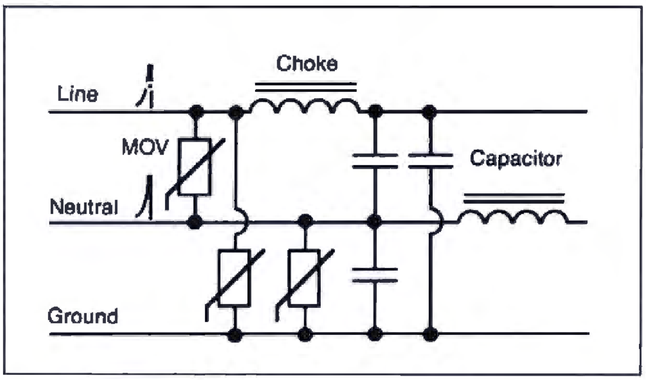

Figure 6: *Typical circuit of a surge suppressor. Most simple surge strips have only a MOV (metal oxide varistor) and capacitors from line to neutral.*

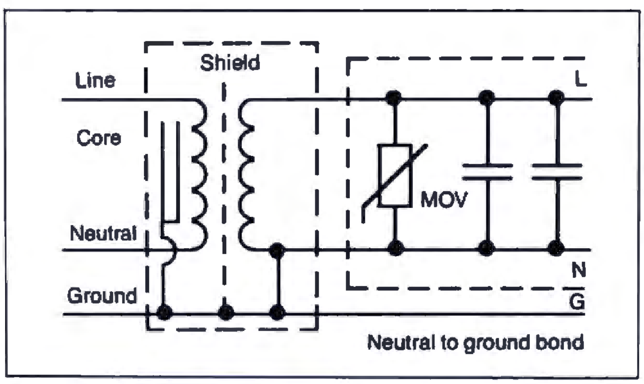

Figure 7: *A power-line conditioner contains an isolation transformer with secondary surge suppression and the neutral and ground bonded.*

voltage is likely to be as high as 340 V in some cases. Most often, you may think of a spike as appearing at the peak of the sine wave. But if the spike appears in the valley of the sine wave, the level of the voltage before clipping will be high. This is one of the weaknesses of this type of transient suppression device.

Zener diodes, sometimes called avalanche diodes, act similarly to MOVs. They do, however, have different performance characteristics. Zeners have a faster response time and come in sizes with a lower breakdown voltage than MOVs. MOVs, however, can usually handle more current than zeners. In order to take advantage of these complementary qualities, manufacturers often place both devices in surge suppressors.

Filters, in the form of capacitors and chokes (coils), are used in surge products to block the flow of noise current at the design frequency and to divert it through a lower-impedance path. Most surge suppressors have one or more capacitors. The better ones have chokes in series on the line and neutral wires.

Another device common to some suppression products is the gas tube. When voltage builds up across a gas tube's terminals, the gas inside the tube ionizes and becomes a conductive path. Through arcing, the path ionizes, and the energy is bypassed.

The arcing action of a gas tube, though, creates very undesirable high-frequency characteristics that make it inappropriate for placement near your computer. In addition, a gas tube can take a seemingly unimportant impulse and turn it into a damaging impulse. Yet, the market has seen the proliferation of tiny gas tubes inside surge suppressors. Evidently, designers think that including a gas tube in a surge suppressor will give you the illusion that it can handle enormous amounts of energy.

The proper use for a gas tube is in a lightning arrester placed near your building's service transformer. Enough wire exists between this point and your machine to block the passage of the high-frequency effects of gas-tube firing.

In figure 6, which shows a typical surge-suppressor circuit, notice the MOV that is placed between line and neutral. As this MOV conducts a high-energy impulse from the normal mode, current is dumped onto the neutral. This current flow creates a voltage drop between neutral and ground. By this process, the surge device has used normal-mode noise to generate common-mode noise. Photo 1 shows that the impulse created by this current flow is nearly as large as the one from line to neutral.

Notice that to protect your computer from common-mode noise, figure 6 also shows MOVs connected from line to ground and from neutral to ground. This is a good feature. But remember that common-mode noise sensitivity is significantly higher than that for normal mode. You must be concerned with the logic and any voltage that might appear across it. A MOV will allow up to several hundred volts to pass through before it activates.

Suppressor Circuit Caveats

In the surge-suppressor circuit (see figure 6) you see filtering elements made up of chokes and capacitors. This is a fairly well-engineered circuit. Someone has taken the time to worry about both normal- and common-mode noise and has included filtering as well. Unfortunately, simple surge strips that go for about $10 to $20 usually have only one MOV between line and neutral. Obviously, you should be concerned about what's inside the surge suppressor, though it is difficult (if not impossible) to tear open a product before you buy it.

There is still another problem. Not only does the common surge protector convert one kind of noise into the kind your computer finds least tolerable, but when parts of your device

continued

fail, the device won't give you any indication that you no longer have surge protection. Because they are connected in parallel to your computer, when MOVs or zener diodes fail, your machine will still run and you won't know that the surge device has passed away.

Perhaps to make you feel better, some manufacturers build

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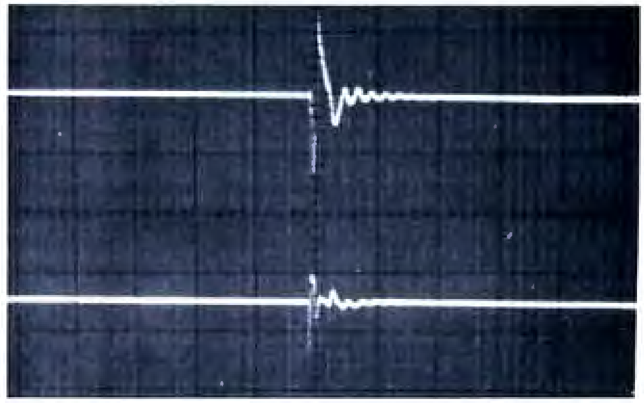


Photo 1: *As the impulse in the normal mode (top trace) is conducted by the MOV from line to neutral, another impulse (bottom trace) appears between neutral and ground, the common mode.*

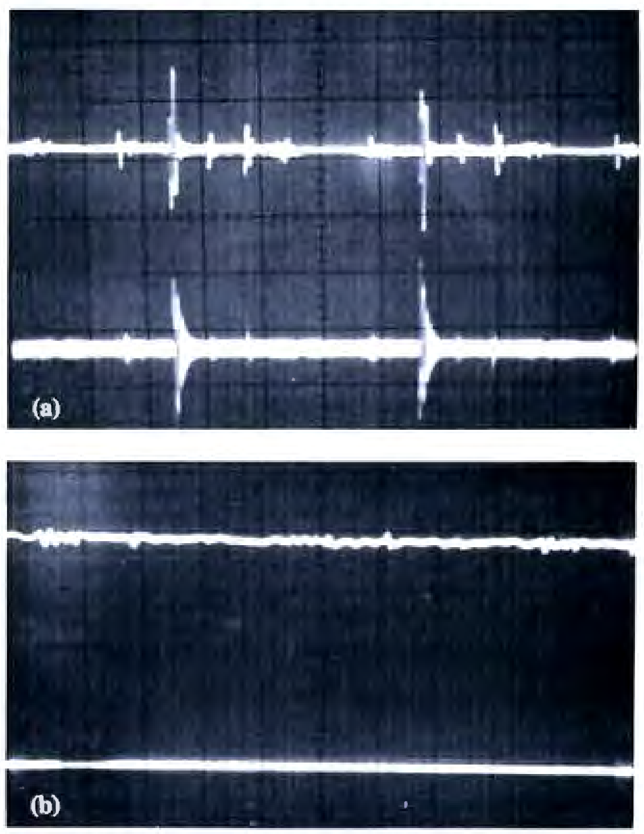
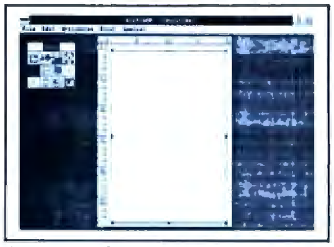


Photo 2: *These photos show noise in an electrical circuit,* **(a)** *before and* **(b)** *after insertion of a power-line conditioner. In both photos, the top trace is normal-mode noise and the bottom trace is common-mode noise.*



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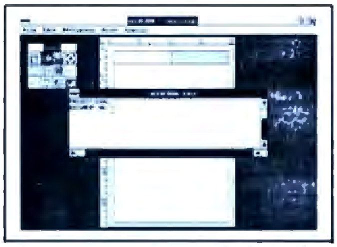
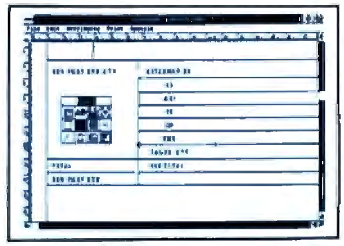


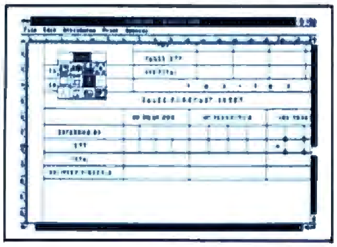
2. Type in text through Edit window.

3. Load image and add lines.

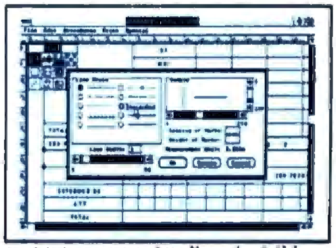


4. Add lines to form table.

5. Type and place sub heading.



6. Use tool 7 to add multiple lines.



7. Make connecting lines invisible.

8. The finished form in Reduced View at 1:24:32 p.m.

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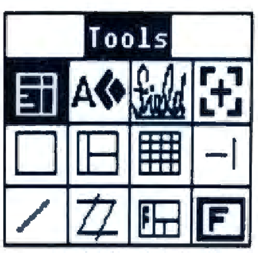

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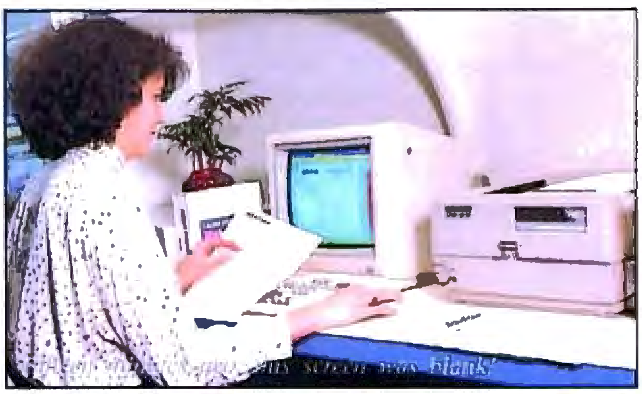

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Circle 4 on Reader Service Card

into surge protectors a status indicator—usually a little green light. A green light tells you everything is OK, right? Wrong. Most status indicators just tell you that power is flowing. Thus, you may think your surge strip is protecting you, but you don't know for sure.

So, is a surge suppressor the answer to protecting your equipment? Not really. There is an alternative that will protect your computer investment much better than a surge suppressor.

A Better Solution

If you want to protect your investment in computing without wasting money on products of dubious utility, or if you are trying to solve power problems you already have, I recommend a power-line conditioner with a built-in isolation transformer at its heart (see figure 7). Properly designed, the transformer, along with a couple of capacitors and a MOV across the secondary, will give you security far superior to that of a surge protector. Photos 2a and 2b (before and after insertion of a power-line conditioner) show how effective this design can be in protecting your computer from undesirable voltage impulses.

The isolation transformer acts as an inductive cushion, stripping away high-frequency components of normal-mode noise. Any remaining normal-mode noise will be shunted by the filter capacitors connected across the transformer's secondary, or by the MOV if it contains high energy.

Perhaps a power-line conditioner's most important feature is the neutral-to-ground bonding on the secondary side of the transformer. This is a requirement of the national electrical code that has some very happy consequences for all microcomputer users. This bonding is a short circuit for common-mode noise, and, since there is no impedance across a short circuit to allow a voltage to develop, common-mode voltages do not occur (Ohm's law: current × impedance = voltage). With this type of device, no voltage will appear across your logic circuits.

Suppress or Condition?

When all's said and done, then, what kind of device will really power-protect your computer? If you opt for a surge suppressor, a device that is relatively inexpensive and easily available, what features should you make sure it has? You want filtering as well as surge suppression. You have to have both normal- and common-mode protection. And you should have some way of determining the state of the device's internal components. In addition, be sure that it has been tested to UL 1499 or IEEE 587 standards. To obtain this type of surge suppressor, you will probably have to pay more than $100. But even if you do choose this route, you have hardly obtained the ultimate in power protection for your computer.

If you opt for the alternative, a power-line conditioner, you may need to ask the advice of a power professional to help you make the best choice, or you can purchase your device from an industrial or commercial dealer. This more effective product costs around $250, much more than a simple surge strip.

Computer power protection is not as easy or inexpensive as you might think. Protective devices are like insurance—a trade-off between cost and risk. In most cases, a quality choice, while it may not be the least expensive, is the best choice. ■

Editor's note: *Next month, in Part 2 of this series, Mr. Waller will discuss backup power devices.*

Mark Waller is a computer facilities consultant and the author of Computer Electrical Power Requirements *and* Mastering PC Electrical Power, *both published by Howard W. Sams. He can be reached on BIX as "editors."*

Part 1

A SUPERCOMPUTER

Steve begins a supercomputer project by looking at multiprocessing basics

Every month, I get several hundred letters from readers. Many of them ask for help with specific hardware or software problems, but there are always a few letters chiding me for not building a *real* computer. They imply that even 80386 and 68030 machines are simply uninteresting, and that I should design a supercomputer of one sort or another.

Unfortunately, the problem with a supercomputer is that it takes super software to drive it. Remember, my favorite programming language is solder, and that doesn't make me particularly fond of introducing "Yet Another Computer System" with "Yet Another Programming Language."

But around the Circuit Cellar we like to do things that are out of the ordinary. I thus decided to see what it would take to build a supercomputer, and I thought you would be interested in how I determined the proper architecture. The result is a three-part description of multiprocessing that starts with theory and ends with reality.

The Circuit Cellar supercomputer is a multiprocessor computer specialized to evaluate the iterative formula describing the Mandelbrot set, so a more accurate name is the Circuit Cellar Mandelbrot engine. A driver program running on an IBM PC AT presents the results in real-time color on an EGA or a VGA, with smooth panning and scrolling so you can examine the results on the fly. System performance increases as you install more processors. You can start with a single processor, graduate to 64 processors (as in my example), or work up to a monster system with 256 processors.

The Circuit Cellar Mandelbrot engine starts at roughly twice the performance of an 8-MHz AT with just one card of 8 processors, increases smoothly past a 16-MHz 80386 with three cards (24 processors), and zooms far beyond it with 64 processors (eight cards). I haven't found anything (under $500,000) to compare with a full-bore system of 32 cards. Not bad, considering that the Mandelbrot engine is based on the lowly Intel 8051.

In this first part, I'll describe how to increase the performance of single-processor systems and show why there's a definite upper limit to processing speed. The solution seems to be using multiple computers on the same problem, so I'll explore some of the different ways to connect multiple processors in arrays, and the troubles that arise from these connections.

Before launching into a discussion of multiprocessing, I'll review some of the performance problems and solutions for single-processor systems. I'll start with the simplest possible system and work up to pipelining and caching.

Building Performance

In comparing performance, you must be careful what you're measuring. A convenient unit is the number of instructions per second, which you get by dividing the total number of instructions executed by the elapsed time from start to finish. A processor that executes twice as many instructions in a given time has twice the performance, for an increase of 100 percent. (Some of the examples I'll give will focus on the number of cycles per instruction, which is the reciprocal of the number of instructions per cycle. Be careful not to compute the performance ratio upside down.)

Figure 1 shows the two essential components of a computer: a CPU and memory to hold the program and data. The fat arrow between the two represents the address, data, and control lines running between them. For these discussions, I'll ignore the necessary I/O hardware and presume that the program and data are already loaded into memory.

This CPU is so simple that it doesn't include any registers; all operations must refer to memory locations. For example, an ADD instruction must specify three memory locations: one each for the two numbers to be added and where to put the result. Although your favorite microcomputer may not have such an ADD instruction, the earliest computers (back in the Good Old Days of relays and vacuum tubes) actually worked this way. Figure 2 shows the execution sequence for the ADD instruction I've described. Each vertical line marks a single CPU clock cycle or memory access.

The first step, of course, is to fetch the ADD instruction from memory. After the instruction arrives in the CPU, it is decoded to determine the addresses of the operands. The CPU then fetches the operands and performs the addition. Finally, the CPU stores the result back into memory. This sequence repeats for each instruction, with some variation.

What's of interest is that a single instruction requires four memory accesses: an instruction fetch, two data fetches, and one data store. During two more cycles, memory is idle while the CPU decodes and executes the instruction. Other instructions have different sequences, but the overall pattern is similar.

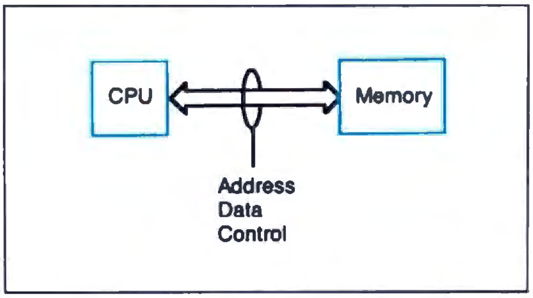
The memory in this example must be able to return data within a single CPU cycle and also be ready for another access at the start of the next cycle. Dynamic RAMs need some time after an access to get ready for the next operation; the minimum time between accesses is the DRAM's cycle time. The memory's cycle time is necessarily longer than the access time required to return data. Typically, DRAMs have a cycle time that's about twice the access time.

continued

For example, premium DRAMs with a 100-nanosecond access time have a cycle time of about 200 ns, so each CPU cycle must be 200 ns. The ADD instruction I've presented will therefore take 6 × 200 ns, or 1200 ns. Some instructions may be faster and some slower, so the CPU will run at about 800,000 instructions per second.

Increasing the performance of this machine by a factor of 2 sounds simple enough: Double the clock frequency and reduce the CPU and memory cycle times to 100 ns. Unfortunately, DRAMs with a 50-ns access time and a 100-ns cycle time are on the forefront of technology right now, and more expensive than you can imagine. But all is not lost.

Figure 1: *The essential parts of a computer system.*



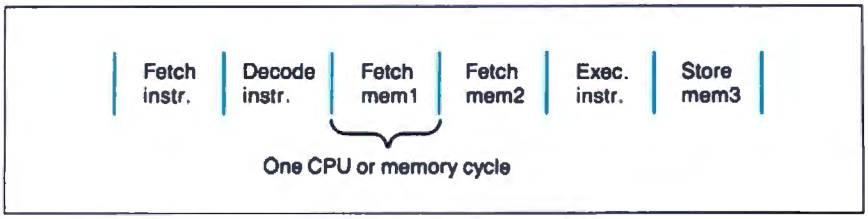
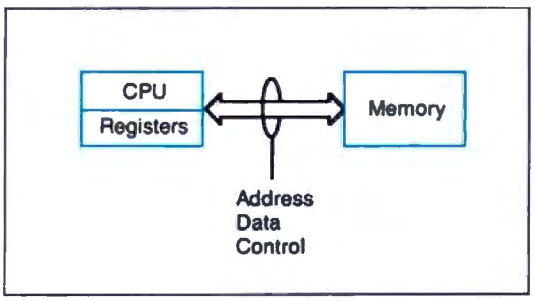


Figure 2: *Execution sequence for the instruction* ADD mem1,mem2,mem3.

Figure 3: *Adding registers to the CPU of figure 1.*



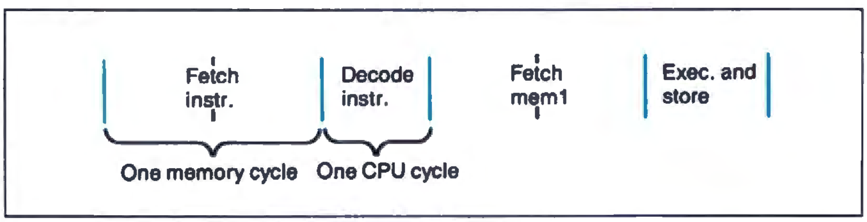


Figure 4: *Execution sequence for* ADD mem1,reg. *Note that memory access is now two CPU cycles (see text).*

Registered Speedup

Figure 3 shows a more complex CPU with internal data registers. Each register can hold the same amount of data as one memory location, so an instruction can refer to either memory or registers. Because the registers are on the CPU chip, register accesses are faster than memory accesses. To take advantage of this, the definition of an ADD instruction changes so that it now adds the contents of a memory location to an internal register and puts the result back into the same register. This reduces the number of memory accesses to two: one instruction fetch and one data fetch.

The reason for these changes is to let the CPU run with a faster clock rate than the memory could otherwise tolerate. The CPU cycle time can now be 100 ns, half the memory cycle time of 200 ns. Any memory access must include one extra cycle, but operations within the CPU can now proceed twice as fast as before.

Figure 4 shows the execution of the new ADD instruction. Fetching the instruction takes two clock cycles because of the memory access, but decoding it takes only one. Fetching the operand from memory takes two more cycles, but the result is computed and stored in a register in a single cycle. The ADD instruction takes six cycles from start to finish, but the faster CPU clock rate reduces the total elapsed time to only 6 × 100 ns, or 600 ns, half that of the processor in figure 1.

Both processors use the same type of memory, but the second system has twice the performance of the first. Bearing in mind that a typical system has only one CPU and several megabytes of memory, a more complex CPU is a good way to improve the overall system performance without increasing the overall cost beyond reason.

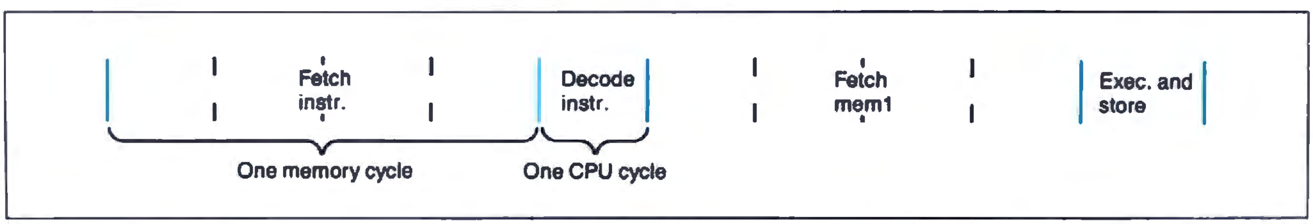


Figure 5: *Doubling the CPU clock speed for the instruction shown in figure 4 yields this sequence. Since the CPU is running twice as fast, memory access now requires four cycles.*

The extra cycle for each memory access is commonly called a wait state. Many of the newer AT clones run with zero-wait-state memory, which simply means that the memory can keep up with the processor. The complete details are a little more complicated than I've shown here, because the AT's memory is actually measured by access time rather than cycle time, but the principle is similar.

If doubling the CPU clock rate helped so much, how about doubling it again? Memory accesses now require 4 cycles (4 × 50 ns, or 200 ns), and figure 5 shows what happens. The ADD instruction now takes 10 cycles, for an elapsed time of 10 × 50 ns, or 500 ns. Doubling the clock rate improves performance by only about 20 percent because the CPU now spends most of its time waiting for memory accesses.

But if 100-ns-cycle-time memory was too expensive, you can imagine what 50-ns memory will cost. At some point, the system will outrun the fastest DRAMs, so static RAMs are the only choice. SRAMs have about 25 percent the density of DRAMs, so the chip area that can hold a 1-megabyte DRAM will hold only 256K bytes of SRAM. Prices are driven by chip area, so the memory cost increases by a factor of 4, even without considering the additional cost of the faster memory.

Access Caching

There's another trick we can use: memory-access caching.

Although the system may have megabytes of memory, most program instructions are clustered in small groups. For example, a loop may execute a dozen instructions hundreds of times. Data accesses can be clustered in the same way, as with a word processor updating successive characters in a buffer.

A cache takes advantage of this typical program behavior by storing the most recently accessed instructions and data in a local memory that's much faster than the main memory. Figure 6 shows a cache inserted between the CPU and the memory unit. Instructions and data in this cache can be returned in one cycle, just like the CPU registers. But if there's a cache miss and the cache must access the main memory, the access will take five CPU cycles.

Assuming that the CPU is running at 50 ns, figure 7a shows that an ADD instruction with all cache hits takes only 4 × 50 ns, or 200 ns. If those hits turn into misses, the ADD instruction takes 12 × 50 ns, or 600 ns (see figure 7b). It's obvious that the cache hit ratio determines the overall system performance.

More complex caches guess where the processor will need data and prefetch from those locations so that the CPU's accesses will be hits. Some systems have separate instruction and data caches with different updating strategies to take advantage of the differences in access patterns. In fact, a cache is one of the trickiest parts of a system, and it can harbor the most obscure bugs for the longest times.

The Last Drop: Pipelining

We can squeeze more performance from the processor by introducing instruction pipelining. Pipelining, also known as overlapped execution, takes advantage of the fact that each instruction breaks down into several distinct phases. The ADD instruction I've been using has four phases, which I'll call I-fetch, I-decode, D-fetch, and D-store. By adding CPU hardware to handle each phase separately, we arrive at figure 8.

Figure 9 shows the sequence of events as the CPU begins executing a series of ADD instructions, each with different memory and register operands. A new ADD instruction starts every clock cycle, so, after the pipeline fills, the throughput is one ADD instruction every clock cycle. Although an ADD instruction (with cache hits) still takes four cycles, one ADD instruction finishes every cycle, so the overall performance is 50 ns per ADD instruction.

In this example, the pipeline hardware improved performance by a factor of 4 at the same clock rate. As with the other tricks, pipelining doesn't always provide that much improvement. For example, if an instruction needs a register set by a previous ADD instruction, the CPU must ensure that the instructions complete in the right order.

Not all instructions have the same number of phases, so the pipeline may not always be full. Branch instructions are a particular problem, because the system can't determine the next instruc-

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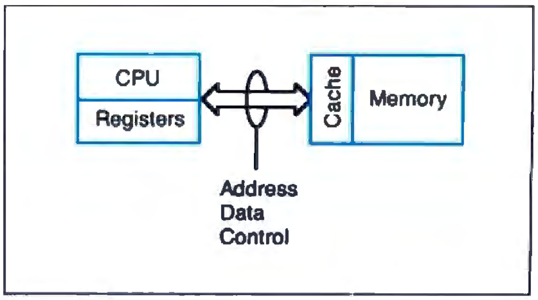

Figure 6: *The modified system from figure 3 is further modified by adding a cache between the CPU and memory.*

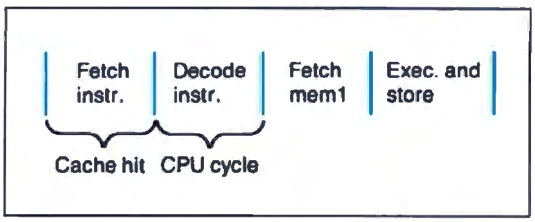

Figure 7a: *Executing the instruction* `ADD mem1,reg` *on the cached system, assuming one-cycle cache hits.*

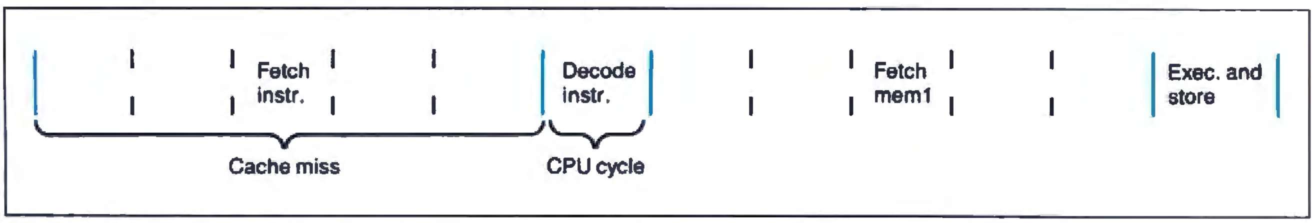

Figure 7b: *Executing the same instruction as in figure 7a with five-cycle cache misses.*

tion address until after the branch is decoded. As with caches, pipelines require some very subtle logic to take account of all the possible combinations.

It's worthwhile to remember that these tricks do not always improve the processor's performance. For example, if a program doesn't use a small set of data that fits into the cache, every data reference will be a cache miss. Similarly, if the program has many branches that flush the pipeline, the throughput will drop off to the level of a processor that hasn't been pipelined. No matter what the hardware assumes, someone can always write a program to bring the system to its knees.

Performance Limits

From these examples, you can see that the ultimate limit to a processor's performance is one instruction per clock cycle. Although several instructions may be in the pipeline, each clock cycle will produce only one result at a time. That's the upper, theoretical, ideal limit, so cache misses and pipeline flushes can only detract from it.

Because a single processor can produce only one result in a clock cycle, the only way to boost performance (for a given processor design) is to increase the clock frequency. This explains the "clock race" pushing 80386 machines beyond 20 MHz. Unfortunately, performance increases by the same factor as the clock rate. Therefore, a 24-MHz 80286 is, at best, three times faster than an 8-MHz 80286.

What the block diagrams do not show is the incredible amount of hardware required to add caches, pipelining, and all the other sorcery to support the higher clock rates. All this circuitry must run at the increased speed, and designers find out that tricks that worked well at lower speeds aren't as effective at higher speeds.

Regardless of your cleverness, the hardware circuit technology will set an upper limit to the clock rate. Mainframe computers, with custom LSI chips and optimized interconnections, run at about 60 MHz. In round numbers, 30 MHz is the fastest clock rate you'll see on your desktop computer for quite a while, because the price of the technology goes up dramatically beyond that point.

A 30-MHz clock rate means that a processor can produce one result every 33 ns at best. If the program and hardware can support one instruction per clock cycle, the processor will hit 33 million instructions per second. In real life, of course, your mileage may vary....

To put this into perspective, a standard 4.77-MHz IBM PC runs at about 0.1 MIPS. A stock 8-MHz AT runs at about 0.5 MIPS, and a 20-MHz PS/2 Model 80 does about 3 MIPS. The best we can expect in the near future is only another order of magnitude faster.

Obviously, something has to give if we want still more performance from a computer system.

Architectural Choices

If one processor can deliver one answer in one clock cycle, how many answers will two processors deliver in the same time? Although this sounds like a child's riddle, the answer is profound: two!

The work needed to solve some problems can be divided more or less equally among multiple processors. If each processor can run simultaneously, the total performance increases directly with the number of processors. Two processors will produce the result in half the time of a single processor, and so on.

There are several different types of multiprocessor systems, each suited for a different class of problem. I'll discuss some of the main architectural choices and describe what sort of problem each is best suited to solve; after that, the description of the Circuit Cellar supercomputer will make more sense.

A *scalar* is a mathematical term indicating a value that can be expressed as a single number. A scalar computer, therefore, can work on a single number at a time. You are probably most familiar with scalar processors, although you may never have thought of your computer in quite that way before. All the examples in the previous sections have dealt with scalar processor design.

A *vector* is a value that must be expressed with two or more numbers. For example, the coordinates for a point in space consist of three numbers: the distance from the origin along the *x*, *y*, and *z* axes. The notion of a vector is more flexible than that, though, and can describe

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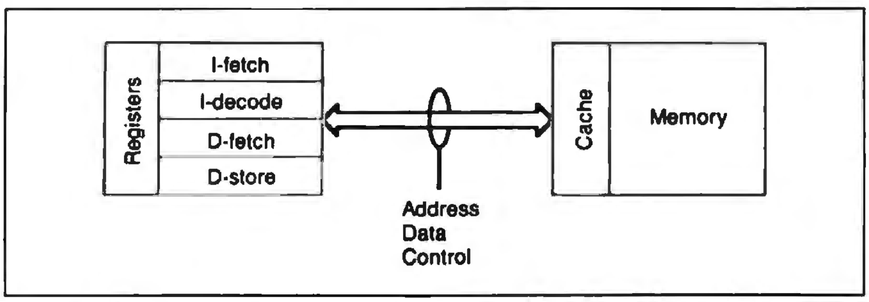

Figure 8: *In a final attempt to improve throughput, pipelining is added to the CPU.*

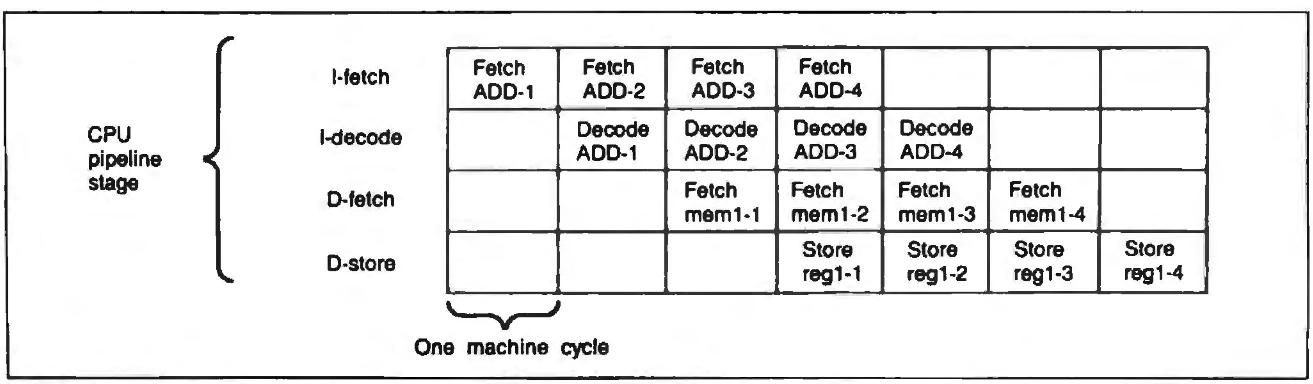

Figure 9: *The CPU from figure 8 executes a series of* `ADD mem1,reg` *instructions.*

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Figure 10: *Two processors connected to a common memory. Access to the memory is regulated by a memory control.*

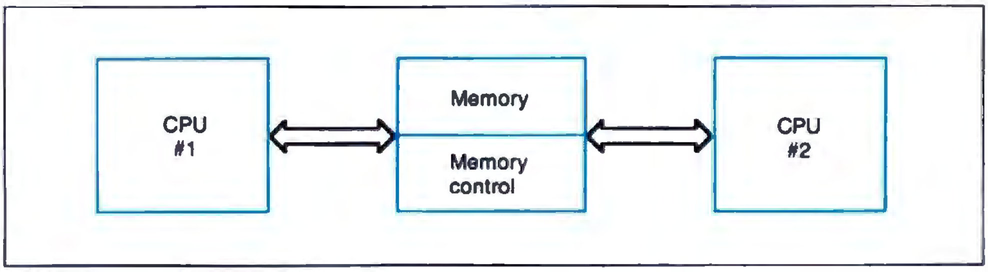


Figure 11: *Both CPUs of the system described in figure 10 execute* ADD *instructions.* ▼

CPU #1	Fetch instr.	Decode instr.	Fetch mem1	Fetch mem2	Exec instr.	Store mem3	Idle	Idle	Idle
CPU #2	Wait	Fetch instr.	Decode instr.	Wait	Fetch mem4	Wait	Fetch mem5	Exec instr.	Store mem6

One CPU or memory cycle on either processor

Figure 12: *A four-way tightly coupled multiprocessor system.*

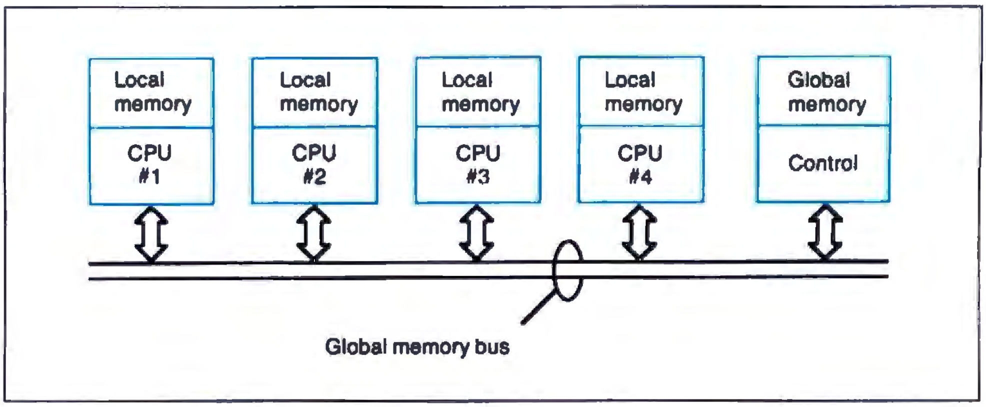


Figure 13: *A four-way direct-connected multiprocessor system.*

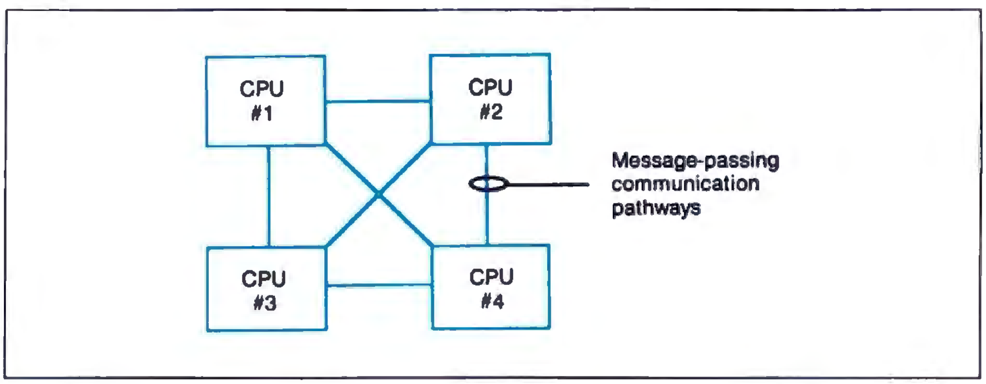
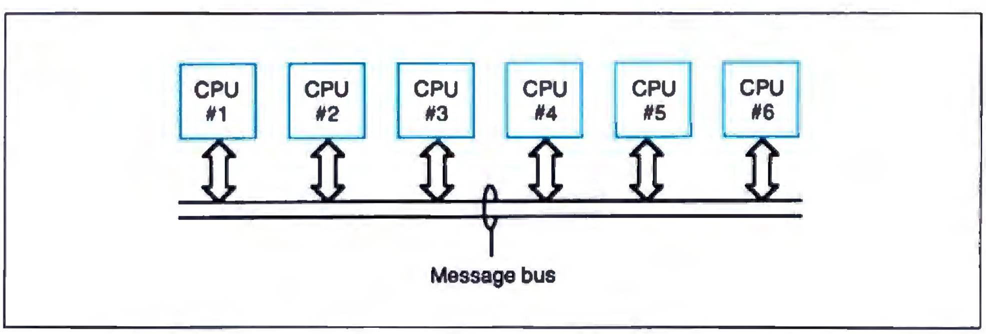


Figure 14: *A multiprocessor system consisting of six CPUs connected via a common message bus.*



points with hundreds or thousands of associated numbers.

A vector processor includes enough hardware to perform computations on all (or at least many of) the numbers for each point at one time. A machine with three ALUs could add all three coordinates of two points simultaneously, delivering the result in one-third the time of a scalar processor with one ALU.

All the ALUs in a vector processor perform the same operation on each of the vector's components. Many problems involving vectors need exactly this sort of lock-step processing, but some simply need more freedom. Although you can create some variations, in general, all the ALUs in a vector processor must do the same thing at the same time. This means that some problems simply don't fit the vector processor pattern.

The solution to problems that need more performance than the best scalar processor can provide, but are too unruly for a vector processor, can often be handled by a true multiprocessor system. Unlike scalar and vector machines, though, the exact design of a multiprocessor system determines what type of problems it can handle. In fact, some multiprocessors on the market are so specialized that they can solve only one class of problem.

The distinguishing feature of a multiprocessor system is that—unlike a vector system—the processors are all executing different instructions on different data. There's no centralized control determining which instruction to use on what data.

Although using multiple processors on a single problem can provide a dramatic performance improvement, not all problems will respond to this sort of treatment. For example, a program that computes the factorial of a number by recursive calls can't be split up on multiple processors, because each result depends on the preceding one. A word processor won't attain a dramatic speed increase on a multiprocessor system, because most of the time the software is waiting for keystrokes. (You could speed up reformatting by assigning one paragraph to each processor, but that's not a convincing application.)

It's worth pointing out that, regardless of the type of multiprocessor system, each individual processor can be any sort of scalar processor you'd like to use. Any and all of the tricks described earlier to crank up scalar performance are fair game in multiprocessor applications. The only catch is that, because the system has many processors, the cost goes up dramatically as each processor becomes more complex. Sometimes, as we'll see next month, many simple processors can outperform fewer complex ones.

And, as I mentioned above, the design of a multiprocessor system determines the types of problems it can handle with greatest efficiency. Just as with caches and pipelines, some problems will actually run slower on a multiprocessor than on a scalar machine.

Tightly Coupled Multiprocessors

Any multiprocessor system starts with two or more scalar machines. Figure 10 shows two simple processors connected to a common memory, which is similar to the simple DRAM we started with in figure 1. Because the memory can handle only one access at a time, a memory controller must decide which processor will get access to the memory on each cycle. If the processors access the memory simultaneously, one must wait until the other is finished.

Figure 11 shows what happens when these two processors both start executing different `ADD` instructions with three memory operands each. This is the same situation described in figure 2, but now you can see the lost time when CPU #2 is locked out of the common memory by an access from CPU #1. The two `ADD` instructions take 9 cycles to complete, where two on a pure scalar machine take 12 cycles.

Doubling the number of processors should increase performance by 100 percent, but it went up only 33 percent ($^2/_9$ compared to $^2/_{12}$). What went wrong?

Even though the processors are executing separate instructions with different data addresses, both processors must access the shared memory to get information. Because it is possible for the memory to handle only one request, the system is running at only half efficiency when both processors need the memory simultaneously.

There are two solutions to this problem: The memory can become complex enough to handle two accesses at once, or the processors can reduce the number of memory accesses required for each instruction. Each solution raises additional problems, but the latter choice is the only practical one for systems that use more than a few processors. Imagine building a memory that can support a dozen simultaneous accesses.

Figure 12 shows a four-way multiprocessor. Each processor has a local memory for its program and working variables. Results and status flags are stored in common memory, which is accessed over the global memory bus connected to each processor. The memory controller decides which of the four processors will gain access during each memory cycle. Processors that lose the battle for access to common memory must wait for the next free memory cycle.

Because each processor has direct access to the global memory, this is an example of a tightly coupled multiprocessor system. The tightest of coupling is the limiting case occurring when the processors have no local memory. Each processor can change the state of any other processor's computation by simply writing new data in the right addresses. As you can imagine, this may not be an entirely good thing, particularly for debugging errant programs.

The hardware problem with this architecture is that the global memory bus requires a large number of signal lines. If the processors use 32-bit words and the global memory has only 1 megabyte, the bus needs over 50 lines for just the data and address. High-frequency transmission-line techniques are required to extend this bus more than a few feet, so there is a distinct limit to the number of processors that can connect to a single global memory bus.

For problems that demand a large number of processors, there is no feasible way to connect each processor to a shared high-bandwidth memory bus. Worse, the contention for that memory will begin to wipe out the advantage of multiple processors (remember the simple example in figure 11). Again, there must be a better way.

Loosening the Bonds

The best performance for a tightly coupled multiprocessor architecture occurs when you are running programs that don't need much access to the global memory. If that is indeed the case, the wide, fast, expensive global memory bus can be replaced by a relatively narrow connection between processors. The ultimate reduction is a bidirectional serial link, but it could be a byte-wide or word-wide channel with some handshaking control lines.

Figure 13 shows a four-way multiprocessor connected by narrow ports between each pair of processors. Because each link has a relatively low bandwidth compared to the previous global memory bus, the processors can exchange only limited amounts of data. But for problems with fairly strict partitioning, this works reasonably well.

continued

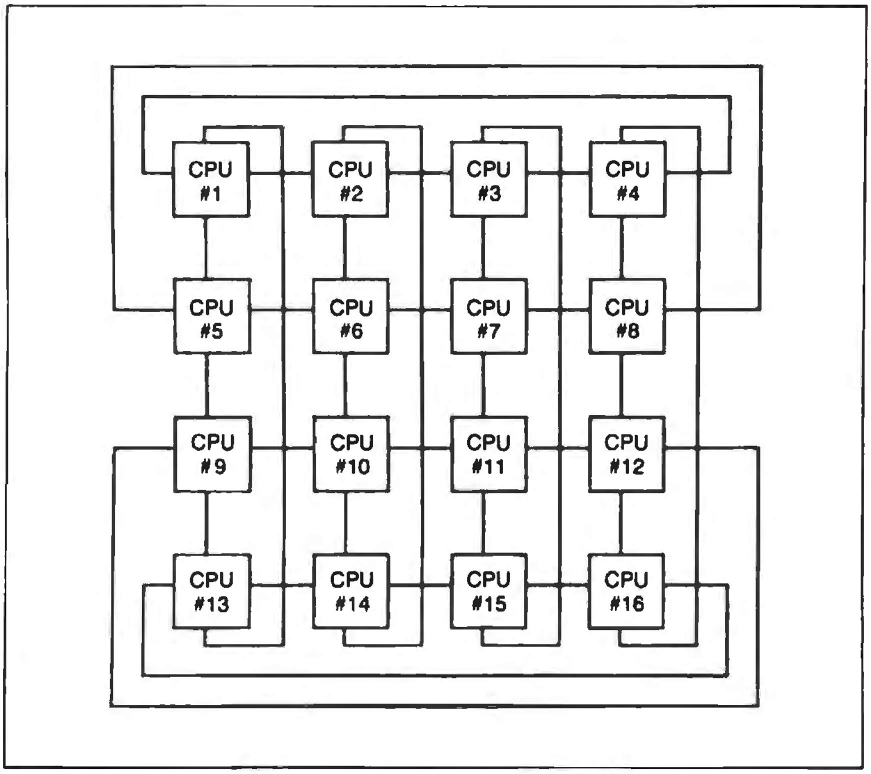


Figure 15: *A 16-processor system. Each processor can communicate with its four closest neighbors.*

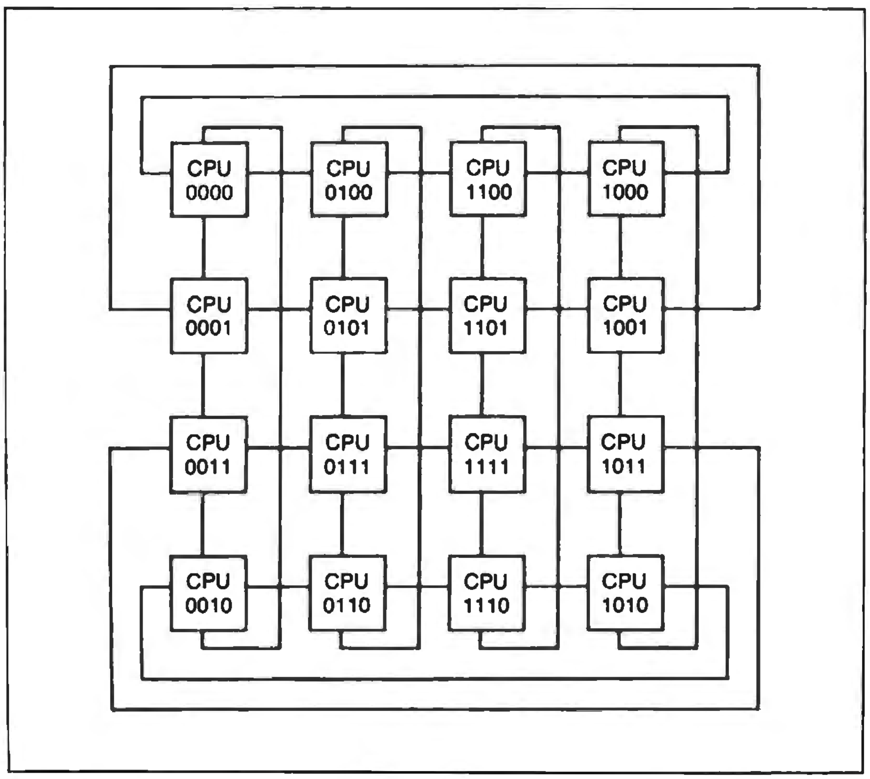


Figure 16: *The processors from figure 15 are each assigned an ID number to simplify message passing.*

Connecting each processor to all the others simplifies the task of exchanging data, but it requires $n-1$ ports on each processor. For four processors this is feasible, but I challenge you to draw the connections for a 16-processor system. For lots of small processors, there's a problem fitting all the connections into the available physical space.

One way around this is to connect all the processors to a common "message bus," as shown in figure 14. Although the figure looks much like figure 12, the difference is that the common bus is relatively narrow and doesn't connect to a global memory. Any processor can send a message to any group of the others, but only one transmitter can be active at any one time.

You'll notice a striking resemblance between figure 14 and the standard block diagram for a local-area network. In fact, although LANs are usually thought of as a way to share peripherals, they're also useful for coordinating the work of many processors. I've seen some work that uses otherwise idle computers on a LAN to perform "background" computations on a complex problem, shifting the calculations around the network to take best advantage of the available hardware.

The problem with a LAN, of course, is that there can be only one message active at a time. Regardless of the LAN bandwidth, there will be some lost time when the processors queue up to use that single resource.

Figure 15 shows one way around this problem. Each processor can send messages to its four closest neighbors, with processors on the edges of the array wrapped around to the other side. Depending on how the processors are programmed, each can support up to four messages at once. If the code is particularly clever, any processor can send a message to any other one by routing it along the shortest distance between the two.

That layout will work if most of the messages are to adjacent processors. Sending a message across the entire array will involve all the processors between the two nodes, and the overhead involved in figuring out the proper path can be significant. A slightly different way of connecting the processors can improve message passing, at the cost of greater wiring complexity.

Figure 16 looks almost the same as figure 15, with each processor linked to four others. If you look closely, you'll see that the processor numbers differ by only 1 bit across each link. That change makes the message-routing problem almost trivial.

When a processor receives a message, it compares the destination address in the message header with its own address by performing an exclusive-OR. If the result is 0, the two addresses are the same and it can process the message. If the result isn't 0, the message must be forwarded to another processor. The processor sends the message to the neighboring processor that has an address differing in that same bit position.

Using this method, you can interconnect 65,536 processors with only 16 links per processor and a maximum message delay of 16 transmissions. This seems to be the best way to connect truly large arrays to minimize transmission delay without unduly complicating the backplane wiring.

Communication Bottlenecks

What should be obvious from these sample systems is the need to figure out just what level of communication will occur between the processors. A large communication volume requires high-bandwidth connections, with the attendant complexity of common memory design. Programs with shorter, less frequent messages between fewer processors can run effectively on processors with "narrower" links, perhaps using message passing between links to reduce the number of distinct connections.

A multiprocessor system must be designed to solve a particular class of problems. Ideally, it will handle that class with particular efficiency (although every now and again the designers find that there's a skeleton in the closet that hampers performance). Attempting to fit a problem from a different class onto that machine will result in poor performance, perhaps even lower than on a scalar machine.

Upcoming Events

If you're at all familiar with the calculations behind the Mandelbrot set, you can probably tell why I elected to use it as the foundation for a supercomputer. A single image requires massive amounts of computation, but it can be easily divided between an arbitrary number of processors. The results of the computations can be summarized by 1 or 2 bytes, so the output data transmission can use a relatively slow link. Even better, the algorithm doesn't need any communication between neighboring processors, so the interprocessor communication isn't a critical issue.

In the next part of this project, I'll describe the system architecture of the Circuit Cellar Mandelbrot engine and explore the mathematics and algorithms behind its operation. In the concluding part, I'll cover the array hardware and the control/display software for the Mandelbrot engine. ■

Special thanks to Ed Nisley and Merrill Lathers for their expert contributions to this project.

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, 12 Depot Square, Peterborough, NH 03458. 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 on-line 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.

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

Part 2

FLOATING-POINT WITHOUT A COPROCESSOR

Emulating a math chip is fine, but you still need some way to talk to the outside world

Last month I introduced a binary floating-point mathematics package and described the code for the four primary math operations: addition, subtraction, multiplication, and division. Using those routines, you can build the more complex functions—transcendentals and trigonometrics, for example—that you find in high-level languages.

But there are a couple of ingredients still missing from the recipe. Although you can manipulate floating-point numbers with the functions I've given, you need to be able to get numbers to and from the routines. I can remember when I toggled in my first program on my old Altair 8800's front panel and showed my mother its results on the accumulator LEDs.

"Look, Mom! That light means a 2, that one means an 8, and that light means a 16, for a total of 26!"

"That's nice, dear."

A mathematics package with no easy way to get the numbers in or out is not much better. It's time for some I/O.

Inside/Outside

As you'll recall from last month, the floating-point format I've defined accommodates storage for a 15-bit exponent, an 80-bit mantissa, and a 1-bit sign (which needs a separate byte of its own; you may want to refer to the diagram on page 314 of last month's BYTE). All this requires 13 bytes of storage per number local to the package. I referred to this storage area as the *floating-point accumulators*, FAC1 and FAC2.

However, a program that calls the package is not likely to want to allocate 13 bytes of storage for each floating-point number: A large array of such numbers can consume memory rapidly. And the format I've described uses an entire byte to hold the mantissa's sign. This is necessary only to make the execution of floating-point operations faster. When a number is being stored externally—waiting around until you use it again—it doesn't make sense to use 8 bits to store the sign when 1 bit will do.

Listing 1 shows the pseudocode for a pair of routines called LDFACC and STFAC1. LDFACC loads one of the two floating-point accumulators (selected by the DI register) from an external memory location, assuming that the number at that location is in external floating-point form. STFAC1, the reverse of LDFACC, stores the number in FAC1 to an external location. I didn't provide a routine for storing FAC2 anywhere, because the four operations I've so far defined all leave their results in FAC1.

The external representation the package uses is very close to the 10-byte extended format used by the Apple Macintosh's Standard Apple Numeric Environment library (which is compatible with the IEEE 10-byte extended definition). My numerics package doesn't define special cases like NAN (not-a-number) and infinity as defined in SANE, but some intrepid programming could add such entities; in fact, you can make the package compatible with whatever you want.

Most of these routines' time is spent shifting and masking. The external representation stores the mantissa's sign in the highest bit of the exponent (a bit that, internally, is used to detect exponent overflow). Also, since the normalization routine I presented last month aligns the mantissa so that its topmost bit is 0 (to catch overflow), STFAC1 shifts the mantissa before storing so you don't waste space storing an empty bit.

Actually, you can grab one more bit's worth of accuracy in the external representation if you consider that, unless the floating-point number is true zero, after one shift to the left the most significant bit of the number must be a 1. You could rewrite STFAC1 to perform a second shift before it stores the number. Then, rewrite LDFACC to recover those top 2 bits by shifting the mantissa to the right twice and setting the highest 2 bits to 01 binary. The IEEE and Microsoft formats for encoding short and long real numbers use this trick.

You can modify the load and store routines to customize your own external representations (or adhere to those of some other commercial numerics library). Perhaps you don't need a 64-bit mantissa's worth of accuracy—you'd prefer handling lots of less-precise numbers quickly, rather than take more time for a few really precise ones. In this case, you can lop bytes off the mantissa from the right—but keep in mind that for every bit you give up in the mantissa, you lose about one-third of a decimal digit's worth of accuracy. If you want to store the exponent in a byte rather than a word, you'll certainly have to pick a smaller bias value (128 comes to mind, since that number divides a byte's range: 0 to 255) and write some routines for translating to and from byte-wide and word-wide exponents.

Incoming

Getting a floating-point number into the package from the outside—typed in from the keyboard or read from a file—simply requires a routine to read a character string representing a floating-point number and translate that number into the package's internal representation. You can break this requirement down further into a series of simpler requirements: The routine must read and translate signs (+ or −), a mantissa, and an exponent.

The routine I've provided reads a character string whose format can handle any

continued

Listing 1: *Pseudocode for the* LDFACC *and* STFAC1 *routines that move numbers to and from the floating-point accumulators.*

```
LDFACC:
(Assumes SI points to number, DI points to _SIGN field of
 the floating-point accumulator to store.)

(Set the sign field)
Set byte at [DI] based on high bit of byte at [SI];

Move the number into the accumulator;
Clear lowmost word of mantissa;
Clear highmost bit of exponent;
Shift mantissa right 1 bit;
RETURN;

STFAC1:
(Assumes DI register points to destination.)

Shift FAC1_MAN left 1 bit;
IF FAC1_SIGN = 0 THEN FAC1_EXP = FAC1_EXP AND 7FFFH;
ELSE
   FAC1_EXP = FAC1_EXP OR 8000H;
Move the number out of FAC1, exponent first, followd by
 the top 4 words of the mantissa; (Since FAC1_EXP and
 FAC1_MAN are contiguous, this uses an REP MOVSW
 instruction.)
RETURN;
```

Listing 2: *Inputting a floating-point number.*

```
FPINPUT:
 CH = NextCHAR;
 IF CH = '+' THEN FAC1_SIGN=0; ELSE FAC1_SIGN=128;
 DEC_EXP=0;
 FAC1_MAN=0;
 CH = NextCHAR;
 CALL ADDIGIT(CH);
 CH = NextCHAR; (Skip decimal point)
 REPEAT
  BEGIN
   CH = NextCHAR;
   IF CH is not a digit THEN GOTO FPI1;
   CALL ADDIGIT(CH);
   DEC_EXP=DEC_EXP-1;
  END
FPI1:
(The next line skips the "E" and reads the exponent sign.)
  CH = NextCHAR;
  IF CH = '+' THEN EXP_SIGN=0; ELSE EXP_SIGN=128;
  EXP_VAL=0;
  REPEAT
   BEGIN
    CH = NextCHAR;
    IF CH is not a digit THEN GOTO FPI2;
    EXP_VAL = 10 * EXP_VAL + VALUE(CH);
   END
 FPI2:
  IF EXP_SIGN = 0 THEN
     DEC_EXP = DEC_EXP + EXP_VAL;
  ELSE
     DEC_EXP = DEC_EXP - EXP_VAL;
  FAC1_EXP=BIAS+79;
  CALL NORM1;
  FAC2 = 10.0
  IF DEC_EXP > 0 THEN
   REPEAT DEC_EXP TIMES
     CALL FPMULT;
  IF DEC_EXP < 0 THEN
   REPEAT ABS(DEC_EXP) TIMES
     CALL FPDIV;
  RETURN;
```

continued

floating-point number that the package is capable of handling. I haven't built a great deal of flexibility into the input routine—it likes its strings just so—but I'll point out places where you should have no problem extending the software to handle freer entry formats. While I'm on the subject of formats, here's the format that my input routine expects:

```
sD.DDDDEsDDD<null>
```

where s is a sign (+ or −), D is a digit (0 to 9), `<null>` is the null character (ASCII 0), "." is a decimal point, and E is E (which signals that the exponent portion follows). If you've done any engineering or scientific programming, you'll feel right at home with this format. You can see that a number is written as the sign of the mantissa, followed by the mantissa, followed by E, followed by the sign of the exponent, followed by the exponent. As I mentioned before, my input routine is fairly inflexible, so none of this is optional. You must write 1 as +1.0E+0; 5000 as +5.0E+3; −.0045 as −4.5E−3; and so on.

Listing 2 shows the pseudocode for the input routine. `NextCHAR` is a fictitious function that returns the next character from the input string (in the actual code, the SI register points to the input string, so the `NextCHAR` function is actually a `LODSB` instruction). Once `FPINPUT` translates the sign of the mantissa, it simply grabs each mantissa digit from the input string and adds it into `FAC1`'s mantissa. (Like the other routines in the package, this routine returns with the inputted number stored in `FAC1`.) As each digit is added in, the routine treats `FAC1_MAN` not as a binary fraction but as a large binary integer. In effect, the routine ignores the decimal place; it remembers where it is by counting how many digits appear to the right of the decimal point. This value is kept in `DEC_EXP`.

Next, the routine reads the exponent sign and exponent value. This process is a miniature version of what's just gone on in the mantissa. For the exponent: Get a digit, multiply the accumulated exponent value by 10, add the new digit in, and repeat. Once the routine has successfully converted the ASCII exponent to binary, it adds that amount into `DEC_EXP`.

Now it's a cleanup job. The routine has all the numbers it needs. First, it normalizes the contents of `FAC1_MAN`. Notice the value loaded into `FAC1_EXP` prior to normalization to reflect the fact that the number in the mantissa is an integer—that is, that the binary point is to the right of the least significant bit. Then the rou-

```
ADDIGIT:
 CALL FAC1x10;
 FAC1_MAN = FAC1_MAN + VALUE(CH);
 RETURN;

FAC1x10:
(This routine multiplies FAC1's mantissa by 10 using
 the identity 10*x=8*x+2*x.)
 Shift FAC1_MAN left 1 bit;
 FAC3_MAN = FAC1_MAN;
 Shift FAC1_MAN left 2 bits;
 FAC1_MAN = FAC1_MAN + FAC3_MAN;
 RETURN;
```

tine loads a floating-point 10.0 into FAC2 and, depending on the sign of DEC_EXP, either multiplies or divides FAC1 repeatedly by 10.

You now have a binary floating-point number in FAC1.

My routine requires one digit to the left of the decimal point. Modifying the algorithm to accept any number of digits to the decimal point's left should be trivial. It would also be simple to recode things so that signs are not required; no sign would indicate an implied plus sign. Finally, you could have the routine assume a zero exponent if it encountered the end of the string before running into an E.

Outgoing

Once you've done all sorts of complicated floating-point calculations, you need a way to examine the results of your cipherings. You need the reverse of the input routine: something to convert a floating-point number to an ASCII character string (see listing 3).

The output algorithm works like this: Remember that the internal representation of the floating-point numbers is in base 2, so we need to somehow extract the base-10 exponent portion of the number. We already know the internal representation for 10.0 (we used that in our input routine), so we can perform a series of multiplications or divisions by 10 until the number falls somewhere between 1 and 16. You can tell when the number is in this range by watching the exponent (in this case, FAC1_EXP minus the bias amount), which tells you how many digit positions the binary point is from the number's most significant bit. For example, if FAC1_EXP = BIAS + 5, you know the number looks like *bbbbb.bbbbb*... (where *b* is a bit, 1 or 0). If FAC1_EXP = BIAS − 2, the number looks like this: 0.00*bbbbbbbbb*... (where the leftmost *b* is the most significant digit).

Each time the routine performs a multiplication (or a division) by 10, it increments (or decrements) DEC_EXP. In this way, the routine determines the number's base-10 exponent.

The routine's next step is to narrow the number's range even further by verifying that it is between 1 and 10. If the number is greater than 10 (it cannot be less than 1 because of what the routine has done to the number so far), FPOUTPUT does one more division by 10. Now the routine adjusts the number so that the binary point is between bits 75 and 76, and the top 4 bits of the number are its integer portion. And thanks to all the

continued

Listing 3: *Pseudocode for the floating-point output routine.*

```
FPOUTPUT:
 DEC_EXP=0;
 IF FAC1_EXP=0 THEN GOTO FOUT1;
 FAC2=10.0;

(Note: The comparisons in the following two WHILE
 statements treat FAC1 as a positive number.)
 WHILE FAC1 > 15
  BEGIN
   CALL FPDIV;
   DEC_EXP=DEC_EXP+1;
  END
 WHILE FAC1 < 1
  BEGIN
   CALL FPMULT;
   DEC_EXP=DEC_EXP-1;
  END

 IF FAC1>=10 THEN
  BEGIN
   CALL FPDIV;
   DEC_EXP=DEC_EXP+1;
  END

(Set binary point between bits 75 and 76.)
 IF FAC1_EXP=BIAS+4 THEN
  Shift FAC1_MAN left 1 bit;
 ELSE
  WHILE FAC1_EXP < BIAS+3
   BEGIN
    Shift FAC1_MAN right 1 bit;
    FAC1_EXP=FAC1_EXP+1;
   END

 ROUND FAC1_MAN;

FOUT1:
 IF FAC1_SIGN = 0 THEN OUTPUT('+');
 ELSE
    OUTPUT('-');
 CH = Leftmost nibble of FAC1_MAN;
 OUTPUT(ASCII(CH));
 OUTPUT('.');
 REPEAT N TIMES
   BEGIN
     Clear leftmost nibble of FAC1_MAN;
     CALL FAC1x10;
     CH = Leftmost nibble of FAC1_MAN;
     OUTPUT(ASCII(CH));
   END
 OUTPUT('E');
 IF DEC_EXP>=0 THEN OUTPUT('+');
 ELSE
    OUTPUT('-');
 OUTPUT(Integer_to_ASCII(ABS(DEC_EXP)));

 RETURN
```

multiplying and dividing by 10 that's gone on, we know that the integer portion of the number must be between 1 and 10—that is, a single decimal digit.

The rest of the job is a snap. Since you've isolated your first digit in the top 4 bits, you simply strip those bits out, convert binary to ASCII, and output the character. Then you multiply the mantissa by 10, strip the top 4 bits out again, and keep up the process until you have however many digits you need. (Warning: Do *not* use the package's FPMULT routine to do this multiplication, since FPMULT exits through the normalization routine, which would reset the binary point. Instead, you should use the fact that $10 \times x = 2 \times x + 8 \times x$ and implement the multiplication as a series of shifts and adds. Check out the pseudocode for routine FAC1 × 10.) The decimal exponent portion is waiting for you in DEC_EXP, so just output it using an integer-to-ASCII routine (the details of which I won't go over here, since there are plenty of sources for such algorithms), and you're all done.

The only thing I've glossed over is rounding (the pseudocode shows it as ROUND FAC1_MAN). There are various ways you can go about rounding the number for output; the choice depends on what sort of accuracy you're looking for. If you modify FPOUTPUT to be part of some formatted numeric output package, you'll have to add code to determine which digit to round on. This will depend on how many digits a particular calling routine requests to output. My math package's output routine simply adds 5×10^{-19} to the number in the mantissa since, as I said earlier, a 64-bit mantissa gives about 19 digits of accuracy. (It does this by adding 9393 hexadecimal to the least significant word of FAC1_MAN and rippling any carries on up the rest of the mantissa.)

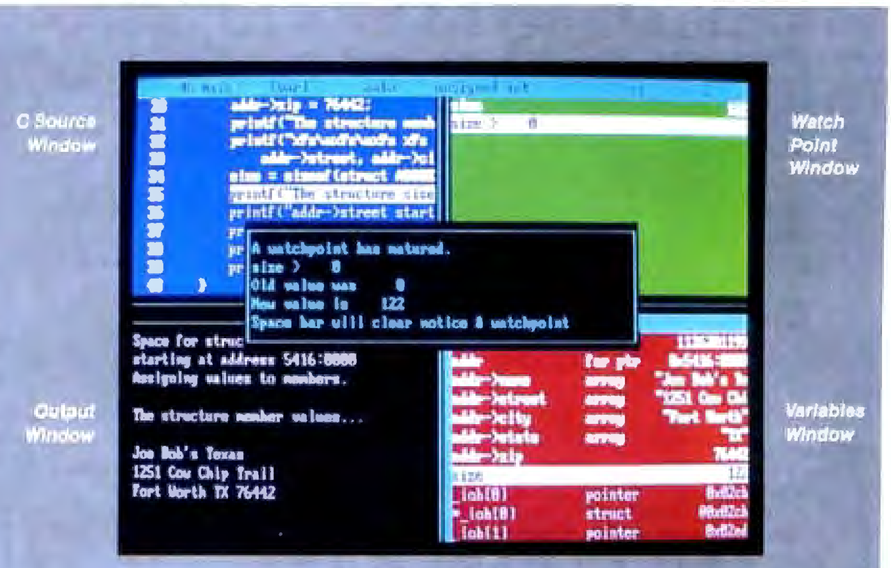
Left as an Exercise

Carnivorous floating-point addicts may want to extend the package even further. This is understandable; there are plenty of functions involving floating-point numbers that I haven't covered here. Some of the more esoteric are beyond what I have room to present. Other, more recognizable functions are quite easy to implement:

- *Integer-to-floating-point*: The clue to this is hidden in the floating-point input routine. First, you check the sign of the integer, store that in FAC1_SIGN, and, if it's negative, convert the integer to a positive number. You move the integer into FAC1_MAN—right-justified, so that the low word of the integer is in the rightmost word of FAC1_MAN. Then you load FAC1_EXP with the value BIAS+79 and call the normalization routine.
- *Floating-point-to-integer*: Load the number into FAC1 using LDFACC and examine FAC1_EXP. If FAC1_EXP is less than or equal to BIAS, forget it—the number has no integer part. Otherwise, FAC1_EXP − BIAS tells you how many bits, starting with bit 78 and moving to the right, are the integer portion. For example, if FAC1_EXP − BIAS = 5, then bits 78 through 74 form the integer (with bit 78 being most significant). Do a looping shift operation and a final check with FAC1_SIGN to see if you have to negate things, and you're there.
- *Floating-point comparisons*: Comparison operations—greater than, less than, equal to, and so on—are easily done using the floating-point subtract routine

continued

How to create high-performance programs without wasting your time or money



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(execution times in seconds)

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2) sieve	27.6	43.2	25.5
3) tdbl	3.5	9.0	9.6
4) diskio	13.5	14.4	14.3
5) report	11.0	71.7	60.7
6) drystone	36.6	41.6	31.8
Compile/Link	73.9	113.5	81.4
EXE File Size	25120	32092	27184
Compiler Price	$19.95	$99.00	$99.95
Debugger Price	$19.95	N/C	N/A
Library Source	$10.00	$150.00	$150.00
Total Cost	$49.90	$249.00	$249.95

N/C no charge - N/A not available
Benchmarks compiled using Make utility, command-line compiler and medium memory model

The Assembly Window

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(FPSUB) and checking the sign of the result.

Of course, there are other routines that are even simpler. To take the absolute value of a floating-point number, you simply clear the sign bit. To change a floating-point number's sign, you do an exclusive-OR operation on the sign bit. You can perform these functions without even moving the number into the accumulator.

Then there are the tough routines, such as trigonometric and transcendental functions. You can handle these by applying either interpolation to lookup tables (if you have lots of storage and you're looking for speed) or series expansion (which is best when storage is tight and you don't mind waiting a little for your answer). For example, the series expansion for sine(x) is as follows:

$$\text{sine}(x) = x - x^3/3! + x^5/5! - x^7/7! + x^9/9! \ldots$$

The infamous CRC (Chemical Rubber Company) Handbook of Standard Mathematical Tables, forever the sidekick of any university math, science, or engineering student and available in most college bookstores, will provide you with the series expansion for more functions than you can think of.

Finally, you can find more information on floating-point processing in the In Depth section of the March issue of BYTE.

Next Month

Dave Betz, author of XLISP, joins in for a discussion of embedded languages. ■

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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."

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

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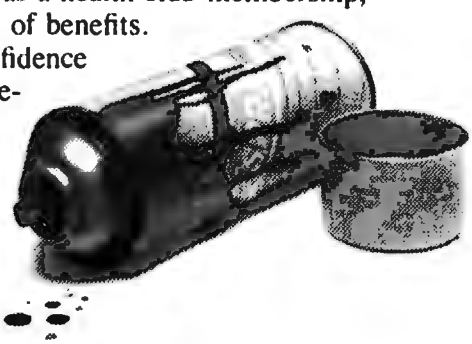

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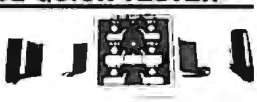

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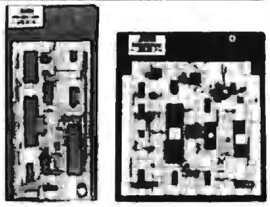

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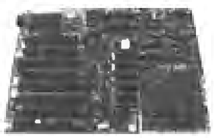

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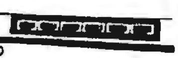

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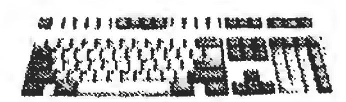

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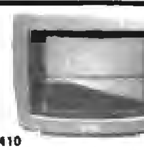

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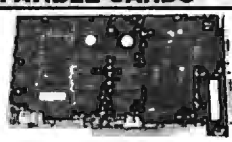

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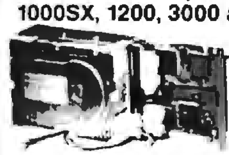

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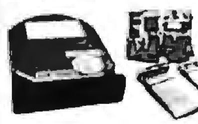

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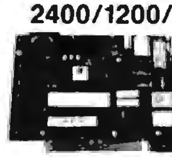

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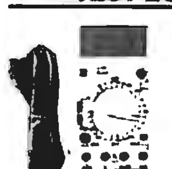

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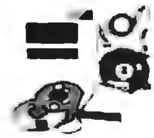

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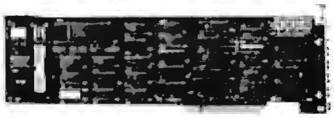

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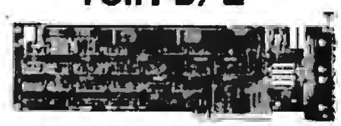

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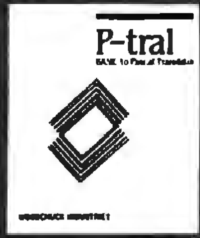

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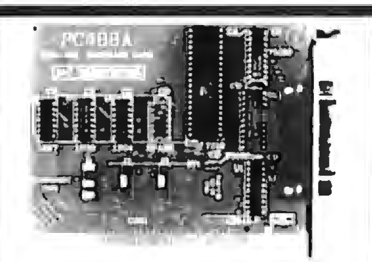

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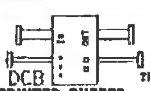

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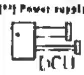

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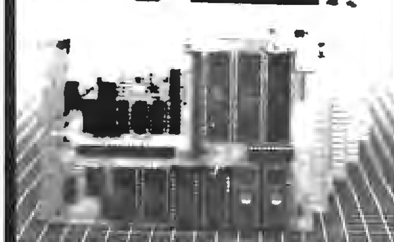

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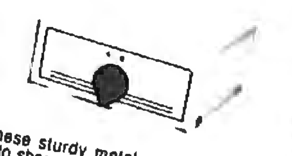

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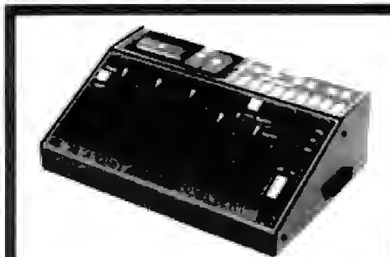

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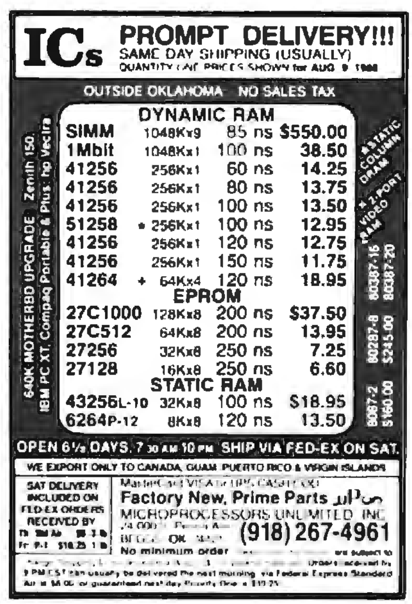

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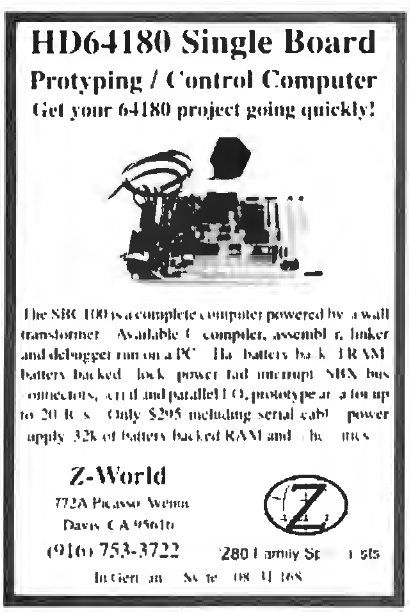

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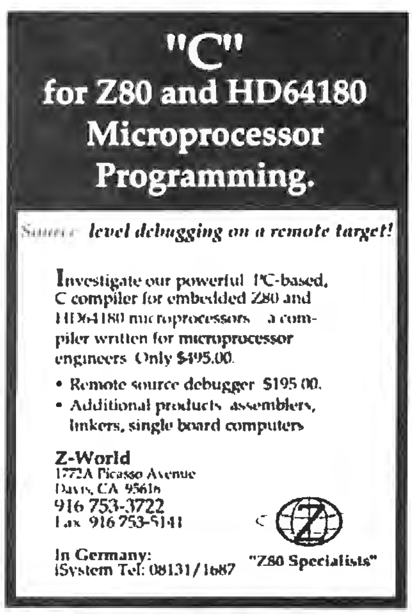

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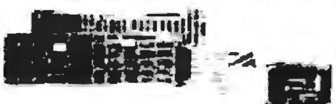

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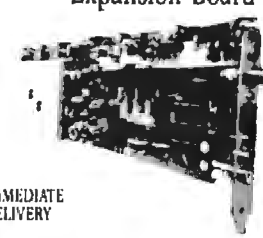

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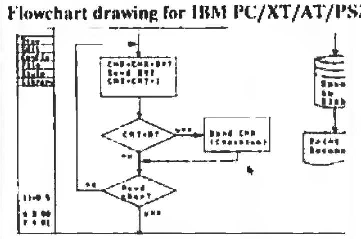

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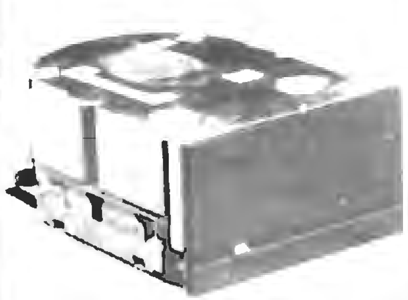

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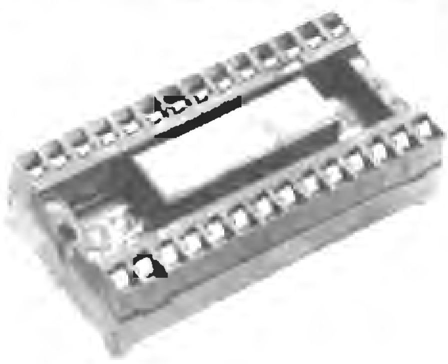

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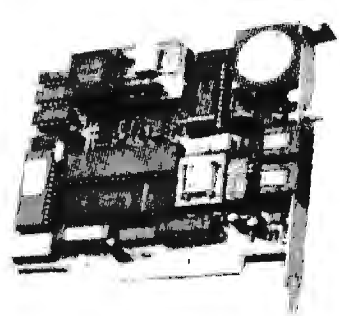

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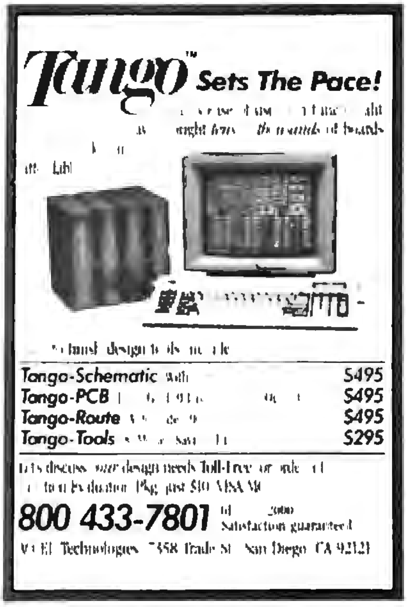

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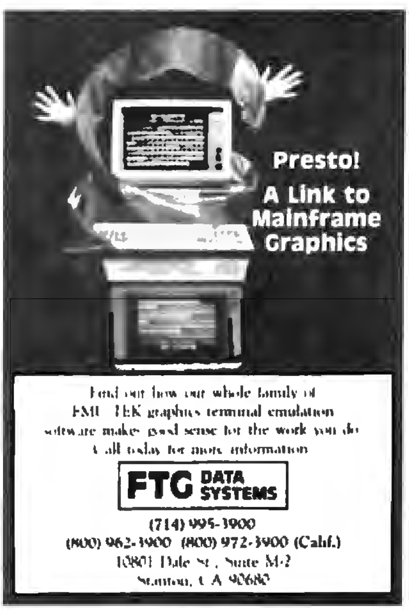

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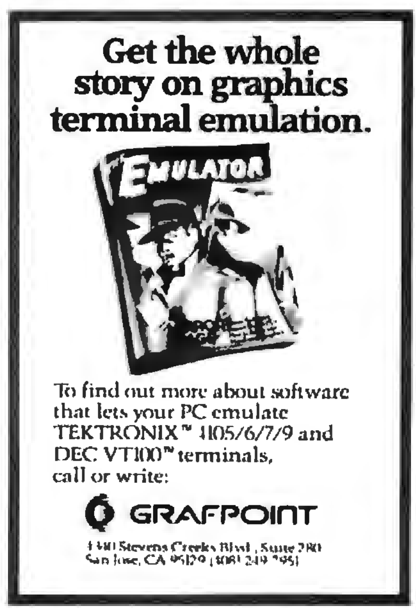

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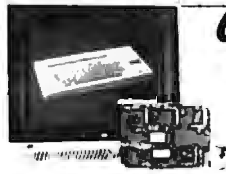

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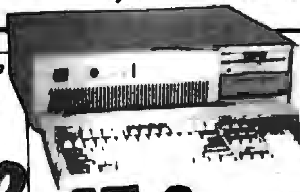

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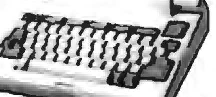
NEC/8500 Laptop

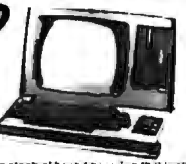
$319 ~~$995~~



The NEC PC/8500 laptop computer incorporates a 25 line liquid crystal display and modem that plugs directly into any RJ11 wall jack. An auto log on feature instructs the 8500 to phone the users host computer and automatically send password and log/on information. The computer also includes both serial and Centronics parallel ports packaged in this six pound laptop.
This is the ideal computer for Realtors, insurance people or any individual that requires immediate access to remote information. ROM based telecommunication software, spreadsheet and Wordstar also make the 8500 a great computer for students. Files can be transferred from this CP/M computer to any other including the IBM/PC.

Heath H/89 Computer

$179



Hard to believe... but we found a stash of brand new Zenith/Heath Model H/89 computers. These computers feature the Zilog Z-80 CPU and operate under CP/M. The unit incorporates a 12 inch green screen, three serial ports and one 5¼" disk drive.
Zenith's original price was $1895. We have 350 units available for sale. while supplies last we are offering the H/89 at only $179.
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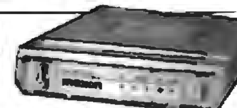

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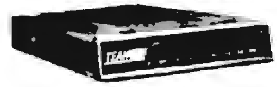
Manufactured by Maxon Systems, one of the Worlds largest producers of consumer electronics. Originally priced at $249. While supplies last California Digital is offering the MAX/2400 at only $119

Smarteam 2400



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The Smarteam 2400 offers all the features of the Hayes Smart Modem for a fraction of the price. Now is your opportunity to purchase a 2400 baud modem for only $239. **Also available:** The Miniteam 1200 ...

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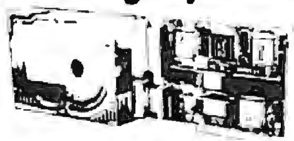
21 Megabyte Gold Card



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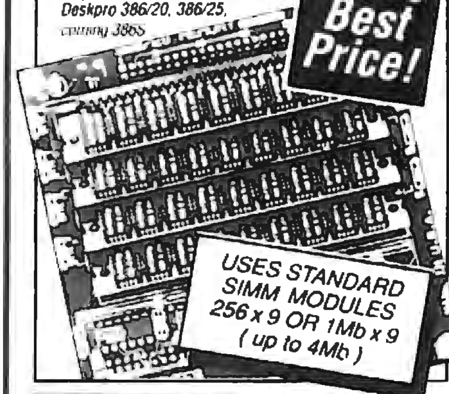

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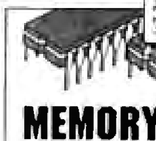

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74LS03	.18	74LS124	2.75	74LS244	.69
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74LS05	18	74LS126	39	74LS251	.49
74LS08	18	74LS132	39	74LS253	49
74LS09	.18	74LS133	49	74LS257	.39
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74HC14	35	74HC367	.69	74HCT161	79
74HC32	35	74HC373	69	74HCT240	89
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4015	.29	4044	69	4093	49
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4017	.49	4047	69	14433	14.95
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7407	29	74153	.55	74S10	29
7408	24	74154	1.49	74S32	.35
7410	19	74157	55	74S74	49
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7474	33	74F10	35	74S244	1.49
7475	.45	74F32	.35	74S280	1 95
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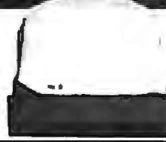

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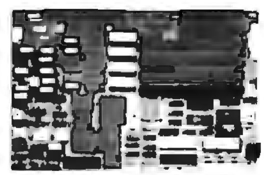

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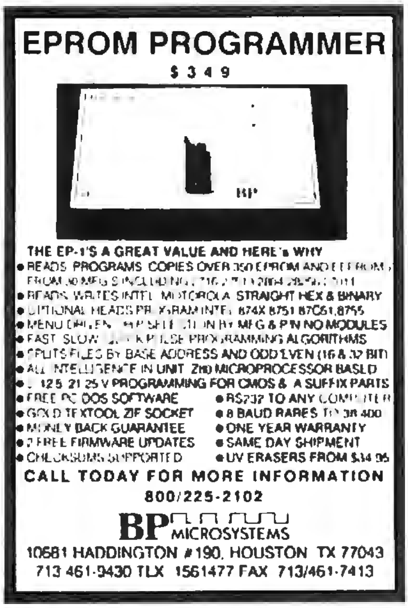

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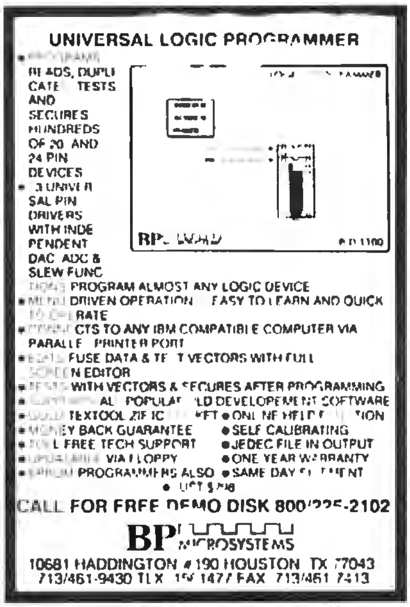

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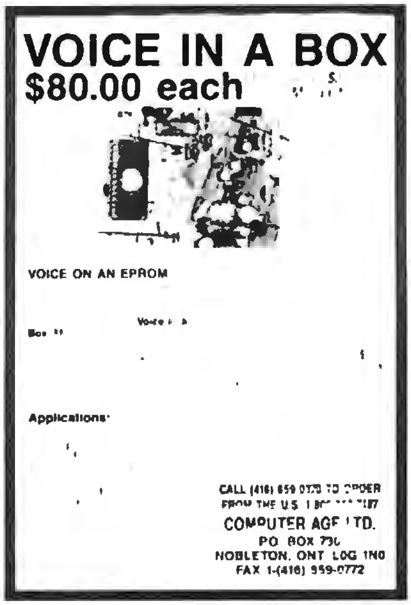

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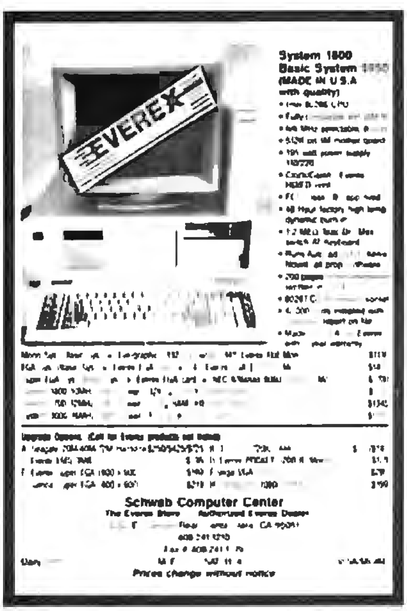

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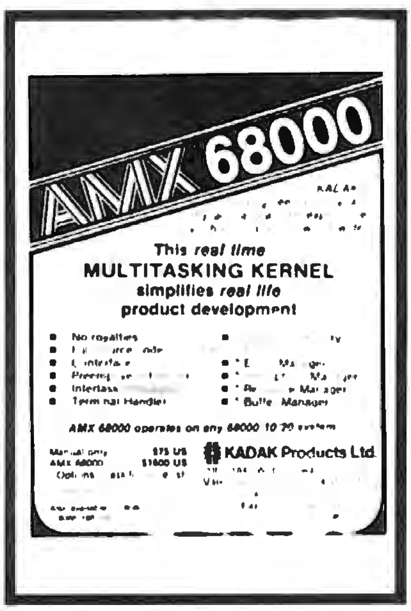

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Editorial Index by Company

Index of companies covered in articles, columns, or news stories in this issue
Each reference is to the first page of the article or section in which the company name appears

COMING UP IN BYTE

PRODUCTS IN PERSPECTIVE:

As we go to press for October, here is the tentative lineup of articles on tap for November. While last-minute changes or delays can always occur, the following are those pieces we plan to bring to you.

In the **front of the book**, as usual, will be the Microbytes, Nanobytes, and What's New sections, along with Short Takes—next month on new laptops, languages, utilities, applications, and peripherals. On top of everything else, we'll have our columns: Jerry Pournelle's Computing at Chaos Manor, Ezra Shapiro's Applications Plus, Wayne Rash Jr. and Down to Business, Don Crabb's Macinations, Brock N. Meeks with COM1:, and Mark Minasi's OS/2 Notebook.

The **Product Focus** for November will be project management software. These programs are designed to assist you in keeping track of multiple jobs, schedules, tasks—whatever. How well do they work, and how easy are they to work with? Can something be a help to you if it can't be integrated into the way you do your job? If you've ever wondered if these programs could make your life easier but balked at the price tag, our November Product Focus might be just what you need to help you make up your mind.

System reviews for November include Compaq's new 386s and ALR's new 386 FlexCache machine.

We'll have a **hardware review** on Transputer boards for both IBM PC–compatible and Macintosh computers.

In the software department, our **software reviews** will look at Zortech's C++ and Gimpel Software's PC-Lint.

For **application reviews**, we'll take a look at a hard disk drive utility program from Gibson Research called SpinRite, Ashton-Tate's FullWrite Professional 1.0 word processor, and a new communications program from Crosstalk Communications called Remote².

IN DEPTH:

Our In-Depth section will focus on **parallel processing**. We've lined up articles on an entire range of related topics—all intended to work together to provide a comprehensive look at an area that has so far been endowed with more potential than anything else. Where is parallel processing now? Is it always going to be one of those areas that look so good from a distance but up close just seem to dissolve? In November, you'll have a chance to answer these questions for yourself. Not only will we have pieces on new parallel processing chips, but also on programming languages specially designed to take advantage of parallel processing technology. Things may be starting to take on a definite shape.

FEATURES:

We'll have articles detailing a new chip, **Rekursiv**; a method for performing **multiple regression analysis with Excel**; Part 2 of a piece on **PC power**, this time on backup; **Ciarcia's Circuit Cellar** covers the second part of his project on a supercomputer; in **Some Assembly Required**, David Betz talks about a new extendable, embedded language.

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Tel: (11) 259-3811
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READER SERVICE

To get further information on the products advertised in BYTE, fill out the reader service card by circling the numbers on the card that correspond to the inquiry number listed with the advertiser. This index is provided as an additional service by the publisher, who assumes no liability for errors or omissions.

* Correspond directly with company

Index to Advertisers by Product Category

READER SERVICE

Advertising Supplement included with this issue:
JDR Microdevices (U.S. and Canada Subscribers)

* Correspond directly with company.

	1985	1986	1987	1988
Jan.	$4.00			$6.00
Feb.	$4.00	$6.00	$6.00	
March	$4.00		$6.00	$6.00
April	$4.00		$6.00	
May	$4.00		$6.00	$6.00
June	$4.00	$6.00	$6.00	$6.00
July		$6.00	$6.00	$6.00
Aug.	$4.00	$6.00	$6.00	$6.00
Sept.	$4.00	$6.00	$6.00	
Oct.	$4.00			
Nov.	$4.00			
Dec.	$4.00	$6.00		

BACK ISSUES FOR SALE

SPECIAL ISSUES and INDEX	
BYTE '83–'84 INDEX	$2.00
BYTE 1985 INDEX	$2.50
BYTE 1986 INDEX	$2.00
BYTE 1987 INDEX	$2.50
1985 INSIDE THE IBM PCs	$4.75
1986 INSIDE THE IBM PCs	$5.00
APPLICATIONS SOFTWARE TODAY SPECIAL	$4.00

Circle and send requests with payments to:

BYTE Back Issues
One Phoenix Mill Lane
Peterborough, NH 03458
(603) 924-9281

[ ] Check enclosed *Payments from foreign countries must be made in US funds payable at a US bank.*

☐ VISA ☐ MasterCard

CARD # ______________________ EXP. DATE ______________

SIGNATURE ______________________

The above prices include postage in the US. Please add $ .50 per copy for Canada and Mexico; and $2.00 per copy to foreign countries (surface delivery). Please allow 4 weeks for domestic delivery and 12 weeks for foreign delivery.

European customers please refer to Back Issue order form in International Advertising section of book.

NAME ______________________

ADDRESS ______________________

CITY ______________________ STATE ____________ ZIP ____________

TIPS

SUBSCRIBERS ONLY!*

Use BYTE's Telephone Inquiry Processing System

Using TIPS can bring product information as much as 10 days earlier.

SEND FOR YOUR SUBSCRIBER I.D. CARD

1) If you are a new subscriber or have lost your I.D. card, circle #1 on the Reader Service Card; **attach mailer label**. We will immediately send your personal TIPS subscriber card.

GET PREPARED

2) Write your Subscriber Number, as printed on your Subscriber I.D. Card, in boxes in Step 5 below. (Do not add 0's to fill in blank boxes)

3) Write numbers for information desired in boxes in Step 7b below. (Do not add 0's to fill in blank boxes.)

CALL TIPS

4) Now, on a Touch-Tone telephone dial: (413) 442-2668 and wait for voice commands.

ENTER YOUR SUBSCRIBER AND ISSUE NUMBERS

5) When TIPS says: "Enter Subscriber Number"
(Enter by pushing the numbers and symbols [# or * enclosed in the boxes] on telephone pad ignoring blank boxes)
Enter ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ # #

6) When TIPS says "Enter magazine code & issue code"
Enter 1 # 1 0 8 # #

ENTER YOUR INQUIRIES

7a) When TIPS says "Enter (next) Inquiry Number"
Enter one inquiry selection from below (ignore blank boxes)

b) Repeat 7a as needed (maximum 17 inquiry numbers)

1. ☐ ☐ ☐ # # 6. ☐ ☐ ☐ # # 10. ☐ ☐ ☐ # # 14. ☐ ☐ ☐ # #
2. ☐ ☐ ☐ # # 7. ☐ ☐ ☐ # # 11. ☐ ☐ ☐ # # 15. ☐ ☐ ☐ # #
3. ☐ ☐ ☐ # # 8. ☐ ☐ ☐ # # 12. ☐ ☐ ☐ # # 16. ☐ ☐ ☐ # #
4. ☐ ☐ ☐ # # 9. ☐ ☐ ☐ # # 13. ☐ ☐ ☐ # # 17. ☐ ☐ ☐ # #
5. ☐ ☐ ☐ # #

END SESSION

8) End session by entering * * 9 1 # #

9) Hang up after hearing final message
If you are a subscriber and need assistance, call (603) 924-9281.

Available 24 Hours, 7 Days a Week

If you are not a subscriber fill out the subscription card found in this issue or, call BYTE Circulation 800-423-8272.
*Domestic and Canadian Subscribers Only!

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To assist you in making your evaluations, purchasing decisions, or recommendations, you can request further information directly from the manufacturer or service company on products and services advertised in this issue. There is no charge, no obligation. Just complete and mail the attached post-paid, self-addressed reply card, and we'll do the rest.

1. Circle numbers on reply card which correspond to numbers assigned to items of interest to you.
2. Check all the appropriate answers to questions "A" through "F".
3. Print your name and address and mail.

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS MAIL PERMIT NO. 176 DALTON, MA

POSTAGE WILL BE PAID BY ADDRESSEE

BYTE
READER SERVICE
PO Box 298
Dalton, MA 01227-0298
USA

Fill out this coupon carefully. PLEASE PRINT. Requests cannot be honored unless the zip code is included. This card is valid for 6 months from cover date.

A. What is your primary job function? (Check one only)
1 ☐ Business Owner, General Management, Administrative
2 ☐ MIS/DP, Programming
3 ☐ Engineering/Scientific, R&D
4 ☐ Professional (law, medicine, accounting)
5 ☐ Other

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
2 ☐ Business use for your company
3 ☐ Personal use

D. Your next step after information is received:
1 ☐ Purchase order
2 ☐ Evaluation
3 ☐ Specification/Recommendation

E. Please indicate the product categories for which you influence the selection or purchase at your (or your client's) company or organization. (Check all that apply).
1 ☐ Microcomputers
2 ☐ Peripherals
3 ☐ Software
4 ☐ Accessories and supplies

F. For how many microcomputers do you influence the purchase of products at your (or your client's) company or organization?
1 ☐ 1 3 ☐ 5–9
2 ☐ 2–4 4 ☐ 10 or more

Name ______________________
Title ______________________
Company ______________________
Address ______________________
City ______________ *State* ______________
Zip ______________ *Telephone* ______________

OCTOBER 48ARSU

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946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972
973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999

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3 Print your name and address and mail.

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1 ☐ Business Owner, General Management, Administrative
2 ☐ MIS/DP, Programming
3 ☐ Engineering/Scientific, R&D
4 ☐ Professional (law, medicine, accounting)
5 ☐ Other

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1 ☐ 25 or fewer
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3 ☐ 5–9
4 ☐ 10 or more

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ____________ *State* ____________

Zip ____________ *Telephone* ____________

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622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648
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676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702
703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729
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757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783
784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810
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946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972
973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999

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